Analogy in morphological change:
The diachronic treatment of irregularity in Greek



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Abstract

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This thesis focusses on the tendencies of morphological change, as a source of evidence for how linguistic knowledge is stored and structured in the mind, and how speakers access and use this knowledge. I empirically test various hypotheses that morphological change is directed towards the optimisation of synchronic grammar. In chapter 4, I test the common claim that diachrony is guided by a universal preference for one-to-one mapping of meaning and form in language, implemented via Universal Grammar, and in chapter 5, I consider the diachronic implications of a set of claims by Carstairs-McCarthy (1998), that the degree to which synchronic systems of inflectional morphology deviate from this ideal meaning-form relationship is limited by a set of constraints on the acquisition of lexical semantics. I test the predictions made by these teleological theories against systematic data from synchronic verbal paradigms in classical Greek, and their subsequent diachronic restructuring, and show that the theories are not supported by this evidence. On the other hand, using the same data, I demonstrate two important factors influencing morphological change: the type frequency of formal patterns of implication between paradigm cells (chapter 4), and the token frequency of inflected words (chapter 6). I argue that this is best understood if we view diachronic tendencies as by-products of language use, and I make a case for a synchronic theory of morphology in which words are the fundamental stored units of language, and analogy is a psychologically real mechanism of both synchronic productivity and change.

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Chapter 0: Preface

The tendencies of language change are a rich and relatively untapped source of evidence for questions of how linguistic knowledge is stored and structured in the mind, and how speakers access and use this knowledge. In this thesis I will test a number of potential factors which have been claimed to influence morphological change, using systematic empirical data from the history of Greek verbal paradigms. On the evidence of this data, I will argue against teleological accounts which attribute diachronic tendencies to the optimisation of synchronic grammar. On the other hand, I will show that both type and token frequency are important factors influencing morphological change, supporting an analysis of diachronic tendencies as by-products of language use. I will argue that is strong evidence in favour of a synchronic theory of morphology in which words are the fundamental stored units of language, and analogy is a psychologically real mechanism of both synchronic productivity and change.

The thesis is divided into two parts: part one (ch. 1-3) provides context for the data-driven studies of part two (ch. 4-7). In chapter 1, I give an account of the history of analogy as a concept, and explain why further research into analogy is still needed. This will include a critical review of existing work on the tendencies of morphological change, and explain how this thesis will attempt to improve on this work. I will also describe the data on which the thesis is based, and how I have dealt with various methodological issues which arose in collecting and processing the data.

In chapter 2 I will provide a synchronic overview of Greek verbal morphology, from the perspective of paradigm structure, with particular attention to autonomously morphological phenomena such as suppletion,

inflection class, and morphomic patterns of distribution. In doing so, I will explain and justify the descriptive framework I have used in my data collection and analysis. Chapter 3 will give a diachronic overview of how the synchronic system described in chapter 2 developed out of Proto-Indo-European, and how it subsequently evolved into the modern Greek verb, to illustrate the long-term context of the changes which will be the focus of chapters 4-6.

In part 2, I present the findings of my research. In chapter 4, I will consider the claim that analogical levelling is motivated by a preference for one-to-one alignment of form and meaning in language ('Humboldt's universal'), implemented via Universal Grammar. I will test this hypothesis by comparing the synchronic paradigms of a population of verbs with irregular and suppletive lexical allomorphy against a diachronic dataset of subsequent examples of analogical levelling in the paradigms of the same verbs. I will demonstrate a strong correlation between the type frequency of invariant phonological expression of the lexical morpheme in any given subset of paradigm cells, and the probability of allomorphy in that subset of cells being eliminated diachronically, and argue that this renders an explicit UG constraint theoretically superfluous.

In chapter 5, I will consider a set of claims by Carstairs-McCarthy (1998) that the degree to which languages deviate from Humboldt's universal is limited by universal constraints on the distribution of allomorphy within paradigms, derived from broader constraints on the acquisition of lexical semantics. I will test the predictions made by these constraints for both the synchronic distribution of affixal allomorphy in Greek, and its subsequent diachronic redistribution. Although the synchronic system already violates

these constraints to a very large extent, diachrony regularly increases the degree of violation, ruling out the possibility that they influence morphological change.

In chapter 6, on the other hand, I will demonstrate that token frequency is a strong predictor of some of the diachronic data from chapter 5. Here I will outline a precise algorithm which mirrors our intuitive ability to solve an analogical proportion of the form $a : b = c : x$. Using an implementation of this algorithm, I will develop a computational procedure for generating the full set of possible changes involving the diachronic redistribution of a set of aorist active suffixes, which can be represented as analogical proportions. I will show that the viability of a proportion (i.e. its probability of generating a form for x which is attested in the history of Greek) is well predicted by the relative token frequency of the person/number value for a and c (the 'base'), and the complement of the same value for b and x (the 'target'), while the probability of each unique value for x being attested in the historical record is a function of the viability of each of the proportions which generated it.

Finally, in chapter 7, I will summarise both my empirical findings and theoretical conclusions, and suggest profitable directions for further research.

Chapter 1: Analogy

The term 'analogy' in historical linguistics is used as an umbrella term for a ragbag of diachronic phenomena, all of which have the effect of making some part of a language more similar to a model elsewhere in the same language. Most often, 'analogy' refers to proportional analogy, where a formal relationship between two words or expressions *a* and *b* is extended to *c* and *x*, where the same semantic relationship is thought to apply, generating a novel expression *x*. Thus the formal relationship between *sister* and its plural counterpart *sisters* was extended to *brother*, generating novel *brothers* for earlier *brethren.* This conception of analogy has been fundamental to historical linguistics since at least the 19th century, when it was first incorporated into a systematic theory of language change by the Neogrammarians.[1] Despite its indispensability, there has been continuous controversy ever since about its true nature. Indeed, some have doubted whether the label 'analogy' picks out any real and coherent phenomenon at all.

The purpose of this thesis is to bring some systematic empirical data to bear on a number of related questions about analogy in morphological change. A better understanding of analogy is urgently needed to solve certain methodological problems in historical linguistics. Furthermore, because language change ultimately originates in mistakes made in performance,[2] the

[1] Morpurgo Davies (1998).

[2] I do not mean to imply that there is a direct link between errors on the part of individual speakers and language change. Rather, sufficiently systematic errors may become synchronic variants, which in turn have the potential to spread (via well documented sociolinguistic mechanisms, e.g. Labov 2001) and may eventually replace competitors. The factors influencing the probability of a variant coming into existence are theoretically separate from factors influencing the sociolinguistic spread of an existing variant, although they may overlap. Whether such errors result from anomalous grammar acquisition during childhood (e.g. Kiparsky 1970, 1974c), or erroneous projections of 'correct' grammars by adult speakers (Hooper 1976, 1979, Bybee 2010: 6.6), is a separate question (see section 1.5.1 of this chapter).

tendencies of analogical change have the potential to shed light on the nature of our language ability.

This introductory chapter will start with an account of the development of the concept of analogy, from the early Greek grammarians to the present day. This will include a selective review of relevant theoretical literature, and explain how this thesis will attempt to improve on some of its shortcomings. In section 2 I will explain the data on which the thesis is based, and in section 3 I will discuss methodological issues surrounding the collection and analysis of this data. Finally, in section 4, I will list the specific research questions which each chapter will address.

1. THE HISTORY OF ANALOGY

1.1. Analogia and the Greek grammarians

The Greek *analogía* was primarily a mathematical expression meaning 'proportion'. Its life as a linguistic term started with the Alexandrian grammarians, who conceived of analogy as the principle of regularity underlying language, or at least correct language.[3] Like words were expected to behave alike. Thus Latin *marmoreus* 'marble' (adj.) was preferable to *marmorale*,[4] because *marmor* 'marble' was like *ebur* 'ivory', and *ebur* had the adjectival counterpart *ebureus*. Rule-governed language was preferable to

[3] Much has been made of a dispute between the Alexandrian grammarians and the Pergamene school of Crates of Mallus, who is supposed to have championed anomaly, rather than analogy, as the dominant principle in language. This alleged dispute has been shown by Fehling (1956) to depend solely on a single passage from Varro (*de Lingua Latina* 8-10), who in turn may have misinterpreted an argument from Sextus Empiricus against the analogists' claim that there is a standard of correct language independent of use, which can be discovered by analogy. Sextus criticised the analogists' method for its circularity, and deemed it incapable of yielding true scientific knowledge (Blank 1982, 1994).
[4] Charisius, *Ars grammatica* 93.10.

lawless language, and where language deviated from reason it was thought to be mistaken. Analogy also served as a practical tool in editing, to predict a morphological form by reference to another paradigm: for example, Aristarchus corrected Greek *pseúdessi* 'deceitful' (dat. pl.) to *pseudéssi* in *Iliad* IV.235 by analogy with *saphéssi* 'clear (dat. pl.).

Although the concept of analogy chiefly applied to morphology, it was also thought to be behind syntactical regularity. For Apollonius Dyscolus, only an analogical theory of syntax could explain rather than merely describe: "some people will think they can preserve correct syntax even if they do not grasp the reason behind it. They will experience something similar to those people who learn the forms of words just from experience, but not from the explanatory power of the proven usage of the Greeks and the analogy which follows from it… just as the collected research on Hellenism is extremely useful, serving to correct readings in poetry and everyday language as well and even judging the imposition of words by the ancients, in the same way the present investigation of syntactical regularity will correct what sorts of mistake occur in discourse."[5]

Where even correct language appears to deviate from the rule, this must be accounted for. Apollonius' explanations are semantic: for example, most transitive verbs in Greek govern the accusative case, but verbs of sensation tend to take the genitive. This, we are told, is because the speaker is not purely an actor, but his body is also affected by external objects which it cannot help but perceive, and the genitive is associated with passivity because it is governed by *hupó* 'by' in passive constructions.[6]

[5] *De syntaxi* 51.1 = 1.60, translated in Blank (1994: 159).
[6] *Ibid*., p. 161.

Analogy was later inherited by the Latin grammatical tradition, various glosses of the Greek ἀναλογία being used in addition to *analogia*, such as *proportio*, *regula* and *ratio*.[7] From the Latin grammarians the term was passed on to medieval scholars, and eventually, to modern linguistics.

1.2. The 'old grammarians'

The above paragraphs may seem irrelevant to a discussion of analogy in our sense of the word; although *analogía* is the etymological source of *analogy*, it denotes a quite different concept. Most importantly, the Greeks did not conceive of analogy as a historical process. But the historical background helps to clarify the way the term is used in the early days of historical linguistics. Analogy was recognised as a cause of language change,[8] but was called '*falsche Analogie*'[9] because it was the result of seeing regularity where none really existed. For Schleicher and his contemporaries, this could only take place in decaying languages; Classical languages like Sanskrit and Greek possessed perfect morphological clarity, so that the rules underlying the forms could be readily apprehended, and it was impossible for speakers to make the kind of mistakes which resulted in analogical change. A commitment to this belief meant that data like Greek *eimi*, Sanskrit *asmi* ('I am'), but Greek *pher**ō***, Sanskrit *bharā**mi*** ('I bear') had to be regarded as inexplicable exceptions to otherwise regular sound correspondences.

[7] Schironi (2007).
[8] E.g. by Raumer (1856), who mentions analogy as a type of sound change, as an afterthought to a list of the major causes of change, such as ease of pronunciation, and imperfect transmission of language between generations.
[9] Falsche Analogie was one term among many: Analogiebildung, Formübertragung, Parallelbildung, Association, Contamination, Ausgleichung, etc.

1.3. The neogrammarians

Scherer (1868) was the first to reject explicitly the Schleicherian paradigm of a prehistoric period in which language was created, followed by a process of deterioration. He reasoned that the processes observable in contemporary language change must have also been at work in antiquity, because the nature of language – and thus language change – was dependent on human nature, which was constant. Meanwhile, the groundwork for the neogrammarian hypothesis was being laid. Grassman's law (1863) and Verner's law (1875) finally accounted for all the exceptions to Grimm's notoriously irregular sound shift, and the possibility of stating sound laws in absolute terms was starting to seem an achievable goal. Scherer's 'uniformitarian hypothesis' and the doctrine of regular and exceptionless sound change were interdependent: without analogy to account for apparent exceptions to sound laws the regularity hypothesis would have been untenable, and without the need to account for apparent exceptions to sound laws, there would have been no impetus to develop and refine the concept of analogy.

By 1876, Leskien was able to state confidently that sound laws admit no exceptions. The same publication also gives an early account of the neogrammarian sound change/analogy dichotomy.[10] This was developed by Brugmann (1876), who in his celebrated article on the Indo-European *nasalis sonans* echoes Scherer's argument for the uniformitarian hypothesis: analogy must always have existed, because it is part of human psychology.[11] This is part of a generally psychological characterisation of analogy, which is said

[10] Leskien (1876: 2).
[11] Brugmann (1876: 317 ff.).

not to be the result of sound change, but of cross-contamination from related forms in the speaker's mind during speech.

Brugmann and Osthoff's preface to the first volume of *Morphologische Untersuchungen auf dem Gebiete der indogermanischen Sprachen* (1878) sets out the neogrammarian manifesto in a crystallised form. The most important principles are the exceptionless nature of sound change (taken from Leskien) and the uniformitarian hypothesis (taken from Scherer). The uniformitarian principle was again justified in terms of the new psychologism: "just as certainly as our Indo-European ancestors, like us, needed lips, tongues, teeth etc. for the physical production of linguistic sound, we can also be certain that the psychological side of their speech production – the emergence of sound images from a state of unconsciousness, and the development of sound-concepts into words and sentences – was affected by the association of ideas [i.e. analogy], just as it is today, and will continue to be as long as people are people.". [12,13]

[12] Bruggman and Osthoff (1878: xvi). This and all subsequent translations are my own, unless otherwise indicated.

[13] This psychological characterisation of analogy is often contrasted with a physiological conception of sound change, particularly because of the use of the word 'mechanical' in relation to sound laws, which attracted significant criticism from contemporaries who charged the neogrammarians with inappropriately treating language as a physical entity and neglecting its psychological aspect (Jankowsky 1972: ch. 5). The opposition between psychological analogy and physiological sound change works on one level, as sound change can (according to the neogrammarians) only be conditioned by phonetic environment, whereas analogy is conditioned by meaning. Even in their *Vorwort*, however, Brugmann and Osthoff recognise the psychological nature of sound change as well as analogy: "even the most ordinary sound changes, such as the change of *nb* to *mb*, or *bn* to *mn*, or the metathesis of *ar* to *ra*, are incomprehensible if one takes into account only the physical production of sounds. In addition, there needs to be a science which makes full observations of the psychological factors which operate in countless sound changes and innovations, as well as in all so-called analogical formations" (Brugmann and Osthoff 1878: iv). It seems therefore that the word 'mechanisch' was generally intended metaphorically rather than literally (except perhaps by Osthoff – see Morpurgo Davies 1998: 9.3), and after the first few neogrammarian publications it was dropped. The regularity of sound change was not supposed to follow inherently from its mechanistic nature; rather, regularity was independently justified on empirical grounds, and the term 'mechanistic' was used figuratively to reflect this regularity (e.g. Brugmann and Osthoff 1878: viii-ix).

1.3.1. Objections to the neogrammarian conception of analogy

The idea that analogy took place in all stages of language met with violent opposition from some outside the neogrammarians' circle, such as Curtius, who declared "it seems to me entirely implausible that languages even in the earliest period altered their forms, which were only just created and fresh and lively in thought, and that they should be subject to change" (1885: 66-7).

A more substantive objection to the neogrammarian doctrine would be that if analogy can be used to dismiss any apparent exception to a sound-law, historical reconstructions become unfalsifiable. Osthoff and Brugmann's preface preempts these criticisms to some extent. Analogy should not be invoked arbitrarily: it is an '*ultimum refugium*' to be used only when the sound-laws demand it. They defend analogy against the charge of arbitrariness, contending that the use of analogy allows us to have a much more concrete theory of sound change: "(there) are numerous other cases, where we have recourse to our principle [of analogy], while others artibrarily stretch and bend the sound laws, so as not to let the speakers [of ancient languages] be bad grammarians who did not know their forms and paradigms properly" (xvii); "we are convinced that even the most daring assumption of analogy, as long as it is in the realms of possibility, still demands more credence than arbitrary evasions of the mechanical sound-laws" (xvii-xviii). They stress that the concept of analogy is in its infancy, and further inquiry needs to be made into the principles governing it, taking account of evidence from contemporary language:

> "It was not long ago that the principle of analogy began to be established. Therefore, it is very likely – certain, in fact – that mistakes have been made here and there in assuming analogy has taken place. But it is also very likely that more general principles will gradually be found to account for the diverse tendencies of analogy, especially when the modern languages have been investigated more thoroughly with regard to their analogical formations. In this way a scale of the probability of analogy can also be gradually established. Meanwhile, the most important thing is to learn from modern language developments, keeping an open mind, and to apply the findings conscientiously to the older stages of a language."[14]

1.3.2. Analogy as productivity

A year before the publication of Brugmann and Osthoff's manifesto, in a preface to an article on the vocalism of German suffixes,[15] Hermann Paul had proposed analogy as the fundamental factor in language production. He hypothesised that the speaker could only learn a certain number of words and forms, so he continuously creates new forms on the basis of those he has learnt. Thus analogy is responsible for recreating 'correct' forms as well as innovations. This provides a stronger basis for the uniformitarian principle, as it makes analogy necessary to the existence of language itself. Paul's argument was motivated by a commitment to words as the fundamental units of language: he opposed the morphological segmentation of words,

[14] Brugmann and Osthoff (1878: xviii).
[15] Paul (1877).

which comparativists did on the model of the Indian grammarians, as an abstraction which had no basis in psychological reality. Paul's theory, repeated in successive publications of his *Principien der Sprachgeschichte*[16] concerned morphology rather than syntax, which is hardly mentioned.[17] Steinthal had given a similar account of syntactic productivity in an 1860 article,[18] which was referred to in Brugmann and Osthoff (1978): "The sentence is a string of words. This string is ready-made and given only for the hearer and reader; for the speaker himself, it is something being created… Sentences do not lie waiting in our thoughts, like words, so that one simply has to remember them. The mechanism of the soul does not only have to reproduce, but to produce; from recollected words new strings – sentences – are built". Brugmann (1885) echoed Paul's characterisation of analogy as the creative force in language: "analogy is today no longer the utterly destructive driving force with no purpose other than to interfere with the straight course of the phonetic development of languages, but… an eminently important factor in the process of both learning and speaking the language".

1.3.3. Analogical proportions and non-proportional analogy

Analogical proportions of the form $a : b = c : x$ – where x represents a new form being created on the basis of a real or perceived relationship between a and b, which is thought also to hold between c and x – were a later addition to the neogrammarian canon. Although the proportion is chiefly associated with Paul (and still sometimes referred to as 'Paul's proportion'), it was first

[16] Paul (1880), (1886). A further edition in 1898 did not differ much from the second edition.
[17] This is surprising, since if analogy is responsible for linguistic creativity we would expect it to be most visible at the level of syntax (Morpurgo Davies 1978).
[18] Steinthal (1860: 142).

suggested by Louis Havet in the preface to his translation of a book on Latin inflection in 1875.[19] It is not clear whether Paul was influenced by Havet's book, or if he came up with proportions independently. Either way, proportions soon turned up again in Paul's *Principien* (1880) (his 1877 article had talked about analogy in vague terms, as remodelling due to influence between 'associative groups' of words). For both linguists, who shared the age's antipathy to morphological segmentation, proportions were a convenient model of morphological extension which made no reference to the morpheme. Paul was responsible for the first attempts to constrain proportional analogy: in a four-part analogy of the type $a : b = c : x$, there had to be a parallel agreement in the 'material element' between a and b, and c and x, and a parallel agreement in the 'formal element' between a and c, and b and x (Paul 1886)[20]. Thus in the proportions below, (1) is acceptable because Latin *servus* and *servum* share a common segment [serw-], which is parallel to the segment [corp-] in *corpus* and *corpum*, and because *servus* and *corpus* share the common element [-us], parallel to the common segment [-um] in *servum* and *corpum*.[21] (2) is not acceptable as a proportion, because there is no common formal element on the vertical axis between Greek *oînos* and *neanías*, although both items are masculine singular nominatives.

[19] Havet (1875).
[20] Paul does not explicitly define these terms, but the context implies that the 'material' element essentially equates to the lexical morph, and the 'formal' element to the grammatical morph.
[21] This parallelism is presumably to be understood in terms of meaning/function, although Paul does not make this explicit.

(1) *servus* : *servum*

'slave' nom. sg acc. sg

= *corpus* : *corpum* ⟵ *corpus* (nom-acc. sg)

'body', nom-acc. sg acc. sg

(2) *oînos* [oin-os] : *oínou* [oin-ō]

'wine' nom. sg gen. sg

= *neanías* [neani-ās] : *neaníou* [neani-ō] ⟵ *neaníao* [neani-āo] (m. gen. sg)

'youth' nom. sg. gen. sg

Nonetheless, changes of the latter type do in fact take place (including this specific example), posing an obvious difficulty for Paul. One solution to these uncooperative examples is to make them proportional by allowing the stem to appear in the proportion: *oîn-* : *oínou* = *neaní-* : *neaníou*. This was the approach of Osthoff in an 1879 article on the nominal inflection of the Indo-European languages,[22] in which he makes a distinction between proportional analogy and 'Formübertragung' – mere redistribution of affixes – contrasting the two alternative 3sg passive subjunctive forms *rhēgnúētai* 'shatter' and *rhḗgnūtai*. The former has simply taken on the ending of (for example) *phérētai* 'bear (3sg pass. subj.), whereas the latter is the solution of a proportion *phéretai* (3sg pass. indic.) : *phérētai* = *rhḗgnūtai*: *x*. Osthoff regards *Formübertragung* as the normal type of analogy, but argues that the two types are essentially the same process, if stems can be included in proportions. For Paul, there could be no such compromise. By the 1886 edition of the *Prinzipien*, Paul realised that some of the phenomena which used to be regarded as '*falsche Analogie*' could not be regarded as proportional analogy,

[22] Osthoff (1879).

and had instead to be regarded as morphological spreading or *Formübertragung*.[23] Although he does not acknowledge as much, this is an implicit acceptance of the validity of segmentation. Thus the distinction between proportional and non-proportional analogy was born.

1.4. Constraining analogy: Kuryłowicz and Mańczak

As we have just seen, Paul made some attempt to constrain the use of (proportional) analogy. Largely, however, Brugmann and Osthoff's 1878 call for investigation into the principles governing analogy was ignored, especially their recommendation that contemporary language be consulted as a source of evidence. This call was answered in the next century by Kuryłowicz (1949) and Mańczak (1958, 1978, 1980). In this section, I will discuss each of Kurłowicz's and Mańczak's claims in turn; in section 2, I will explain how this study will attempt to improve on their efforts to constrain analogy.

Kuryłowicz's 'laws' of analogy are intended to be a comprehensive account of the tendencies of analogy, in order to constrain the power of analogy in historical work as an all-purpose explanation for exceptions to sound laws. They are predictive in that they suggest which items analogy is likely to affect, and which direction analogical change is likely to take, should it take place, but they do not aim to predict when analogy will take place. The six laws will be discussed here in the English translations of Hock (1986: 210-228).

[23] Paul (1886: 95).

I. A bipartite marker tends to replace an isofunctional morpheme consisting of only one of these elements, i.e. a complex marker replaces a simple marker.

This accounts, for example, for the spreading of German umlaut from i-stems, where it was originally phonologically predictable (OHG *gast* 'guest', *gesti* 'guests'). Subsequently unstressed vowels in final position merged and umlaut became a secondary marker of plurality, spreading e.g. to NHG *Baum* 'tree' - *Bäume* 'trees'. While this phenomenon undoubtedly exists, the opposite direction of change is also frequently attested: cf. English *old - older - oldest* in addition to inherited *old - elder - eldest*. For Kuryłowicz, this tendency of analogical change is a symptom of a general principle of 'polarisation': languages seek to maximise functional contrasts.

II. Analogical developments follow the direction 'basic form' → 'derived form,'[24] *where the relationship between basic and derived forms is a consequence of their spheres of usage.*

In other words, analogical changes create or replace derived forms rather than basic forms. Basicness is determined by 'sphere of usage' (effectively markedness); basic forms are used in neutral contexts. For example, masculine adjectives in Greek are basic whereas their feminine counterparts are 'derived', because masculines are used in contexts where sex is irrelevant, or where there is no accompanying noun with which to agree in gender.

[24] In this context, the intended sense of 'derived forms' (*formes fondées*) is not opposed to 'inflected forms', but to 'basic forms' (*formes de fondation*). Law II applies equally to inflectional and derivational replacements and coinages, though it may be superseded by law III (see below).

Again, this law is regularly contradicted, this time in the case of back-formation: English *emote* is created from the more morphologically complex *emotion*, extending a pattern which obtains a basic form (e.g. *relate*) from a 'derived' form (*relation*). Similarly in the domain of inflection, Latin *honōr* 'honour (nom.)' replaced *honōs,* extending a pattern which obtains a basic form (the nominative) from various 'derived' forms (cf. *honōris* 'honour (gen.)').

III. A structure consisting of a basic member and a subordinate member forms the foundation for a basic member which is isolated, but isofunctional.

One of Kuryłowicz's examples is French *lèves* 'lift' (2sg), which was remodelled from Old French *lieves* on the basis of *levons* (1pl). In this case *levons* is a structure consisting of a basic member (the lexical stem *lev-*) and a subordinate member (the inflection *-ons*). *Lieves* is basic and isolated, in that it lacks an inflectional ending, the <*es*> being unpronounced, but isofunctional in that it is marked only for person, whereas *levons* is marked for both person and number.

The purpose of this law seems to be to explain certain cases of levelling, where a simple form is influenced by a derived form. It directly contradicts Kuryłowicz's second law, which states that basic forms should influence derived forms. The implication seems to be that a derived form can influence a basic form if and only if the basic form is isolated and isofunctional. If this is the correct interpretation, it makes the second law rather redundant, as basic forms will frequently be isolated and isofunctional: a neutral 'sphere of usage' correlates with lack of overt formal marking, and grammatical or

semantic markedness correlates with degree of overt formal marking, as shown by Greenberg (1966). In any case, it is in conflict with historical evidence. Levelling can proceed in both directions, as illustrated neatly by the development of the Germanic verb 'to choose'. Old English *cēas, curon, (ge)coren* was remodelled to *choose, chose, chosen*, whereas the OHG equivalents *kōs, kurun, (gi)koran* was levelled to NHG *küren, kor, gekoren*. In the German case the derived past tense forms with *r* influenced the basic members of the paradigm with *s/z*, and in the English case analogy took the exact opposite direction.

IV. When, as a consequence of a morphological change, a form undergoes differentiation, the new form takes over its primary ('basic') function, the old form remains only in secondary ('derived') function.

A commonly cited example is *brethren*, which was replaced by analogical *brothers* in its primary function, but remained in the sense of 'members of a religious order'. Kiparsky (1974) argues that this law is contradicted as often as obeyed: *wolf* has an analogical plural *wolfs* rather than *wolves* in its secondary meaning of 'aggressive men', *bad* has comparative *badder* in the sense of 'tougher', and *weave* has regularised its past tense to *weaved* in metaphorical uses like 'weaved through traffic'. The difference seems simply to be whether analogy acts on the primary or secondary member of a prior lexical split, in the case of pairs like *badder - tougher*, and potentially which part of a paradigm is lexicalised. For example, *straight* was originally the past participle of *stretch*, but was lexicalised as an adjective, losing its semantic

association with *stretch* and therefore becoming ineligible to participate in the remodelling of the past participle to *stretched*.[25]

V. In order to reestablish a distinction of central significance, the language gives up a distinction of more marginal significance.

In the prehistory of Spanish, regular sound change led to a system of nominal inflection whereby the nominative singular and nominative and accusative plural had the same case ending, and only the accusative singular was differentiated morphologically. In Spanish, the nominative singular was remodelled on the basis of the accusative singular, restoring a morphological distinction between the singular and plural at the cost of the distinction between the nominative and accusative. One problem with this account is the difficulty of finding independent evidence for the relative significance of different morphological contrasts in a given language.

VI. The first and second term of a proportion can belong to originally different systems: one belongs to a prestige dialect, the other to a dialect imitating it.

[25] Kiparsky also produces a number of examples like 'sabertooths', which I have not reproduced because they complicate the argument, since they are new coinages rather than analogical replacements. Hock (1986: 226) dismisses all Kiparsky's examples on the grounds that the separation between primary and special function has arisen before the process of regularisation, rather than as a consequence of it, including in cases where the differentiation was purely semantic rather than morphological, such as *wolf* 'aggressive man'. Technically this makes them irrelevant to Kuryłowicz's law ("when, as a *consequence* of morphological change, a form undergoes differentiation…"). However, I am inclined equally to see examples which do conform to Kuryłowicz's law, like *brethren*, as the result of a lexical split prior to any analogical process, rather than as a consequence of it. Whatever the correct order, there can be no principled reason to view one group of lexical splits (*brethren* etc.) as the result of analogy, and the other (*wolfs*) as preceding analogy, unless one is prepared to take Kuryłowicz's fourth law of analogy on faith alone.

This brings hypercorrection into the class of proportional analogy. For example, Southern British English [ā] corresponds to [æ] in many Northern varieties in words like *path, bath, laugh*. When Northerners imitate Southerners, whether for humorous reasons or as genuine social imitation, they often pronounce [ā] instead of [æ] even in words where both varieties of English have [æ]. This can be represented by a proportion as in (3) below:[26]

(3)

	Northern		Southern
path	[pæθ]	:	[pāθ]
cat	[kæt]	:	*x* = [kāt]

Kuryłowicz specifies that the items in the first half of the proportion (*a* and *c*) should be from the speaker's native dialect. While this may usually be true, it is unnecessary to restrict analogy of this type to these cases.

A number of criticisms can be made in response to Kuryłowicz's laws. Firstly, for all those laws which are formulated in such a way as to be predictive, exceptions can be found amongst the historical data. Laws II and III are particularly unsatisfactory, since they directly contradict each other, predicting opposite outputs for a largely overlapping set of inputs. Law V fails to be predictive as it refers to a hierarchy of the significance of linguistic

[26] This form of proportional analogy, with each column of the proportion representing a different dialect or sociolect (or perhaps even idiolect), is essentially identical to the model of sound change suggested by Schuchardt in his essay *gegen die Junggrammatiker* (1885), and developed by Sturtevant (1907): "what has been called sound change starts in a few isolated words, in the speech of one or two individuals. For reasons such as prestige, this new pronunciation may spread to other speakers… each person who substitutes the new sound in his own pronunciation tends to carry it into new words… Such a spread of a sound change from word to word closely resembles analogical change; the chief difference is that in analogical change the asociation groups are based upon meaning, while in this case the groups are based upon form". Early empirical evidence for this type of sound change was furnished by Gauchat (1905) and Sapir (1921), who in his *Language* details the lexically gradual change of original [ū] to [ʊ] in English *stood, wood* and *good,* for example, but not *food, loot and boot*, with a few items such as *broom, room* and *roof* waivering between the two pronunciations. The theory of lexical diffusion, in its first incarnation (Wang 1969), invoked a similar analogical mechanism, although this was later dropped (but cf. Kiparsky 1995).

contrasts, which we are given no method of discovering; it is no good simply observing which contrasts are favoured by analogy, because to take this as evidence would be presupposing the validity of the law.

Moreover, the teleological flavour of Kuryłowicz's account of analogy is disconcerting. In Law I, we are told that languages like to maximise morphological contrast; in V, we find the language giving up a minor contrast in order to reestablish a more central one. But languages do not literally have intentions, and their speakers do not consciously strive to maximise morphological contrasts or to sacrifice less important contrasts for more important ones. Presumably, the teleological language is to be interpreted metaphorically, but we are not told how to interpret the metaphor. It is common to say that teeth are 'for' chewing, for example, but this is merely an informal shorthand, and the theory of evolution supplies a set of principles for relating the metaphor to reality. Kuryłowicz gives no such account, and stripped of its teleological aspect, his work on analogy becomes purely descriptive rather than explanatory. This is not necessarily a problem in itself: the goal is to constrain analogy, i.e. to be able to make predictions about how and when analogy will happen, and these predictions can in theory be generated either by an explanatory or a descriptive model. A descriptive model, however, can only be taken seriously if it is based on a systematic statistical study of a representative corpus of attested analogical changes. Kuryłowicz's study is not systematic, and it includes examples of analogy which are not directly attested, but based on reconstructions which themselves presuppose certain assumptions about analogy.

Mańczak (1958) also proposes a set of general principles governing analogy, though he more cautiously calls his formulations 'tendencies' rather

than 'laws'. For ease of comparison, I shall list them in the order in which they apply to Kuryłowicz's laws, to which they are meant as a response.[27]

II. Root alternation is more often abolished than introduced.

This 'tendency' is reminiscent of 'Humboldt's universal': "one meaning, one form". It makes root levelling the rule rather than the exception, contradicting Kuryłowicz's first law. Kuryłowicz restricts levelling to cases where the model is morphologically complex and the target is simple (law III). Mańczak makes no such restriction, and deals with the normal direction of levelling separately, in I, III and VI-VII.

IV. Zero-endings are more frequently replaced by full ones than vice versa.

V. Monosyllabic endings are more frequently replaced by polysyllabic ones than vice versa.

These two tendencies cover some of the same ground as Kuryłowicz's first law. Mańczak and Kuryłowicz seem to be driving at the same essential point – that analogy tends towards maximisation of morphological contrast – but both formulate this in an unnecessarily restrictive way. Kuryłowicz' limits the application of his first law to bipartite and isofunctional morphemes, whereas Mańczak makes these tendencies apply to length, which is only a secondary indicator of morphological markedness. He refers only to endings, excluding other morphological marking strategies (for example, neither of these

[27] English translations taken from Hock (1986: 229-234).

tendencies cover Kuryłowicz's example of the spread of German umlaut to originally ineligible paradigms like *Baum* - *Bäume*).

I. Excepting the forms of a paradigm [i.e. an inflectional paradigm], *longer words more frequently are remade on the model of shorter words than vice versa.*

III. Excepting cases where there is one word with zero-suffix and another with a clearly marked suffix, longer inflectional forms are more often remade on the model of shorter forms than vice versa.

These are equivalent to laws II and III, making the direction of change suggested by Kuryłowicz's second law the default, except in the case of zero-suffix members of inflectional paradigms, which are likely to influence more morphologically marked members. Again, it is questionable whether length of words/suffixes is the true criterion here, in itself rather than as a correlate of markedness or frequency.

VI. The forms of the indicative more frequently bring about the remaking of other moods than vice versa.

VII. The forms of the present more frequently bring about the remaking of the other tenses than vice versa.

Tendencies VI-VII can be seen as appendices to I and III, but with reference to specific morphological categories rather than the length of forms. This is in line with Kuryłowicz's second law, if we assume the indicative and present

are more 'basic', which may be true for the languages on which Mańczak's study is based (French, German and Czech), but is unlikely always to be the case.[28] In Mańczak (1980), the singular and third person are added to the list of categories of forms which are more likely to influence other categories than vice versa. This is attributed directly to their relatively high token frequency. In response to criticism from Best (1973), Mańczak provides some empirical confirmation of these claims, based on frequency counts in French from the first and second acts of Molière's *L'école des femmes* (1980: 287).

The claim that forms which represent more frequent values for morphosyntactic variables tend to bring about the remaking of less frequent forms has been made often, including by Greenberg (1966), who conceived of 'markedness' in terms of token frequency. Bybee (1985, 1988), like Mańczak, attributes the observation that irregularities tend to be concentrated in frequent members of paradigms to the fact that they are resistant to analogical reformation, and so sound changes have a better chance to set in and eradicate their morphological structure.

VIII. If there is a difference between the inflection of a geographic noun and a common noun, which otherwise are similar, the local cases generally present an archaic character, while in the non-local cases innovations are more common.

IX. If a paradigmatic form of a geographic noun undergoes an analogical change under the influence of another form of the same paradigm, the starting point of that change more often lies in the local cases than in the non-local ones.

[28] In Greek, for example, levelling in the verb was more often modelled on the aorist than the present. For examples, see Garrett (2008) and Hock (1986: 219), and chapter 3 of this thesis.

These are formulated specifically with regard to geographic nouns, but again exemplify the conventional wisdom that frequently used forms are more resistant to analogical innovation; this is why morphological irregularity tends to be found in common paradigms. Because the local cases of geographic names are more frequently used, they are more resistant to analogy, and thus the effect of sound change is more visible.

Mańczak's tendencies improve on some of the shortcomings of Kuryłowicz's laws; significantly, they are based on statistical results from a systematic survey of analogical changes found in a corpus of etymological dictionaries. However, they also suffer from certain weaknesses. Mańczak's study is based on data from French, German and Czech, which are relatively closely related and typologically similar languages, in which (with the exception of Czech) allomorphy is much rarer and less productive than in highly inflecting languages like Greek. The etymological dictionaries on which his study is based include forms which have been reconstructed on the basis of *a priori* assumptions about analogy. Potential bias is not limited to reconstructed forms: Mańczak (1980: 286) writes "in some cases, there are different ways of interpreting an analogical form, e.g. Fr. *chante* for Lat. *cantet* may be considered as analogical with *chante* < *cantat,* with *entre* < *intret*, or with *vende* < *vendat*. The linguist scrutinizing a text might be tempted to choose the interpretation which suits his thesis. This temptation does not exist if one decides to scrutinize an historical grammar and to accept all the interpretations of its author". The problem with this solution is that the interpretations of the author of an etymological dictionary are also likely to be influenced by his preconceptions about analogical change. To eliminate these sources of bias, it is necessary to look at a large set of analogies which

are securely attested in texts, treating all possible analyses as equal, and see what tendencies emerge from the data.

Ultimately, both Mańczak's tendencies and Kuryłowicz's laws fail to be practically useful for constraining the use of analogy in historical work. This is because, despite Kuryłowicz's terminology, both sets of formulae are merely tendencies rather than laws. They freely admit exceptions, but do not state the conditions under which exceptions can take place. For a philologist reconstructing the history of a language, there is no disincentive for hypothesising as many exceptions as his heart desires to either set of tendencies. If he finds at the end of the exercise that 90% of his reconstructions contradict a general tendency, he will have reason to suspect himself of error, but no way of knowing where the error lies. In order to progress from this point, he needs to know at the very least under what conditions exceptions are likely to occur. For example, in what circumstances can a preference for the elimination of root alternation be overridden?

1.5. Analogy as grammar simplification: the generative critique of the neogrammarian conception of analogy

As an unregulated category, non-proportional analogy seriously undermined the neogrammarian theory, since any exception to a proposed sound-law could still be admitted as non-proportional if it happened not to meet the criteria for proportional analogy. This weakness of the theory was partly responsible for a recharacterisation of sound change and analogy in the late sixties from generative linguistics, which made quite different predictions for

the tendencies of morphological change from the approaches of Mańczak and Kurłowicz.

This recharacterisation started with Paul Kiparsky's PhD thesis (1965). Here he argued for a new conception of sound change as the addition of phonological rules at the end of the grammar,[29] with potential restructuring by subsequent generations, to account for the fact that the simplest synchronic analysis of phonological processes does not necessarily mirror the historical order in which they came into existence.

Postal (1968) has a similar conception of sound change, arguing that it can be structurally conditioned and thus is not blind or regular in the neogrammarian sense. He identifies the neogrammarian position, somewhat anachronistically, with that of autonomous phonemics: the neogrammarians held that sound change could only be conditioned by phonetic environment, which has a certain paralellism to the American structuralists' belief that only phonetic facts were relevant to phonemic analysis. Following the rejection of the phonemic level of representation in generative phonology, [30] morphophonemic rules became equivalent to phonological rules. Sound change was change to phonological rules, which now encompassed morphophonemic rules, and morphophonemic rules were structurally conditioned. Thus sound change can be structurally conditioned. If sound change can be conditioned by factors other than phonetic environment, the theoretical need for analogy is greatly reduced, an implication which Postal observes in passing: "'analogy' is really an unfortunate term. There is reason to believe that rather than being some sharply defined process, analogy

[29] Kiparsky also argues that rules can be inserted into the grammar, to account for what he regards as morphologically conditioned sound change.
[30] A generative model of phonology with separate morphophonemic and phonemic levels was deemed to be uneconomical, because rules at the morphophonemic level are replicated at the phonemic level, as shown by Halle (1959: 22).

actually is a residual category into which is put every kind of linguistic change which does not meet some set of *a priori* notions about the nature of change. In particular, I think that the term 'analogy' has been used very misleadingly to refer to cases of perfectly regular phonological change in which part of the conditioning environment involves Surface Constituent Structure; i.e. changes which happen only in nouns, or only in verb stems, etc. I suspect that an analytic survey of cases which have been referred to as 'analogy' would yield many instances of regular phonological change with nonphonetic environments" (1968: 234, footnote 3).

Thus under the generative scheme, many examples of analogy which had traditionally been regarded as instances of morphological change – chiefly instances of root levelling – were perceived as conditioned phonological change. For example, Proto-Indo-European *k^w is generally reflected in Greek by [t] before a high (unrounded) vowel, and [p] before low vowels. Nonetheless, in the paradigms of verbs whose stems originally ended in *k^w, we do not find the alternations which the relevant sound law would predict: for example, we find *hep-omai* (1sg), *hep-etai* (3sg, 'follow', < *sek^w), rather than expected **het-etai*. The Neogrammarian tradition would attribute this to a secondary analogical levelling of the stem, subsequent to the action of the sound law. Since the assumed intermediate forms ***hetetai*, etc., are not attested, the generative approach would regard this account as spurious, and explain the Greek data instead by a morphologically conditioned sound change whereby *k^w became [p] at the end of verbal stems, and elsewhere its product was conditioned by the quality of the following vowel.

Analogical changes which could not be analysed as change to phonological rules came to be regarded as change to morphological rules. This shift in

outlook is summarised by King (1969: 128): "as historical linguistics is treated in generative grammar, grammar is enough: 'sound change' is grammar change, 'analogy' is grammar change, borrowing is grammar change". The neogrammarians had regarded surface change as equal to structural change, because they made no distinction between surface and underlying structure, and the structuralists had distinguished between phonetic shift in *parole* and subsequent restructuring of *langue*. Both sound change and analogy were now redefined in terms of the underlying grammar: phonological rules added at the end of the grammar accounted for traditional sound change, and the role of analogy was taken by various operations on rules during the process of acquisition by the following generation: rule simplification, rule loss, and rule reordering.[31] This account was first set out clearly by Kiparsky (1968), who argued that the tendency of all these processes is towards greater formal simplicity. This is evident for rule loss. In the case of reordering, this simplification manifests itself as a tendency to maximal applicability: rules tend towards a feeding relationship and away from bleeding relationships. As for rule simplification, in a rule of the form $x \longrightarrow y \ / \ z$, a simplification of y (the product) of a rule was equivalent to traditional levelling, and simplification of x or z (the target or environment) corresponded to analogical extension. For the neogrammarians, analogy had been a mechanism of change. In these early works (Kiparsky 1968, King 1969), 'analogy' was redefined as simplification of grammar, and the supposed mechanism – imperfect learning – was at first only vaguely alluded to.

[31] Kiparsky (1968) admits restructuring of the lexicon as another possibility. For example, final devoicing of German stops resulted in reanalysis of the underlying forms of words like *ab, ob* and *weg*, where no morphophonemic alternation existed to motivate the learner's acquisition of a synchronic devoicing rule. Kiparsky seems to regard this as theoretically uninteresting, however.

Various criticisms of the neogrammarian conception of analogy were made, different aspects being emphasised at different times. We have already heard the methodological objection of Postal (1968), that analogy was only made necessary by the neogrammarians' arbitrary insistence on the regularity of sound change. This is echoed by King (1969), who objects to the use of analogy as a 'dustbin' for exceptions to sound laws. If sound change can be structurally conditioned, there is no need for analogy (Postal 1968, Kiparsky 1974a). The 'proportional theory' of analogy left a number of non-proportional processes in 'theoretical limbo', which the generative approach could assimilate easily (Kiparsky 1992). Non-proportional morphological change, which had caused problems for the neogrammarians, could simply be treated as the simplification of the environment of a morphological rule (the spread of the masculine genitive singular in -ō in a) above, for example, can be regarded as the removal of a restriction to a rule for forming masculine and neuter genitive singulars). The proportional model implies that analogical change should proceed sporadically, word by word, which is unusual for syntactic and phonological analogy, and not always true for morphological change (Kiparsky 1974c). If analogy really proceeded proportion by proportion, we would expect far more relic forms like *brethren* than actually exist (King 1969).[32] Kiparsky (1974c) explicitly addresses the need to constrain analogy, arguing that the proportional model ascribes too much significance to formal relationships: we do not expect an analogy *ear* : *hear* = *eye* : *x* = *heye*, even though it is formally identical to *sister* : *sisters* = *brother* : *brethren* ⟶ *brothers*, a textbook case of analogy. Attempts to

[32] King actually suggests that something like traditional proportional analogy might exist as a marginal phenomenon rather than a major force in language change. Proportional analogy "gives a plausible account of some of the isolated realignments found in virtually all languages. Analogy as a proportion is a kind of one-shot affair duplicated, if at all, only sporadically elsewhere in the language".

constrain analogy at the formal level of the proportion have failed, he argues; analogy can only be successfully constrained at the level of grammar, by the requirement that it should be a simplification of grammar.

Ultimately, this attempt to constrain proportional and non-proportional analogy under the same scheme was unsuccessful, because the claim that analogy always simplified grammar was contrary to empirical evidence. Often analogy is neutral in its effect on the complexity of the grammar, and sometimes it complicates grammar.[33] In cases where analogy gradually brings lexical items into a regular paradigm, although the ultimate effect may be simplification of the grammar, this motivation cannot necessarily be invoked in individual cases: the -(*e*)*s* plural in English is now so overwhelmingly productive that instances of its extension can be seen as the elimination of lexically marked exceptions, which is plausibly a form of simplification. If we accept this, however, we are also forced to accept analogical changes which do not simplify the grammar, since at the beginning stages of the spread, -(*e*)*s* was merely one productive plural marker amongst many. Therefore early instances of its extension can only be regarded as redistribution of lexical items between the domains of various rules of equal status. Words are not infrequently transferred into irregular paradigms: an innovation like *dived* ⟶ *dove* must be analysed as the addition of a lexical exception to a regular rule. Cases of reanalysis are often difficult to regard as simplification. The reanalysis of Latin *Roma-nus* as *Rom-anus* led to the creation of a new morpheme *-anus*, which was then extended to consonantal roots like *urbanus*

[33] E.g. Thomason (1976) detailed the expansion of accusative-genitive syncretism for animate nouns in Slavic languages, originating in the o-stem masculine singular and spreading to the plural and other noun classes, and shows that these changes complicate the grammar, as they make additional morphological rules necessary to describe the morphological system. According to Thomason, if the syncretism were to spread to all nouns, it could ultimately be regarded as a simplification, but in Czech it cannot even be seen as a transitional stage to grammar optimisation, since spoken Czech in 1976 was moving in the opposite direction.

and *mundanus*. This change complicated the grammar of Latin, because it meant that more nominal stems had to be marked as to which rule they should undergo in order to derive an adjective. Similarly, levelling does not always result in simplification; although it can eliminate phonological contrasts, making fewer phonological rules necessary, it can also create exceptions to regular rules.

These types of counterevidence led Kiparsky (1971) to make a significant revision to the theory, now proposing that analogy tends towards transparency and paradigm coherence, in addition to formal simplicity. These tendencies were attributed to three additional constraints in the evaluation measure, which chooses the optimal grammar from a number of possible analyses of linguistic data. Previously, the evaluation measure had been thought to choose the simplest possible grammar, i.e., the grammar which generates the correct linguistic output using the shortest description in terms of number of feature specifications.

One of these is the paradigm condition: analogy tends towards minimisation of allomorphy, because the evaluation measure devalues grammars where they generate inconsistent surface realisation of morphs. This condition was added to the theory to account for some counterevidence to the principle of maximal applicability in Kiparsky (1968). Kiparsky gives the example of an innovation in certain German dialects, which have reordered two phonological rules – final g-deletion after /ŋ/, and final devoicing – from a feeding relationship into a bleeding relationship (4).

(4)

	lang (/laŋg/)	*lange* (/laŋg + e/)
Dialect Group 1		
1. devoicing	[laŋk]	[laŋge]
2. g-deletion	–	[laŋe]
Dialect Group 2		
1. g-deletion	[laŋ]	[laŋe]
2. devoicing	–	–

He counters further exceptions to the principle of maximal applicability by a constraint favouring transparent rules, and disfavouring rules which are contradicted by surface evidence. The tendency of analogical change towards more transparent grammars is also attributed to a further abstractness condition on underlying representations of segments. Underlying representations which do not correspond to anything on the surface are hard for children to learn, we are told, and therefore the evaluation measure places a high cost on them. One of Kiparsky's examples is a passivisation process in Maori (5).

(5)

Verb	Passive
[awhi]	[awhitia]
[hopu]	[hopukia]
[aru]	[arumia] …

The standard generative analysis would posit underlying forms /awhit/, /hopuk/, and so on, with a passive ending /ia/, but Hale (1973) argues for a reanalysis of the underlying forms as /awhi/, /hopu/, /aru/, based on the

diachronic productivity of the suffix *-tia* in words which did not historically have a final /t/. Kiparsky analyses this into a constraint placing a high cost on underlying forms which violate universal surface patterns. Maori words have no final consonants at the surface level, so the evaluation measure devalues analyses of Maori surface data which involve underlying forms with final consonants.

These three additional constraints on the evaluation measure are effectively constraints on analogy, accounting for its apparent tendency towards paradigm uniformity and transparency, manifested by levelling and reanalysis respectively. Note that all three constraints are characterised at the surface level, bringing the generative theory much closer to the traditional view of analogy.

1.5.1. Analogy as an artefact of acquisition

Kiparsky's principles of the evaluation measure represent different elements of learnability: transparency makes it easier to discover the structure of a language, whereas formal simplicity reduces the amount of information which must be remembered.

Kiparsky (1974b) addresses the question of how these factors are valued relatively, since they could potentially be in conflict with each other. He concludes that minimisation of opacity and minimisation of formal complexity must be considered separate motivating factors in language change, and therefore separate principles of the evaluation measure, but is more optimistic about getting rid of the paradigm condition proposed in (1971). Although levelling and simplification cannot be defined in terms of

each other, it is possible to make the empirical claim that attested examples of levelling always simplify grammar, if one is prepared to assume phonological analyses which are closer to the surface forms than generative orthodoxy would like (along the lines of Vennemann's 'natural generative phonology'). This would make an independent principle of paradigm coherence redundant. In (1971), Kiparsky analysed the change of *honos* to *honor* in Latin as the addition of an extra lexical environment to a rule /s/ ⟶ [r], which is required by derived forms like *honestus*. This seemed to be grammar complication rather than simplification, and served as evidence for an independent paradigm condition. Now, Kiparsky suggests that this change is a reanalysis of the underlying baseform as /honor/, presumably motivated by other members of its nominal paradigm which all show a root-final [r]. He is cautious about this approach, as it requires such a major overhaul to phonological analysis, but concludes "no unequivocal evidence exists for considering minimisation of allomorphy as a separate motivating factor in linguistic change."

Kiparsky's work on analogy makes acquisition the mechanism of analogical change. This is at first only mentioned, but gradually developed over the course of successive publications. In (1968), he accounts for the fact that analogical changes are typically geographically sporadic, whereas sound change tends to be geographically continuous, by the explanation that simplification involves restructuring of the grammar, which must take place during acquisition, whereas sound change is simply the borrowing of phonological rules at the end of the grammar, which can take place during adulthood. In (1970) he explains that restructuring takes place because the child creates the simplest grammar which will produce the forms he has been

exposed to: "the child is the synchronic linguist *par excellence*. On hearing [nayf]… the child will have no reason whatever to postulate a basic form with initial [k]… synchrony gives no reason to do so, and history is irrelevant." He cites studies on child language acquisition: at first the child has no trouble with irregular forms, presumably because he is learning them as unanalysable wholes. At a later stage he grasps the regular rule, but forgets the irregular forms, and then gradually relearns them. At the point when sub-regularities are learnt, forms like *brang* as the past tense of *bring* can be created (extending a minor morphological rule which deals with words like *sing* in the adult grammar). Kiparsky thus supposes that traditional analogy, i.e. morphological simplification, as well as the simplification of phonological rules, originate in the mistakes children make during acquisition. They can become genuine historical changes if they are borrowed into the adult language as variants, then replace the standard forms by ordinary sociolinguistic processes. In (1971), as we have just seen, the restructuring of grammar during acquisition is attributed explicitly to the way the evaluation measure works.

A subtly different account is given by Kiparsky (1974c), in which the idea of intermediate grammars becomes important to the theory. Children construct the optimal grammar to account for limited linguistic data to which they have been exposed. These intermediate grammars are continually revised, as new data is encountered. Projections of intermediate grammars, like *brang*, may when sufficiently marginal escape correction, and be retained into adulthood. If they continue to spread into the speech community at large, they may cause historical change. This accounts for the direction of change, because earlier grammars will have been simpler, as they were

constructed to deal with a smaller body of linguistic data. It also deals with another problem with the generative account. If analogy is simplification, why do attested examples of simplification never entail a large change to the surface language? Kiparsky explains that if the language generated by an intermediate grammar is very different from the standard language, it will be more noticeable and thus under more pressure to be revised. The implications of this formulation for the evaluation measure are explicitly drawn out: "consequently the evaluation measure assumes a different role in the theory than was originally meant for it. Rather than just functioning as a procedure for selecting the 'right' grammar among a number of grammars that generate the same language, it now is required to define a hierarchy of complexity even among grammars that generate different languages. We can, in fact, think of the evaluation measure as a theory of the order in which alternative hypotheses are entertained in the process of language acquisition."

Vincent (1974) discusses certain cases of analogical case shift which do not seem to be motivated by grammar simplification, but mere surface similarity, such as the shift of Latin *corpus* from the third declension to the second, on the basis of the superficial resemblance of the nominative to second declension nominatives like *servus*. Similarly, during the development of Romance, many neuter plurals in *-a* were reanalysed as feminine singulars, which also ended in *-a*. He argues on the basis of such examples that grammar simplification is not sufficient to deal with all instances of analogy. A principle like 'Humboldt's universal' is needed: "suppletion is undesirable, uniformity of linguistic symbolization is desirable: both roots and grammatical markers should be unique and constant." So far, the argument is

similar to that of Kiparsky (1971), but where Kiparsky's next step is to write an additional set of constraints into the evaluation measure, Vincent attributes this tendency directly to performance factors. 'Humboldt's universal' arises from the interaction between the productive and perceptual sides of language, in other words, levelling occurs when novel forms are predicted on the basis of known forms, and reanalysis occurs when a novel analysis of a heard form is made. Each process is informed by the evidence of surface linguistic data familiar to the speaker. Thus analogy is located 'outside the grammar', in performance rather than competence, and grammar simplification (and consistent realisation of underlying morphs/phonological segments) is merely its effect on the grammar.

In (1974b), Kiparsky was evidently concerned by the inelegance of adding arbitrary stipulations to the evaluation measure, but was unable to eliminate the paradigm constraint without committing himself to a radically different approach to phonological analysis. The particular problem with the paradigm condition is that, unlike formal simplicity, the concept of the paradigm has no other role in generative grammar except in explaining language change. For the neogrammarians, the paradigm had been central to language knowledge and use as well as change, but in generative grammar the paradigm was made redundant by the theoretical position that inflected words are merely the transient output of grammatical rules. Clearly, it is unsatisfactory to resurrect the notion of the paradigm as an *ad hoc* explanation of certain phenomena of language change. The solution offered in Kiparsky (1978) is to delegate even more of the burden of explanation to the mechanism, as Vincent does, although his approach is quite different from Vincent's. In (1974c) we were introduced to the idea that elements of

intermediate grammars constructed during acquisition may be retained into adulthood. Now Kiparsky elaborates that the incompleteness, variation and ambiguity of language data to which learners are exposed may provoke quite different intermediate grammars. In response to new language data, the learner patches up his grammar rather than starting a completely new analysis from scratch. This explains paradigmatic levelling and reanalysis. Kiparsky reanalyses a now familiar example: for the Latin learner who has thus far only encountered *honoris* and *honorem*, *honor* is the simplest prediction for the nominative singular. Later it is necessary to acquire a phonological rule /s/ ⟶ [r] to account for data like *flos* ~ *floris* and *honestus*, but by this point *honor* has already stuck. The paradigm and transparency conditions can be derived from this account, therefore it is no longer necessary to attribute them to constraints of the evaluation measure. This account involves a serious concession, in that it undermines the generative assumption that the simplest formal grammar has an *a priori* claim to represent psychological reality.

Further tendencies of analogy are derived from functional and sociolinguistic factors affecting a variant's likelihood of being generally adopted, or lost entirely. A variant will be disfavoured if it is more salient, i.e. if it replaces a frequent form, if it is radically different from an old form, or if it alters surface structure or phonotactics. Innovations will also be more salient the more formal the register. On the other hand, a variant will be favoured if it is functionally useful. Partial analogy – analogy which would simplify grammar, if it followed through to completion, but where simplification cannot be invoked as a motivation of individual instances –

happens when an innovation is favoured in certain environments but disfavoured in others.

Kiparsky concludes that the difficulties in redefining analogy as grammar optimisation have turned out to be artefacts of the idealisations of the ideal speaker-hearer and instantaneous language acquisition, which are appropriate in the study of formal grammar, but not in historical linguistics. Later publications still refer to analogy as 'optimisation' (e.g. Kiparsky 1995, 2000),[34] but the substance of the original generative claim has been lost. At first, analogy was grammar simplification by definition, and the mechanism was only alluded to. Gradually, the mechanism has taken centre stage in the theory, and its effect on the grammar has become merely contingent. Kiparsky effectively admits this in (1978): "the assumption that analogy must represent simplification with respect to the *adult* grammar is entirely unwarranted. The most that we can legitimately claim is that analogical innovations represent analyses which are optimal at the particular stage of language acquisition at which these analyses arise and for the particular set of primary linguistic data which is under consideration by the language learner at that stage." This later stance directly opposes the early generative line, and is much closer to the traditional approach, although this is not immediately obvious because it has been arrived at gradually. Analogy is now characterised and constrained at the level of its mechanisms: speakers' likely analyses of the surface linguistic data they encounter, and formal and functional factors of this surface data affecting its sociolinguistic potential. Proportions, too, had been an attempt to model the mechanism of analogy –

[34] As does more recent work within optimality theory which makes use of *paradigm uniformity* or *uniform exponence* constraints (Burzio 1994; Kenstowicz 1997; Steriade 2000; McCarthy 2005).

the reasoning processes of the speaker in response to surface linguistic data – and attempts to constrain analogy at the formal level of the proportion had been trying to place limits on what was plausible given the assumed mechanism of analogy. Although the two theories are expressed in very different language, they are now roughly equivalent. This leaves us no closer to constraining analogy: both the surface-based approach of the neogrammarians and the grammar-based approach of generative linguistics have turned out to be insufficient.

There is a further reason why it may be worthwhile to gain a better understanding of analogical change. The striking parallels between analogy and spontaneous mistakes and nonce words found in everyday speech strongly imply a common mechanism for both, in which case analogical change may be an important source of evidence for understanding the mental processes underlying linguistic creativity. Kiparsky limits analogical creation to language acquisition; in (1974c) he considers the possibility that analogical change lies in 'slips of the tongue' by mature speakers, but concludes that "change involving substantial reanalysis of the rules and/or the underlying representations… could obviously not be brought about by a simple slip of the tongue… therefore, any case of analogy involving such restructuring must be attributed to fresh analyses imposed by learners on the language they hear". It is indeed unlikely that grammatical restructuring could be caused by slips of the tongue, but the fact that slips of the tongue have so much in common with analogical change does suggest that the two phenomena could have a common cause. This would imply that grammatical analysis of surface forms takes place to some extent in adulthood as well as during acquisition.

1.6. Autonomous morphology and the resurrection of the paradigm

Morphology was marginalised in early generative grammar, and the job of accounting for the construction of words out of morphemes tended to be redistributed between phonology and syntax. Recent decades, however, have seen increasing interest in morphology as an autonomous component of language, and in the paradigm as a level at which significant generalisations can be made. Bybee (1985, 1988) pointed out that various statistical universals of morphology can only be described, let alone explained, at the level of paradigms: semantic basicness, formal unmarkedness and high token frequency tend to coincide, the degree of formal similarity between related forms parallels their degree of semantic relatedness, and irregularity tends to be concentrated in frequent and unmarked forms. Bybee attributes these facts to diachronic explanations: frequent and semantically basic forms tend to bring about the remaking of less frequent forms, the likelihood of analogical influence between two forms is a function of their semantic closeness, and frequent forms are less likely to be remodelled and therefore more likely to become irregular through sound change. Tiersma (1982) argued that it is token frequency, not markedness, which influences the direction of change, based on Frisian data, where in lexemes for which the usual direction of levelling from singular to plural is reversed, the plural can be shown to be more frequent than the singular, for example in words like 'teeth', 'arms', and 'geese'. He refers to these cases, in which "due to semantic or (perhaps better) real-world considerations a certain well-defined set of lexical items

constitutes an exception to the general markedness conventions", as 'local markedness' (1982: 834-5).

The European school of Natural Morphology went even further in attributing these statistical universals of morphology to general principles of 'naturalness' in language, the most important of which are constructional iconicity (more meaning - more form), uniform encoding (one meaning - one form), and transparency (the relationship between meaning and form should be clear and straightforward) (Mayerthaler 1981a, 1981b). These universal constraints on morphology are derived from semiotic principles. They can be overridden to varying degrees in individual languages, by principles of 'system-dependent naturalness', which promote stability of the form-meaning relationship (Wurzel 1984b). Natural morphology generally aims at retrospective explanation rather than prediction; it is not clear under what circumstances diachrony will favour system-dependent naturalness over universal naturalness. Dressler (1988) claims that a language's typological profile reveals the choices it has made for various parameters of naturalness, which are sometimes in conflict with each other. For example, agglutinating languages prioritise iconicity and uniform encoding over indexicality: affixes are indexes of the stem to which they are attached, and agglutinating languages like Turkish have very long words where every element of morphosyntactic meaning is expressed by a separate affix, which entails large distances between affixes and stems. In principle this could be predictive, if the typological classification proposed (isolating, agglutinating, inflecting, introspecting and incorporating, following Skalička 1979) referred to genuine natural kinds. If so, we would expect diachrony to continue to promote the principles which are prioritised in individual languages, as manifested by

their typological profiles. But this would predict that languages do not change their typological affiliation, which is empirically false (see Haspelmath (2009) for further arguments against this approach to morphological classification).

Matthews (1972) highlighted a number of common morphological phenomena, such as empty morphs, discontinuous morphemes, and inflection classes, which are difficult to account for in theories of morphology which afford no status to the paradigm. Of particular importance are what Matthews called 'parasitic' patterns of stem syncretism, where a particular lexical allomorph consistently appears in disparate paradigmatic 'cells' which cannot be delimited by any natural class of morphosyntactic features. For example, participles like 'written' and 'sought' in English are used in both past and passive constructions for all verbs, although the past and passive are semantically disparate. These patterns of syncretism, termed 'morphomic' by Aronoff (1994), can also cut across the boundary between inflection and derivation. The Latin 'third stem' appears in various nominal formations as well as past participles, future participles, and the supine (cf. *fero* 'I bear', *tuli* 'I bore', but *latus* 'borne', *laturus* 'about to bear', *latio* 'act of bearing', *lator* 'bearer'). Maiden (2004, 2005, 2013) has shown that such morphomic patterns are not only diachronically persistent, but tend to be exaggerated and extended by morphological change. This directly contradicts the oft-repeated claim that analogy promotes one-to-one alignment of meaning and form.

Albright (2002a, 2008, 2009) has attempted to model analogy computationally. Building on the claim of Venemann (1979), he argues that analogy favours the preservation of phonemic contrasts. This follows from his model of acquisition, in which learners initially construct a potential

grammar based on each member of inflectional paradigms, and eventually select as basic the form which enables the most reliable prediction of the remaining members. Because these grammars are constrained by the requirement that there must be a single basic paradigm member for each word class, this makes deterministic predictions about the direction in which analogy will act. Albright's model is successful in explaining the data he considers, but it is uncertain how it can be extended to languages with more extensive inflectional paradigms which seem to demand multiple bases. His data comes from the levelling of phonological and morphophonemic alternations within paradigms, rather than purely morphological alternations seen e.g. in suppletion and inflection class allomorphy. In a language like Greek, where suppletion is a systematic feature of verbal paradigms, there is a conflict between morphological informativeness and phonological informativeness: the perfect mediopassive forms tend to share the same stem as other forms in the paradigm, for example, but they consistently neutralise stem-final consonants (see chapter 4). It is unclear how such conflicts are to be resolved in Albright's model. Moreover, it seems to predict that analogy cannot take place in two opposing directions within the same language, which is contradicted by historical evidence. Garrett (2008) showed that the normal direction of levelling in Greek verbs is from the aorist to the present, but this is occasionally contradicted by innovative forms such as *éleipsa* 'I left', from *leípō* 'I leave' (replacing earlier *élipon*). Garrett suggests that the normal direction of levelling is reversed only as a last resort, when no model is available which would make it possible to predict an analogical present from the aorist. However, a number of models are available in Greek which

could predict a present from *élipon*. One such model, represented by *manthánō* 'I learn' (aor. *émathon*), did in fact generate an analogical present *limpánō*.

The work of Carstairs-McCarthy (Carstairs 1983, 1984, 1985, Carstairs-McCarthy 1994, 1998, 2002, 2008), has focussed on affixal allomorphy governed by inflection class. This disunity of meaning and form is limited, he claims, by universal constraints on the distribution of allomorphy within paradigms, which he derives from principles of lexical semantics. Although these are synchronic constraints, they necessarily have diachronic implications, which I will consider in detail in chapter 5. There I will argue that these constraints only hold true for the languages on which they are based because in these languages affixal allomorphy is governed by inflection class, and the constraints are part of the diagnostic criteria for inflection class. In Greek, where affixal allomorphy is largely not a matter of inflection class, the constraints are extensively flouted, and changes affecting the distribution of affix allomorphs regularly increase the degree to which Greek violates them.

2. CONTRIBUTION OF THIS THESIS

This thesis will improve on the weaknesses of previous research on the tendencies of morphological change, by considering a large body of securely attested analogical changes in a single language, and systematically testing the contribution of various potential factors to the probability of a possible change actually taking place. The data I will use comes from Ancient Greek verbal paradigms. Greek makes an ideal source of data, because it is a highly inflecting language, with extremely extensive morphological irregularity not

limited to unpredictable morphophonemic alternations, and its diachronic development is continuously well documented over a very long period. I will show that teleological attempts to constrain analogy by the requirement that it should optimise grammar do not account for the patterns of change in this data. On the other hand, I will demonstrate that type and token frequency are reliable indicators of whether a hypothetical change will take place or not, which is best explained by a usage-based account of morphological change.

2.1.1. Diachronic data

The data will consist of a corpus of attested analogical changes to the paradigms of Greek verbs, over the course of about one thousand years of history, from the eighth century BC, when the first literary texts and alphabetic inscriptions are found, to the end of the fourth century AD. I have chosen this particular period for two main reasons: firstly, it is richly documented, giving the best possible chance of finding enough attestations of the verbs I am looking at to draw meaningful conclusions about the changing shape of their paradigms over time. Secondly, during this period Greek was a living language, transmitted through first language acqusition and spoken over substantial geographical areas, whereas in some periods and places it has been largely confined to liturgical, literary or administrative purposes. This maximises the chance of finding authentic forms which were used in spoken language, rather than self-conscious literary forms. Although only examples of analogical changes which took place during these periods will be included in the data, they will be considered in the light of the earlier and later history of the language when appropriate.

The data will be drawn exclusively from the historical period, excluding any examples of analogy which are conjectured for prehistory. This is in order to avoid prejudicing the data by inputting into it any of the assumptions about language change on which reconstructions are based. For the same reason, changes which could in theory have a purely phonological explanation will also be excluded.

Although analogy is thought by many to take place in all levels of language – phonology, morphology, syntax and semantics – this study will be exclusively concerned with morphological change. This is of course necessary because of space and time limitations. However, even without these practical obstacles, it would be methodologically preferable to examine diachrony at each level of language separately before attempting to come up with a unified theory of language change. Morphology is the natural starting point for an investigation of analogy, since its effects are most visible there. If synchrony requires an autonomously morphological level of description (see section 1.6), there is strong reason to suspect that diachronic laws affecting morphology will also be most concisely stated at the morphological level, even if it eventually turns out that the same general mechanism underlies some or all types of phonological, syntactic and semantic change.

In the initial phase of data collection, I looked for all examples of analogy affecting the paradigms of the fifty most common verbs in Greek,[35] by lexical frequency, in various online databases of texts: (1) UC Irvine's *Thesaurus Linguae Graecae* (stephanus.tlg.uci.edu); (2) papyri.info (produced by the Duke Collaboratory for Classics Computing and the Institute for the Study of

[35] Calculated using the Perseus Project's vocabulary tool (perseus.tufts.edu/hopper/vocablist) from a corpus consisting of the following authors and texts (chosen to represent a range of periods and genres): Homer, Strabo, Sophocles, Aristophanes, Aristotle, Lysias, Lucian, Polybius, and the New Testament.

the Ancient World); (3) The Packard Humanities Institute's database of Greek inscriptions (epigraphy.packhum.org).

When the same type of change turned up several times in different lexical paradigms, I moved away from individual lexemes and identified the class of verbs for which the type of change in question was relevant: thus in chapter 4, I will examine changes in the paradigms of a group of verbs exhibiting unpredictable alternations of lexical allomorphy, and in chapters 5-6, I will look at changes in a population of verbs with irregular person/number suffixes. By using individual lexemes as the starting point of investigation, my purpose has not been not to restrict the study to morphological changes which take place in the environment of individual lexemes, but to make it systematic. Since it is obviously impossible to catalogue every example of analogy in the history of the entire language, the study will be limited to a corpus of changes which are manifested in some attested part of a specific group of lexical paradigms. This is to avoid selection bias: the arbitrary corpus serves as a sample from which to draw inferences about the language as a whole, and languages in general.

The choice of verbal paradigms, rather than, for example, nominal paradigms, is partly arbitrary. Verbs seem especially appropriate, however, as they tend to have particularly extensive paradigms. This is certainly the case for Greek, whose regular verbal paradigm has at least 206 inflected members, at a conservative estimate.

2.1.1.1. Data preprocessing

I entered each example of analogy into a database, along with the following information:

- Where and when each analogical form is attested;
- The part of the paradigm affected;
- Every possible paradigmatic source of the change;
- Whether or not it can be regarded as proportional, and if so, every potential model it could have been based on;
- Whether it involves the reduction or extension of allomorphy, or both;
- Whether it involves change to affixes, stems, or both;
- Whether it involves the replacement of or introduction of a competitor to a previous form, realises a previously defective paradigm cell, or is a new derivational coinage;
- Whether it can be understood as a part of various broader trends in Greek, for example, the loss of the middle voice, or the loss of the synthetic future.

Much of this information takes the form of binary feature tags, making it possible to easily obtain counts and proportions of analogical changes which satisfy a given set of criteria. The database structures the data in a way that makes it easy to answer questions like "how many examples of levelling are non-proportional?", or "what proportion of examples of extension of affix allomorphy are from the singular to the plural, versus the opposite direction?"

2.1.2. Synchronic data

This thesis will also use various forms of synchronic data. Chapter 4 uses a synchronic dataset on the type frequency of patterns of invariance of the lexical morpheme between subsets of paradigm cells represented by principal parts, and compares this to patterns of subsequent levelling in the same population of verbs. Chapter 6 examines the role of the synchronic token frequency of different combinations of person and number to analogical developments in the distribution of person/number suffix allomorphy. These chapters explain how I obtained these synchronic datasets (ch. 4: 3.2.1; ch. 6: 2.5).

2.2. Systematicity

Much work on analogy is potentially compromised by selection bias. Quite reasonably, authors choose examples of analogy which illustrate particularly well the points that they wish to make, but without any method of making sure that these examples are representative, it is impossible to draw conclusions about the tendencies of analogy in general. We have seen in the previous section how the claim that analogy always involves simplification of grammar was gradually watered down to the point of triviality, when empirical evidence which had not originally been taken into account was considered. The only study of analogy I know of which uses a systematic corpus is Mańczak (1958). This consists of examples of analogy collected from a set of French, German and Czech etymological dictionaries, but suffers

from various other limitations (1.4). My solution to this problem has been to delineate an arbitrary corpus by cataloguing every securely attested example of analogical change affecting a set list of verbal paradigms, as described in 2.1.1 above.

Another problem with many existing studies on analogy is that they are not sufficiently predictive to be of practical use. This is particularly true of Kuryłowicz's 'laws' of analogy (1949), which freely admit exceptions, but do not state the conditions under which exceptions can take place. For example, law II ("analogical developments follow the direction 'basic form' → 'derived form', where the relationship between basic and derived forms is a consequence of their spheres of usage") appears to be contradicted directly by law III ("a structure consisting of a basic member and a subordinate member forms the foundation for a basic member which is isolated, but isofunctional"). By using a large, structured dataset, which can be searched and analysed statistically, I have been able to measure the relative strength of such tendencies, and observe the conditions under which they are contradicted. This is crucial, since a list of tendencies alone is of little practical use in constraining the use of analogy in historical work.

2.2.1. Reconstructed data

Existing work on analogy, particularly that of by Kuryłowicz (1949) and Mańczak (1958, 1978, 1980), has been based on both attested and reconstructed linguistic evidence, with little distinction being drawn between the two. Regardless of whether the reconstructions involved are correct, it is methodologically unsound to base a study of the nature of analogical change

on reconstructions which themselves make certain presuppositions about the object of investigation. I have avoided this problem by excluding examples of analogical change which are not securely attested in the historical record (see also section 3).

2.2.2. Typological bias

The work of Carstairs-McCarthy and Albright (1.6) makes specific and testable predictions about morphological change. However, in both cases the predictions are extrapolated from a sample of languages in which irregularity is structured by inflection class.[36] This is not the case for Greek verbs, as I will show in chapter 2. Therefore, using Greek as the source of data reduces a typological bias in existing work on morphological change.

3. METHODOLOGICAL PROBLEMS

The following paragraphs will discuss some of the methodological problems I have encountered in collecting the Greek data described in 2.1, and how I have attempted to solve or at least limit them.

3.1. Mistakes and artificial forms

Perhaps the most difficult of these is distinguishing genuine examples of linguistic innovation from sporadic 'mistakes' (e.g. spelling mistakes, non-native errors) and self-conscious literary forms. The former are especially

[36] See chapter 2 for a precise discussion of what is meant by the term 'inflection class' (2.1-3).

likely in relatively colloquial texts from the Greek empire in the Hellenistic and Roman periods, particularly papyri. Mistakes are not too difficult to exclude if one takes into account contemporary phonology. For example, a third century AD papyrus has 2sg *eídeis* [iðis] for *oídeis* [yðis] 'you (sg) know'.[37] At first glance, this might seem like a semantic updating of the etymologically perfect but semantically present stem of *oîda* 'know', based on the pattern of e.g. *leípō* 'I leave' ~ *léloipa* 'I left', but since <*oi*> and <*ei*> were differentiated only by lip rounding by this point, and on the way to merging completely, it is impossible to prove that it is anything other than a simple spelling mistake.

In addition to phonology, it is also necessary to consider wordforms in the context of the texts in which they appear, and the wider linguistic context. A form like *epeleúsasthai* for *epeleúsesthai* 'to proceed against' in the Ptolemaic papyri appears to consist of the aorist infinitive ending *-asthai* attached to the future stem *epeleus-*. The form could plausibly be regarded as an error; the pitch accent of classical Greek had by this time developed into a stress accent, and unstressed vowels are frequently misspelled, reflecting a less careful articulation which would be especially liable to be misheard by non-native speakers. In this case, however, the evidence suggests that *epeleúsasthai* is a genuine morphological variant of the future infinitive, extending the functional and formal syncretism of the future indicative and aorist subjunctive in regular verbs, which arose because of the loss of distinctive vowel length in contemporary Greek. The relatively high frequency of the form supports this analysis: *epeleúsasthai* is found 97 times in papyri of the late second century BC to the seventh century AD, compared with 275 counts

[37] P.IFAO 2 18.

of *epeleúsesthai*. We can be sure that *epeleúsasthai* is intended as a future rather than an aorist infinitive, because it is most often attested in semi-formulaic passages of sales contracts: "so-and-so agrees to the sale and not to proceed against (it) (in future), make any further claim". Where *epeleúsesthai*/*epeleúsasthai* is replaced by an alternative verb, it is explicitly future rather than aorist.

Artificial forms are found in all periods of Greek, starting with the literary Ionic of Homer, which draws on a mishmash of geographical and historical dialects to create metrically useful hybrid forms which do not necessarily correspond to any real spoken form. Classical literature is likewise full of linguistic imitation, both of the Homeric *Kunstsprache* and idealised versions of the geographical dialects. With the emergence of the Koiné in the third century BC, the administrative language of the empire gradually accumulated enough prestige to be suitable for some literary purposes, bringing the spoken and literary languages closer together to varying extent in areas such as science, philosophy, religion, and biography. This was partly undone by the revival of literary 'Atticism' in the first century BC, and again with the 'second sophistic' of the second century AD, but some genres, such as patristic writings, remained relatively close to the spoken language. Like mistakes, artificial forms can be excluded with reasonable confidence by being aware of sociolinguistic context. Forms which are widely attested will be more likely to reflect genuine changes in the spoken language, and certain genres of text will be more reliable than others. Particularly important evidence for the spoken language is provided by non-literary dialect inscriptions, whose language is based closely on spoken local varieties before the emergence of the Koiné as a standard language of administration. Non-

literary papyri are also an excellent source of evidence for developments in the spoken language (although the possible interference of substratum languages always has always to be kept in mind), because they were generally intended as temporary documents written for some practical purpose, and written in an accordingly straightforward, unpretentious manner. Personal letters are especially interesting linguistically, as they were often written by people who had not been subjected to the homogenising education that bureaucrats received.

With sensitivity to context and common sense, it is generally possible to make reasonably confident judgements of whether a particular attested form represents a real linguistic innovation. Sometimes, the evidence is not strong enough to make a decision either way, and in these cases I have excluded the relevant forms from the data to be on the safe side. Ultimately, however, it is impossible to look at language change in complete isolation from extraneous factors such as dialect/genre imitation and second-language learning. These factors exist in all language communities to some extent. Even in societies which are both monolingual (which is the exception, rather than the rule) and illiterate (which is increasingly becoming exceptional), variant forms of the language exist, which inevitably take on social nuances, and are therefore imitated for all sorts of non-linguistic purposes. Since these non-linguistic factors are part of the very mechanism of change, it is both impossible and undesirable to exclude them entirely from an investigation of language change.

A further note is required on lexicographical and grammatical texts, which started with the Alexandrian grammarians of the third and second centuries BC. The enduring prestige of classical and archaic Greek literature in the

Hellenistic world, and a newfound philosophical interest in language, led to an abundance of grammatical and lexicographical treatises making sense of the language of earlier literature and recommending 'correct' use on its model. These texts sometimes preserve earlier forms which are not found anywhere else, and they are a valuable source of information on contemporary forms (often in the context of condemning them), but they also prescribe forms which are inauthentic to historical as well as contemporary use for ideological reasons. Distinguishing between these cases would require additional time disproportionate to the extra data it would yield, since most of the forms which reflect genuine usage are also attested elsewhere. For this reason, I decided to exclude these texts categorically rather than examine each attestation on a case by case basis.

3.2. Incompleteness of the evidence

Because of the patchiness of the historical record, it is not always possible to determine the scope of a particular change. Several aspects of this problem are demonstrated in the merging of the weak and strong aorist paradigms, which is a long-term process in Greek, beginning in prehistory and finishing in the Byzantine era.[38]

[38] The weak and strong aorist are alternative perfective paradigms, which in the indicative also indicate past tense. The weak aorist, which has the highest type frequency, is characterised by a suffix *-s-* attached to the verbal root (sometimes lost through phonological change), and a particular set of endings, the majority of which have the vowel [a]. The strong aorist is used by a relatively small but frequent set of verbs, and is usually accompanied by a different form of the lexical morpheme from the present. It does not have its own set of endings, but shares those of the present in non-finite forms and the subjunctive and optative, while the indicative has the endings of the imperfect. These generally differ from the weak aorist endings only by having [o] or [e] where the weak aorist has [a]. The indicative forms are given below:

	paúein 'to stop'	*lambánein* 'to take'
1sg	é-pau-s-a	é-lab-on
2sg	é-pau-s-as	é-lab-es
3sg	é-pau-s-e(n)	é-lab-e(n)
1pl	e-paú-s-amen	e-láb-omen
2pl	e-paú-s-ate	e-láb-ete
3pl	é-pau-s-an	é-lab-on

Firstly, because paradigms tend to be incompletely attested, it is often unclear how much of a paradigm is affected by a change. When we come across a form like *aneipátō* ('let him proclaim') in a fourth century BC inscription,[39] should we assume that the writer would have said *aneîpa* or *aneîpon* ('I proclaimed'), and *aneîpai* or *aneipeîn* ('to proclaim')? Should this be treated as a change to the whole paradigm of *aneîpon*, just the 3sg imperative, or something in between? When we find variation between two sets of forms, this can be interpreted as a single mixed paradigm belonging to a single grammar – like *eîpon* in classical Attic, which has weak aorist endings in the second person forms and strong aorist endings elsewhere – or two competing paradigms, belonging to two variant grammars. The choice of interpretation depends on the conditions of the variation. Where the choice between two sets of forms (such as the weak and strong aorist suffixes) is conditioned mainly by morphosyntactic categories like person and number, the former interpretation is more apt; where the choice is governed by sociolinguistic factors like style or register, it is more likely a case of competing paradigms. Even if we had complete evidence, though, this would be a slippery distinction, with real-life situations falling on a spectrum between the two theoretical poles, and in practice the incompleteness of the evidence makes it very difficult to draw firm conclusions about the conditions governing the distribution of variants. This is partly because of the difficulty of factoring out other sources of variation such as historical period, dialect, genre, sociolect and individual style, and partly because paradigms are rarely attested extensively enough to constitute a fair sample for statistical inference. These problems can only be overcome where a large body of stylistically consistent

[39] IG II^2 1186.19.

text is available from closely contemporary authors, or ideally a single author, which contains enough attestations of the relevant paradigms to draw conclusions about the conditions on their distribution. This is sometimes possible, but more often not. For example, Herodotus almost always uses the weak aorist forms of *eîpon* in participles (the *Histories* contains 57 inflected forms of *eípas*/*-asa*-*an* 'having spoken' (masc./fem./neut.), compared to only 6 of *eipṓn*/*oûsa*/*ón*, but prefers the strong aorist in the infinitive (*eipeîn* 'to speak' is found 93 times, compared to 11 counts of *eîpai*). This suggests a regular paradigm of *eîpon* which uses a mixture of first and strong aorist endings, but still alternating in some grammatical categories with more marginal variants.

Secondly, because attestations are so few, it is impossible to get detailed statistics which would indicate to what extent a particular change is lexically or grammatically conditioned. Again, the distinction is gradient rather than binary. *Eîpon* is the first of the strong aorist verbs to be transferred to the weak aorist during the historical period.[40] In the beginning this change is limited to the second person, and gradually it spreads to the rest of the paradigm. At this stage, we are still dealing with a change in the environment of a particular lexeme. Around the third century BC, the change begins to spread to other verbs, particularly *êlthon* 'I came'. At first, there is still a significant amount of lexical conditioning, which is gradually reduced as the change spreads to all the original strong aorists. Nonetheless, some variation between individual lexemes remains: *eîpas* 'you spoke' is retained alongside *eîpes* well into the Koiné, while *êlthas* 'you came' is not found until the first century AD, and never overtakes *êlthes* as a standard, although the other weak aorist forms of the indicative are already starting to make headway in

[40] A weak aorist paradigm of *énegka* 'I bore' is attested alongside the strong aorist from the earliest literature (Homer uses *éneika*).

the iii BC Septuagint. Retrospectively, by the time all eligible lexemes have been affected, the environment of the merger was the entire class of verbs originally having strong aorists. Subsequently, alongside a functional merging of the perfect and aorist, this change begins to extend to etymological perfects, starting in words where the feature +perfect is least synchronically transparent (*oîdes* 'you know',[41] for example, is found as early as the first century AD, and 3pl *oîdan* from the second century). Eventually this process results in a regular Byzantine preterite paradigm which alternates between originally weak and strong aorist endings (6). At this point, we can say that the environment of the change is the aorist.

(6)

1sg	*-(s/k)a*
2sg	*-(s/k)es*
3sg	*-(s/k)e*
1pl	*-(s/k)amen*
2pl	*-(s/k)ete, -ate*
3pl	*-(s/k)an (-asi)*

This gradual progression of analogical change from a specific lexical environment to broad grammatical and semantic categories is particularly interesting because it bears a clear resemblance to lexically diffused sound change. I have tried to answer these questions of scope as far as the textual record allows, but where there is simply not enough evidence, I have erred on the side of caution by assuming only the forms which are attested actually existed. Because I am looking at statistical tendencies over a large set of data,

[41] For *oîdas*. *Oîda* is semantically present (non-perfect), but formally it takes the same suffixes as the regular present perfect.

rather than basing inferences on any individual change, this should not threaten the validity of my results.

3.3. Ambiguous data

Another problem is distinguishing innovation from inheritance, that is, telling apart analogical creations from mere spreading of geographical variants, which may or may not themselves be originally analogical. For example, Homer generally uses the strong aorist endings of *eîpon*, apart from the second person plural which is always *eípate*, and the second person singular, which alternates between *eîpas* (found twice) and the more common *eîpes*/*éeipes* (47 times). Later Ionic literature varies more freely between the two sets of endings; Herodotus tends to prefer the weak aorist in the finite verb and participle, but the strong aorist in the infinitive, imperative, and 1sg indicative. Meanwhile, Attic retains the strong aorist except in second person forms, until the late fifth century when the weak aorist alternatives begin to creep into literary texts. We cannot know whether weak aorist forms of *eîpon* in Attic are examples of spontaneous analogy or just gradual adoption of the standard Ionic forms. In these situations it seems best to judge on a case-by-case basis. If a particular form is not attested before a certain point where it can reasonably be expected to occur – i.e. if sufficient earlier texts exist, in which the form under consideration is not attested but its predecessor is – then it can be reasonably assumed to be an innovation. If a particular form or set of forms is attested in an earlier period in a different dialect, particularly where borrowing from that dialect is already established for the period, we are more likely to be dealing with the geographical spread of variants (the

same is true in theory of sociolects, but less easy to determine from the historical record). In this case, it seems that the weak aorist forms of *eîpon/eîpa* are an indigenous innovation in Ionic, because Homer almost exclusively uses the strong aorist forms, even though most of them are metrically equivalent to their weak aorist counterparts. When the same forms occur in late fifth century Attic, they are more likely to be simply adopted from Ionic than independently innovated, since they are attested in an earlier period in Ionic, Ionia and Attica were always in close contact, and Ionic influence on Attic was particularly strong in this period.[42]

These are just a few of the ways in which the data can be ambiguous, sometimes irreconcilably so. As another illustration, an apparently athematic aorist *(é)génto* 'he/she/it became', for *egéneto*, is occasionally found.[43] Assuming *égento* is the innovated form (which is not in fact clear), there is no principled reason for judging whether it is an analogy based on the athematic verbs, or a syncopated form of *egéneto* (as argued by Szemerényi)[44]. In cases like this, where innovations may plausibly be purely the result of sound change rather than analogy, I have excluded them from the data. Sometimes the ambiguity is between morphological analogy and phonological analogy.

[42] The distinction is somewhat artificial, however. The structural pressures which led to this analogy taking place in Ionic also existed in Attic and probably created a favourable environment for it to be borrowed, once it had come into existence; moreover to take hold in a dialect in which it is 'indigenous' an analogy must spread from the level of individual speaker(s) to the community, a process which is presumably different only in scale from borrowing between dialects. Thus morphological change can be understood as involving the essential mechanisms of both borrowing and creation at all stages. The reason for drawing a distinction at all is that dialect borrowing can also occur for all sorts of reasons which have nothing to do with analogy, so the way analogical innovations spread geographically provides less direct evidence of the factors constraining analogy than the way they proceed within a specific community.

[43] Athematic verbs form a significant subclass in Greek, including some of the most common verbs such as *eimi* 'be' and *phēmí* 'say'. Historically speaking, they lack an ablauting vowel (*e*/*o*) between the verbal stem and the ending which characterises the more productive thematic conjugation. Because of the effects of consonant loss and vowel contraction, the formal relationship between the thematic and athematic endings is not always obvious, but in the case of *égento* versus *egéneto* it is clear.

[44] Szemerenyi (1964), 168-188, cited in Chantraine (1968), *γίγνομαι*. If Szemerenyi's analysis is correct, this would have to be considered a non-regular sound change, as there is not much evidence for syncope in Greek.

For example, in later Greek sources many forms ending with vowels alternate with forms ending in an additional final *n*, often with a convincing morphological motivation.[45] However, any morphological explanation is rendered superfluous, strictly speaking, by the fact that syllable-final /n/ was increasingly liable to be realised as a nasalised vowel or lost entirely during the development of Greek, starting in the Classical dialects.[46] It is therefore possible to regard hypercorrect insertion of *n* as a mere reanalysis of underlying phonology, similar in origin to the hiatus-avoiding [r] of some non-rhotic English varieties, extended from contexts where it is etymologically justified (*motor* [-ə] vs. *motor* [-ər] *oil*), to those where it is an intruder (*law*[r] *and order*; *draw[r]ing*). Though morphological change can come about through phonological analogy or indeed sound change, the motivation for these changes is extramorphological, and so I have also excluded examples which are ambiguous for these reasons.

Other times, though an innovation is undoubtedly morphologically motivated, it is unclear how it should be analysed. The thematised form *dúnomai* for *dúnamai* 'I can', relatively common in papyri of the second century BC, may either reflect an analysis of [a] in *dúnamai* as a phonological error for /o/, on the model of thematic middles (cf. *hépomai* 1sg, *hépetai* 3sg 'follow'), or a proportional analogy based e.g. on resonant-final verbs with compensatory lengthening from loss of [s] in the aorist middle, e.g. *ekeírato* 'he/she/it was cut off' : *keíromai* 'I am cut off' = *edúnato* 'he/she/it was able' :

[45] For example, starting in the late Hellenistic period, third declension accusative singulars in *-a* start to appear as *-an*, with the phonological analogy presumably being reinforced by *-n* in the accusative singular of vowel-stem paradigms. This led first to the back-formation of nominative singulars in *-a*, (e.g. *Helláda* for *Hellás* 'Greece') and then the merging of the entire third declension (to which originally consonant stem nouns belonged) with the a-stem paradigm.
[46] Horrocks (1997), 113.

dúnomai 'I am able'. The latter analysis makes the change proportional, whereas the alternative makes it non-proportional.

In theory, it is impossible to prove that any example of analogy is proportional: even if a suitable model exists, we cannot prove that the analogy was actually based on this model. On the other hand, if no suitable model exists in the language, we can be certain that the analogy is non-proportional. Where potential models can be found, I have put aside my own intuitions about their plausibility and treated the relevant form as proportional. This leaves me with relatively few clear examples of non-proportional analogy. If it turns out that the non-proportional and the ambiguous examples differ only in the absence or existence of a suitable model, the case for treating proportional and non-proportional analogy as separate categories will be severely weakened.

3.4. Problems with paradigms

One problem for delineating the scope of this study is that the boundaries of paradigms are often indistinct. It is not clear to what extent compound verbs should be included, for example, as in Greek they tend to lie somewhere between productive derivations of simple verbs and lexicalised verbs in their own right. I have made the decision to include compound verbs when collecting examples of analogy, since many interesting forms are found only in compounds. However, I have taken care not to assume that simple and compound verbs inflect in the same way, where there is no textual evidence that this is the case.

In the initial phase of data collection, I included derivational coinages like *deidíssomai* 'frighten' from *deídō* 'be afraid' on the arbitrary criterion of whether they are mentioned in Chantraine's *Dictionnaire étymologique de la langue grecque* (1968). These have been used only as examples to illustrate broad trends in the development of Greek, as the quantitative studies in chapters 4-6 have focussed purely on change to inflectional paradigms.

I have included etymologically unrelated verbal formations as part of the same paradigm where there is sufficient evidence that they are in a suppletive relationship. For example, *eîpon* has been treated with *légō* rather than *phēmí*, although both mean 'speak', because like *légō* it favours a finite clause introduced by *hóti* or *hṓs* ('that') to express indirect speech, whereas *phēmí* and *éphēn*/*éphēsa* 'spoke' are only used with the accusative and infinitive construction.

4. THESIS STRUCTURE AND RESEARCH QUESTIONS

In chapter 2, I will describe the synchronic system of Greek verbal morphology, and in chapter 3 I will give a broad overview of its long-term development from Proto-Indo-European to Modern Greek. In part two, I will analyse the evidence of the Greek data described above (2.1) for a number of open theoretical questions about analogy:

i. Is levelling motivated by a preference for one-to-one alignment of meaning and form? (Chapter 4)

ii. Is the diachronic redistribution of affix allomorphy motivated by universal constraints on paradigm structure? (Chapter 5)

iii. How does synchronic type frequency affect the diachronic productivity of a morphological pattern? (Chapter 4)

iv. What is the theoretical status of non-proportional analogy? (Chapter 4, chapter 7)

v. What determines the direction of levelling? (Chapters 4 & 6)

vi. How does the token frequency of a form affect the probability that it will be remodelled analogically? (Chapter 6)

vii. How does token frequency affect the probability of a form bringing about the remodelling of other forms in its paradigm? (Chapter 6)

Finally, in chapter 7, I will consider the findings of the previous chapters and their implications for synchronic theories of morphology.

Chapter 2: Greek verbal morphology

This chapter will give a synchronic overview of the Greek system of verbal morphology, in order to explain and contextualise the phenomena whose diachronic development will be examined in detail in part two (chapters 4-6). In section 1, I will define some important technical terms, and explain and justify the descriptive framework used in the rest of the thesis. In section 2, I will examine some of the theoretical devices which have been used to describe and explain systems of inflectional morphology. In section 3 I will make some observations about the Greek system, paying particular attention to phenomena which are difficult to incorporate into existing theoretical frameworks, and draw some theoretical conclusions which will have implications for the diachronic studies of the next chapters.

The predominant aim of this overview is to make some generalisations about paradigm structure and the distribution of allomorphy in the Greek verbal system, by developing a more precise and technical articulation of traditional word-and-paradigm treatments as presented in school grammars, incorporating insights from both recent realisational theories of morphology and structuralist morphemic analysis. For general treatments of ancient Greek verbal morphology, see Duhoux (2000), Chantraine (1991) and Rix (1992).

1. Terminology and methodology

1.1. Morphosyntactic features

Morphosyntactic features are elements of grammatical 'meaning' which

languages tend to express by means of morphology and/or syntax (I will not make a distinction between morphosyntactic and morphosemantic features). For finite verbs in Classical Greek, the features which can be expressed by inflectional morphology are organised along seven morphosyntactic variables (I have chosen to analyse the perfect as an independent variable from aspect or tense). Various mutually exclusive values are available for each of these variables, which are summarised in table 1.[1]

Variable	**Possible values**
Tense	Past, present, future
Aspect	Perfective, imperfective
Mood	Indicative, subjunctive, optative, imperative
Voice	Active, middle, passive
Perfect?	Perfect (-perfect)
Number	Singular, dual, plural
Person (subject)	First, second, third

Table 1: Morphosyntactic variables and values in the Greek verb

1.2. Paradigms

The 'paradigm' of a lexeme (a lexical paradigm) refers to the full set of inflected words belonging to that lexeme, i.e. a maximal set of words which share the same lexical meaning, and differ only in morphosyntactic features.

[1] I have chosen to analyse the perfect as a morphosyntactic category in its own right, rather than a value for either aspect or tense. In Classical Greek the perfect is compatible with multiple tenses (future, present and past), so cannot be considered a tense, although it shares with the past tense its ability to place the event of the verb in the past, relative to some reference point. Perfect forms do not mark a morphological distinction between perfect and imperfective aspect, but this does not necessitate analysing it as a third value for the same variable, since neither the future nor the present do so either. Semantically, the perfect expresses a range of values distinct from and not in theory incompatible with the binary distinction between perfective and imperfective aspect made elsewhere (cf. 'I have eaten', 'I have been eating'). Furthermore, the way that the Classical perfect interacts with the morphological expression of voice is different from either perfective/imperfective aspect or tense: like the imperfective subparadigm, the perfect only makes a binary distinction between active and mediopassive instead of a ternary distinction between active, middle and passive (see ch. 5: 1.2.1), except in the future perfect, where only mediopassive forms are available. On the history and semantics of the Greek perfect, see Wackernagel (1904), Chantraine (1927), Jasanoff (1978), Ruijgh (2004), Sicking and Stork (1996), Haug (2004, 2008), Gerö & von Stechow (2003).

By the paradigm of (e.g.) the Greek verb, I mean the full set of morphosyntactic feature combinations which Greek allows verbforms to have as the non-lexical part of their meaning, i.e. a *set of sets* of morphosyntactic features. These morphosyntactic feature combinations define *paradigm cells*, e.g. [past perfective indicative active first person singular], which are realised by wordforms belonging to specific lexemes, in combination with the lexical meaning (table 2).

Wordform	**Lexeme**	**Paradigm cell**	**Value realised**
élipon	LEÍPŌ 'leave'	[past perfective indicative active first person singular]	[LEAVE past perfective indicative active first person singular] = **'I left'**
pépauntai	PAÚŌ 'stop'	[present perfect indicative mediopassive third person plural]	[STOP present perfect indicative mediopassive third person plural] = **'they have been stopped'**

Table 2: the realisation of paradigm cells by wordforms

The paradigm of the Greek verb therefore places an upper limit on the number of members in the lexical paradigm of any individual verbal lexeme. Defective verbs lack wordforms for certain ('empty') paradigm cells: for example, impersonal verbs like DEÎ 'it is necessary' lack first and second person forms.

1.3. Morphemes

The morpheme, the minimal meaning-bearing unit of language, was made central to linguistic theory by the American structuralists and has been adopted in largely unaltered form into most theories of the generative school. Languages with predominantly isolating, agglutinative or analytic word

structure are generally well-suited to a morpheme-based analysis, because a Bloomfieldian morpheme is essentially an arbitrary conjunction of meaning and form, and these kinds of language conjoin form and meaning in a relatively straightforward way. That is, they tend to avoid discontinuous morphemes, empty morphs, cumulative morphemes, syncretism, and suppletion, at least to the extent that they can be regarded as eccentricities, and perhaps completely in the case of isolating languages.[2]

Bloomfieldian item-and-arrangement morphology[3] consigns all arbitrary meaning-form correspondences, including bound morphemes, to the lexicon. However, in synthetic languages it is often difficult to assign a single distinct value to affix morphemes which convey grammatical information in words. The suffix -*ō* simultaneously conveys masculine gender, singular number and either dative or ablative case in Latin nouns, in a single phonological segment. To complicate things further, it is conditioned not only by morphosyntactic features such as case and number, but also by the inflection class of the noun stem it attaches to, a purely morphological piece of information which has no repercussions for either syntax or semantics. These phenomena are no less problematic under the item-and-process approach of most generative treatments of morphology; problems of assigning a meaning to affix morphemes are merely recast as problems of specifying the (syntactic or lexical) environment of a morphological or phonological rule.

These considerations led Matthews (1972, 1991) to reconsider inflection in terms of morphological *exponents*: phonological sequences which 'spell out' (groups of) morphosyntactic features in words. Under this approach, inflected words, rather than morphemes, are the minimal meaning-bearing units of

[2] Aronoff (1994: 165) concludes that morphology cannot be necessary, since isolating languages do without it (see Maiden 2008 for an alternative suggestion).
[3] As exemplified in Bloomfield (1933).

language. Lexical entries may be indexed for inflection class membership, allowing the realisation rules which determine how features are expressed in full word forms to be conditioned for inflection class. Similar realisation-based approaches have been followed by e.g. Anderson (1992), Aronoff (1994), and Stump (2001).

1.4. Assigning meaning to morphs

To avoid prejudicing my results by analysing the Greek data in a way that presupposes a certain theory of morphology, I will remain agnostic, for the time being, about the nature of the lexicon and the appropriate linguistic units to which meaning should be ascribed. I will use the term 'morpheme' as a purely descriptive term, without implying a morpheme-based model of morphology. By 'morpheme', I mean a morph[4] which can be associated consistently with some element(s) of meaning.

Because Greek is a highly inflected language, with most morphs appearing only in the context of larger wordforms, it is often unclear which elements of a wordform's meaning should be associated with which elements of its form. My heuristic for associating meaning with morphs in this thesis has been to ask myself the following question: if we consider the full set of possible words[5] in the language, each one with a meaning consisting of elements like

[4] By a morph, I mean a maximal phonological sequence which recurs within and across lexical paradigms. In addition a morph may include information about the position of this sequence in the word. For example, the prefix ('augment') *e-*, which denotes past tense in Greek, is a different entity from the suffix *-e*, which indicates a third person singular subject.

[5] To simplify the exercise, I have considered only the full set of words belonging to verbal paradigms. This makes the idealisation that the organisation of words into paradigms precedes morphological analysis.

[LEAVE past perfective indicative active first person singular], what conditions best describe where each morph appears?[6]

The starting point in answering this question is to identify groups of words which share some element(s) of meaning in common. The next step is to look for shared phonological sequences within these groups, and attribute the shared element(s) of meaning to the shared phonological sequences as an initial hypothesis. We then test the hypothesis by finding words whose meanings differ from the first set of words only in the element(s) of meaning we have identified, and checking that the phonological sequence we have associated with it does not also appear there. If this test is successful, we go through the same steps for the remaining elements of meaning in the original set of words, and so on, ideally aiming to assign a unique phonological sequence to each unit of meaning (although this is often impossible in practice, so that multiple suboptimal analyses have to be weighed against each other).

For lexical morphemes, the answer will be primarily in terms of lexical meaning. The sequence *leip* appears generally in wordforms having the lexical meaning LEAVE as part of their value (1a), so I have assigned it the meaning 'leave'. Grammatical morphemes consistently appear in wordforms having certain (groups of) morphosyntactic features as part of their value. For example, the word-final sequence *-ei* appears in wordforms with [third

[6] Coming up with a full set of conditions for every morph requires balancing local and global considerations of economy. For example, from the point of view of the lexical morpheme, it would be preferable to segment *baléō* 'I will throw', *baléeis* 'you (sg) will throw', etc. ([balô, ballÊis] in Attic: see 1.5) as *bal + éō*, *bal + éeis*, because the sequence *bal* is also found in *ébalon, ébales,* etc. 'I , you (sg) threw'. From the perspective of the grammatical morpheme, it is preferable to segment *baléo* as *bale + ō,* and *baléeis* as *bale + eis,* because *-ō* and *-eis* are also found in many other 1sg and 2sg forms, such as *paúō, paúeis* 'I, you (sg) stop'. The former analysis requires adding a new allomorph to the inventory for each combination of person and number, while the latter analysis requires adding one new allomorph for the lexical meaning THROW. On the criterion of economy, I have chosen the latter analysis for presenting examples and encoding the input data for chapters 4-6, but under the approach to morphology I will eventually argue for, the distinction is moot (see section 4).

person, singular] as part of their value (1b), so I have assigned it the value '3sg'. In Greek, grammatical meaning is associated with prefixes, affixes and stem alternations, while lexical meaning is expressed by stems, i.e. following prefixes, and preceding suffixes.

(1a) *leípei* 'he/she/it leaves'
leípsō 'I will leave'

(1b) *leípei* 'he/she/it leaves'
leípsei 'he/she/it will leave'
paúei 'he/she/it stops'

In a language which had a perfectly biunique relationship between meaning and form, it would be possible to state necessary and sufficient conditions for the distribution of each morph. In practice Greek falls short of this 'ideal' state, like most languages. For *leip* and *-ei*, it is only possible to state necessary conditions; they appear *only* in wordforms with the values LEAVE and [3sg, active], respectively, but they do not appear in *all* such wordforms (table 3).

Wordform	**Meaning**
léloipa	[LEAVE present perfect active indicative first person singular]
títhēsi	[PUT present active indicative third person singular]

Table 3: alternative forms corresponding to the meanings LEAVE and 3sg

When the same meaning can be attributed to more than one form, we have a case of allomorphy**:** *loip* and *-si* in table 3 function as allomorphs of *leip* and *-ei*. Sometimes it is possible to describe the distribution of an allomorph fully

by introducing secondary semantic and/or phonological conditions,[7] but not always. In both of the examples given the allomorphy is phonologically and semantically arbitrary, and depends purely on the inflectional habits of the lexeme involved.

Sometimes, it is not possible even to state necessary conditions for the distribution of morphs. The suffixes *-omai* (1sg), *-ei* (2sg), *-etai* (3sg), *-ometha* (1pl), *-esthe* (2pl), *-ontai* (3pl) are generally characteristic of mediopassive wordforms, but also appear in active wordforms belonging to certain lexemes, particularly deponent verbs (which are active in meaning but mediopassive in form throughout their paradigms: see 3.2.2) and in a considerable number of future forms like *gnṓsomai* 'I will know'. Often, therefore, the value of a morpheme can only be stated in terms of loose, associative conditions. The ending *-omai* appears predominantly in wordforms with middle or passive voice, but not quite exclusively. This means that more than one analysis is possible when assigning values to morphs in Greek. In such cases, I have tried to choose a reasonable analysis for my present descriptive purposes, without forcing a morpheme-based description on linguistic data which is not suited to one.

[7] Various slightly different definitions of 'allomorph' are used in the theoretical literature. On a Bloomfieldian analysis (Bloomfield 1933), morphemes are minimal units of form to which meaning can be assigned. Under this definition, the morphophonemic alternation between the plural suffixes [s, z, əz] in English qualifies as allomorphy of the morpheme *-s*, but the alternation in the formal expression of plural number between *dogs* and *children* does not, if we assume that *-en* represents a different unit of underlying form from *-s*. On a Hockettian definition (Hockett 1947), morphemes are minimal units of meaning to which form can be assigned; under this definition, *-en* and *-s* are allomorphs of the morpheme PLURAL. I follow Hockett's approach in this thesis, because it allows for more interesting generalisations about the relationship between meaning and form.

Within this approach a further distinction can be made. On one definition, *a* and *b* are allomorphs if and only if they express exactly the same (set of) meaning(s). On another definition, *a* and *b* are allomorphs if they express some element(s) of meaning in common. Only on the latter definition are *leip* [LEAVE] and *loip* [LEAVE, active, perfect] allomorphs of the lexical meaning LEAVE. I will use the latter definition, again because it allows for more interesting generalisations about meaning-form relationships. Carstairs-McCarthy's claim that allomorphy does not exist (e.g. 1998) is to be understood under the former definition of 'allomorphy', however (ch. 5).

1.5. Phonology and segmentation

In this thesis, I have chosen an analysis of underlying phonology which minimises allomorphy, so as to isolate strictly morphological alternations as far as possible. For example, in the verb LEÍPŌ, the stem-final *p* (spelt with the Greek letter π) of the present alternates with *m* (μ) and *ph* (φ) in the middle and passive forms (table 4), where the following consonant supplies its voicing and manner of articulation. I have analysed all of these forms as containing underlying *leip*, so as to restrict my dataset of examples of levelling in chapter 4 to those which have a securely morphological rather than phonological motivation.

	Perfect	**Aorist**	**Future**
1sg	*lé-**leim**-mai*	*e-**leíph**-thē-n*	***leiph**-thḗ-s-omai*
2sg	*lé-**leip**-sai*	*e-**leíph**-thē-s*	***leiph**-thḗ-s-ei*
3sg	*lé-**leip**-tai*	*e-**leíph**-thē*	***leiph**-thḗ-s-etai*
1pl	*le-**leím**-metha*	*e-**leíph**-thē-men*	***leiph**-thḗ-s-ometha*
2pl	*lé-**leiph**-the*	*e-**leíph**-thē-te*	***leiph**-thḗ-s-esthe*
3pl	–	*e-**leíph**-thē-san*	***leiph**-thḗ-s-ontai*

Table 4: morphophonological alternations in the paradigm of LEÍPŌ 'leave'

I have not permitted myself to make any phonological analysis involving an underlying form which never appears on the surface, or a phonological rule for which there is no evidence external to the phenomenon under consideration. So, for example, I have analysed [lēm] in *léleimmai* as /leip/, because *leip* is found as a surface form in e.g. present *leípō*, and the phonetic sequence [pm] is never found. I have analysed the 'contract' verbs (see section 3) as *philéō*, *philéeis* etc. rather than *philô*, *philêis*, even though the stem-final

vowel (in this case *e*) does not usually appear on the surface in Attic, because it does appear on the surface in other dialects (most of all Ionic, with which Attic was in very close contact), and because there is ample evidence for vowel contraction as a synchronically productive rule.

I have segmented wordforms into morphs using essentially the same principle as I used to assign values to morphemes (see 1.4 above). My priority was to have as economical as possible a description of the distribution (and therefore value) of morphemes, and I have set morphological boundaries within wordforms where they are most conducive to this goal.

Sometimes, where there is conflicting evidence, I have had to make somewhat arbitrary decisions. For example, the perfect mediopassive forms of a number of verbs have a mysterious *-s-* between the version of the lexical morpheme found elsewhere in the paradigm and the usual endings of the perfect mediopassive (*-mai, -sai, -tai, -metha, -sthe*). Historically, this pattern originated in dental-final stems, but various sound changes and morphological processes have obscured the data so that an analysis of this *s* as an underlying dental stop introduces more problems than it solves. The two solutions I considered was to either segment this *s* with the stem, which would complicate lexical allomorphy but maintain the unity of the perfect mediopassive endings, or to segment it along with the endings so that *-smai* counts as an allomorph of *-mai*, and so on. I decided on the second of these analyses, partly because this allows for the most restrictive definition of levelling, and partly because the fact that this *s* was extended to verbs which never ended in a dental stop in Attic suggests that speakers tended to analyse it as characterising the perfect mediopassive rather than belonging to particular lexemes (the allomorphy *-smai*/*mai* also has a parallel in the passive

morpheme *sthē*/*thē*, which may have been the motivation for this analysis).

Sometimes we find recurring phonological sequences which can be associated loosely with some morphosyntactic meaning, but for which there is a lack of evidence that they were perceived synchronically as independent morphological entities. For example, the sequence *-sk-* is found in imperfective forms of a number of verbs, e.g. *halískomai* 'I am captured'. Historically, it derives from a derivational suffix in Proto-Indo-European. However, it does not usually enter into the kind of alternations which determine meaning: in a form like *halískomai* we can attribute the meaning '1sg' to *-omai*, because it alternates e.g. with *-etai* in *halísketai* 'it is captured', but we cannot attribute the meaning 'imperfective' to *-sk-* in the same way, because the remainder of the wordform (*hali*) never appears without *-sk-*. Nor is *-sk-* diachronically productive during the period covered by this thesis, notwithstanding a few sporadic cases of extension. Therefore, I have considered it part of the present stem, rather than a separate affix.

In collecting and processing my data I was confronted with many such little problems of analysis, and in order to get anywhere I had to make some partly arbitrary decisions. I am not overly concerned by this, because in many cases I do not believe there is ultimately a right or wrong answer. Native speakers of any language also have to deal with conflicting linguistic data. The mere facts of language change, variation and divergence suggest that their analyses vary, and this conclusion is supported by psycholinguistic evidence.[8]

For the practical purposes of collecting, processing and presenting data I have chosen a morphological and phonological analysis of Greek which

[8] For a recent survey, see Dąbrowska (2012).

seems reasonable for descriptive purposes, while remaining as theoretically neutral as possible, so as to avoid prejudicing my results by introducing theoretical assumptions into the data. I offer this preliminary analysis merely as one reasonable account of the Greek verb as an abstract system; in part two of this thesis I will discuss the implications of the results for speaker competence.

2. PROPERTIES OF PARADIGMS

In the following passages I will make frequent comparison to Latin, because it has been extensively discussed in theoretical work on morphology (e.g. Matthews 1972, Aronoff 1994). In section 3, I will use this comparison to highlight some phenomena in Greek verbal morphology which have been overlooked in this theoretical work, and cannot easily be assimilated into the frameworks which have been proposed in it.

2.1. Inflection class

Allomorphy threatens the predictability of form-meaning correspondences because it involves the conjunction of a single unit of meaning to multiple forms, so that meaning on its own does not determine form. There are a number of ways languages can mitigate this unpredictability. In practice, when multiple forms are available to express a single meaning, some aspect of the linguistic context (e.g. phonological, semantic, sociolinguistic, syntactic) often determines which alternative will be selected, preserving predictability at an increased cost to memory. For example, allomorphy in the English

plural suffix -s ([*s*/*z*/*əz*]) is conditioned by the phonology of the lexical morpheme which precedes it (cf. *cats, dogs, houses*).

Allomorphy may also be conditioned by inflection class. According to the definition of 'inflection class' I will use in this thesis, if a lexeme belongs to an inflection class, its choice of allomorph in at least one of its paradigm cells must depend on its choice of allomorph in at least one other paradigm cell, so that its allomorph choices in different paradigm cells are not independent variables.[9] This preserves predictability of the meaning-form relationship, at the cost of obliging speakers to remember which inflection class each lexeme belongs to. In this case, predicting which alternative will be chosen depends not on the direct linguistic context, but on how the lexeme in question inflects in other contexts.

I have adopted the definition of 'inflection class' described above because, from the point of view of speakers and learners, inflection classes are only a useful concept where there are consistent implicational statements to be made about allomorph selection within paradigms. Inflection class may determine affix selection, as with the Latin declensions. Table 5 shows an excerpt of these. This table contains four allomorphs of the ablative singular ending (*-ā*, *-ō*, *-e* and *-ū*). If these allomorphs were distributed randomly among lexemes,

[9] This understanding of the term 'inflection class' (and its hyponyms 'conjugation' and 'declension') is often implicit both in grammatical descriptions of individual languages, and theoretical work on morphology. According to an alternative definition, which is also widespread, an inflection(al) class is merely a class of words which inflect according to a single pattern, in terms of their allomorph selection (e.g. Matthews 2007: 194, Carstairs-McCarthy 2000: 630), sometimes limited to affixal inflection (e.g. Carstairs-McCarthy 1994), and generally with the additional implicit criterion that an inflection class must contain more than one lexeme. This broader definition lacks the explicit requirement I make in this thesis that consistent implicational relationships must obtain between the forms which realise at least some paradigm cells of a group of lexemes which inflect alike, in order for that group to qualify as an inflection class. This criterion ensures that it is possible to infer a lexeme's inflection class from some subset of its forms. The economy of learning principal parts for inflection classes separately from diagnostic principal parts for each lexeme depends on this criterion. It is empirically well established, however, that 'inflection classes' on the second, broader definition, tend more or less to satisfy the stricter definition I use here (see Carstairs(-McCarthy)'s work on *paradigm economy*, e.g. 1983, 1984, 1985, 1987, and further discussion in chapter 5).

learners would have to memorise the paradigm of each noun individually. Fortunately, this is not the case: all nouns which select *-s* in the nominative singular have *-e* in the ablative singular, like *prīnceps* 'chief', and all nouns which have *-a* in the nominative singular have *-ā* in the ablative singular, like *puella* 'girl'. The existence of these implicational patterns means that it is more economical to remember a few abstract patterns of inflection and which inflectional class each lexeme belongs to, than to memorise the full paradigm of each Latin noun.

In the types of inflectional system which have been described in terms of inflection classes, both in traditional grammar and realisation-based models, class membership may determine lexical allomorphy, affix allomorphy, or both. The Latin declensions mainly govern affix selection, as we can see from table 5 (which omits neuter nouns and the fifth declension for simplicity):

Declension:	**I**	**II**	**III**	**IV**
Nominative	*puell-a*	*serv-us*	*prīncep-s*	*man-us*
Vocative	*puell-a*	*serv-e*	*prīncep-s*	*man-us*
Accusative	*puell-am*	*serv-um*	*prīncip-em*	*man-um*
Genitive	*puell-ae*	*serv-ī*	*prīncip -is*	*man-ūs*
Dative	*puell-ae*	*serv-ō*	*prīncip -ī*	*man-uī*
Ablative	*puell-ā*	*serv-ō*	*prīncip -e*	*man-ū*

Table 5: Inflection classes in the Latin noun system

Inflection class may determine allomorphy of lexical morphemes in addition to, or instead of, affix allomorphy. In the Latin verbal system, verbs share a common set of suffixes,[10] but stem alternations are determined by inflection

[10] Inflection class may also be said to determine the vocalism of suffixes in the present, and it is also relevant to stem and/or affix allomorphy in the future, depending on how the forms in question are segmented and how their underlying phonology is analysed. Regardless of which analysis is chosen, this means that a single exemplary paradigm like AMŌ 'love' (conjugation I) is not quite sufficient for predicting the entire paradigms of verbs of the other three conjugations, given the four principal parts in table 6, and must be supplemented with additional exemplary present/future subparadigms for conjugations II-IV.

class (see table 6). In conjugations I, II and IV, nearly all verbs follow the same formal pattern of stem alternation as the examples given in the table (*celō* 'hide', *habeō* 'have', *audiō* 'hear').[11]

Conjugation	Present	Infinitive	Perfect	Perfect Participle
I	*cel-ō*	*celā-re*	*celāv-ī*	*celāt-us*
II	*habe-ō*	*habē-re*	*habu-ī*	*habit-us*
III	*carp-ō*	*carpe-re*	*carps-ī*	*carpt-us*
IV	*audi-ō*	*audī-re*	*audīv-ī*	*audīt-us*
(**Irregular**	*fer-ō*	*fer-re*	*tul-ī*	*lāt-us*)

Table 6: Principal parts for the Latin conjugations

Inflection class may govern the distribution of allomorphy, without specifying its substance. For the third conjugation, *carpō* 'pluck' only tells us the distribution of lexical allomorphy, which may follow a number of formal patterns: the alternation between present and perfect does not necessarily follow the pattern of *carp* ~ *carps*, and perfect stems of the third conjugation may look like those of the first (*sternō* ~ *strāvī*), second (*vomō* ~ *vomuī*) or fourth (*petō* ~ *petīvī*) conjugations.

Similarly, in the third declension, inflection class governs the distribution of a stem alternation between the nominative and vocative singular and the rest of the paradigm (e.g. *prīncep-s* (nom. sg.), *prīncip-is* (gen. sg.). The actual substance of this alternation is unpredictable from inflection class alone: compare *nox* [nok-s] 'night' (nom. sg.), *noct-is* (gen. sg.).

[11] The qualification 'nearly' is required because a significant minority of verbs in conjugations I, II, and IV have irregular stem alternations. For example, CREPŌ 'creak' is normally regarded as belonging to conjugation I (by virtue of e.g. its infinitive *crepāre*), but its perfect and perfect participle look like those of conjugation II (*crepuī, crepitum* rather than ***crepāvī, **crepātus*). Table 6 therefore represents an idealisation of the Latin conjugation system. This idealisation is nonetheless useful, because it enables us to predict the remaining principal parts of a verb belonging to conjugation I, II or IV from its infinitive, perfect or perfect participle with a high degree of confidence. In the Greek verb, a much greater degree of irregularity generally prohibits such useful generalisations (see section 3).

2.2. Principal parts

Traditional pedagogic grammars use principal parts to capture allomorph selection in a relatively economical way.[12] Given a certain subset of forms for a lexeme,[13] we can predict the rest of the paradigm, as long as we know either a set of exemplary paradigms, or an equivalent set of morphological rules. Learning principal parts therefore reduces the amount of information that must be remembered in order to predict allomorph selection.

LEÍPŌ 'leave'	**Present**	**Future active**	**Aorist active**
	leíp-ō	*leíp-s-ō*	*é-lip-on*
Perfect active	**Perfect mediopassive**	**Aorist passive**	**Future passive**
lé-loip-a	*lé-leim-mai (/leip/)*[14]	*e-leíp-t^{h}ē-n*	*leip-t^{h}ḗ-s-omai*

Table 7: Principal parts of LEÍPŌ 'leave'

Table 7 lists seven principal parts for the Greek verb LEÍPŌ 'leave'. Each one of these allows us to predict a particular subset of forms in the paradigm; together, they determine all the forms in the paradigm.

The choice of representative form is partly arbitrary. By convention, all the forms given are first person singular, but the second person singular, for

[12] This practice has its origins in the Classical grammatical tradition; in particular, we owe the notion of predicting the rest of the paradigm from diagnostic forms to the Latin grammarians Varro and Priscian (Robins 1997).

[13] More precisely, traditional pedagogic principal parts give forms which are the realisations of a specified subset of paradigm cells; the forms are informative in their capacity as realisations of paradigm cells rather than as forms themselves. The distinction may seem trivial, but if we are evaluating systems of principal parts on the criterion of economy, the answer may be different depending on whether we are looking for the most informative *paradigm cell(s)* or the most informative *forms*. If the latter, we are not required to list the same parts of the paradigm for every word of a particular category (e.g. nouns), and may end up with a 'dynamic' principal part system, in the terminology of Finkel and Stump (2007).

[14] My transcription is based on the conventional transcription of Greek in Roman script. This is usually sufficient to make morphological structure clear, and conveys exactly as much phonological information as the Greek script does. I have broken this rule only where the Greek orthography reflects surface phonetics at the expense of morphological structure, as here (see 1.5).

example, would do just as well. The implicational relationships within these subparadigms are not necessarily mutual, however: the third person singular would not make a suitable principal part, because the suffix *-e* (3sg) in the aorist active can pattern with either *-on* or *-a* in the first person singular.

In table 8, the principal part in the left hand column enables us to predict any cell in the paradigm containing the morphosyntactic features in the right hand column, if we know an exemplary full paradigm such as *paúō* 'stop'.

Principal part	**Predicts**
Present active indicative 1sg	[imperfective]
Future active 1sg	[future active/middle]
Aorist active indicative 1sg	[perfective active/middle]
Present perfect active indicative 1sg	[perfect active]
Present perfect mediopassive indicative 1sg	[perfect middle/passive]
Aorist passive indicative 1sg	[perfective passive]
Future passive indicative 1sg	[future passive]

Table 8: Predictive domains of the Greek verbal principal parts

2.3. How principal parts interact with inflection class

Principal parts for inflection classes, like those given in tables 5 and 6, mediate between full exemplary paradigms and principal parts of individual lexemes. If we know principal parts for a representative lexeme of each inflection class, the number of principal parts which have to be remembered for each lexeme can be reduced. For each verbal lexeme in Latin, if we temporarily ignore third conjugation verbs and anomalous members of the other conjugations (see note 11), one principal part is sufficient; either the perfect or the present infinitive will do, since both of these have distinct stem-formations in each of conjugations I, II and IV and thus determine inflection class (see table 6). This principal part can then be matched up to the corresponding paradigm cell in

the principal parts for the exemplary conjugation member to predict the stem-formations of the remaining three principal parts, and these can then be matched up to an exemplary paradigm like AMŌ 'love' to predict the endings of the rest of the paradigm (but NB note 10). If we already know that a verb belongs to conjugation I, II or IV, however, any form is sufficient for predicting every other form.

We can define the principal parts of a lexeme as prespecified realisations for certain cells in that lexeme's paradigm, which make it possible to predict the realisations of the remaining cells in the paradigm. Which and how many principal parts need to be specified for each individual lexeme depends on the prior knowledge we attribute to the speaker (or model) making the prediction. In a minimally economical system, demanding no prior knowledge on the part of the predictor, the realisation for each cell of every lexeme's paradigm would have to be specified individually. For Latin, however, we can avoid much redundant repetition of the same information if we supply the predictor with two types of auxiliary information: a full exemplary paradigm to convey information about ending selection, and intermediary principal parts for a representative of each inflectional class to convey information about stem allomorphy. This allows us to specify fewer paradigm cells for each individual lexeme, reducing the total number of forms which need to be remembered in order to predict the full paradigm of every lexeme in the language.

2.4. Limitations of principal parts

Listing principal parts is more economical than listing full paradigms for each lexeme, but the principal parts conventionally given in grammars and lexical lists are not necessarily maximally economical, in that they may contain forms which can be predicted from other forms which have already been given. In addition, they may represent a compromise between the most efficient ways of encoding different types of information about paradigms, i.e. affix allomorphy, the distribution of lexical allomorphy, the substance of lexical allomorphy, and patterns of agreement (e.g. gender).

The minimal set of forms which are sufficient for *identifying* inflection class may not be sufficient for *predicting* all the forms of a lexeme, if an inflection class can be partly characterised by the distribution but not the substance of allomorphy. For Latin nouns (table 5), both the nominative and genitive singular are traditionally given as principal parts, although at least for nouns of the first declension, the nominative singular is predictable from the genitive. The nominative singular is actually one of the less predictive forms in the paradigm, because the suffix *-us* is shared by the second and fourth declensions. Given the ablative singular of any Latin noun (table 9),[15] we can predict the endings of all the other forms (as long as we know the gender, which has to be learnt separately anyway, since it is not fully specified by any combination of principal parts).[16] This is sufficient for predicting the entire

[15] Excluding a few irregular patterns which can be regarded as external to the system of declensions.

[16] Gender does affect the forms of the rest of the paradigm members (for neuter nouns, in the second declension the nominative singular takes the form of the accusative, and in declensions III-V the accusative takes the form of the nominative; the first declension contains no neuter nouns). However, gender is not fully specified by any combination of principal parts in Latin, because there is no formal manifestation of the distinction between masculine and feminine in any of the declensions, although the second declension predominantly contains neuter/masculine nouns and the first declension is mainly feminine.

paradigm except in the the third declension, where the ablative singular tells us what class the noun belongs to, and that there may be an alternation of the lexical morpheme between the nominative singular and other forms, but we still need the nominative singular to specify the substance of this stem alternation: cf. *miles* 'soldier', abl. *milite*, but *caput* 'head', abl. *capite*.

Declension	**I**	**II**	**III**	**IV**	**V**
abl. sg.	*-ā*	*-ō*	*-e*	*-ū*	*-ē*

Table 9: ablative singular suffixes of the Latin declensions

In both the third declension and the third conjugation, multiple principal parts function as representatives of potentially distinct and mutually unpredictable stems. Given an inflected form and its inflection class, we can predict any other form in the paradigm *which shares the same stem*. This is one reason why it is more economical to learn diagnostic forms for each lexeme (e.g. *nox* 'night (nom sg), *noctis* (gen sg), *pax* 'peace' (nom sg), *pacis* (gen sg)) than simply to learn a citation form and its class membership (e.g. *pax* (3rd declension), *nox* (3rd declension).

2.5. Suppletion

The lexical allomorphy of suppletive verbs like *fero* 'bear' is even more unpredictable (table 10), in that it represents a one-off pattern. Historically speaking, this is the result of the absorption of etymologically distinct stems into a single lexical paradigm. Most suppletive verbs distribute their lexical allomorphs in the same way as regular verbs, so that they require the same four principal parts as the four conjugations; only a few very high frequency

verbs like ESSE 'be' require even more representative forms to be listed (eg. *sum* 'I am', *'es'* you are).

	Present	**Infinitive**	**Perfect**	**Perfect Participle**
Predictable allomorphy	*cel-ō*	*celā-re*	*celāv-ī*	*celāt-us*
Unpredictable allomorphy	*carp-ō*	*carpe-re*	*carps-ī*	*carpt-us*
Suppletion	*fer-ō*	*fer-re*	*tul-ī*	*lāt-us*)

Table 10: Types of stem allomorphy in the Latin verbal system

The term 'suppletion' is used with slightly different meanings in linguistics: it may refer to stems from the same paradigm which are descended from etymologically distinct roots (like *ferō, tulī, lātum*) or to any kind of synchronically unpredictable stem alternation, irrespective of etymology (e.g. *carpō, carpsī*); this is sometimes called 'weak suppletion' (Mel'cuk 2000). I will limit the term to paradigms where there is no non-trivial phonological relationship between allomorphs. For example, Greek PHÉRŌ 'carry' has the lexical allomorph *pher* in the present, *oi* in the future and *ēnokh* in the perfect. Suppletive alternations can only apply to a single lexeme (or homonyms), because they are too phonologically specific to apply more generally (Aronoff 2012). Unpredictable lexical allomorphy and suppletion are both extremely common in Greek verbs.[17]

2.6. Morphomes

In both Latin and Greek, there is a strong tendency for the distribution of lexical allomorphs within paradigms to be consistent across lexemes,

[17] The extent of suppletion in Greek is documented by Kölligan (2007).

regardless of whether the allomorphy involved is predictable, unpredictable, or suppletive.

The patterns of distribution of these lexical allomorphs may be morphomic (see ch. 1: 1.6). This term was coined by Aronoff (1994) to refer to systematic distributional patterns of morphs which are not defined by any natural class of morphosyntactic features. A commonly cited example is the Latin 'third stem' which appears in various paradigmatic 'cells' which do not have anything in particular to do with each other, semantically speaking. *Ferō* (table 10) for example, has the stem *lāt-* in the supine (*lātum*), future participle (*lātūrus*), past participle *(lātus*) and various derivational forms, e.g. *lātio* '(act of) bringing'. Despite their morphosyntactic incoherence, these patterns can be shown to be psychologically real to speakers, not least by their diachronic persistence (Maiden 2005). Morphomic patterns present a further challenge to morpheme-based models of morphology, because they make it impossible to assign any consistent value to the morphs which appear in their cells (such as *lāt-*).

3. GREEK PRINCIPAL PARTS

There are a few important differences between the Latin and Greek systems of verbal principal parts, which I will clarify in this section. I will start by introducing the categories of Greek verb which are most important from the perspective of this chapter, and then I will describe paradigmatic patterns of lexical allomorphy (3.1) and affixal allomorphy (3.2) in detail. In 3.2.1-3, I will describe a systematic feature of the distribution of person/number allomorphy in Greek, which is parallel to morphomicity in stems, and

problematic for modern word-and-paradigm theories, which attribute only stems, and not affixes, to the lexicon.

Firstly, the number of principal parts required is significantly greater: Greek has seven for each verb, compared to four in Latin. These seven principal parts (table 11) represent seven mutually unpredictable subparadigms (see table 8 above). They can be matched up directly to an exemplary paradigm, e.g. PAÚŌ 'stop', to derive full paradigms. Only a few very high frequency verbs, like EIMI 'be', require more than seven principal parts.

PAÚŌ 'stop':	Present	Future active	Aorist active
	paú-ō	*paú-s-ō*	*é-pau-s-a*
Perfect active	Perfect mp	Aorist passive	Future passive
pé-pau-k-a	*pé-pau-mai*	*e-paú-sthē-n*	*pau-sthḗ-s-omai*
PHILÉŌ 'love':	Present	Future active	Aorist active
	philé-ō	*philḗ-s-ō*	*e-phílē-s-a*
Perfect active	Perfect mp	Aorist passive	Future passive
pe-phílē-k-a	*pe-phílē-mai*	*e-philḗ-thē-n*	*philḗ-s-omai*
LEÍPŌ 'leave':	Present	Future active	Aorist active
	leíp-ō	*leíp-s-ō*	*é-lip-on*
Perfect active	Perfect mp	Aorist passive	Future passive
lé-loip-a	*lé-leip-mai* [*leim*]	*e-leíp-thē-n*	*leip-thḗ-s-omai*
ESTHÍŌ 'eat':	Present	Future active	Aorist active
	esthí-ō	*éd-omai*	*é-phag-on*
Perfect active	Perfect mp	Aorist passive	Future passive
ed-ḗdo-k-a	*ed-ḗde-smai*	*e-ēdé-sthē-n*	—
DÍDŌMI 'give':	Present	Future active	Aorist active
	dídō-mi	*dṓ-s-ō*	*é-dō-k-a*
Perfect active	Perfect mp	Aorist passive	Future passive
dé-dō-k-a	*dé-do-mai*	*e-dó-thē-n*	*do-thḗ-s-omai*

Table 11: A selection of Greek principal parts

In table 11, PHILÉŌ 'love' exemplifies the **contract conjugation**, which consistently selects a particular set of person/number allomorphs in each of the subparadigms represented by its principal parts, and makes a binary opposition between a stem ending with a short vowel in the imperfective, and a stem ending with a long vowel in the rest of the paradigm. This conjugation has three subtypes: *e*-verbs (like PHILÉŌ), *a*-verbs and *o*-verbs. The *o*-verbs have a lengthened stem in *ō*, while the other two types have a lengthened stem in *ē*. The person/number suffixes throughout the paradigm are the same as those in the group exemplified by PAÚŌ (see below), but in the imperfective forms, these have slightly different surface expressions in each of the three subtypes, as the result of the synchronic contraction of the stem-final short vowel with the initial vowel of the suffixes.[18]

The pattern exemplified by PAÚŌ 'stop' is a **default**: it has a very high type frequency, and is applied to most new coinages and loan words. This class of verbs is characterised by a single phonological expression of the lexical morpheme, and selects the highest type frequency grammatical affixes in each of its paradigm cells.

While allomorphy in Latin verbs is governed by inflection class, the contract conjugation is the only verbal inflection class in Greek. The group represented by PAÚŌ is not an inflection class, according to the criteria described in 2.1, because unlike PHILÉŌ, no subset of its principal parts identify it as inflecting in the way it does. All seven principal parts are required to establish that a particular lexeme is not irregular in any way, and belongs to the same group as PAÚŌ. Outside the contract conjugation, allomorphy in verbal paradigms is not a matter of inflection class: there are no

[18] In 1.5 and footnote 6 I explain my reasons for this synchronic analysis. The diachronic scenario is more complicated: see ch. 3 (2.5) and Tucker (1990).

subsets of diagnostic principal parts from which the remaining principal parts of a verb can be inferred with any consistency, as in Latin (see Finkel and Stump 2007: 54). For this reason, the system of principal parts does not fit into the taxonomy proposed by Finkel and Stump (2007), which is designed for languages in which principal parts identify inflection class.

The remaining verbs in table 11 are **irregular**. In a verb like LEÍPŌ, there is a characterisable phonological relationship between the three lexical allomorphs (LAs) in the paradigm – *leip, loip* and *lip* – which is capable of applying to a number of lexemes. What makes such verbs irregular is that the abstract pattern of their full paradigm differs from the default pattern, in a way that cannot be predicted on the basis of any subset of diagnostic principal parts. In the case of **suppletion**, there is no non-trivial phonological relationship between LAs. Of the LAs found in the paradigm of ESTHÍŌ, some (e.g. *ed, ēdo,* and *ēde*) have a phonological relationship which is abstract enough to apply to more than one lexeme, but others (e.g. *esthi* and *phag*) do not. Suppletive allomorphy has to be remembered arbitrarily; it can in theory be expressed by a rule, but the rule will be too phonologically specific to apply to more than one lexeme, making it no more economical than stipulating the surface forms.[19]

Unlike Latin, Greek verbal paradigms have extensive affix allomorphy as well as lexical allomorphy. DÍDŌMI is an 'athematic' verb, which takes an alternative set of suffixes in its imperfective forms, represented by the present principal part. Similarly, LEÍPŌ is a strong verb, which takes a different set of suffixes in the part of the paradigm represented by the aorist active principal part (see section 3.2).

[19] Aronoff (2012).

Greek has a very large number of irregular verbs: by way of illustration 181 are listed in Morwood's (2001) *Oxford Grammar of Classical Greek*, not including productive compounds of simple verbs, while Smyth's (1956) *Greek Grammar for Colleges* lists a mammoth 763 irregular verbs. Irregular verbs may deviate from the default pattern of inflection by virtue of unpredictable alternations of the lexical morpheme, non-default affix selection, or both, in any number of the subparadigms represented by principal parts.

In Greek grammars, seven principal parts are conventionally given even though some principal parts are usually predictable from others, in order to establish what the patterns of predictability are, since they differ on a verb-by-verb basis. In table 11, the future active *leípsō* of LEÍPŌ can in theory be derived from its present active form (cf. *paúō* ~ *paúsō*), but it is listed anyway, since this is not a legitimate assumption for all verbs (cf. *édomai* from ESTHÍŌ). This conventional system of principal parts is 'parallel' (Finkel and Stump 2007: 51), because it gives the same seven diagnostic forms for each verb. We can imagine a more economical system which would stipulate for each verb only one of each set of mutually predictable principal parts, and leave the remainder to be dealt with an 'elsewhere' rule. For the purposes of lexical allomorphy, this rule would need to determine which stated principal part each unstated principal part inherits its lexical allomorph from: for example, we might say that the future passive inherits the lexical allomorph of the aorist passive, unless it is separately stipulated. This would be a 'skewed' system of principal parts, in which the minimal set of forms which need to be stated in order to predict full paradigms differs from lexeme to lexeme. The purpose of these diagnostic forms would be to override the default for a specific subsection of the paradigm, rather than to identify inflection class.

3.1. Lexical allomorphy

Table 12 shows the principal parts for a selection of verbs with irregular alternations of lexical allomorphy.[20]

Present	Future	Aorist	Perfect	Perfect mp	Aorist pass.	Future pass.
lég-ō 'say'	*eré-ō* [-ô]	*é-ep-on* [eîp-]	*eírē-k-a*	*eírē-mai*	*e-lég-thē-n* *[lekth]*	*rhē-thḗ-s-omai*
stéll-ō 'send'	*stelé-ō* [-ô]	*é-steil-a*	*-é-stal-k-a*	*é-stal-mai*	*e-stál-ē-n*	*-stal-ḗ-s-omai*
klépt-ō 'steal	*klép-s-ō*	*é-klep-s-a*	*ké-kloph-a*	*ké-klep-mai* *[klem]*	*e-kláp-ē-n*	–
didásk-ō 'teach'	*didák-s-ō*	*e-dídak-s-a*	*de-dídakh-a*	*de-dídak-mai* *[didag]*	*e-didák-thē-n*	*didák-s-omai*

Table 12: Lexical allomorphy in a selection of Greek principal parts

Many of these alternations are suppletive. For example, LÉGŌ 'say' has the lexical allomorph *leg* in the present and aorist passive, *eip* in the aorist active

[20] Lexical allomorphs within wordforms are underlined where necessary. I use the term 'lexical allomorph' to refer to the phonological segment of a word which belongs properly to the lexeme, in contrast to a 'stem', which refers to any part of a word to which affixes are attached. These terms partly overlap in reference, although they are distinct in sense. For example, *ere* is both a lexical allomorph of LÉGŌ and its future active stem (see table 12), while its future passive stem *rhēthēs* contains the passive suffix *-thē* (also found in its aorist passive stem *elekthē*), and the future suffix *-s* (also found e.g. in the future active *klépsō*), in addition to the lexical allomorph *rhē*.

I avoid the term 'root' for both pragmatic and theoretical reasons. 'Root' has separate meanings in historical linguistics and morphology, which naturally introduces confusion when discussing historical morphology. Even within morphology it is used variously (see Matthews (1974), ch. 3., for discussion). One usage holds a root to be an 'ultimate unanalysable element of language', something similar to a Saussurean sign, a definition which encompasses grammatical as well as lexical morphemes, is indifferent to the inflection/derivation distinction (e.g. *pau* appears not only *paúō* 'I stop' and *paúeis* 'you stop' but also *paûsis* 'stop (n)'), and arguably should include abstract word-construction and syntactic signs. Clearly this is not the concept required here. Aronoff defines a root as "the default (lexical) phonological form associated with a lexeme" (2012), or "what is left when all morphological structure has been wrung out of a form" (1992). The problem with this definition is that suppletion is so widespread in Greek that it is often unclear which version of the stem is the 'default', if there is a default. I suspect not, which brings me to my theoretical motivation for avoiding the term 'root': it implies an essential difference between the relationship of root and stem (e.g. *pau* 'stop' and *pepau* 'stop (perfect)') and that between stems (e.g. *pepau* and *pepauk* 'stop (perfect active)'), when it is possible and simpler to regard these paradigmatic relationships as involving the same kind of inheritance of meaning and (except in the case of suppletion) form.

(and middle), and *ere* in the future. The historical explanation for their lack of formal relationship is that they come from etymologically distinct roots. The remaining lexical allomorphs, *eirē* and *rhē*, are etymologically related to *ere*, although the relationship is not synchronically obvious for *rhē*.

Suppletion represents the extreme end of a spectrum of unpredictability. The alternation *stell* (present) ~ *stele* (future) ~ *steil* (aorist) in the paradigm of STÉLLŌ 'send' (table 13a) is parallelled in the paradigm of AGGÉLLŌ 'announce' (b), while the alternation between the aorist *steil* and the passive *stal* is parallelled in DIAPTHEÍRŌ 'destroy' (c). These patterns of implication do not hold throughout whole paradigms, as the remaining principal parts of AGGÉLLŌ and DIAPTHEÍRŌ show. Nor are they consistently reliable: MÉLLŌ 'intend' (d) has a present stem with the same phonological shape as STÉLLŌ and AGGÉLLŌ, but the formal relationship between the lexical allomorph of the present, future and aorist is different.

Present	Future	Aorist	Perfect	Perfect mp	Aorist pass.	Future pass.
(a) *stéll-ō*	*stelé-ō*	*é-steil-a*	*-é-stal-k-a*	*é-stal-mai*	*e-stál-ē-n*	*-stal-ḗ-s-omai*
(b) *aggéll-ō*	*aggelé-ō*	*é-aggeil-a [ē-]*	*é-aggel-ka [ē-]*	*é-aggel-mai [ē-]*	*e-aggél-thē-n [ē-]*	*aggel-thḗ-s-omai*
(c) *dia-ptheír-ō*	*dia-ptheré-ō*	*di-é-ptheir-a*	*di-e-pthor-a*	*di-é-pthar-mai*	*di-e-pthár-ē-n*	*dia-pthar-ē-s-omai*
(d) *méll-ō*	*mellḗ-s-ō*	*e-méllē-s-a*	–	–	–	–

Table 13: Patterns of alternation in a selection of Greek principal parts

The probability of an alternation of the lexical morpheme between two forms in a paradigm differs depending on which principal part's subparadigm they belong to. For example, the passive principal parts are more likely to share the same lexical allomorph than the active principal parts. These tendencies are merely probabilistic, however. Irregular verbs are irregular because they cannot be neatly grouped into classes, either on the basis of the formal

substance of lexical allomorphy or the patterns of distribution of lexical allomorphs within paradigms.

3.2. Inflectional allomorphy

In certain subsections of verbal paradigms, there is lexically arbitrary allomorphy of the word-final suffixes which express person and number of the subject. In imperfective forms, there is a distinction between the productive 'thematic' class of verbs, and the 'athematic' class (table 14), each of which selects a distinct set of person/number allomorphs. In the aorist there are four distinctions between the endings of the weak aorist (which has the highest type frequency), the strong aorist, the root aorist, and the kappatic aorist, which has the endings of the weak aorist in the singular and the root aorist in the plural (table 15).

	1sg	2sg	3sg	1pl	2pl	3pl
Thematic (*paúō* 'I stop')	*-ō*	*-eis*	*-ei*	*-omen*	*-ete*	*-ousi(n)*
Athematic (*dídōmi* 'I give')	*-mi*	*-s*	*-si*	*-men*	*-te*	*-āsi*

Table 14: Person/number suffix allomorphy in the present indicative active

	1sg	2sg	3sg	1pl	2pl	3pl
Weak aorist (*épausa* 'I stopped')	*-a*	*-as*	*-e(n)*	*-amen*	*-ate*	*-an*
Strong aorist (*élipon* 'I left')	*-on*	*-es*	*-e(n)*	*-omen*	*-ete*	*-on*
Root aorist (*ébiōn* 'I lived')	*-n*	*-s*	*ø*	*-men*	*-te*	*-san*
Kappatic aorist (*édōka* 'I gave')	*-a*	*-as*	*-e(n)*	*-men*	*-te*	*-san*

Table 15: Person/number suffix allomorphy in the aorist indicative active

In both cases, this allomorphy is limited to the domain of a single principal part: the distinction between thematic and athematic is only made in the imperfective subparadigm (including the middle and passive), represented by

the present principal part (see table 8), and the distinction between weak, strong, root and kappatic aorists is only made in the perfective active/middle subparadigm,[21] represented by the aorist active principal part. Although only a representative few forms are given in tables 14 and 15, this allomorphy is found throughout these subparadigms, in forms of all tenses and moods. In the subparadigms represented by the remaining five principal parts, all verbs select a single set of person/number affixes.

Apart from the contract conjugation,[22] affix allomorphy in Greek verbs is not a matter of inflection class (2.1). Both types of allomorphy are limited to the paradigmatic 'domain' of a single principal part, and the choice of suffixes a verb makes in this domain does not tend to have implications elsewhere in the paradigm: for example, some verbs which are thematic in the imperfective forms have root aorists, others have strong aorists, and others have weak aorists. This will be discussed further in chapter 5 (1.1.1.1-2), where I will make a more detailed and technical argument against viewing them as inflection classes proper.

Affix allomorphy is largely independent from lexical allomorphy, apart from a few tendencies, which only hold over subsets of principal parts. For example, verbs which have root aorists tend to have the same lexical allomorph in the future active, aorist active and perfect active, although they can have a number of present stem formations (table 16). The athematic, root and kappatic endings are often accompanied by alternations of lexical allomorphy between the singular and plural (table 17).

[21] A few verbs whose senses differ in the active and middle voice pattern with the strong aorists in the aorist middle, but are weak in the aorist active, e.g. *apṓlesa* (aorist active) 'I destroyed' but *apōlómēn* (aorist middle) 'I perished'. However, all verbs which have strong aorist active forms also have strong aorist middles.
[22] Tucker (1990).

Present	Future (middle)	Aorist	Perfect
zá-ō 'live'	*biṓ-s-omai*	*é-biō-n*	*be-bíō-k-a*
baín-ō 'go'	*bḗ-s-omai*	*é-bē-n*	*bé-bē-k-a*
gignṓsk-ō 'know'	*gnṓ-s-omai*	*é-gnō-n*	*é-gnō-k-a*

Table 16: Lexical allomorphy in three verbs with root aorists

1sg	*hístē-mi* 'I stand (tr.)'	*héstē-k-a* 'I stand (intr.)'
2sg	*hístē-s*	*héstē-k-as*
3sg	*hístē-si*	*héstē-k-e*
1pl	*hísta-men*	*hésta-men*
2pl	*hísta-te*	*hésta-te*
3pl	*histá-āsi* [*â*]	*hestá-asi* [*â*]

Table 17: Lexical allomorphy in the paradigm of HÍSTĒMI 'stand'

Although allomorphy of person/number suffixes is mostly irrelevant to lexical allomorphy, it is relevant to allomorphy of the other affixes which feature in stems. For example, in the default pattern of inflection, the aorist active stem is composed of the lexical morpheme, followed by the aorist suffix *-s*. The perfective active optative stem is further distinguished by the addition of the optative suffix *-ai*, which is followed by the optative endings *-mi*, *-s*, *-ø*, *-men*, *-te*, *-en*. However, verbs with strong aorists lack the suffix *-s*, and compose their perfective optative active stem with the allomorph *-oi* instead of *-ai*, although they select the same person/number suffixes (table 18).

	PAÚŌ 'stop'	LAMBÁNO 'take'
perfective active optative 1sg	*paú-s-ai-mi*	*láb-oi-mi*
2sg	*paú-s-ai-s*	*láb-oi-s*
3sg	*paú-s-ai*	*láb-oi*
1pl	*paú-s-ai-men*	*láb-oi-men*
2pl	*paú-s-ai-te*	*láb-oi-te*
3pl	*paú-s-ai-en*	*láb-oi-en*

Table 18: allomorphy of the optative suffix

Other affix allomorphy is independent of person/number suffix choice. Some verbs mark passive voice with the suffix *-sthē*, others select its allomorph *-thē*, and others *-ē* (table 19).

	Aorist passive	Future passive
NOMÍZŌ 'think'	*e-nomí-sthē-n*	*nomi-sthḗ-s-omai*
BÁLLŌ 'throw'	*e-blḗ-thē-n*	*blē-thḗ-s-omai*
THÁPTŌ 'bury'	*e-táph-ē-n*	*taph-ḗ-s-omai*

Table 19: Allomorphy of the passive suffix

3.2.1. The distribution of person/number suffixes

The meaning of a verb form cannot necessarily be deduced from the combination of its lexical and affix morphemes. Word meaning is very often underspecified by sub-word units. *Píomai* (2) means 'I will drink', but neither of its morphemes are restricted to the future tense: cf. *épion* 'I drank', *loúomai* 'I wash myself'. Only their combination marks this form out as future. For this reason, morpheme-by-morpheme glosses throughout this thesis will often be less morphosyntactically specific than their accompanying translations.

(2) *pí-omai*
DRINK-1.sg.indic.
'I will drink'

The cause of this situation is that the suffixes which express the person and number of the subject in verbs are often distributed within paradigms in such a way that is difficult to attribute any further morphosyntactic meaning to

them. For example, the person-number suffixes which characterise strong aorists (3) are also found systematically in thematic imperfects (4).

(3)	*é-bal-on*	*é-bal-es*
	past-THROW-1.sg	past-THROW-2.sg
	'I threw'	'you threw'

(4)	*é-pau-on*	*é-pau-es*
	past-STOP-1.sg	past-STOP-2.sg
	'I was stopping'	'you were stopping'
	é-ball-on	*é-ball-es*
	past-THROW.impftv-1.sg	past-THROW.impftv-2.sg
	'I was throwing'	'you were throwing'

The endings of the athematic imperfect (5), on the other hand, are also found in root aorists (6), and aorist passives (7)

(5)	*e-títhe-san*	*é-tithē*
	past-PUT-3.pl	past-PUT
	'they were putting'	'he was putting'
(6)	*e-bíō-san*	*é-biō*
	past-LIVE-3.pl	past-LIVE
	'they lived'	'he lived'
(7)	*e-paú-sthē-san*	*e-paú-sthē*
	past-STOP-pass-3.pl	past-STOP-pass
	'they were stopped'	'he was stopped'

The distribution of these person-number allomorphs differs radically from the Latin system, because it cannot be described in terms of natural combinations of morphosyntactic feature combinations. This will be clarified by a comparison with the phenomenon of deponency.

3.2.2. Deponency

GIGNŐSKŌ (8) has a distinct set of endings in the future, which are also found in the present passive of thematic verbs like PAÚŌ (9). In other verbs, such as HÉPOMAI 'follow' (10), they are found in present and future verbforms which are active in meaning, and have no formally active counterparts (11). These are known as 'deponent' verbs – verbs which are formally passive but semantically active – and are also found in Latin, along with many other languages. In Greek they usually take the endings of the middle voice in the future and aorist, where the middle endings are distinct from those of the passive. Since the situation is clearer in Latin, which does not mark a distinction between middle and passive voice, we will return briefly to Latin in the following discussion.

(8) *gnṓ-s-omai*
KNOW-fut-1.sg
'I will know'

(9) *paú-omai*
STOP-1.sg
'I am stopped'

(10) *hép-omai*

FOLLOW-1.sg

'I follow'

(11) ***hép-ō*

FOLLOW-1.sg.act.

Like Greek, Latin has a number of deponent verbs, which have the same endings as passive forms of non-deponent verbs (table 20).

audīre 'to hear'	*audiō* 'I hear'	*audīvī* 'I heard'
audīrī 'to be heard'	*audior* 'I am heard'	*audītus sum* 'I was heard'
patī 'to suffer'	*patior* 'I suffer'	*passus sum* 'I suffered'
***patīre*	***patiō*	***patīvī*

Table 20: forms of PATIOR 'suffer'

There is no reliable way of predicting whether a particular verb is deponent in Latin. Often deponents are unaccusative or at least intransitive, but not all intransitives are deponent, and not all deponents are intransitive (12).

(12) *iam* *sequ-or* *te,* *mater* (Plaut. Aul. 4.7.15)

now follow-1sg you_{ACC} $mother_{VOC}$

"Now I follow you, mother"

Like inflection class, deponency is not predictable from phonology or semantics, and yet it determines what suffixes a verb takes. However, deponency seems to be an independent variable from membership of conjugation classes I-IV, because there are deponent verbs which are formed in the same way as passives of each conjugation class (table 21).

	Passive		Deponent	
I	*amor, -āri, -ātus*	to be loved	*cōnor, -āri, -ātus*	to try
II	*habeor, -ēri, -itus*	to be had	*vereor, ēri, -itus*	to fear
III	*petor, -ī, -ītus*	to be sought	*loquor, -ī, locūtus*	to speak
IV	*audior, -īri, -ītus*	to be heard	*potior, -īri, -ītus*	to rise

Table 21: Examples of deponent verbs belonging to the four Latin conjugations

One way of accommodating deponency in a realisational framework is to invoke some kind of special rule, whereby active paradigm cells are 'spelled out' by the same realisation rules which normally supply exponents in passive paradigm cells. For example, in Stump's (2002, 2006, 2007; Stewart and Stump, 2007) realisational framework of Paradigm Function Morphology, lexemes have 'content paradigms', which specify every permitted combination of morphosyntactic features for the purposes of semantic interpretation and syntactic insertion, and lexical stems have 'form paradigms', which specify the range of morphosyntactic property sets for which the stem is inflectable. Cells in content paradigms are linked to cells in form paradigms by 'rules of paradigm linkage'. Cells in form paradigms feed into realisation rules, which produce inflected words. Following Stump (2012), table 22 gives correspondences and table 23 gives realisation rules for some active forms of the Latin verb AMŌ 'love'.

Content cell	Form cell[23]	Shared realisation
<AMĀRE, {1sg, active, indicative}>	<$am_{[1st\ conj.]}$, {1sg, active, indicative}>	*amō*
<AMĀRE, {2sg, active, indicative}>	<$am_{[1st\ conj.]}$, {2sg, active, indicative}>	*amas*
<AMĀRE, {3sg, active, indicative}>	<$am_{[1st\ conj.]}$, {3sg, active, indicative}>	*amat*

Table 22: Form and content cell correspondences for forms of AMŌ 'love'

[23] Inflection class features are included at the level of the stem in this model, to account for the fact that irregular paradigms in some languages can pattern with different inflection classes for different stems.

	Form Cell		Realisation
a.	<$X_{[1st\ conj.]}$, {1sg, active, indicative}>	→	*Xō*
b.	<$X_{[1st\ conj.]}$, {2sg, active, indicative}>	→	*Xas*
c.	<$X_{[1st\ conj.]}$, {3sg, active, indicative}>	→	*Xat*

Table 23: Realisation rules for forms of AMŌ 'love'

In Stump (2007, 2012), deponency is analysed as one possible type of deviation from 'canonical' inflection (Corbett 2009). Canonical inflection, in Stump's model, is defined by a default rule of paradigm linkage, which links a content cell <L, σ> (e.g. <AMĀRE, {1sg, active, indicative}>) with a form cell <X, σ> (e.g. <*am*$_{[1st\ conj.]}$, {1sg, active, indicative}>) where L is a lexeme (in this case AMĀRE), X is the σ-stem for that lexeme (*am*), and σ is a morphosyntactic property set ({1sg, active, indicative}).

Deponency deviates from this canonical paradigm linkage in that there is a discrepancy between the morphosyntactic features in the content cell and those of the form cell with which it is linked. Thus, for the Latin deponent verb HORTĀRĪ, content cells following the format <HORTĀRĪ, {active, …}> are linked with form cells of the format <*hort*$_{[1st\ conj.]}$, {passive, …}> (table 24). These then feed into the same realisation rules that derive true, semantic passives (table 25).

All this is accomplished by means of a special rule of paradigm linkage for deponent verbs: "where σ is a finite active property set with τ as its passive counterpart and L is a deponent verb with τ-stem X, a. the content cell <L, σ> has <X, τ> as its form correspondent; b. the content cell <L, τ> has no form correspondent."[24]

[24] Stump (2012: 9).

Content cell	Form cell	Shared realisation
<HORTĀRĪ, {1sg, active, indicative}>	<*hort*$_{[1st\ conj.]}$, {1sg, passive, indicative}>	*hortor*
<HORTĀRĪ, {2sg, active, indicative}>	<*hort*$_{[1st\ conj.]}$, {2sg, passive, indicative}>	*hortāris*
<HORTĀRĪ, {3sg, active, indicative}>	<*hort*$_{[1st\ conj.]}$, {3sg, passive, indicative}>	*hortātur*

Table 24: Form and content cell correspondences for forms of HORTĀRĪ 'urge'

	Form Cell		Realisation
a.	<X$_{[1st\ conj.]}$, {1sg, passive, indicative}>	→	*Xor*
b.	<X$_{[1st\ conj.]}$, {2sg, passive, indicative}>	→	*Xāris*
c.	<X$_{[1st\ conj.]}$, {3sg, passive, indicative}>	→	*Xātur*

Table 25: Realisation rules for forms of HORTĀRĪ 'urge'

In theory, deponency could be treated the same way as inflection class, by means of an arbitrary index or tag to lexical stems, which then condition the realisation rules which derive full forms. The disadvantage of this approach would be that it reduces the formal identity of the passive and deponent endings to mere coincidence; the two sets of endings would have to be listed separately by two unrelated sets of realisation rules. It is more economical to have a system which somehow redirects the expression of morphosyntactic properties of deponent verbs to the passive suffixes; this point stands regardless of whether we accept Stump's specific architecture.

3.2.3. Greek verbal suffixes as morphomes

We prefer a solution along Stump's lines because of its economy, and because it fits with our gut feeling that the deponent endings and the passive endings don't just happen to look the same, but actually are the same. But while this solution seems satisfactory for Latin, it is less so for a language like Greek, where something formally equivalent to deponency is the norm

rather than the exception: the same sets of suffixes crop up repeatedly in sets of paradigm cells which do not match up consistently with any morphosyntactic feature or group of morphosyntactic features. The following is just a selection of the overlaps which can be found (for a full description of the distribution of each set of suffixes, refer to appendix):

i. *-ō, -eis, -ei, -omen, -ete, -ousi* in both the present and future indicative active:
***paúō* 'I stop', *paúsō* 'I will stop'**

ii. *-on, -es, -e, -omen, -ete, -on* in both the imperfect and aorist (past perfective) indicative active:
***éballon* 'I was throwing', *ébalon* 'I threw'**

iii. *-mai, -sai, -tai, -metha, -sthe, -ntai* in the present indicative passive and perfect middle/passive:
***títhemai* 'I am put', *pépaumai* 'I have been stopped'**

iv. *-n, -s, -∅, -men, -te, -san* in the aorist indicative active, aorist indicative passive, and imperfect indicative active:
***ébēn* 'I went', *epaústhēn* 'I was stopped', *etíthēn* 'I was putting'**

v. *-a, -as, -e, -amen, -ate* in the aorist indicative active and perfect indicative active (the two sets of suffixes differ in the third plural *-an*/*-āsi*):
***épausa* 'I stopped', *pépauka* 'I have stopped', *éthēka* 'I placed', *téthēka* 'I have placed'**

As with deponency, a model of morphology which specifies each set of endings only once will be more economical than one which repeatedly lists the same suffixes as expressions of different sets of morphosyntactic features. Evidence from the historical development of Greek also supports the psychological unity of these sets of endings. For instance, starting in pre-Classical Greek and finishing in the Byzantine era, there is a general merger of two sets of endings which are selected in the aorist indicative active by the majority of verbs: the 'first aorist' endings *-a, -as, -e, -amen, -ate, -an* and the 'second aorist' *-on, -es, -e, -omen, -ete, -on*, whose endings are also found in the imperfect of most verbs. As part of this merger, in the third century BC, we start encountering 3pl 'strong' aorist forms with a new ending, *-osan* for expected *-on*, e.g. *ēlthosan* for expected *ēlthon* 'they went', *eíposan* for *eîpon* 'they said', showing influence from the 'root' aorist ending *-san*. At the same time, we also find 3pl imperfect forms such as *ephérosan* for *épheron* 'they were bearing'. This suggests that the 3pl aorist *-on* and the 3pl imperfect *-on* were perceived as the same entity, at least for some speakers.

Similarly, Greek underwent a formal and functional merger of the perfect and the aorist, starting in the Hellenistic period, and later reinforced by the lack of a distinction between perfect and past perfective in Latin. Eventually this resulted in a common set of preterite endings taken from both the first/second aorist and the regular perfect endings in *-a, -as, -e, -amen, -ate, -āsi*,

again in the Byzantine era. Before this, though, we often find aorist forms used as perfects, perfects used as aorists, and hybrid forms which combine aorist stems with perfect endings or vice versa, e.g. *dédōkan* 'they have given' for *dedṓkāsi* (cf. the standard aorist form *édōkan*, 'they gave'). Exactly the same changes are found in the paradigm of OÎDA, 'know', which shared the endings of the perfect active in standard Koiné, but is also found with endings taken from the aorist: 2sg *oîdes* for *oîdas* 'you know' (from the strong aorist), 3pl *oîdan* for *oîdāsi*, 'they know' (from the weak aorist). OÎDA is a very frequent verb, which might be expected to have a high degree of autonomy, and it is semantically present, but it seems to be subject to the same changes which we see in the perfect simply by virtue of sharing the same endings. Again, this suggests a relationship of numerical rather than qualitative identity between the endings in the Koiné present paradigm of OÎDA, and those of the present perfect: in other words, they don't just look the same, but actually are the same.

In theory, this is compatible with a solution along the same lines as Stump's analysis of deponent verbs. To deal with a verb like OÎDA, which is present in meaning but has the same endings as the perfect (in the standard Koiné), we would have to have a special rule of paradigm linkage which connected cells with the feature set {+present…} in the lexeme's content paradigm to cells with the feature set {+present, +perfect…} in the stem's form paradigm. These cells would then feed the realisation rules which usually give us semantically perfect forms. In this model, endings are only 'listed' once, as part of the realisation rules for sets of morphosyntactic features in stems, which may also indirectly realise different sets of morphosyntactic features in lexemes. The fact that endings are listed only

once in the model mirrors the intuition that they are psychologically unitary, and is compatible with the above observations about morphological change: a change to a verbal ending can simply be regarded as change to a realisation rule, which naturally affects any paradigm cell which is the environment for the realisation rule in question, and any surface form which is its output.

While this solution may be acceptable for a marginal case like OÎDA, there is so much general overlap in the system of endings in Greek that, if we were to adopt it wholescale, we would be forced to make arbitrary choices about which morphosyntactic properties are realised by default for a particular ending or set of endings, and which only by special exception. The suffixes *-n, -s, -∅, -men, -te, -san* are particularly prolific, appearing in the aorist passive indicative (preceded by stem-final *-thē-*), the aorist passive optative (apart from 3pl *-san*), the aorist active indicative (so called 'root aorists', some deponent verbs which have the same form as the regular aorist passive, and the plural forms of verbs with athematic presents), imperfect active indicative (of verbs with athematic presents), and in later Greek the pluperfect indicative active (preceded by stem-final *-ei-*) and in third person imperatives of all voices and tense/aspects. Thus they are found in forms with both perfective and imperfective aspect, active and passive voice, optative, indicative and imperative mood, perfect and non-perfect value, and in past tense and tenseless forms. Any decision about which set of morphosyntactic features are realised by these suffixes by default, and which by special rules of paradigm linkage, would have to be completely unprincipled.

This pragmatic problem is a symptom of a more fundamental problem with modern word-and-paradigm models. By allowing realisation rules to refer to stored stems, they make it possible to capture linguistically significant generalisations about the paradigmatic distribution of stems, but by treating affixes and stems as essentially different sorts of thing, they preclude similar generalisations about the distribution of affixes. In Greek, the same sets of person-number suffixes recur consistently in the same environments across lexical paradigms, but their distribution cannot be described by any natural class of morphosyntactic features. Like the Latin 'third stem', they therefore have to be referred to with arbitrary labels.

These facts are better accommodated in traditional word-and-paradigm approaches, in which the word is regarded as the fundamental stored unit of language, and words are organised into abstract paradigms based on formal and functional alternations between words. Grammar, at least as far as morphology is concerned, is seen as a set of abstract relationships between surface forms. Analogy, i.e. the extension of these relationships, is the mechanism of both morphological productivity and morphological change. Sub-word units such as stems and affixes exist as abstractions over sets of surface forms. This was essentially the view of the neogrammarians and in particular Paul, who regarded words as the basic unit of language, and attributed morphological productivity to analogy, as we saw in the previous chapter (1.3.2-3).

There are various advantages to a model of morphology which admits the possibility of storage of fully inflected surface forms: it can accommodate

morphomic patterns better, and deal with inflection classes more economically, using principal parts, without recourse to redundant diacritical indexes to lexical entries. It is also supported by recent work in psycholinguistics which suggests that even morphologically regular surface forms may be stored (e.g. Baayen, Dijkstra & Schreuder 2003, Baayen & Plag 2009), and that morphological families are accessed in both production and processing (e.g. Krott 2009 for derivational compounds).

So far, I have suggested that the synchronic description of Greek verbal morphology is more compatible with a word-based framework, as defined in this section. The rest of this thesis will make a sustained case for this position from various diachronic evidence. Chapters 4-6 argue, on the basis of developments affecting lexical and affix allomorphy, that morphological change in Greek is best understood as the extension of relationships between fully inflected surface forms stored in memory. Chapter 3 will prepare the way for the detailed studies of the following chapters, by giving a long-term overview of the historical development of Greek verbal morphology, from Proto-Indo-European to Modern Greek.

Chapter 3: From Proto-Indo-European to Modern Greek

The modern descendant of ancient Greek has simplified and streamlined its verb system into one which is usually described in terms of numbered conjugations. The history of Greek might then tell us something interesting about how the phenomena described in the previous chapter come into existence. Since at least one verbal inflection class, the contract conjugation, is already present in the synchronic system described in the previous chapter, we must also consider where the ancient verbal system came from. This chapter will therefore be divided into three. Section 1 will discuss how the Greek system might have grown out of the verbal system of (late) Proto-Indo-European, the immediate ancestor of the earliest historical Greek. Section 2 will give an overview of the Modern Greek verbal system. Section 3 will describe, in general terms, the evolution of the verb between ancient and modern Greek. This will provide context for a more detailed examination, in the next three chapters, of changes which took place between the classical period and the end of the third to fourth centuries AD.

1. Proto-Indo-European to classical Greek

In this section I will explain the diachronic origins of the verbal system described in chapter 2. I will start by describing the basics of the verbal morphology which is reconstructed for Proto-Indo-European (1.1-3), and follow this by picking out features relevant to the synchronic phenomena which were the focus of the previous chapter, and trace their development into Greek.

1.1. The reconstruction of the Proto-Indo-European verb

Comparative historical linguistics has always been much better at reconstructing form than function. From the comparative evidence of the Indo-European languages, it is an easier task to reconstruct a collection of verbal roots and endings for Proto-Indo-European (PIE) than it is to establish the precise details of what these reconstructed morphemes meant and how they were used. This is because we understand more about sound change than other types of language change. Although the Indo-European languages diverge considerably in both their phonological treatment of PIE morphemes and the functional use to which they put this inherited phonological material, the formal divergence follows fairly exceptionless and straightforward rules, whereas the functional divergence does not. This makes formal properties of the proto-system more easily recoverable than its functional properties.

Nonetheless, two very early attested Indo-European languages – Greek and Vedic Sanskrit – show striking functional and formal agreement in their verbal systems, and so the reconstruction of the PIE verb system has traditionally drawn particularly on evidence from these two languages. This section is intended as a broad-brush portrait of the verbal system of the stage of PIE which immediately preceded the separation of Greek and Indo-Aryan. Therefore, it largely ignores the evidence of the Anatolian languages, which are attested even earlier than Sanskrit and Greek, and may suggest a very different reconstruction for an earlier stage of PIE.[1] My account relies heavily

[1] For example I will not discuss the origin of and relationship between the Hittite *ḫi*-conjugation and the PIE stative and middle. (Rosenkranz 1953; Cowgill 1975, 1979; Jasanoff 1979, 2003). The Hittite verbal system is so radically different from the Greco-Aryan reconstruction that it is hard to see how it can be derived from it. On the other hand there is

on the 'Cowgill-Rix' reconstruction of the PIE verb, as articulated in Rix (1992), Rix et al. (2001), Sihler (1995), Ringe (2006).

Our interest in the PIE verb, for the purposes of this discussion, is for what it can tell us about how one kind of verbal system can change into another kind of verbal system. Therefore, this section will focus on can be inferred from the comparative evidence about very general typological features of the verb system, in particular the morphosyntactic features which were marked morphologically, constraints on their cooccurrence, what kinds of morphological exponents realised these distinctions, and the status and organisation of verbal paradigms. There are many controversies about the precise phonological reconstruction of the verbal endings and their development in Greek, which I will skip over, since they are mostly irrelevant from this perspective. Naturally there are also many controversies which are relevant to this discussion. I have tried to summarise what is believed with reasonable certainty and consensus, for the sake of brevity. It must be admitted, however, that almost all details of the following account can be disputed.

1.2. Morphosyntactic distinctions and how they are realised

1.2.1. Stative. The first distinction marked by the PIE verb system seems to have been the contrast between stative formations, which describe states, and eventives, which describe events. Stative verbs are continued by the Greek

enough agreement between Greek and Vedic to justify reconstructing some common ancestor for at least these two, and the other IE languages can be derived from this common ancestor comparatively easily. Therefore, following Cowgill (1975, 1979), it seems legitimate to reconstruct something like the traditional Greco-Aryan model of the PIE verb as the ancestor of the Greek verb, and assume that the ancestor of the Anatolian languages either split off from the proto-language at an earlier stage, or descended from a more conservative area of a PIE dialect continuum.

perfect, which like the Indo-European formation, has its own set of stems and endings which are formally distinct from those of the present and aorist. This is reconstructed as a stative rather than a perfect because various relic formations with stative value survive in the Indo-European languages, e.g. Latin *meminī* 'I remember', Greek *oîda* 'I know' (not 'I have seen', though formed with the same root as *eîdon*, 'I saw').

Formally, stative value is realised by a root vocalism alternating between [o] and zero in place of [e] elsewhere,[2] (usually) preceded by a reduplicating prefix, and followed by a set of unique endings, cumulatively marking person and number as well as stativeness. The Greek perfect has made various formal innovations in both stems and endings, but a number of verbs preserve the inherited formation, e.g. *le-loip-a* 'I have left', < **le-loik^{w}-H_2e*.

Although the Greek perfect makes distinctions of voice (active/mediopassive), mood (indicative, subjunctive and optative) and tense (present, past and future), there is reason to believe that these are late developments.[3] Thus we reconstruct only person and number inflection for PIE stative verbs, whereas eventives are reconstructed with multiple distinctions of aspect, tense, voice, and mood. This is one reason for reconstructing the two as separate systems. Although the stative was unmarked for tense, it may have already in PIE denoted states resulting from an action or event in the past, as it developed into a preterite in some of the daughter languages, such as Germanic (Ringe 2006).

[2] Proto-Indo-European morphology includes regular alternations of root vocalism known as 'ablaut'. For instance, *dérkomai* 'I see' preserves the e-grade, or full grade, of the PIE root **derk* 'look', while *dédorka* 'I have seen' contains the o-grade **dork*, and [drak] in *édrakon* 'I saw' is the Greek reflex of the zero-grade **dṛk*.
[3] e.g. Berg (1977).

1.2.2. Eventives. For the finite forms of eventive verbs, the following morphosyntactic features are obligatorily marked (table 1).

Morphosyntactic variable	Values
Person	1st, 2nd, 3rd
Number	singular, dual, plural
Voice	active, mediopassive[4]
Mood	indicative, subjunctive, optative, imperative

Table 1: Morphosyntactic variables and values for eventive verbs in PIE

1.2.2.1. Person, number, voice. Person, number and voice were marked by means of cumulative endings. A possible reconstruction of these endings is given in table 2, omitting the dual, which is on its way out in most of the daughter languages, and largely for this reason, difficult to reconstruct securely. The precise reconstruction of some of these endings, particularly those of the middle plural, is debatable. Nonetheless, it is clear that there is some formal (albeit unpredictable) relationship between the active and mediopassive endings for some combinations of person and number, particularly the third person singular and plural.[5]

[4] The mediopassive voice was used in various situations where the subject of the verb is not a prototypical agent. This includes passives (where the subject is the patient), reflexives (where the subject is both agent and patient), 'indirect' reflexives (where the subject is agent and beneficiary), reciprocals (where multiple subjects are both agents and recipients/beneficiaries/patients) and unaccusatives (where the subject performs the action in some capacity other than that of agent, e.g. 'the stone fell') (Allan 2003). At least in late PIE there were also deponent verbs, which were morphologically mediopassive but had straightforward active semantics, e.g. **sek^{w}-* 'follow' (Greek *hépetai*, Latin *sequitur*, Skt. *sácate*, Av. *hacaitē*, Oir *sechur*, Lith. *sekù*, *sèkti*). These deponents may have come about through semantic change to verbs which originally had mediopassive semantics; e.g. following this idea Rix (2001) gives the meaning 'sich anschließen' ('(make oneself) join company with') for **sek^{w}-*.

[5] The evidence of the Anatolian languages may suggest that the mediopassive endings were at an earlier stage synchronically related to the ancestor of the perfect endings, in which case their formal relationship to the eventive active endings would be the result of relatively recent interference between the two paradigms (see note 1).

	Active	Mediopassive
1sg	*-m*	*-H_2e*
2sg	*-s*	*-tH_2e*
3sg	*-t*	*-to*
1pl	*-me(s)*	*-med^hH_2*
2pl	*-te*	*-d^hwo*
3pl	*-nt*	*-nto*

Table 2: Reconstructed person/number suffixes for eventive verbs

1.2.2.2. Mood. Apart from the imperative, which has its own suffixes (continued in the Greek imperative), mood is marked on or by a suffix between the stem and the ending for person/number/voice. This 'slot' in the wordform may also be occupied by the so-called 'thematic vowel', a suffix *-e/o-* with no clear function or meaning which also appears between the stem and the ending (this will be discussed further in 1.7.1).

1.2.2.3. Tense. Past tense may have been marked by a stem prefix **e-*, known as the 'augment', which survives in Greek as *e-* and in Vedic as *a-*. In the earliest Greek and Vedic texts, we find numerous apparent past-tense forms lacking an augment. Partly for this reason, it is thought that the morphological marking of past tense was not obligatory in PIE,[6] if it was possible at all: the augment may have originally had some other function. It is not attested in the verbal system of the Indo-European languages other than Greek, Indo-Iranian, Armenian and Phrygian, which may imply that it was an independent word in PIE, of unknown value. From these observations we can

[6] The hypothesis that the marking of past tense was optional is supported somewhat by the value of augmentless forms in Greek and Vedic. In Greek, they often have gnomic force, describing general truths with no specific time reference. This is true of augmentless imperfects in metaphorical passages of Homer, although not for aorists (West 1989). In Vedic they occur particularly in prohibitions, where tense usually does not need to be specified, and in sequences of multiple verbs where the tense is either clear from context, or explicitly marked by the first verb in the sequence, so that subsequent verbforms need not be marked for tense (Hoffmann 1967, Szemerényi 1989). In Homer, although the augment is used inconsistently in past tense verb forms, it is particularly common in forms which would otherwise be monosyllabic, as in Classical Armenian (Clackson 2007: 123).

conclude very little, save that finite verbforms were not obligatorily tensed, but that there may have been a prefix, particle or preverb which was available to mark past tense when necessary.

To the basic person/number/voice endings given in table 2, a further suffix could be added to indicate non-past tense. This is reconstructed as *-*i* in the active, and *-*r* in the mediopassive,[7] although Greek generalised the suffix -*i* (e.g. 3sg aorist -*to*, present (archaic) -*toi*; cf. Latin -*tur*). In Greek, forms characterised by the suffix -*i* are usually present, but we reconstruct the value 'non-past' for two main reasons (Clackson 2007: 119). First, although the majority of the Indo-European languages have distinct future tense forms, they are formed in disparate ways, suggesting they have been independently innovated using different inherited morphological material. For example, the Latin future continues the PIE subjunctive (Weiss 2009),[8] whereas the Greek future comes from an original desiderative formation. Secondly, in Slavic and Gothic, present formations can also be used with future value, adding weight to the hypothesis that this was also the case in PIE.

It is possible that the morpheme *-*i* was originally a separate word denoting relevance to the place and time of the speech situation; an identical morpheme appears in various indexical pronouns and adverbs in the daughter languages, such as (Attic) Greek *nuní* 'now'. If this is correct, it is likely that this marker was also optional at some stage of PIE.

[7] Cowgill (1968: 25-7) first argued for the equivalence of active *-*i* and mediopassive *-*r*; despite the appeal of this theory, it reconstructs for PIE a distribution of the two markers which is not perfectly preserved anywhere, so if we accept it we must assume extensive analogical restructuring in the daughter languages. NB The suffixes *-*r and* *-*i* are called 'primary markers' by Indo-Europeanists, although in terms of morphological and semantic markedness they are secondary.

[8] The PIE subjunctive was used to express events which were less than fully realised, which probably included future events.

1.2.2.4. Aspect. Aspect was an important functional category in PIE, but its morphological marking is more complicated than that of mood, voice or tense. Firstly, the distinction between perfective and imperfective aspect was neutralised in nonpast forms.[9] Secondly, although the distinction between perfective and imperfective aspect existed for past tense forms, it had no consistent formal realisation, according to the Cowgill-Rix reconstruction, because the aspectual interpretation of a past verbform depended on the interaction of its formal properties with its lexical aspect or *Aktionsart*. Thus past-tense root-formations, consisting only of the verbal root (perhaps prefixed by the augment) and unmarked endings, could function either as imperfects or aorists depending on whether the root in question was inherently durative or punctual.[10] Because non-past forms were necessarily imperfective, the non-past endings could only be attached directly to lexically durative roots:

(1)	**(e)-kei-to*	'he was lying'	**kei-to-r*	'he lies'
(2)	**(e)-$g^{w}eH_2$-t*	'he stepped'	***$gweH_2$-t-i*	'he steps'

The particular examples above have been chosen because they have direct descendants in Greek: (1) gives the root imperfect *ekeito* 'he was lying' and the present *keitai* 'he lies', and (2) gives the root aorist *ebē* 'he went'. *ebē* in Greek means 'went', but is reconstructed with the meaning 'step' precisely because it forms a root aorist (the semantic reconstruction is also supported by

[9] This is a typologically normal feature of many verb systems: if an event is literally happening in the present, it must necessarily have some kind of inherent duration, and present tense forms are used metaphorically to convey other kinds of non-perfective aspect such as iterativity ('I am having guitar lessons'), conativity ('she is mounting a horse'), and inceptivity ('he is dying').
[10] Or perhaps more accurately telic or atelic. See Strunk (1994).

cognates such as Avestan *jāman-* and Greek *bêma*, both 'step'). This may seem circular, but it is generally agreed that there is a strong enough overall correlation between the lexical aspect of cognate verbs in the IE languages, and the ability of those verbs to form root aorists or presents respectively, to justify this kind of reasoning.

Lexical aspect can be quite fluid, though; besides clear cases like punctual 'die' and durative 'know', we find verbs like 'say' which are capable of being viewed as ongoing or momentary. Perhaps it is no great problem, then, to find that whether a verb is treated as punctual or durative in PIE, insofar as the interpretation of its root formations goes, is not entirely predictable from lexical semantics. The root *$*g^{wh}en$-* has the punctual meaning 'strike' or 'kill' in the IE languages, but is reconstructed with non-past tense forms consisting simply of the verbal root and non-past endings (cf. Hittite *kuenzi*). Similarly, the distinction between statives and eventives seems to have been partly lexicalised: the root 'be', *$*H_1es$-*, takes the eventive endings in all the Indo-European languages, despite being prototypically used to describe states.

1.3. The originally derivational status of aspectual paradigms. So far, we have discussed verb forms consisting of a set of basic person/number endings attached directly to the verbal root, with or without the additional tense-marking affixes **e-* and **-i/r*. Additionally, these affixes can be attached to characterised stems, usually consisting of a root plus a suffix. Some Greek reflexes of characterised imperfective stems are given in table 3.

**-n-* (infix)	*lanthan-* 'escape notice' (aorist *lath-*)
**-ske/o* (suffix)	*bask-* 'go' (aor. *bā-*)
**-ye/o* (suffix)	*stell-* (<**stel-y-*) 'put in order' (cf *stolḗ* 'equipment')
**-n(e)u* (suffix)	*ornū-* 'rouse' (aor. *oror-*)
*C*i-* (prefix)	*tit^{h}ē-* 'put' (aor. *t^{h}ē-*)

Table 3: Some PIE imperfective affixes and their Greek reflexes

Originally, these characterised stems are thought to have independent meanings, and to have been derivationally related to their corresponding simple roots, rather than part of the same inflectional paradigms. Under this account, the paradigms of durative roots would have had present tense forms, and past tense forms which were semantically imperfective, i.e. semantically equivalent to the Greek imperfect. Punctual roots would have had past tense forms which were semantically perfective (semantically equivalent to the Greek aorist), and no present tense forms. In a later stage of Indo-European, the grammaticalisation of these derivational affixes led to the first oppositions within inflectional paradigms between past perfective and past imperfective forms; this opposition survived into the daughter languages as a paradigmatic opposition between aorist and imperfect (Strunk 1994).

There is evidence for this version of events in the daughter languages: *-ske-* has traces of an iterative value in Homer, and an inceptive value in Latin. In Hittite, **nu* is used to make causatives (Hoffner and Melchert 2008: 175). This is supported by the fact that verbs containing inherited derivational affixes in the daughter languages tend to have only imperfective forms, suggesting an earlier situation in which imperfective affixes (like those in table 3) could not appear in the same wordforms as other derivational affixes, because the function of both types of affix was to form distinct lexemes.

Because there is significant agreement between Greek and Vedic in which characterised stems appear in the present and imperfect, we can infer that the original differences in meaning between different constructions must have been largely lost by the time the languages diverged. Derived stems must have already started to be absorbed into inflectional paradigms as the

imperfective counterparts to perfective root formations, allowing the root in question to appear with non-past tense. Presumably the semantic bleaching of derived stems was a necessary precursor to their lexicalisation, but we cannot know exactly how the two processes interacted. Hittite perhaps represents an earlier stage in that the marking of imperfectivity is not obligatory – uncharacterised past tense forms, for example, can be interpreted as perfective (like the Greek aorist) or imperfective (like the Greek imperfect) – but imperfective aspect can be made explicit when necessary by means of various suffixes, the most productive being a cognate of **ske* (Hoffner and Melchert 2008: ch. 24).

The derived stem formations mentioned so far have the ability to turn an inherently punctual root into an imperfective stem, which is capable of being used with present/future or imperfect value, depending on the presence or absence of the non-past marker **-i/r*. Apart from root aorists, in Greek and Vedic we find many aorist stems characterised by the suffix *-s*, which also appears less systematically in the past tenses of some of the other languages (e.g. Latin *dīcō* 'I say', *dīxī* 'I said'), although not in Anatolian.[11] This seems to have had the function, in late PIE, of forming a perfective stem from a durative root.[12] In Greek, this became the dominant strategy for forming the aorist stem in terms of type frequency, often replacing original root formations, which are more likely to be preserved in Vedic. With the establishment of a productive s-aorist, which allowed imperfective roots to have paradigm members with past tense and perfective aspect, the morphological marking of aspect started to become systematic. When this happened, the paradigms of individual verbal lexemes must have been

[11] The s-aorist may be related to the s-presents, which do occur in Hittite (Jasanoff 1988).
[12] Narten (1964).

severely defective, as is still the case in Vedic, and to some extent also in Greek. But the grammaticalisation of the stem suffix *-s* established the *possibility* of a complete paradigm for lexically imperfective roots.

1.4. Filling out defective paradigms. Greek then took advantage of this possibility by extending the s-aorist beyond its original enviroment, which, if we follow the above account, would have been verbs which form root presents. Thus Greek moved away from the defectiveness and polysemy typical of the Vedic verb system.

Already in PIE, verbforms featuring stems characterised by affixes like **-ske*, **-n-* and **Ci-*, which had at an earlier stage belonged to separate lexemes, had started to be absorbed into the inflectional paradigms of simple roots as exponents of aspect. We know that this process had already started before the divergence of Greek by the level of agreement there is between the Indo-European languages, particularly Greek and Indo-Iranian, in which of numerous possible constructions they select for individual verbal roots. The agreement is not total, though, and the comparative evidence sometimes justifies reconstructing more than one possible imperfective formation for PIE. Internal evidence agrees with this: Vedic has multiple competing imperfective stems for a number of verbal lexemes, and widespread defectiveness, which is exactly what we would expect if imperfective stems had transferred from derivational to inflectional status relatively soon before the IE languages separated. Greek also shows occasional variation between stems which have an equal claim to be inherited, particularly in Homer, usually because Homer preserves metrically useful dialectal alternatives rather than reflecting coexistence of multiple formations in any individual's

speech. The root *$g^{w}em$-, for example, is reconstructed with two present stems *$g^{w}m$-*ye*- and *$g^{w}m$-*ske*-, reflected in Greek *bainō* and *báskō*, both 'go'. In general, where we reconstruct more than one imperfective stem for PIE, Greek tends to settle on a single variant, and where we reconstruct no imperfective stem, Greek innovates one on the basis of an established pattern.

1.5. Suppletion. The lexical absorption of characterised imperfective stems is in essence no different to the lexicalisation of etymologically distinct stems, which led to 'strong' suppletion (see ch. 2: 2.5) in Greek paradigms such as *légō* 'I speak', *eîpon* 'I spoke', *eréō* 'I will speak'. In both cases, stems originally belonging to distinct lexemes have been assumed into complementary subsets of cells of the same lexical paradigm. Only in the former case, though, do we end up with 'weak' suppletion, where there is a characterisable formal relationship between perfective and imperfective stems which is capable of being extended to new items.

These formal patterns were extended not only in analogical remodelling of existing paradigms, but also in the creation of newly-coined verbs, like *ebasíleusa*, 'I ruled', aorist of *basileúō* 'I rule', from the noun *basileús* 'king'. The aorist in -*s* is the only aorist formation attested for denominative verbs in Greek, which were a major source of new vocabulary.

Presents in -*ye*/*o* were particularly productive, first as a way of thematising original root-presents (see 1.7.1): the root *$g^{wh}en$- 'strike' is reconstructed as a root present on the basis of Hittite 3sg *kuenzi*/ 3pl *kunanzi*, Lycian 3pl *qāñti*, Vedic *hánti*, *ghnánti*, and Avestan *jaiṇti*, -*γnəṇti*, but Greek has *theinō* < *$g^{wh}en$-*yō*. Athematic inflection was only retained in roots whose Greek reflexes were

vowel-final, such as *phâmi* 'I say', aorist *éphān*, < *b^heh_2-mi*, *e-b^heh_2-m*, and over the course of many centuries it was eventually phased out entirely (3.5).

1.6. Expansion of the paradigm of the verb. Apart from the lexicalisation of particular root-formations, the major structural innovation in the Greek verbal system is the phenomenal expansion of the verbal paradigm, making it possible for verbforms to realise a much greater number of possible morphosyntactic feature combinations. This had already started in late PIE with the increase in productivity of the s-aorist. By the time of the earliest written records, Greek has developed a future tense, infinitives for all voices and aspects, a much greater range of participles, dedicated passive forms for the aorist and future, and mood, tense and voice distinctions in the perfect, all of which were absent in PIE.

1.6.1. Desiderative to Future. In 1.2.2.3, we reconstructed only a binary distinction of tense between past and nonpast for PIE. In Greek, future forms were largely created by the grammaticalisation of old derivational morphology: the Greek future stem comes from an earlier desiderative suffix *-*s*, which was followed by the thematic primary endings. This is a common path of semantic change; cf. the English periphrastic future "I will", and the Modern Greek future with the particle *tha* < *thélō* 'wish' (3.2). The desiderative origin accounts for the fact that many active verbs have middle futures in Greek, since if the subject wishes the action of the verb to take place, he is likely to be a beneficiary as well as a potential agent (see note 4). Apart from a few exceptions like *eîmi* 'I will go', all Greek futures come from the formation with *-*s*, but it has different results depending on the phonological shape of

the root. After occlusives, *-s-* was retained, as in *deíxō* [dēks-] 'I will show', cf. present *deíknūmi*. In laryngeal-final roots the sequence *h_1sV became *eV (via *ehV); an example of this type is *eréō* 'I will speak' < *$werh_1$-s-ō. This pattern then spread to other resonant-final roots, pivoting on presents in *-*ye*/*o*. These had become indistinguishable from present tense forms of roots ending in *Rh_1 by Pinault's rule, which eliminated laryngeals in word-internal sequences of consonant + laryngeal before **y*.[13]

1.6.2. The creation of the passive. For PIE, we reconstructed a binary distinction between active and mediopassive voice (1.2.2.2). This binary distinction is largely preserved in Greek, except in the future and aorist, where dedicated passive forms were created by the grammaticalisation of an old stative suffix *-eh_1-, in combination with the active person-number suffixes. This semantic reanalysis is natural enough: English uses the same formal construction for both the past passive and the past stative, so that 'the bread was burnt' can be equivalent to either German 'das Brot *war verbrannt*' (stative) or 'das Brot *wurde verbrannt*' (passive). Thus a form like *ekáēn* < *e-kh_2w-eh_1-*m*, originally meaning 'I was (in a state of being) burnt' was reanalysed as a passive past perfective 'I was burnt (by someone/thing)'. In Homer, the majority of aorist passives show this construction, and most are from verbal roots whose stative meaning would have been closest to the passive. Later, a stem suffix *-thē* (sometimes *-sthē*) became a more productive maker of the aorist passive, e.g. *ekaúthē* 'it was burnt' is attested alongside *ekáē*. The source of this construction is unclear, but it was likely influenced by *-ē* (< *eh_1), and like *-ē* it takes the athematic active person-number suffixes. In the future, specialised passive

[13] An alternative account, favoured by Sihler (2008: 556-7), reconstructs the desiderative suffix as *-h_1s. To make this explanation work we must assume that *h_1 was lost between occlusives and *s in the future of verbs like *deíknūmi*, a sound law for which there is no other evidence.

forms were built on the aorist passives in -(*s*)*thē* (*kauthḗsomai* 'I will be burnt') and *-ē* (*taphḗsomai*, 'I will be buried', cf. *etáphēn*, 'I was buried'), although for a number of verbs the future middle retained its passive value (e.g. *aiskhunoûmai* 'I will be disgraced').

1.6.3. Stative to Perfect. The expansion of the perfect paradigm took place alongside a change in its semantics: while it retains some of its stative value in Greek, it also develops a use as a secondary tense, much like the English periphrastic perfect with auxiliary 'have' (e.g. 'I refused her offer of chips because I had already eaten'). The pluperfect (past perfect) active was formed on the full grade of the present perfect stem: thus *eleloípē* 'I had left', which contains the stem *leloip-* of the perfect active *léloipa* 'I have left'. Mediopassive forms are built on the imperfective stem, and the relationship of the tense forms to each other follows the model of the imperfective system: *leleípsomai* 'I will have been left', *léleimmai* (< **léleipmai*) 'I have been left', *eleleímmēn* (< **eleleípmēn*) 'I had been left' (not ***léloimmai*, etc.). Similarly, optative and subjunctive forms were supplied by analogy to the formal relationship of the different mood forms in the perfective and imperfective paradigms.

The perfect active (present and past) were formally remodelled with a new form of the stem featuring initial reduplication and stem-final [k], as seen in *léluka* 'I have freed' above. The origins of this *k* are unknown.[14] This became the highest type-frequency perfect formation in post-Homeric Greek (it is unattested in Mycenean, although this does not guarantee its absence). The pluperfect stem was then further expanded with a stem-final [e], which contracted with the original endings *-a, -as, -e, -men, -te, -san*, which were

[14] Sihler (2008: 577) discusses a few possible explanations, none of which I find convincing.

descended from the PIE athematic active endings, to give a set of endings *-ē, -ēs, -ei, -emen, -ete, -esan* which were unique to the pluperfect.

1.7. The origins of affix allomorphy

The pluperfect serves as one illustration of how the relatively minimalist expression of person and number in PIE (1.2.2.1) was complicated by Greek developments. The following two sections will explain the origins of the lexically conditioned allomorphy of the person-number suffixes described in ch. 2 (3.2).

1.7.1. Imperfective allomorphy. So far this account has neglected the thematic vowel, which is functionally obscure, but crucial to the formal development of the Greek verbal system. The thematic vowel is reconstructed as a suffix **e* or **o* (the **o* variant probably originally before resonants) which appears between PIE verbal stems and final suffixes. The formal relationship between thematic and athematic equivalents is often obscured by sound changes in the daughter languages, but it cannot be reconstructed as a completely transparent relationship even for PIE: at least the first singular active nonpast thematic ending is reconstructed as a cumulative morpheme **-ō* rather than expected ***-omi* (cf. athematic **-mi*).[15]

Thematicity seems to have been a property of stems. Of the characterised stems listed in table 3 (1.3), most imperfective stems were thematic, apart

[15] An ending formally equivalent to **-omi* was analogically created in Sanskrit, however, on the model of the more usual relationship between the athematic and thematic endings.

from those featuring the suffix *-*nu* or reduplication, while root formations were athematic.[16]

Imperfective stems in Greek continue three inherited categories of PIE imperfective stems (indirectly, because of substantial analogical extension, so that the Greek formation does not necessarily reflect the formation we reconstruct for PIE): (i) root formations of verbs with durative *Aktionsart* (athematic); (ii) characterised imperfective stems with athematic inflection (e.g. **Ci*- reduplication, *-*nu*); (iii) characterised imperfective stems with thematic inflection (e.g. *-*ye*/*o*, *-*ske*). The Greek distinction between thematic and athematic inflection in the imperfective subparadigm (ch. 2: 3.2) continues the opposition of thematic inflection in (iii) with athematic inflection in (i-ii). Various Greek developments have obscured the relationship between the two, so that the Greek reflexes of the thematic vowel in conjunction with the PIE person-number suffixes function synchronically as allomorphs of the bare person-number suffixes, with or without the primary marker -**i* (table 4). A number of sound changes, particularly the loss of final consonants other than [n] or [s], have removed the synchronic motivation for segmenting [i] in the primary suffixes as a separate morpheme. As a result, to the degree that this [i] still marks tense in Greek, it does so cumulatively rather than agglutinatively.

[16] Root formations in the daughter languages are predominantly athematic, and exceptions can often be explained as secondary formations: Greek *leipō* 'I leave' < *$leik^{w}$-, which looks like an original root present, can be compared with Latin *linquō* and Vedic *riṇákti,* which suggest an n-infix. The Greek strong aorist *elipon* looks like it continues a PIE thematic root aorist **e-lik^{w}-o-m*, but there is little agreement between the daughter languages, and these forms are perhaps best regarded as later thematisations of original root aorists (i.e. 2sg **e-lik^{w}-s* rather than ***elik^{w}es*; the introduction of the thematic vowel can perhaps be regarded as a strategy for getting rid of the difficult-to-pronounce final consonant cluster, as argued by Cardona 1960, and followed e.g. by Rix: "die unredupliziert thematischen Aoriste sind hier sämtlich als erst nachurindogermanisch thematisierte Wurzelaoriste oder als Neubildungen angesehen, auch wenn sie bei der gleichen Wurzel in mehreren Einzelsprachen belegt sind" 2001: 20). The only thematic root-aorist which is attested in more than two IE branches is *$h_1$ludh-e/o- 'arrive'.

		Root formation STEM = ROOT e.g. *phēmi* 'say' (*b^heH_2-)		Characterised athematic STEM = *Ci*+ROOT e.g. *títhēmi* 'put' (*$di\text{-}d^heH_1$-)		Characterised thematic STEM = ROOT+*ske* e.g. *báskō* 'go' (*gwm-ske-)	
		PIE	Greek	PIE	Greek	PIE	Greek
Present	1sg	STEM-m-i	*phēmí*	STEM-m-i	*títhēmi*	STEM-ō	*báskō*
	2sg	STEM-s-i	*phḗs*	STEM-s-i	*títhēs*	STEM-e-s-i	*báskeis*
	3sg	STEM-t-i	*phēsí*	STEM-t-i	*títhē*	STEM-e-t-i	*báskei*
	1pl	STEM-mé	*phamén*	STEM-mé	*títhemen*	STEM-o-m-e	*báskomen*
	2pl	STEM-té	*phaté*	STEM-té	*títhete*	STEM-e-te	*báskete*
	3pl	STEM-nt-i	*phāsí*	STEM-nt-i	*tithéāsi*	STEM-o-nt-i	*báskousi*
Imperfect	1sg	e-STEM-m	*éphēn*	e-STEM-m	*etíthēn*	STEM-o-m	*ébaskon*
	2sg	e-STEM-s	*éphės*	e-STEM-s	*etítheis*	STEM-e-s	*ébaskes*
	3sg	e-STEM-t	*éphē*	e-STEM-t	*etíthei*	STEM-e-t	*ébaske*
	1pl	e-STEM-mé	*éphamen*	e-STEM-mé	*etíthemen*	STEM-o-me	*ebáskomen*
	2pl	e-STEM-té	*éphate*	e-STEM-té	*etíthete*	STEM-e-te	*ebáskete*
	3pl	e-STEM-nt	*éphan*[17]	e-STEM-nt	*etíthen*	STEM-o-nt	*ébaskon*

Table 4: The PIE origins of suffix allomorphy in the Greek imperfective system

1.7.2. Aorist allomorphy.

The Greek aorist (active/middle) indirectly continues three categories of perfective stem in late PIE: (i) root formations of verbs with punctual *Aktionsart* (athematic), (ii) characterised perfective stems with thematic inflection (reduplicated aorists), and (iii) characterised perfective stems with athematic inflection (the s-aorist). (i) is reflected by the Greek root aorists, (ii) by the strong aorist, and (iii) by the weak aorist (table 5).[18]

[17] The 3pl athematic suffix, when not followed by the primary marker *-i*, was later replaced by the suffix *-san*, showing influence from the s-aorist.

[18] The origins of the stem-final [k] of the kappatic aorist in Greek are unclear, and may be related to the kappatic perfect (see Sihler 1995: 576). Synchronically, the person-number suffixes of the kappatic aorist alternate between those of the weak aorist in the singular, and the root aorist in the plural (ch. 2: 3.2)

		Root formation STEM = ROOT		s-aorist STEM = ROOT+*s*		Reduplicated aorist STEM = *Ce*+ROOT	
		e.g. (*ap-*)*édrān* 'ran' (**dreH*$_2$-)		e.g. *éklepsa* 'stole' (**klep*-s)		e.g. *eîpon* 'said' (**we-wk*^{w})	
		PIE	Greek	PIE	Greek	PIE	Greek
Aorist	1sg	e-STEM-m	*édrān*	e-STEM-m	*éklepsa*	STEM-o-m	*eîpon*
	2sg	e-STEM-s	*édrās*	e-STEM-s	*éklepsas*	STEM-e-s	*eîpes*
	3sg	e-STEM-t	*édrā*	e-STEM-t	*éklepse*	STEM-e-t	*eîpe*
	1pl	e-STEM-mé	*édramen*	e-STEM-mé	*eklépsamen*	STEM-o-me	*eípomen*
	2pl	e-STEM-té	*édrate*	e-STEM-té	*eklépsate*	STEM-e-te	*eípete*
	3pl	e-STEM-nt	*édran*	e-STEM-nt	*éklepsan*	STEM-o-nt	*eîpon*

Table 5: The PIE origins of suffix allomorphy in the Greek aorist system

Various sound changes in Greek obscured the formal relationship between the thematic and athematic paradigms after consonant-final roots, particularly the loss of word-final consonants other than [n] and [s], and the vocalisation of vocalic resonants, which in PIE had been allophones of consonantal resonants in syllable nuclei. The development of the two paradigms is summarised in table 6; the weak aorist has also been influenced by the thematic past tense paradigms, particularly in the analogical spread of [a] from the first person singular.

	Pre-Greek	Thematic imperfect/strong aorist (V_)	s-aorist (C_)
1sg	**-m*	**om* > *on*	**sm̥* > *sa*
2sg	**-s*	*es*	**ss* → *sas*
3sg	**-t*	**et* > *e*	**st* → *se*
1pl	**-men*	*omen*	**smen* → *samen*
2pl	**-te*	*ete*	**ste* → *sate*
3pl	**-nt*	**ont* > *on*	**sn̥t* > **sa* → *san*

Table 6: The development of the thematic and weak aorist active suffixes

1.8. Contract verbs.

The paradigm of the contract conjugation (ch. 2: 3) uses particular formations for the future, present, aorist and perfect which consistently correlate with

each other.[19] This group has three subtypes, traditionally described as having a vowel *e, a* or *o* before the thematic endings of the present: e.g. TĪMÁŌ 'honour', PHILÉŌ 'love', DĒLÓŌ 'show'.[20] These paradigms are characterised by a short stem-final vowel in the present and imperfect, which is lengthened in the rest of the paradigm, and extended with *-s*/*thēs* in the future, *-s*/*thē* in the aorist, and *-k* in the perfect active (table 7).

Present	*tīmá-ō,* *tīmá-omai*	*philé-ō,* *philé-omai*	(*dēlô, dēloûmai*)
Future	*tīmḗs-ō,* *tīmḗs-omai,* *tīmēthḗs-omai* (*ē* < *ā*)	*philḗs-ō,* *philḗs-omai,* *philēthḗs-omai*	*dēlṓs-ō,* *dēlṓs-omai,* *dēlōthḗs-omai*
Aorist	*et'īmēs-a,* *etīmēs-ámēn,* *etīmḗthē-n*	*ephílēs-a,* *ephilēs-ámēn,* *ephiléthē-n*	*edḗlōs-a* *edēlōs-ámēn* *edēlṓthē-n*
Perfect	*tet'īmēk-a,* *tetímē-mai*	*pephílēk-a,* *pephílē-mai*	*dedḗlōk-a* *dedḗlō-mai*

Table 7: Three subtypes of the contract conjugation

The PIE origins of this group are various. The a-type comes mainly from (i) factitives with a stem-suffix *-(*e*)H_2- (e.g. **new-e*H_2-(*ye*/*o*-) > *neáō* 'renew', cf. *néos* 'young, new'), and (ii) denominatives built to nouns or adjectives with stems ending in *-*e*H_2- (e.g. *tīmáō*, cf. *tîmē* 'honour' < *-*e*H_2). The e-type has two main sources: (iii) denominatives with the stem-suffix *-*eye*/*o* (e.g. **woikeye*/*o*- > *oikéō* 'inhabit, cf. *oîkos* 'house'), and (iv) statives in *-*e*H_1- (e.g. **p*^{h}*ileH*$_1$- > *philéō* 'love', cf. *phílos* 'beloved'). Of these, (iii) would in early Greek have had a short *e* throughout the paradigm, whereas (i), (ii) and (iv) would have had a long *ē*/*ā* throughout the paradigm, owing to the lengthening effect of the

[19] Not completely reliably, since a few verbs have contract formations in the future, perfect and/or aorist but not the present, such as HAMARTÁNŌ 'fail' (perfect *hēmártēka*).
[20] While *philéō* and *tīmáō* are genuinely behind contracted *philô, tīmô,* forms with *-o-* like *dēlóō* are actually artificial, and never found in epigraphical texts. The 'contracted' equivalent *dēlô* itself seems to be a secondary formation from non-present forms with *-ō-*, such as aorist *edḗlōsa* (Tucker 1981).

laryngeal (*H_1/H_2) on a preceding vowel. Some kind of analogical interference between the various paradigms led to the alternation between a short vowel in the present/imperfect and a long vowel elsewhere for the whole group.[21] The o-type, a purely Greek innovation, fell in with the same pattern of alternation. This coalescence suggests that the three types were felt to belong together from the earliest Greek, and their continued parallel development in the later language confirms this. The imperfective forms were affected by contraction of the stem-final and the thematic vowels, depending on dialect, with Attic typically having the most contracted forms and Ionic being most likely to preserve uncontracted forms. Thus the boundary between the stem and ending was obscured in the imperfective system.

1.9. Typological differences between PIE and Greek verbal morphology

The overall impression is that Greek has enriched the inflectional morphology it inherited from PIE, at the expense of morphological transparency and predictability. The main typological differences between PIE and Greek verbal morphology appear to have been as follows.

PIE has more agglutinating and less cumulative morphology than Greek, or the other IE daughter languages. In Greek, person, number, voice, mood, tense, perfect and thematicity are all realised by means of cumulative suffixes. In PIE the only categories which are realised by cumulative morphemes are person, number, voice, imperative, stative, and (in the first person singular) thematicity.

[21] The details of this analogical interference are problematic, and complicated by the fact that one or more of the constructions may have been originally athematic. Athematic forms are also found in the Aeolic dialects, although at least some must be analogical (Tucker 1981).

PIE has less obligatory morphological marking than Greek. The morphological marking of tense may have been optional, while in Classical Greek it is obligatory. The PIE stative marked only person and number, whereas its descendant, the Greek perfect, also marks voice, tense, and mood.

It is likely that a greater number of functional distinctions in the verb were made by derivational morphology, and fewer by inflectional morphology, at least in an early stage of PIE. At this stage, inflectional paradigms were much less extensive than in Greek. Because different stem formations were absorbed into inflectional paradigms as perfective or imperfective stems, Greek inflectional paradigms are formally more irregular and unpredictable than PIE inflectional paradigms.

1.10. Summary

Table 8 summarises the various formations found in the Classical Greek verbal system, and their origins, according to the account just given.

	E.g.	*Origins*
Present formations		
Athematic root presents	*phēmí* 'I say'	*lexically imperfective roots + primary markers*
Athematic characterised presents	*órnūmi* 'I rouse' *dídōmi* 'I give'	*athematic derived imperfective stems of lexically perfective roots + primary markers*
Thematic root presents	*phlégō* 'I burn' *luō* 'I free'	*lexically imperfective thematic roots + primary markers OR secondary thematisations of lexically imperfective athematic roots + primary markers*
Thematic characterised presents	*theínō* 'I slay' < **then-yō* *báskō* 'I go'	*thematic derived imperfective stems of lexically perfective roots + primary markers*
Contract presents	*tīmáō* 'I honour' *philéō* 'I love'	*convergence of various factitive, denominative and stative formations*
Athematic middle presents	*keîmai* 'I lie down' *dúnamai* 'I can'	*lexically imperfective roots and derived imperfective stems of lexically perfective roots (deponents and middles) + primary middle endings*
Thematic middle presents	*hépomai* 'I follow' *peíthomai* 'I obey'	*lexically imperfective roots and derived imperfective stems of lexically perfective roots (deponents and middles) + thematic vowel + primary middle endings*
Imperfect formations		
Athematic root imperfects	*éphēn* 'I was speaking'	*As above, but with augment (e-) and without primary marker (-i).*
Athematic characterised imperfects	*ṓrnuon* 'I was rousing' < *eórnuon* *edídoun* 'I was giving'	
Thematic root imperfects	*éphlegon* 'I was burning'	
Thematic characterised imperfects	*étheinon* 'I was slaying' *ébaskon* 'I was going'	
Contract imperfects	*etímaon* 'I was honouring' *ephíleon* 'I was loving'	
Aorist formations		
Athematic root aorists	*ébēn* 'I went'	*Lexically perfective roots + secondary endings*
Thematic root aorists	*élluthon* 'I came'	*Lexically perfective thematic roots + secondary markers OR thematised lexically perfective athematic roots + secondary endings*
Reduplicated aorists	*eîpon* 'I spoke' (<**e-we-wk*^{w}*-om)*	*PIE reduplicated aorist (root + thematic vowel + secondary endings)*
s-aorists	*élūsa* 'I freed'	*Perfective stems derived from lexically imperfective roots with suffix *s + secondary endings*
Lengthened aorists	*ággeila* 'I announced' (pres. *aggéllō)*	*earlier s-aorists with loss of *s and compensatory lengthening in resonant-final stems*
Contract aorists	*etímāsa* 'I honoured' *ephílēsa* 'I loved' *edēlōsa* 'I showed'	*s-aorists of various factitive, denominative and stative formations*
k-aorist	*édōka* 'I gave'	*Unknown*
Aorist passive in *-ē-*	*ekáēn* 'I (was) burned'	*Stative with suffix -eh*$_1$*-*
Aorist passive in -(*s*)*thē-*	*ekaúthēn* 'I was burned'	*Greek innovation, origin obscure*

Future formations		
s-future	*lúsō, lúsomai* 'I will free/I will be freed'	*PIE desideratives with *-s suffix + thematic primary endings*
Contract future	*erô* 'I will speak'	*desideratives with vocalisation of laryngeal, loss of intervocalic *s and vowel contraction*
Futures of contract verbs	*philésō* 'I will love'	*desideratives of various factitive, denominative and stative formations, with vowel lengthening caused by laryngeal*
Presents with future value	*eîmi* 'I will go'	*Inherited value of PIE nonpast*
Perfect formations		
Inherited perfect	*léloipa* 'I have left'	*PIE stative*
k-perfect	*léluka* 'I have freed'	*Greek innovation, unknown origin*
Aspirated perfect	*dédeicha* 'I have shown' (aorist *édeiksa*)	*Greek innovation, unknown origin*
Pluperfect	*elelúkē* 'I had freed'	*Greek innovation, analogically based on imperfective system*
Future perfect	*leleípsomai* 'I will have been freed'	*Greek innovation, analogically based on imperfective system*
Future perfect	*leleípsomai* 'I will have been freed'	*Greek innovation, analogically based on imperfective system*

Table 8: Summary of the PIE origins of Greek verbal formations

3. THE MODERN GREEK VERB

The Modern Greek verbal system is recognisable to anyone familiar with the classical language, but what it has inherited from Ancient Greek verbal morphology has been vastly simplified. A number of functional categories which were realised in Ancient Greek by synthetic wordforms, often irregular, have been formally renewed by periphrastic constructions. The pervasive morphological arbitrariness of Ancient Greek has been reduced to a system of conjugations, which govern the majority of stem allomorphy, and determine affix allomorphy for entire paradigms.

3.1. Morphosyntactic distinctions and how they are realised

Including periphrastic constructions, Modern Greek verbs mark three tenses (present, past, future), two voices (active and passive), three moods[22] (indicative, subjunctive and conditional), two aspects (perfective and imperfective) and an analytic perfect, which is compatible with any tense, voice or mood but makes no distinctions of aspect. There is no morphologically distinct middle voice, although the passive formally continues the classical mediopassive, except in the aorist, and encodes some of the values of the old middle (e.g. reciprocity and reflexivity). Deponents which are passive in form but active in meaning have also been retained. There has also been a reduction in nonfinite forms: the infinitive remains only as a fossilised complement in the perfect construction (3.2), and ancient Greek's abundance of participles has dwindled to a meagre range of indeclinable gerunds and fossilised adjectives.

As in ancient Greek, aspect is always realised by the choice of stem. A distinction between past and non-past is realised mainly by the choice between two sets of suffixes, descended from the weak/strong aorist and thematic present respectively, each of which also cumulatively express person, number and voice. In non-past forms, present is unmarked, whereas the future is preceded by the preverbal particle *tha*. Indicative mood is unmarked, while the subjunctive is realised by the particle *na* (conditional mood is less straightforwardly realised by the combination of both future and past exponents). The perfect construction consists of the auxiliary *ékhō* 'have', which is inflected for tense, mood, person and number in the same ways as

[22] Modern Greek also has an imperative mood, which is available only in the second person. I exclude it from this account for the sake of simplicity.

main verbs. This is followed by a form of the verb which is descended from the present infinitive, which is inflected only for voice, consisting of the perfective stem + the ending *-ei* [i] (from the present infinitive ending *-ein* [ēn], but now indistinguishable from the 3rd person singular active ending *-ei* [i]).

Although suffixes are the primary exponents of past tense, it is also accompanied by a characteristic placement of the accent on the antepenultimate syllable.[23] The augment is prefixed to wordforms which would otherwise have less than three syllables, and therefore be unable to satisfy this requirement. This is usually *e-* [e], as in Classical Greek, but sometimes *ē-* [i], and it can in some cases appear internally as well as as a prefix. Which verb takes which rule varies significantly both by dialect and by register, due to the greater influence of *katharévousa* on educated and formal strains of the language.

2.2. Distributional constraints on morphosyntactic features

As mentioned above, the perfect makes no distinctions of aspect, like the Classical perfect, but always uses the perfective version of the main verb stem regardless of semantics. There is, however, a future perfect, which was lacking in Ancient Greek.

The interaction of aspect, tense and mood is complicated. Subjunctives are tenseless. There is no perfective form of the present indicative, as in ancient Greek, but the aspect distinction has extended into the future formation with

[23] With two exceptions: past imperfect forms of 2nd conjugation verbs in Standard Modern Greek have stems in *-oús-* with the accent fixed on the final syllable of the stem (dialectally, stems in *-ag-* are also common, which do conform to the requirement of antepenultimate stress). The second group of exceptions is vowel-initial verbs, e.g. *ékhō* 'I have', *eíkha* 'I had'.

tha. The contrast between perfective and imperfective is also lacking in the conditional, which always selects the imperfective stem. Nor is there a future conditional; the conditional both looks and acts very much like a future of the past, so there is a case to be made for treating ±future as a separate variable from ±past, reducing a three-way distinction of tense to the product of two binary variables. If so, the future would be reclassified as [+future, -past], and conditionals as [+future, +past]. In this scheme, there are six binary morphosyntactic variables: ±past, ±future, ±subjunctive, ±passive, ±perfective and ±perfect. Of the 64 (2^6) morphosyntactic feature combinations that this allows in theory (excluding person and number, and the imperative), 26 are actually possible. These are summarised in table 9.

As in Classical Greek, all morphosyntactic features which apply in a particular syntactic context and are available for morphological or syntactic marking must be marked; there are no optionally marked morphosyntactic variables.

PAST	FUT	SUBJ	PASS	PERFTV	PERFCT	Conventional name	1sg
+	+	-	+	+	+	pluperfect conditional passive	*tha eíkha detheí*
+	+	-	+	-	-	conditional passive	*tha denómoun*
+	+	-	-	+	+	pluperfect conditional active	*tha eíkha dései*
+	+	-	-	-	-	conditional active	*tha édena*
+	-	-	+	+	+	pluperfect passive indicative	*eíkha detheí*
+	-	-	+	+	-	aorist passive indicative	*déthēka*
+	-	-	+	-	-	imperfect passive indicative	*denómoun*
+	-	-	-	+	+	pluperfect active indicative	*eíkha dései*
+	-	-	-	+	-	aorist active indicative	*édesa*
+	-	-	-	-	-	imperfect active indicative	*édena*
-	+	-	+	+	+	future perfect passive	*tha ékhō detheí*
-	+	-	+	+	-	perfective future passive	*tha dethó*
-	+	-	+	-	-	imperfective future passive	*tha dénomai*
-	+	-	-	+	+	future perfect active	*tha ékhō dései*
-	+	-	-	+	-	perfective future active	*tha désō*
-	+	-	-	-	-	imperfective future active	*tha dénō*
-	-	+	+	+	+	perfect passive subjunctive	*na ékhō detheí*
-	-	+	+	+	-	aorist passive subjunctive	*na dethó*
-	-	+	+	-	-	present passive subjunctive	*na dénomai*
-	-	+	-	+	+	perfect active subjunctive	*na ékhō dései*
-	-	+	-	+	-	aorist active subjunctive	*na désō*
-	-	+	-	-	-	present active subjunctive	*na dénō*
-	-	-	+	+	+	perfect passive indicative	*ékhō detheí*
-	-	-	+	-	-	present passive indicative	*dénomai*
-	-	-	-	+	+	perfect active indicative	*ékhō dései*
-	-	-	-	-	-	present active indicative	*dénō*

Table 9: Distributional constraints on morphosyntactic features in the Modern Greek verb

3.3. Paradigm structure and inflection classes

Like its Classical ancestor, the Modern Greek verbal system is still usefully described in terms of principal parts. However, much of the allomorphy which was encoded by the ancient Greek principal parts has either merged, been lost, or increased in productivity, so that the system is more amenable to description in terms of numbered conjugations. Three representative forms for each individual verbs are sufficient both to identify which conjugation it

belongs to, and enable prediction of full paradigms via six exemplary principal parts for each conjugation, similarly to how the Latin conjugation system works (ch. 2: 2.3), whereas in ancient Greek seven principal parts had to be given for each individual verb (ch. 2: 3).

Most grammars ascribe two conjugations to Standard Modern Greek, each with two subpatterns. The first (paroxytone) conjugation, with the accent fixed to the root in the present, descends from the PAÚŌ pattern, which was the most frequent pattern from early Greek (ch. 2: 3). A small subgroup of frequent verbs within this conjugation have syncopated the vowel of the ending in all but the third person singular of the present, creating a new inflectional pattern.

The second (oxytone) conjugation is characterised by the placement of stress on the person/number suffixes in the present. It is subdivided into conjugation 2A, a pattern which descends from old contract verbs in *-áō* (like TIMÁŌ) and 2B, from the old contract verbs in *-éō* (such as PHILÉŌ). In conjugation 2B, the imperfective forms reflect the contracted forms found in Attic (1.8; ch. 2: 1.5, 3), e.g. *philô, phileîs, phileî, philoûmen, phileîte, philoûsi* (rather than *philéō, philéomen…*). Because the synchronic phonology no longer justifies an analysis of underlying *-éō, -éomen*, the modern forms reflect a segmentation *phil-ô*, *phil-oûmen*, etc. This phonemicisation of vowel contraction has thus added an extra set of imperfective person-number allomorphs to the inventory. In conjugation 2B, two alternative sets of imperfective forms exist, one which allows the segmentation of *á* with the stem, and one which does not (see note 25).

There are also a small number of deponent verbs which also have the accent fixed to the ending and a characteristic [a] vowel, but a separate set of

endings, such as *phobámai* [fováme] 'I fear'. This adds up to five distinct patterns (excluding the unique conjugation of *eímai* 'be'). Table 10 lists principal parts for each of these conjugations.

	Present active	Imperfect active	Aorist active	Present passive	Imperfect passive	Aorist passive
1	*dénō* [ðéno] 'I tie'	*édena* [éðena]	*édesa* [éðesa]	*dénomai* [ðénome]	*denómoun* [ðenómun]	*déthēka* [ðéθika]
1B	*phuláō* [filáo] 'I keep'	*phúlaga* [fílaɣa]	*phúlaxa* [fílaksa]	*phulágomai* [filáɣome]	*phulagómoun* [filaɣómun]	*phuláchtēka* [filáχtika]
2A	*agapáō* [aɣapáo] 'I love'	*agapoúsa* [aɣapúsa] (*agápaga*) [aɣápaɣa]	*agápēsa* [aɣápisa]	*agapiémai* [aɣapʲéme]	*agapiómoun* [aɣapʲómun]	*agapéthēka* [aɣapíθika]
2B	*odēgṓ* [oðiɣó] 'I drive'	*odēgoúsa* [oðiɣúsa]	*odḗgēsa* [oðíɣisa]	*odēgoúmai* [oðiɣúme]	*odēgoúmoun* [oðiɣúmun]	*odēgéthēka* [oðiɣíθika]
(2C)	–	–	–	*phobámai* [fováme] 'I fear'	*phobómoun* [fovómun]	*phobḗthēka* [fovíθika]

Table 10: Principal parts of the Modern Greek conjugations

The primary purpose of table 10 is to tell us which set of person-number suffixes each group of verbs takes in each of six mutually unpredictable parts of the paradigm. For the first conjugation, this is all it tells us: the stem alternation *den ~ des ~ dethē* of *dénō* is just one of many possibilities for this class. For conjugations 2A and 2B, it gives the only possible stem formations for the imperfectives, and the most common stem formations for the aorist active and passive. For 2C, the smallest class, the stem formations exemplified above are the only possible ones.

Table 10 also determines stress placement:[24] in the present, verbs of the first conjugation have the stress fixed to the final syllable of the stem, and in the

[24] The pitch accent of classical Greek became a stress accent quite early in the post-Classical development of Greek, around the mid-second century BC (Horrocks 2010: ch. 6).

second conjugation the stress is fixed to the first syllable of the ending, as it is in the imperfect passive for all verbs. In the imperfect active and aorist active and passive, the stress usually falls on the antepenultimate syllable (which may be an augment), except in the imperfect active of second conjugation verbs, where it is fixed to the stem-final syllable *-ous-* (but see note 25).

2.3.1. Affixes. Apart from stem allomorphy and stress placement, table 10 tells us which of 11 sets of person/number suffixes each conjugation takes (I have counted as part of the suffix any part of the word which does not appear in all forms which differ only by person and number, following the principles outlined in ch. 2: 1.3-5).[25] Table 10 cites the first person singular as a representative form, because the 1sg determines the forms of the other persons and numbers, but this is an arbitrary choice.

Table 11 shows the suffixes of each conjugation in each of the principal parts in table 10. Which conjugation a verb belongs to determines the suffixes of the present and imperfect passive, while the aorist and imperfect active have a single set of suffixes.

[25] In the case of 2A verbs in *-áō,* I have made an exception to this rule and treated the accented *á* as part of the ending, in accordance with standard descriptions of modern Greek grammar. This is because, although the segment *á* is present in all the endings of the nonpast active indicative (*-áō, -ás, -áei, -áme, -áte, -áne*), these endings alternate within the speech of individuals with an alternative set of endings *-ṓ, -ás, -á, -oúme, -áte, -oún(e)*, where the segment *á* is not invariant. The latter set of endings are preferred in more formal contexts, by older speakers, and with verbs with a learned or technical meaning, and they are the only possible endings for some verbs e.g. *diaspṓ* 'I split' (Mackridge 1987: 173-4). The tendency in popular speech is decidedly moving towards the endings in *-á-*, however, which suggests an analysis of *-á-* as part of the stem for at least some speakers; this analysis is supported by the alternative imperfect construction in *-ag-* (more common in the South) which preserves not only the general rule that past forms have antepenultimate stress, but that the past imperfective has the same form of the stem as the present active (*-g-* [γ] is a semi-phonological hiatus avoider). On this analysis, the endings of type 2A and 1B are identical in the present indicative; a stem-final vowel (*á* for 2A, *á, é* or *ó* for 1B) precedes an invariant set of endings *-ō, -s, -ei, -me, -te, -ne*.

	Present active	Imperfect active	Aorist active	Present passive	Imperfect passive[26]	Aorist passive
1	A	E	E	G	K	E
1B	D	E	E	G	K	E
2A	B	E[27]	E	H	K	E
2B	C	E	E	I	L	E
2C	–	–	–	J	K	E

A	**B**	**C**	**D**	**E**	**G**
-ō	*-áō / -ṓ*	*-ṓ*	*-ō*	*-a*	*-omai*
-eis	*-ás*	*-eís*	*-s*	*-es*	*-esai*
-ei	*-áei/-á*	*-eí*	*-ei*	*-e*	*-etai*
-oume	*-áme/-oúme*	*-oúme*	*-me*	*-ame*	*-omaste*
-ete	*-áte*	*-eíte*	*-te*	*-ate*	*-este/osaste*
-oun(e)	*-áne/-oun(e)*	*-oún(e)*	*-ne*	*-an*	*-ontai*

H	**I**	**J**	**K**	**L**
-émai	*-oúmai*	*-ámai*	*-ómoun*	*-oúmoun*
-ésai	*-eísai*	*-ásai*	*-ósoun*	*-oúsoun*
-étai	*-eítai*	*-átai*	*-ótan(e)*	*-oúntan(e)*
-ómaste	*-oúmaste*	*-ámaste*	*-ómastan*	*-oúmastan*
-éste	*-eíste*	*-áste*	*-ósastan*	*-oúsastan*
-oúntai	*-oúntai*	*-oúntai*	*-óntousan*	*-oúntan(e)*

Table 11: Distribution of person/number suffixes in the Modern Greek verb

2.3.2. Stems. If we remove the endings from table 10, we are left with the following (table 12):

	Present active	Imperfect active	Aorist active	Present passive	Imperfect passive	Aorist passive
1	*dén* [ðén]	*dén* [ðén]	*des* [ðes]	*dén* [ðén]	*dén* [ðén]	*déthēk* [ðéθik]
1B	*phulá* [filá]	*phulag* [filaɤ]	*phulax* [filaks]	*phulág* [filáɤ]	*phulag* [filaɤ]	*phuláchtēk* [filáχtik]
2A	*agap* [aɤap]	*agapoús* [aɤapús]	*agapēs* [aɤapis]	*agapi* [aɤapʲ]	*agapi* [aɤapʲ]	*agapēthēk* [aɤapiθik]
2B	*odēg* [oðiɤ]	*odēgoús* [oðiɤús]	*odēgēs* [oðiɤis]	*odēg* [oðiɤ]	*odēg* [oðiɤ]	*odēgēthēk* [oðiɤiθik]
(2C)	–	–	–	*phob* [fov]	*phob* [fov]	*phobēthēk* [foviθik]

Table 12: Distribution of stems in the Modern Greek verb

[26] In the third person plural, sociolectal and dialectal variation is partly conditioned by conjugation. *-óntousan* has a byform in *-óntan(e)*. For 1A and 1B verbs, this byform may appear with stress fixed to the stem (e.g. *dénontan*). This is more common in formal speech, and is recommended in prescriptive grammars. 2A verbs occasionally appear with the 3pl suffix *-oúntan(e)* of the 2B type.

[27] In the aorist active of 2A verbs only, stress is fixed to the stem-final syllable, instead of the antepenultimate syllable (dialectal byforms in *-aga* maintain antepenultimate stress; see note 25 above).

As table 12 shows, there are three different forms of the stem for the 1st conjugation, four for 1B, five for 2A, four for 2B, and two for 2C. In the first conjugation, all imperfective stems are the same. In the other conjugations, whenever the imperfect or present passive stem is different from the present active stem, it differs in a predictable way that is fully captured by the conjugation table (these cells are shaded in light grey). That just leaves the aorist active and passive stems unpredictable from the conjugation table and the present stem, for all conjugations apart from 2C (2C verbs are all deponent, and their aorists all have the same construction). These unpredictable stems are shaded in dark grey in table 12.

For these three stem alternants – the present active, aorist (perfective active, and aorist passive – the conjugations fully capture their distribution, but not the formal relationships between them. As in classical Greek, there are a large number of possible patterns, ranging from strong suppletion (*tróō* 'I eat' has an aorist active stem *phag*, for example) to identity (*krínō* 'I judge' has the same stem *krin* in the aorist active *ékrina*). As in Classical Greek, there are fewer patterns of stem alternation than there are verbs; verbs can be sorted into groups based on the formal relationship between the three stems which are unpredictable from their conjugation, making it possible to sum up the alternations by means of probabilistic rules. From the point of view of both speaker competence and pedagogy it is unclear which patterns are best regarded as rules and which as exceptions: clearly, there is no advantage in learning rules for alternations like *tro ~ phag*, which apply to only one lexeme. A recent grammar aimed at students of modern Greek gives 29 rules for forming perfective stems from the imperfective active, some of which apply

to only two or three verbs, and lists the remaining patterns as irregular verbs.[28]

So far, this is similar to our description of the classical verb system (ch. 2: 3.1). The main difference is that the most common patterns of stem alternation account for a much greater proportion of the verbs in common use in Modern Greek than for its Classical ancestor. The general trend has been for existing patterns to fall together and attract new verbs. A few new patterns have come into existence through borrowing, e.g. the pattern exemplified by *akompaniárō* 'I accompany (on a musical instrument)', *akompanárisa* 'I accompanied', *akompaniarístēka* 'I was accompanied', which applies only to loanwords (the shape of the present stem reflects the Italian infinitive *acompagnare*, but the other stems follow the same pattern as indigenous verbs with the present suffix *-ízō*). Similarly, a number of rare patterns can be regarded as borrowings from Classical Greek, as a result of its continuing prestige throughout the development of the language.[29]

3. Ancient Greek to Modern Greek

The above sketch should be sufficient to show that there have been major changes in the verbal system between the Classical period and the modern day. The degree of person-number affix allomorphy has been reduced. Every verb belongs to an inflection class, which fully determines affix allomorphy throughout its paradigm, and the stems of its imperfective forms. This leaves

[28] Holton et al (2013: 172-84).

[29] Especially in technical or learned vocabulary, e.g. most verbs with imperfective stems ending in [v] have aorists in [ps], apart from a small number of learned words in -[év] which have aorists in [evs], the phonologically regular outcome of ancient Greek *-eus*. E.g. *basiléuō* [vasilévo] has the aorist *basílepsa* [vasílepsa] in the sense 'set' (of the sun), but *basíleusa* [vasílevsa] in the sense 'reign, be a monarch'.

only three unpredictable stems to be learnt, in contrast to the seven of ancient Greek. Moreover, the major classes of stem alternation of ancient Greek have been expanded, so that the majority of these unpredictable stem alternations are captured by a far smaller number of patterns in the modern language. Some morphosyntactic categories, such as the middle voice, have been lost, whereas others have been formally renewed with new analytic structures, reducing the number of inflected forms belonging to each verb.

The overall effect of these changes has been to reduce the rampant unpredictability which characterised the system described in chapter 2. For both stems and endings, fewer allomorphs must be learnt, and the mutual predictability of allormorphs has been strengthened. This section will survey the main processes of change which have brought this about. The main themes are the loss and merger of grammatical categories, the regeneration of lost grammatical categories by means of new constructions, and the loss and analogical regularisation of morphological anomalies. I will discuss these general themes by means of a few selective examples (relying heavily on Horrocks 2010), without, of course, attempting to give a comprehensive account of the development of Modern Greek.

2.1. Loss and merger of grammatical categories.[30] A morphosyntactic distinction can be lost in two ways: either a functional distinction can become imperceptible to speakers, leading to the loss of a parallel formal distinction,

[30] To be pedantically precise, loss and merger are effectively the same thing when it comes to values for morphosyntactic categories such as tense or argument role. These basic semantic categories are expressible in all languages; the question of whether the grammar of a particular language 'has' a particular category such as past tense is really a question of whether it has a way of unambiguously distinguishing past tense from other tenses. In the morphological and syntactic expression of morphosyntactic features, something else always takes on a function that is lost, and thereby becomes more vague. Thus loss of a category implies loss of a distinction (and expansion of another category), and loss of a distinction implies loss of a category.

or vice versa. In either case, the original motivation for the change is not necessarily morphological, but there are knock-on effects for morphology. In fact, it is often difficult to draw a clear distinction between function-led change and form-led change: more often, both functional and formal motivations seem to be at work in the loss of morphosyntactic categories, each supporting the other.

The clearest Greek example of a form-led merger is that of the subjunctive and indicative, whose endings became virtually indistinguishable to speakers through sound change (table 13).

	Indicative non-past (act/m-p)	vii BC Attic	Mid-ii BC	Subjunctive (act/m-p)	vii BC Attic	Mid-ii BC
1sg	*-ō, -omai*	[ɔ:], [omai]	[o], [ome]	*-ō, -ōmai*	[ɔ:], [ɔ:mai]	[o], [ome]
2sg	*-eis, -ēi*	[e:s], [ɛ:i]	[is], [i]	*-ēis, -ēi*	[ɛ:is], [ɛ:i]	[is], [i]
3sg	*-ei, -etai*	[e:], [etai]	[i], [ete]	*-ēi, -ētai*	[ɛ:i], [ɛ:tai]	[i], [ite]
1pl	*-omen, -ometha*	[omen], [omet^{h}a]	[ome(n)], [omet^{h}a]	*-ōmen, -ōmetha*	[ɔ:men], [ɔ:met^{h}a]	[ome(n)], [omet^{h}a]
2pl	*-ete, -esthe*	[ete], [est^{h}e]	[ete], [est^{h}e]	*-ēte, -ēsthe*	[ɛ:te], [ɛ:st^{h}e]	[ite], [ist^{h}e]
3pl	*-ousi, -ontai*	[o:si], [ontai]	[usi], [onte]	*-ōsi, -ōntai*	[ɔ:si], [ɔ:ntai]	[osi], [onte]

Table 13: The effects of sound change on the suffixes of the indicative and subjunctive

A number of sound changes have affected the endings in table 13, but two are relevant to this change: firstly, *ei* [e:] and later *ē* [ɛ:] were raised to [i:], perhaps as early as iv BC,[31] along with the original long diphthong *ēi* [ɛ:i]. Secondly, Greek lost distinctive vowel length (in most places by mid ii BC), which had been the main morphological marker of the subjunctive. Thus the subjunctive and thematic non-past endings, which had always shared the 1sg ending *-ō*, became indistinguishable in most of the other endings, retaining a distinction only in the 2pl and 3pl active and the 3sg and 2pl middle. The imperfective subjunctive was built on the same imperfective stem as the present indicative,

[31] Teodorsson (1974).

and by historical accident the perfective (aorist) active subjunctive usually had the same form of the stem as the future indicative, since both were regularly formed by adding a suffix *-s* to the imperfective stem. This had already led to some confusion before the loss of distinctive vowel length – aorist forms of *phérō* 'I bear' are found from the fifth century BC with the future stem *ois-* – but the loss of distinctive vowel length seems to have been the catalyst that led to the complete collapse of any morphological distinction between the present indicative and subjunctive on the one hand, and the future indicative and the aorist (active) subjunctive on the other.

Hence two originally distinct sets of suffixes became one, and verbs which had previously had a unique future stem lost one of their stem allomorphs. The merger was in favour of the indicative endings, but the subjunctive stems: new indicative-subjunctive forms took on the remaining endings of the indicative (active 2pl *-ete*, 3pl *-ousi*, m-p 3sg *-etai*, 2pl *-esthe*), but the descendant of the aorist subjunctive and future indicative favoured the stem form of the aorist, in verbs where it had not already been identical to that of the future. These new forms, now ambiguous as to mood and tense, were ripe for formal renewal (on which see 3.2 below).

The clearest example of a function-led merger is the loss of the optative mood, which seems to simply fall out of use in the spoken language during the Hellenistic and Roman periods. The optative had already been marginal in Classical Greek, functioning to express a wish, or as an optional synonym of the indicative or subjunctive in various subordinate constructions with a past tense main clause. In Hellenistic Greek the optative lost the second of these functions, and in the Roman period it disappeared also in its core meaning of expressing a wish (although it continued to be used in learned

writing, often hypercorrectly, as a marker of an educated, Classicising style). There is no formal motivation for the loss of the optative, at least until the 3sg active endings *-ei* (indicative) and *-oi* (subjunctive) merge as [i] much later in the mid-Byzantine period. The most plausible explanation is simply that it was semantically redundant in most of its uses.

In the Roman period, when the disappearance of the optative was already underway, it was probably spurred on by the lack of an optative mood in Latin. The same goes for the middle voice, which was also lost in Greek, as Latin only made a binary voice distinction between active and passive. Again, this can only be part of the explanation, because the middle endings were already on their way out in the Hellenistic Koiné. In this case there is also significant formal motivation, as middle forms had only been distinct from their passive equivalents in the aorist and future in Classical Greek.

Finally, starting in Hellenistic Greek, a merger took place between the perfect and the aorist. In the long term this did not lead to the loss of the perfect as a grammatical category – like the future and subjunctive, the perfect was reformed with a new analytic construction (3.2) – but it did increase the predictability of verbal paradigms, since the old synthetic perfect had in many cases been unpredictable and irregular, whereas the new construction was built out of leftover morphological material in the language according to a consistently predictable formula.

The merger clearly had both formal and functional motivations, though in this case it is difficult to separate them. The perfect and the regular s-aorist had almost the same active endings, identical in all but the third person plural. But this formal overlap is itself the result of analogical influence on the perfect from the aorist over a long time period, in parallel with the perfect's

semantic shift from a stative to a perfect meaning, which is semantically closer to the aorist in that the action of the verb has taken place in the past and is complete. Thus the eventual absorption of the perfect into the aorist can be seen as the culmination of a process beginning in Greek prehistory: as soon as the stative became a perfect, it was under threat from the aorist. Nonetheless, it may have been helped by the lack of a distinction between perfect and aorist in Latin, which used a single construction for both.

It is typologically common for the distinction between perfect and preterite to be lost during the history of languages. This has happened in colloquial German, for example, where the old perfect construction is used in ordinary speech as an unmarked preterite, and the old preterite has virtually fallen out of use. In Greek as in German, the merger has been functionally in favour of the preterite in that this is the unmarked value of the old perfect construction. Unlike German (and most of the Romance languages), in Greek the merger was formally as well as functionally in favour of the aorist: the Modern Greek descendant of the two constructions regularly takes an augment rather than a reduplicating syllable, a stem characterised with *-s-* rather than *-k-*, and endings descended from those of the aorist. For a long time, though, perfect, aorist and mixed forms were used interchangeably: one frequently finds otherwise aorist forms with reduplication instead of augment, for example. In the early middle ages, the aorist, imperfect and perfect active endings settled into a common set of forms (given in table 14). Eventually the 3pl variant in *-an* and the 2pl in *-ate,* which originated in the aorist, won out in standard Modern Greek, but the alternatives in *-ete* and *-asi* persist dialectally, and seem to be used as equivalents in Medieval vernacular poetry, conditioned only by metrical considerations.

	Old (1st) aorist	Old perfect	Old imperfect/2nd aorist	New past
1sg	*-a*	*-a*	*-on*	*-a*
2sg	*-as*	*-as*	*-es*	*-es*
3sg	*-e(n)*	*-e(n)*	*-e(n)*	*-e(n)*
1pl	*-amen*	*-amen*	*-omen*	*-amen*
2pl	*-ate*	*-ate*	*-ete*	*-ate/ete*
3pl	*-an*	*-āsi*	*-on*	*-an(e), -āsi*

Table 14: The Modern Greek reflexes of three sets of Classical suffixes

Disregarding dialectal variation, the overall effect of this merger was to reduce three sets of suffixes to one, and to get rid of an originally distinct and often unpredictable stem form. Nonetheless, a few old perfect stems have been absorbed into lexical paradigms as aorist principal parts, increasing suppletion. The modern descendant of *heurískō* 'I find' is *brískō* [vrísko], by regular sound laws, and its past tense *brḗka* [vríka] 'I found' is from the ancient perfect *hēúrēka* 'I have found' rather than the aorist *hēū́ron*.

3.2. Regeneration of lost grammatical categories. While the middle voice and the optative mood disappeared entirely from Greek, the future, subjunctive and perfect were renewed with new formal constructions, via grammaticalisation of periphrases with auxiliary verbs in the case of the future and perfect, and the conjunction *hína* 'in order to' in the case of the future and subjunctive. For the future and subjunctive constructions, there was also a further reduction of everything except the main verb to the status of a preverbal particle.

Modern Greek actually has two perfect constructions: the more normal one uses a form of *ékhō* 'have', inflected for tense, mood, person and number, followed by an invariant form of the verb derived from the present infinitive, which inflects only for voice. Therefore it closely resembles the equivalent

English construction, except that the 'infinitive' which follows the finite verb is found only in the perfect, and has no participial uses. This construction, to which we shall return in a moment, dates from the early modern period.

Much more rarely, one encounters a form of the verb *ékhō* followed by a perfect passive participle agreeing with the object of the verb. This latter construction was the only one available in the middle ages, and was used alongside a passive counterpart with the verb *eímai* 'be' and the perfect passive participle, this time agreeing with the subject. This passive construction had actually existed in Classical Greek, and had always been normal in the non-indicative moods of the perfect mediopassive, which had no synthetic forms. The active construction is typologically common (cf. French *la lettre que j'ai écrite* 'the letter I wrote', with gender agreement between *lettre* and *écrite*), and comes from a reinterpretation of sentences where 'have' has a genuine possessive sense and an object which is qualified by a passive participle: 'I have [written letters]' is reinterpreted as 'I [have written] letters'. This explains the agreement between the participle and the object. In Greek, though, this construction may have arisen as much through Romance influence as by internal developments.[32]

The standard construction, with *ékhō* and the infinitive, had a future value in Medieval Greek. The past tense of this construction, with *eíkha* 'I had' + infinitive, was used in the apodoses of past conditionals, with the past of the future indicating past time relative to the time of utterance, but future tense relative to the action of the protasis. The construction with *eíkha* was then generalised to the apodosis (cf. some varieties of American English "if she would have come to the party, I would have left"), and from there it was

[32] Horrocks (2010: 301).

reinterpreted as a pluperfect ("if she had come…").[33] The present and future perfect were then analogically extended from this new pluperfect construction relatively recently; the construction is still quite rare in 19th century vernacular literature.

After the future merged with the aorist subjunctive, various periphrastic possibilities for expressing future tense emerged. At first *opheílō* 'owe' and *méllō* 'intend' were the most common auxiliary verbs, but by the early Byzantine period, the most common options were with auxiliary *ékhō* or *méllō*, the bare aorist subjunctive, or the present indicative/subjunctive (by analogy with the future value of the aorist subjunctive). The source of the Modern Greek future is a volitional construction with *thélō* followed by the subjunctive, by a common path of semantic change (cf. English 'I will'). The path from volitional to future value passed through a number of stages: first, the bare subjunctive was strengthened by the preverbal particle *na* (see below). Secondly, *thélō* developed phonetically reduced forms *thes* (2sg) and *the* (3sg), and the third singular form began to be used invariably in this volitional construction, since the person and number was already made clear by the following subjunctive form. Both this phonetic reduction and loss of person/number marking are common stages in the road to grammaticalisation.[34] Finally, *the na* started to develop a future value, and underwent further phonetic changes to *tha na*, then *than*, which became the modern future particle *tha*. As well as creating a new way of unambiguously expressing future tense, this made the distinction between perfective and imperfective aspect available in the future, when previously it had only been expressible in the past tense and in tenseless non-finite constructions. The

[33] Hancock (1993).
[34] e.g. Bybee (2006, 2010).

construction with *tha* has also been extended into the past, where it functions as a conditional or future-in-the-past, like the original meaning of the pluperfect with *eíkha*.

Whatever we call the hybrid category which emerged out of the merger of the indicative and subjunctive, it continued to be used in many of the functions of the old subjunctive. At the same time, starting in the Hellenistic period, there was a decline in inherited strategies of subordination involving non-finite verbforms, i.e. participles and infinitives, in favour of finite constructions. When the optative also disappeared, this left the subjunctive/indicative hybrid as the preferred option in subordinate clauses. Thus the range of use of the subjunctive steadily increased, starting at around the same time as it became formally unmarked. Rather than losing subjunctive marking altogether, Greek generalised the conjunction *hína*, which had originally introduced purpose clauses, as a semantically neutral marker of subordination. As it underwent grammaticalisation *hína* was reduced to *na*, the Modern Greek subjunctive particle, which along with negative particles and weak pronouns forms part of a single phonological word with the verb. The *na* + subjunctive construction gradually took over the role of the old infinitive, starting in the Roman period with complements and adjuncts of non-coreferential control verbs (where the subject of the main verb and the dependent clause is different), then in the late middle ages spreading to control verbs with coreferential subjects. Finally, in the last part of the middle ages, the construction spread to complements of modal and aspectual auxiliaries, e.g. *mporó na tragoudó* 'I can sing'. The single remaining exception is the perfect construction with *ékhō*, which continues to appear with the descendant of the old infinitive.

3.3. Loss of morphologically irregular items. Ancient Greek had a large number of irregular verbs, as we saw in chapter 2 (section 3). Discussion of morphological regularisation in language change often focusses on analogical change, but in fact, many of these irregular verbs simply fell out of use in favour of more regularly inflected competitors. This is similar to the way that the loss of grammatical categories can lead to a net reduction in the arbitrariness of morphological paradigms.

The verb OÎDA 'I know' had a highly irregular paradigm in the Classical language, with unique patterns of alternation in both stems and endings. This was abandoned in favour of EXEURÍSKŌ, originally 'find out'. ÉIMI 'go', another irregular verb, likewise gradually disappeared from the language as the more regular HUPÁGŌ 'lead' expanded semantically to take its place. *Exeurískō* and *hupágō* have been subject to various sound changes and analogical remodellings (chiefly in the direction aorist → present) to give Modern Greek *xérō* 'know' and *pēgaínō*/*páō* 'go', which, while still anomalous in some respects, are significantly more regular in their inflection than their classical equivalents.

3.4. Analogical regularisation. Finally we come to traditional morphological analogy, which has also contributed to the simplification of verbal paradigms in Greek. The environment of analogical change may be an entire set of person/number suffixes, as with the levelling of the endings of the subjunctive to those of the (primary) indicative active, which was the final stage in the loss of a distinction between the two categories. This can be

represented in a four-part proportion, though perhaps it is not the most helpful or clear way of presenting the facts:

lúomen [lúomen] (1pl indic. act.)	:	*lúousi* [lúusi] (3pl indic. act.)
= *lúōmen* [lúomen] (1pl subj. act.)	:	*lúousi* [lúusi] (3pl subj. act.)
		(← *lúōsi* [lúosi])

Table 15: Merger of the indicative and subjunctive suffixes

In other cases, the environment of an analogical proportion is a single lexeme or a group of lexemes sharing some formal element. Athematic inflection has disappeared entirely in Modern Greek. Some members of the athematic class were eliminated by being lost in favour of competitors: as mentioned above, *éimi* 'go' was taken over by *hupágo* 'lead', and *phēmi* 'say' was replaced by its near-synonym *légō* 'say' and *homiléō* 'address' (Modern *léō* and *miláō*). The remaining athematic verbs transferred into the thematic class by various analogical developments. The loss of the athematic verbs will be discussed in greater detail in chapter 5, but here is one example: the verb *dídōmi* 'give' was first remodelled as *dídō,* based on the ambiguity of the 1pl *dídomen*, historically *dído-men* but resegmented as *díd-omen* under the influence of the thematic 1pl ending *-omen*. Then the aorist *édōsa* generated a thematic present *dṓnō*, on the model of e.g. *zṓnō* ~ *ézōsa* 'gird', and probably also influenced by Latin *dōnō* 'give'. *Dṓnō* and *dídō* then blended to give *dínō,* which remains in Modern Greek. The other athematic verbs were brought into thematic paradigms, often by similarly idiosyncratic developments, until the whole class had been eliminated.

A number of analogical changes affected the implicational relationships between the imperfective, aorist active and aorist passive stem alternants. The general tendency has been for more common patterns of stem alternation to

attract lexical items which previously followed rarer patterns, although this is not an absolute rule. The alternation *-azō* (present) *-axa* (aorist) has been particularly successful: first the present in *-azō* attracted a number of denominative verbs in *-áō*/*ṓ*, based on a few a-stem nouns which had denominative verbs in both *-áō* and *-ázō*[35], where the two suffixes were felt to be equivalents of each other. Originally verbs in *-zō* which etymologically came from stems ending in velar consonants had aorists in *-x-* [ks], and those which had had stem-final dentals had aorists in *-s-* [s]. Beginning in the Classical dialects, and gaining momentum in the early medieval period, these two patterns of alternation began to be levelled in favour of the aorist in *-x-*. This pattern then attracted a number of verbs with present stems in *-ss-* (< *-*ky*-*) and aorists in *-x-*; Modern Greek has e.g. *tázō* for earlier *tássō* 'arrange', and *allázō* for *allássō* 'change'. So the pattern *-azō* (present) ~ *-axa* (aorist) has attracted a large number of verbs which earlier showed the alternations *-ṓ* ~ *-ēsa*, *-azō* ~ *-asa*, *-assō* ~ *-axa*.

Similarly, there was a class which alternated between [v] in the present and [ps] in the aorist, which was made up of (a) verbs with original stem-final [b] which had developed into [v] intervocalically (e.g. *trí:bō* 'I rub', *étrí:psa* 'I rubbed'), and (b) verbs whose stems had ended in the diphthongs [eu] and [au], which had become [ev] and [av], with [eps] or [aps] (< [evs, avs]) in the aorist, e.g. *basileúō, ebasíleusa* 'reign'. Via their shared aorist stems in [ps], this group absorbed a group of verbs which had formerly had present stems in [pt]: thus Standard Modern Greek has *klébō* [klevo] for earlier *kléptō* 'steal', *kóbō* for *kóptō* 'cut', *krúbō* for *krúptō* 'hide', etc.

[35] The suffix *-ázō* is itself secondary: originally verbs ending in *-zō* were built to dental and velar stems (e.g. *phrázō* [pʰrázdɔ:] 'show, tell', < PG *pʰrad-yō). In these verbs *-az-* and *-iz-* were reanalysed as part of a suffix and used to make further denominative verbs from a-, o- and e-stem nouns, e.g. *agorázō* 'frequent the marketplace' from *agorá* 'assembly, marketplace', *nomízō* 'be accustomed' from *nómos* 'custom'.

Morphological analogy was also responsible for getting rid of the suffixes *-n, -s, -∅, -men, -te, -san*, the Greek reflexes of the PIE athematic secondary endings, which were found in three environments in Classical Greek: imperfects of athematic verbs, root aorists, and the aorist passive. We have already seen how the presents of athematic verbs were reformed; these presents generated new imperfects sharing the usual suffixes of the thematic imperfect. The loss of the athematic secondary suffixes in root aorists and aorist passives was partly related to the functional merger of the perfect and aorist, which led to most reduplicated forms being lost. For a time, aorist and perfect forms were used interchangeably. During this period, the kappatic aorist and perfect forms of a few athematic verbs, which differed only in the choice of augment or reduplication, were felt as equivalents, e.g. *éthēka* 'I put', *téthēka* 'I (have) put'; *édōka* 'I gave', *dédōka* 'I gave/have given'. As a result, a handful of verbal paradigms kept their old perfect forms, in the new function of an unmarked preterite, instead of the old aorist forms: thus *heúrēka* 'I have found' replaced *héuron/héura* as the aorist of *heurískō* 'I found' (and survives as modern Greek *brḗka*). The apparent functional equivalence of the augment and reduplicating syllable in couplets like *éthēka, téthēka,* and the formal identity of the augment and reduplicant in some verbs after the loss of initial [h] (e.g. *éstēn* 'I stood', *héstēka* 'I have stood') also led to the creation and occasional retention of hybrid forms like *ébēka* 'I went', a blend of Classical *ébēn* (aorist) and *bébēka* (perfect), eliminating the small class of root aorists. This pattern was then extended to a number of verbs where the aorist ending was preceded by the vowels [i] or [o], such as *époika* [épika] < *epoíēka* from *poió* 'make', which is still retained in some dialects, but has been replaced with *poiḗsa* in Standard Modern Greek. Finally, based on synchronic couplets like

ébēn and *ébēka*, *éstēn* and *héstēka*, the aorist passive *-thēn, -thēs* etc. was reformed as *-thēka*, *-thēkas*, giving it the same person-number suffixes as the regular aorist active, with a special stem-suffix in -(*th*)*ēk*-. The old athematic secondary endings survive only in a few learned clichés, usually limited to formal writing, such as *sunelḗphē* 'he was arrested'.

This can be regarded as ordinary proportional analogy, if we accept that the two items in a proportion whose relationship is being extended can be synchronic variants of each other. This is formally akin to some types of hypercorrection: *fella* : *fellow* = *umbrella* : *umbrellow*.

3.5. Concluding remarks.

During the course of its development, Greek has formally overhauled its verbal system, in a way that has vastly reduced the amount of arbitrary information speakers need to remember in order to master verbal inflection. There has been a reduction in the number of distinct sets of person-number suffixes, and an increase in the formal overlap between them. Which ending class a verb selects in each part of its paradigm is now fully determined by its membership in one of five inflection classes (excluding the verb *eímai* 'I am'). Which stem a verb selects in each part of its paradigm is now only unpredictable for only three groups of paradigm cells, in comparison to the seven principal parts of Ancient Greek, and for these three unpredictable stems, a smaller number of patterns of alternation capture a greater proportion of the verbs in frequent use.

In the long term, this has been achieved not by a reduction in the number of morphosyntactic features which can be marked morphologically (or

through a combination of morphology and syntax for periphrastic constructions), but by the triumph of more predictable competitors over unpredictable words and constructions. These competitors have come about through a combination of periphrasis, semantic shift, and analogy, as outlined above. Generally, this has involved a shift from more irregular to more regular morphological paradigms, and from more cumulative to more isolating morphology. This is in keeping with what Vennemann (1972) called 'Humboldt's universal': "suppletion is undesireable, uniformity of linguistic symbolization is desireable: both roots and grammatical markers should be unique and constant".[36]

This has often been asserted as a guiding principle of language change. But if we accept that this explains the direction in which the Greek language has developed, we are left with an apparent conflict between this principle and the 'uniformitarian hypothesis': that the mechanisms of language change, and therefore its general tendencies, should be the same in all periods of time. This is because we reconstruct the opposite direction of development for the time between (pre-)PIE and Ancient Greek, from basically agglutinative verbal morphology in the reconstructed proto-language, to an inflectional system characterised by suppletion, syncretism, cumulative expression and defectiveness, as exemplified by Greek and Sanskrit. The uniformitarian hypothesis leads us to expect change to be unidirectional; as it has been told here, the story of the Greek verb seems to be a story of the rise and fall of complicated inflectional paradigms. It looks like language change has taken one direction in prehistory, and performed a U-turn in the historical period.

[36] Vennemann (1972: 184).

There are various tacks one could take to explain this apparent contradiction between prehistory and history. One is to explain the course taken by pre-proto-Indo-European to Modern Greek as part of some universal typological cycle. Similarly, one could take either the prehistoric or the historic phase as the natural state of affairs, and explain the other as arising from some overriding principle particular to the systemic properties of the language at that time, along the lines of Natural Morphology.[37] Another possible type of explanation is sociolinguistic. Perhaps Humboldt's universal is a by-product of language contact, or a function of the complexity of social groups, or second language acquisition particularly favours analytical constructions because they are easier for adults to learn. Finally, the apparent direction of change in prehistory may be an illusion of reconstruction: if the irregular bits of a language tend to be lost, they will be less likely to show up in its daughter languages and thus less likely to be recoverable by our methods of reconstruction.

Many of the processes which have been described in the previous section are already underway in our period, from the beginning of the historical period to the end of the fourth century AD. The next three chapters will look in more detail at changes during this period on the level of individual paradigms, and examine how they relate to the large-scale patterns of restructuring we have just seen.

[37] Cf. Wurzel's (1984) concept of 'system dependent naturalness', whereby language-particular systemic principles of inflectional morphology can override universal principles of 'system independent naturalness' (Mayerthaler 1981).

Chapter 4: Analogical levelling and optimisation

As we saw in chapter 2, Ancient Greek verbal morphology involved extensive allomorphy of lexical morphemes, most of which was phonologically and semantically arbitrary, lexically idiosyncratic, and functionally redundant. Chapter 3 showed how this allomorphy was reduced in the subsequent history of the language, partly through analogical levelling, where an allomorphic alternation is eliminated in favour of a single phonological expression of underlying meaning.

This kind of reduction of arbitrary complexity is often observed in the development of morphological systems, which has inspired a common view of morphological change as being guided by universal preferences, which nudge morphological systems along paths which will lead them to a more optimal status. This chapter uses data from the history of Greek to put to the test two questions about analogical levelling and the role of 'optimisation'. Firstly, is levelling motivated by a universal preference for a one-to-one alignment of meaning and form in language? Secondly, is the direction of levelling determined by universal preferences for particular ways of marking morphosyntactic distinctions? I will argue that the answer to both questions is no: the changes in the Greek data I have examined are remarkably well predicted by language-specific, formal properties of paradigms, without the need to invoke universal preferences. These facts are best accommodated if speaker competence includes detailed probabilistic information about the predictive structure of paradigms, which has important implications for morphological theory, as well as historical linguistics.

1. LEXICAL ALLOMORPHY IN GREEK

In chapter 2 (1.4), we defined a lexical morpheme as a recurring phonological sequence which appears primarily in the context of a particular lexeme's paradigm, in contrast to an inflectional affix, whose appearance or nonappearance depends on morphosyntactic context. In many languages, including Greek, the phonological expression of the lexical morpheme may be additionally conditioned by morphosyntactic context: the verb *leípō* has the lexical allomorph (LA) *leip-* in the present and *lip-* in the aorist active, for example (table 1). Likewise, affixes can be conditioned by lexical environment: the suffix *-a* expresses that the subject of *paúō* is first person singular in the aorist active, whereas the suffix *-on* performs the same function for *leípō*.

Greek verbal inflection involves extensive lexical allomorphy, that is, non-unique phonological expression of the lexical morpheme. In table 1, PAÚŌ is the only verb for which the lexical morpheme remains invariant throughout the paradigm (lexical allomorphs within inflected words are underlined where necessary throughout this chapter).[1]

[1] See chapter 2 (section 3) for explanation of the system of principal parts.

	Present	Future active	Aorist[2] active
PAÚŌ 'stop':	*paú-ō*	*paú-s-ō*	*é-pau-s-a*
Perfect active	Perfect mp	Aorist passive	Future passive
pé-pau-k-a	*pé-pau-mai*	*e-paú-sthē-n*	*pau-sthḗ-s-omai*
	Present	Future active	Aorist active
PHILÔ 'love':	*philé-ō*	*philḗ-s-ō*	*e-phílē-s-a*
Perfect active	Perfect mp	Aorist passive	Future passive
pe-phílē-k-a	*pe-phílē-mai*	*e-philḗ-thē-n*	*philḗ-s-omai*
	Present	Future active	Aorist active
LEÍPŌ 'leave':	*leíp-ō*	*leíp-s-ō*	*é-lip-on*
Perfect active	Perfect mp	Aorist passive	Future passive
lé-loip-a	*lé-leip-mai* [*leim*]	*e-leíp-thē-n*	*leip-thḗ-s-omai*
	Present	Future active	Aorist active
ESTHÍŌ 'eat':	*esthí-ō*	*éd-omai*	*é-phag-on*
Perfect active	Perfect mp	Aorist passive	Future passive
ed-ḗdo-k-a	*ed-ḗde-smai*	*e-ēdé-sthē-n*	—

Table 1: A selection of Greek principal parts

Although irregular and suppletive verbs exist in many languages, the sheer extent of this irregularity in Greek is egregious: each verb has up to 7 principal parts, and there are a large number of irregular verbs in common use.[3] There are also a number of verbs for which more than the usual seven principal parts have to be learnt. Moreover, assuming the purpose of form in language is to convey meaning, most of this allomorphy is strikingly pointless. Only occasionally can it be held responsible for conveying meaning non-redundantly, as in (1) below, where the existence of a morphological

[2] The conventional label 'aorist' can be more precisely designated perfective (as in interlinear glosses in this thesis), with obligatory past tense (marked by the prefix *e-*) in indicative forms.
[3] Morwood's (2001) grammar, intended for use in schools, lists 182 irregular verbs which are sufficiently common in classical Attic to be worthwhile for learners to memorise early on, while Smyth (1920), a more advanced grammar, lists 763, from a greater range of periods and dialects, and Veitch's (1871) *Greek Verbs Irregular and Defective* contains approximately 2500 verbs (estimated by counting entries on a random sample of ten pages).

minimal pair means we must attribute the expression of perfective/imperfective aspect to the alternation *leip* ~ *lip*. In (2), the combination of the reduplicating prefix *le-* and the ending *-a* make *léloipa* morphosyntactically unambiguous. The allomorph *loip* can be seen at best as a secondary indicator of the morphosyntactic feature set [perfect, active], but this additional indicator is surplus to requirements. In other cases, a shared LA is only found in sets of paradigm cells defined by mutually exclusive morphosyntactic features, so that no grammatical meaning can be assigned to it at all. When such patterns are sufficiently systematic they can be regarded as morphomic (Aronoff 1994). For instance, the future and aorist active often share a unique LA, as in the paradigm of PÍNŌ 'drink' (3).

(1a) *é-lip-on*

past-LEAVE.perfective-1.sg.indic.act

'I left'

(1b) *é-leip-on*

past-LEAVE-1.sg.indic.act

'I was leaving'

(2) *lé-loip-a*

perfect-LEAVE.perfect.active-1.sg.indic.act

'I have left'

(***lé-leip-a*, ***lé-lip-a*)

(3a) *pí-omai*

DRINK-1.sg.indic.

'I will drink'

(3b) *é-pi-on*

past-DRINK-1.sg.indic.act

'I drank'

2. THEORETICAL QUESTIONS

This kind of lexical allomorphy increases the burden placed by the morphology on memory, making the language harder to learn for native and non-native speakers alike. Moreover, it appears to serve no purpose. Why, then, would languages tolerate it? One possibility is that they do not: allomorphy tends to be eliminated more often than it is introduced, resulting in a general diachronic tendency towards what has been called HUMBOLDT'S UNIVERSAL (HU): 'one meaning, one form'.[4] In other words, languages tend towards a biunique relationship between units of meaning and units of form. Within the realm of morphology, allomorphy violates this preference because it involves a one-to-many relationship of meaning to form (table 2).

Form	Meaning	Level	Violation
one	many	lexicon	**homonymy**
one	many	morphology	**syncretism, cumulation**
many	one	lexicon	**synonymy**
many	one	morphology	**allomorphy, multiple exponence**

Table 2: Violations of Humboldt's Universal

In the modern descendant of Ancient Greek, as in many European languages, there has been a general move towards more analytic structure, which has brought the morphology closer to HU, as outlined in chapter 3.

[4] First by Vennemann (1972), and expressed as the slogan 'one meaning, one form' by Anttila (1989).

One way that allomorphy may be reduced is through analogical levelling (4). The term 'levelling' is often used in contrast to 'extension', where an allomorphic alternation is extended beyond its original environment (5).

(4) *leípō* 'I leave', *élipon* 'I left' ⟶ *leípō*, *éleipsa*

(5) *dokéō* 'I seem', *dóksō* 'I will seem' ⟶ *dokéō*, *dokḗsō*

(cf. *philéō* 'I love', *philḗsō* 'I will love')

2.1. Objectives of this study

In this chapter I will test two related questions concerning the role of 'optimisation' in morphological change. Section 3 will consider claims that levelling is caused by HU, acting via a property of the language faculty, by testing the correlation between the synchronic and diachronic productivity of inflectional patterns involving invariance of the lexical morpheme. Section 4 will make some observations about the usual direction of levelling in Greek verbs, and evaluate the evidence this provides for diachronic optimisation. For example, if levelling is motivated by HU, we might expect to find a tendency to redistribute lexical allomorphy within paradigms along clear morphosyntactic lines, so that alternations of form can be attributed to alternations of meaning.

2.2. Definition of levelling

I include under the term 'levelling' any change within a lexeme's paradigm which introduces an already existing LA to one or more (non-defective) paradigm cells where it was not previously attested, regardless of any accompanying change to affixes. Both changes in table 3 involve an extension

of the aorist active suffix *-s* and the 1sg active indicative ending *-a* to new environments, but only (a) involves a change to the part of the word which expresses the lexical meaning.

(a)	*dēk-s-omai* BITE-fut-1.sg.indic 'I will bite'	:	*é-dak-on* past-BITE.perfective.active-1.sg.act.indic 'I bit'
→			***é-dēk-s-a*** past-BITE-perfective.active/middle-1.sg.act.indic
(b)	*biō-s-omai* LIVE-fut-1.sg.indic 'I will live'	:	*é-biō-n* past-LIVE-1.sg 'I lived'
→			***e-bíō-s-a*** past-LIVE-perfective.active/middle-1.sg.act.indic
Model:	*klaú-s-omai* WEEP-fut-1.sg.indic 'I will weep'	:	*é-klau-s-a* past-WEEP-perfective.active/middle-1.sg.act.indic 'I wept'

Table 3: The definition of levelling

3. 'ONE MEANING, ONE FORM': IS LEVELLING CAUSED BY A UG PREFERENCE FOR PARADIGM UNIFORMITY?

Levelling seems to be a particularly common type of analogy. Some have explained this by appealing to a universal preference for uniform realisation of morphological meaning, acting through innate characteristics of the language faculty (e.g. Kiparsky 1971, Steriade 2000, McCarthy 2005). Such explanations of levelling hold it to be an essentially distinct phenomenon from the extension of allomorphic alternations, at the level of its underlying cause. On the other hand, it is possible to view levelling as a special case of extension, where the pattern being extended merely happens to be a non-alternating one (e.g. Deutscher 2001, Garrett 2008, Maiden 2005).

Deciding between these two views depends on evidence for a non-trivial connection between synchronic patterns of invariance and the diachronic introduction of invariance through levelling. Garrett (2008) argued from

Greek evidence that levelling is always proportional: cases of levelling can always be regarded as the extension of an invariant pattern which exists elsewhere in the language, making it unnecessary to motivate them separately from extension by appealing to HU. Garrett's argument is essentially a negative one: because a model always exists, it is always possible to regard cases of levelling as cases of extension, and since this is the most economical analysis, it is to be preferred. In Greek, the default pattern of verbal inflection (ch. 2: 3), represented in table 4 by PAÚŌ 'stop', has a single phonological realisation of the lexical morpheme throughout its paradigm. Therefore, it is inevitable that there will be an invariant model available for all cases of levelling.

Present active	Future active	Aorist active	Perfect active	Perfect mediopassive	Aorist passive	Future passive
paú-ō	*paú-s-ō*	*é-pau-s-a*	*pé-pau-k-a*	*pé-pau-mai*	*e-paú-sthē-n*	*pau-sthḗ-s-omai*

Table 4: Principal parts of PAÚŌ 'stop'

This does not necessarily imply that levelling can always be represented in a traditional analogical proportion, because proportionality relies on an exact formal equivalence between the two items of the proportion in their affixes as well as the lexical morpheme. This often holds, but not always. The verb TUNKHÁNŌ 'happen' (6) has an analogical perfect *tétukhe* in New Testament Greek. This gets rid of an irregular allomorphic alternation between the aorist (*tukh*) and the perfect (*tukhē*), but there is no proportional model: PAÚŌ (7) has the requisite relationship of invariance between the aorist and perfect LA, but different suffixes; DIṔKŌ (8) has an equivalent construction for the perfect, but not for the aorist, whereas LANKHÁNŌ (9) has the equivalent construction in the aorist but a different LA in the perfect. Such examples undermine Garrett's evidence: levelling in Greek is not always strictly proportional, although the *paúō* pattern of inflection always provides a non-proportional

model for invariance of the lexical morpheme throughout any set of paradigm cells.[5]

(6) *é-tukh-e* 'it happened', *te-túkhē-k-e* 'it has happened' ⟶ *té-tukh-e*

(7) *é-pau-s-e*, *pé-pau-ke*

(8) *e-díōk-s-e*, *de-díōkh-e*

(9) *é-lakh-e*, *e-élēkh-e*

Since extension is not always proportional either, a weaker version of the argument still stands. It is still possible and economical to regard levelling and extension as essentially the same phenomenon. Here I will aim to complement this negative argument with a positive one.

3.1. The structure of the argument

The premise of this argument is that in general, higher type frequency patterns of inflection are more more likely to be extended diachronically.[6] Therefore, if the hypothesis that levelling is simply the diachronic extension of a pattern of inflection involving phonological invariance of the lexical morpheme is correct, we should expect the synchronic type frequency of such invariant patterns to be predictive of subsequent patterns of levelling. I will argue that this hypothesis is supported by the example of Greek.

As we have seen, the high type frequency default pattern of verbal inflection in Classical Greek has a single phonological expression of the lexical morpheme throughout its paradigm (ch. 2: 3), which ought to exert a

[5] In my sample, 15 of 132 cases of levelling were non-proportional. Of the 116 proportional examples, the majority could be regarded as an extension of the PAÚŌ pattern or a minor variant of it.

[6] This is often enough observed that it can be regarded as a general assumption, though I know of no attempt to prove it cross-linguistically.

general pressure on alternating paradigms to be levelled. However, there is also a substantial group of irregular verbs with unpredictable alternations of lexical allomorphy. Within this group, the probability of invariance of the lexical morpheme between a given pair of paradigm cells varies dramatically depending on the paradigm cells in question. For example, future passive and aorist passive forms share a common LA in all but a tiny handful of irregular verbs, whereas the majority of irregular verbs show an alternation of the LA between the forms of the present and the perfect active.[7]

If the hypothesis is correct, the probability of levelling between any two mutually unpredictable paradigm cells (represented by principal parts) should correlate positively with the probability of those paradigm cells sharing a common LA in the population of irregular verbs. Cases of lexical allomorphy between the aorist passive and future passive should therefore be much more likely to be eliminated through levelling than between the present and perfect active, for instance. If this is borne out by the data, it not only shows that it is possible to analyse cases of levelling as extension, but gives us a positive reason for preferring this analysis.

3.2. Methodology

I calculated for the classical Attic (5^{th}-4^{th} century BC) paradigms of 173 irregular verbs how many of each pair of attested principal parts share a common LA. Then I looked for subsequent examples of levelling in these paradigms, up to AD 300, in order to calculate for each pair of principal parts

[7] Amongst the sample of 173 irregular verbs used in this study, the minimum number of lexical allomorphs in any verb's paradigm is one. Because some lexical allomorphy and affix allomorphy are largely independent, some verbs are irregular by virtue of their affix allomorphy, but nonetheless have a single phonological expression of the lexical morpheme throughout their paradigm, like PAÚŌ (table 1). The highest number of lexical allomorphs for any one verb in the sample is five, but the mean is only 2.7.

the percentage of alternations of the lexical morpheme which were subsequently eliminated by levelling. Finally, I tested the correlation between these two sets of values.

3.2.1. Synchronic data

The sample of 173 irregular verbs was taken from Morwood (2001: 98-118). I used this list as the starting point for building a canonical set of principal parts, checking for each principal part that it is the usual form for the relevant period and dialect. Certain verbs, such as OÎDA 'know' and EIMI 'be', were eliminated from the sample because they are more than usually irregular, in that the usual seven principal parts are insufficient for predicting the rest of their paradigms. A few other verbs (KHRÉ and DEÎ, both 'it is necessary') were omitted because their paradigms are so defective as to make segmentation impossible. Two verbs, PHŨŌ 'produce, be by nature' and APÓLLUM(A)I 'destroy, perish', appear in the sample twice, because their choice of stems and endings systematically differs in their transitive and intransitive senses.

'Classical Attic' refers to the dialect of Attica in the 5th-4th centuries BC, but naturally the language changed during this period, and within the region there were finer dialectal and sociolectal gradations. Some degree of idealisation is therefore necessary when making statements about its synchronic grammar. These universal problems for linguistic description are exacerbated by the particular difficulties of historical data, that the texts we happen to have inherited are an incomplete representation of the language, and there are no native speakers to consult in order to fill in the gaps. As a result, my synchronic data on paradigms is necessarily something of an approximation. The statistics which I use are calculated from forms attested

in the 5th-4th centuries BC. Where I have found competing forms, I have chosen to include forms found in prose over poetry, except in the case of comedy, which is more likely to represent colloquial usage. Despite this, it is possible that small diachronic, dialectal and sociolectal inconsistencies remain in the synchronic data, but these should not invalidate the statistical tendencies I have observed.

I have taken care that none of the forms which make up the synchronic data also appear in the diachronic data, as this would make any correlation between the two trivial. For forms which are attested late but abundantly in the Classical period, and are also listed as innovations in Chantraine (1968-1980) or Liddell & Scott (1996), I have included them in the synchronic data rather than the diachronic data (as long as they also meet the other criteria above).

3.2.2. Diachronic data

3.2.2.1. Source. My first ports of call for the historical data were Chantraine (1968-1980) and Liddell & Scott (1996). I followed up the analogical forms cited in these works using various online databases.[8] This made it possible to exclude forms originating outside the relevant period (500 BC - AD 300), forms attested only in grammatical and lexicographical works, and forms found only in texts whose genre or provenance made them unlikely to reflect any real usage (for example the mock-Homeric of Oppian).

3.2.2.2. Criteria for inclusion. The diachronic data consists of examples of changes to lexical morphemes, as defined above (2.2), in the paradigms of the

[8] Namely: (1) UC Irvine's *Thesaurus Linguae Graecae* (stephanus.tlg.uci.edu); (2) papyri.info (produced by the Duke Collaboratory for Classics Computing and the Institute for the Study of the Ancient World); (3) The Packard Humanities Institute's database of Greek inscriptions (epigraphy.packhum.org).

same verbs which made up the synchronic data, after the period represented by the synchronic data. Some examples can be regarded equally as levelling and extension: GAMÉŌ 'marry' originally had a future *gaméō* which was identical to the present. This was replaced by *gamḗsō*, which shares an LA (*gamḗ*) with the perfect active and mediopassive *gegámēka*, *gegámēmai*, but can equally be seen as an extension of the usual formal relationship between present and future in contract verbs (cf. *philéō*, *philḗsō*). I have included these examples in the data, since they eliminate an allomorphic alternation, but I have excluded them from my results on the direction of levelling (section 4), because the direction is different depending on whether they are analysed as levelling or extension.

The data also includes examples of levelling from compounds of the simple verbs in the sample, where there is sufficient evidence that a previous allomorphic alternation existed for the compound as well as the simple verb. For example, I have included analogical forms in the paradigm of APO-KTEÍNŌ ('kill') alongside KTEÍNŌ ('slay').

3.2.2.3. Processing. Each eligible example of levelling was entered into a database as a single entry, to which I added information about what part of the paradigm was affected (the TARGET) and where the new form of the LA was previously attested (the SOURCE). In some cases, there was reason to suspect that the paradigm from which an innovative form sprung was different to that represented by the synchronic data. For example, the innovative perfect active *apéktanka* 'I have killed' seems to be based on the aorist *apéktanon*, rather than the more common *apékteina*. For this reason each innovative form and the linguistic context in which it occurred had to be investigated on a case-by-case basis. Thus the diachronic data on the source

of levelling takes into account more information than is included in the synchronic data.

The main difficulty in processing the diachronic data was deciding what constitutes a single instance of levelling. Where multiple forms are attested based on the same LA, the shortcomings of the historical record often make it impossible to tell the order in which different parts of the paradigm have been affected. An example will make this problem clearer. Table 5 shows the principal parts of the verb GAMÉŌ 'marry' in Classical Attic (a) and in AD 300 (b). The paradigm has been made to conform to the regular inflection of contract verbs, which oppose a stem-final short vowel in the imperfective subparadigm to a stem-final long vowel elsewhere.

	Present active	Future active	Aorist active	Perfect active	Perfect mediopassive	Aorist passive
(a)	*gaméō*	*gaméō*	*égēma*	*gegámēka*	*gegámēmai*	–
⟶ (b)	*gaméō*	*gamḗsō*	*egámēsa*	*gegámēka*	*gegámēmai*	*egamḗthēn*

Table 5: Absorption of GAMÉŌ 'marry' into the regular contract paradigm

The three innovative forms in (b) – *gamḗsō*, *egámēsa* and *egamḗthēn* – have the same LA as the perfect active and mediopassive, and can be seen as the absorption of GAMÉŌ into the regular contract conjugation. From the point of view of the lexical morpheme, it is most economical to analyse this as a single change, levelling the lexical morpheme in the future active, aorist active and aorist passive to the allomorph found in the perfect active and mediopassive. Least economically, it could be seen as three separate changes, e.g. from the perfect active and mediopassive to the future active, then from the previous three forms to the aorist active, and finally from all four forms to the aorist passive.

In theory, the choice between these two types of analysis should depend on empirical evidence. In practice, this evidence is often lacking, because full

paradigms are rarely attested in a single author. *égēma* and *gaméō* (with both future and present value) are both attested from the earliest texts, e.g. Homer, which do not contain any perfect or aorist passive forms. The perfects *gegámēka* (active) and *gegámēmai* (mediopassive) first appear in the Classical period, at around the same time as each other. Because the authors who first use the new perfects continue to use the old future and aorist forms – Herodotus, for example, uses *gegámēka* alongside *gaméō* and *égēma* – we can be reasonably sure that the perfect forms predate the innovated forms *egámēsa, gamésō* and *egaméthēn*. The next of these to appear, in the 4th-3rd centuries BC, is the aorist *egámēsa*. *Gamésō* and *egaméthēn* emerge more than two centuries later, at about the same time, in authors of the early Roman period. It is tempting to assume that the aorist active was affected first, followed by the aorist passive and future active, but a closer look at the evidence shows that this is insufficiently cautious, because the sources in which *egámēsa* is first attested contain no future or aorist passive forms for this verb. It is therefore impossible to know whether the lack of earlier attestations of *gamésō* and *egaméthēn* is because they were absent from the language, or just because they are absent from the texts which happen to have survived. Given this uncertainty, the most economical analysis is the best compromise between the various possibilities, in that it only marks as sources the principal parts which we know for sure are potential sources of the change, namely the perfect active and mediopassive. Therefore I have always treated multiple innovative forms based on the same construction as a single change to the paradigm, where there is no compelling evidence for a different analysis.

3.3. Results

3.3.1. Synchronic results. Table 6 shows the results of my analysis of the synchronic paradigms. Column (a) gives the number of verbs in the sample in which both principal parts are attested in classical Attic. (b) gives the number of these in which both have the same LA. (c) expresses (b) as a percentage of (a), giving a measure of the likelihood of two principal parts to share an LA: its DEPENDENCY. The table is arranged by descending dependency score.

Principal parts	a. Eligible pairs	b. Syncretic pairs	c. Dependency (%)
Aorist passive/future passive	79	73	92.41
Perfect/Perfect mp	73	58	79.45
Perfect mp/aorist passive	97	76	78.35
Perfect mp/future passive	74	57	77.03
Perfect/future passive	62	41	66.13
Perfect/aorist passive	77	49	63.64
Future/perfect mp	115	67	58.26
Aorist/perfect mp	112	65	58.04
Future/aorist	166	95	57.23
Future/future passive	78	44	56.41
Aorist/aorist passive	110	61	55.45
Future/aorist passive	112	62	55.36
Aorist/future passive	78	41	52.56
Aorist/perfect	111	54	48.65
Future/perfect	108	50	46.30
Present/aorist passive	112	24	21.43
Present/future passive	79	16	20.25
Present/future	169	34	20.12
Present/aorist	170	32	18.82
Present/perfect mp	116	14	12.07
Present/perfect	113	13	11.50

Table 6: Dependency scores for each principal part pair

3.3.2. Diachronic results. The first question to be addressed by the diachronic data is this: given an alternation of the LA between any two paradigm cells, what is the probability that it will be eliminated through levelling? For instance, the synchronic data shows that in our sample of 173 irregular verbs, there are 71 lexemes where the future active forms have a different LA from the aorist active forms. The diachronic data shows that in 19 of these 71 lexemes (26.76%) this alternation was eliminated. Sometimes levelling favoured the LA found in the aorist (e.g. *phágomai* in table 7), sometimes the

future (*édēksa*). Occasionally, analogical forms are attested in two conflicting directions in the same verb. The results in this section do not distinguish between these three cases: the relevant fact is that there was an alternation which has been levelled, at least once, in either direction.

Verb	**Future active**	**Aorist active**
ESTHÍŌ 'eat':	*éd-omai*	*é-phag-on*
	phág-omai	←
DÁKNŌ 'bite':	*dēk-s-omai*	*é-dak-on*
	→	*é-dēk-s-a*

Table 7: Levelling in two opposing directions

Table 8 gives the full results for each pair of principal parts. Column (b) gives the number of verbs in the sample for which the two principal parts given in (a) had an alternation of the lexical morpheme, and (c) gives the number of these alternations which were subsequently eliminated by levelling. (d) expresses (c) as a percentage of (b), giving a measure of the likelihood of an existing alternation to be levelled depending on the areas of the paradigm involved.

The table is ranked by descending probability of levelling, *given an alternation*. Note that this is relative rather than absolute probability; pairs of principal parts which tend more often to have an alternation of the lexical morpheme yield more examples of levelling in absolute terms, simply because there are more verbs where an alternation exists which can be levelled.

a.Principal parts	b.# allomorphy	c. # levelled	d. % allomorphy levelled
Aorist passive/future passive	6	3	50
Perfect/aorist passive	28	11	39.29
Perfect/future passive	21	7	33.33
Aorist/aorist passive	49	14	28.57
Perfect mp/aorist passive	21	6	28.57
Aorist/perfect mp	48	13	27.08
Future/aorist	71	19	26.76
Perfect/Perfect mp	15	4	26.67
Aorist/future passive	37	7	18.92
Future/aorist passive	50	9	18.00
Aorist/perfect	57	10	17.54
Future/perfect mp	48	8	16.67
Future/perfect	58	9	15.52
Perfect mp/future passive	17	2	11.76
Future/future passive	34	2	5.88
Present/aorist passive	88	4	4.55
Present/aorist	138	6	4.35
Present/perfect	100	3	3.00
Present/future	135	4	2.96
Present/future passive	63	1	1.59
Present/perfect mp	102	0	0.00

Table 8: Probability of levelling for each principal part pair

3.3.3. Correlation. There is a highly statistically significant (p = 0.00000463) correlation between average levelling and dependence (illustrated in fig. 1): the Pearson correlation coefficient for the two sets of values is 0.82.

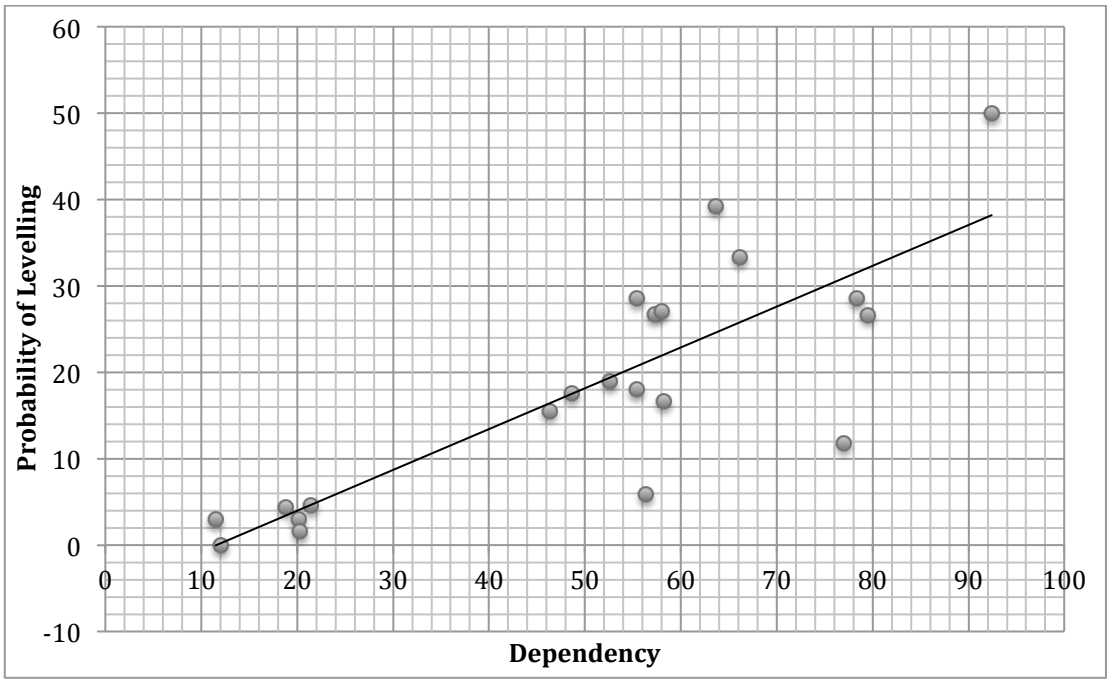


Fig. 1: Correlation between dependency and probability of levelling

On average, the probability of levelling between two principal parts is about 30% of their probability of sharing an LA. The relationship between the two sets of values is illustrated in the charts below. These present the same information in two ways: fig. 2 shows levelling and dependency scores for each labelled pair of principal parts. In fig. 3, each vertical line with two points represents a principal part pair; the chart is ordered by dependency to make the ratio between the two sets of values clearer.

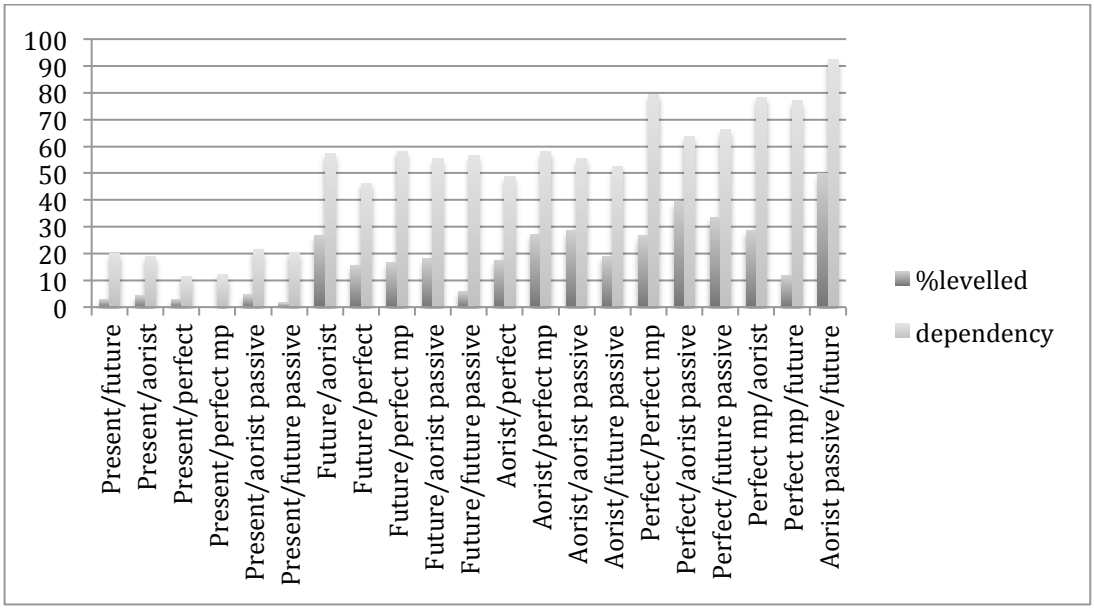


Fig. 2: Dependency and probability of levelling for each principal part pair

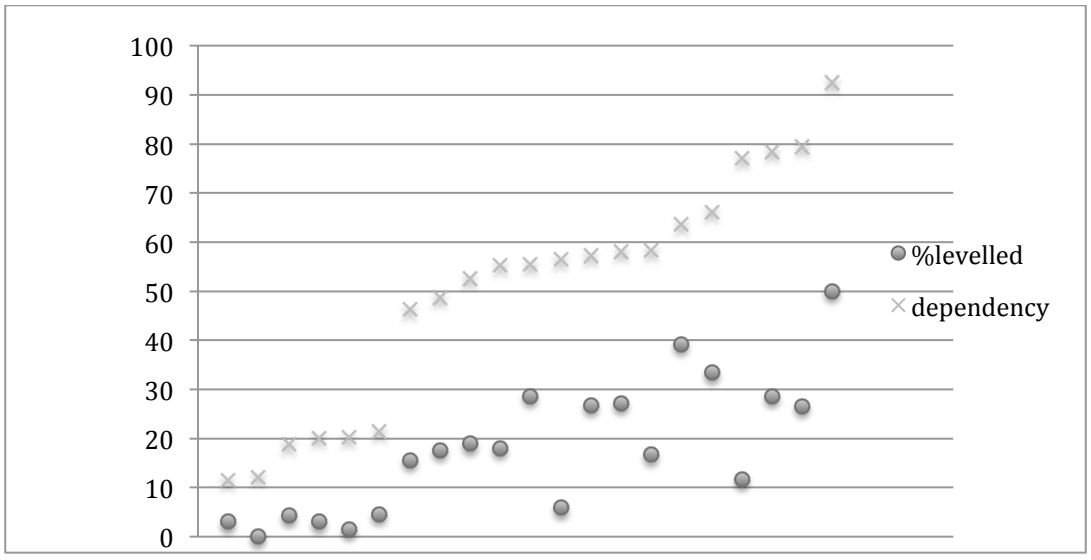


Fig. 3: Dependency and probability of levelling for each principal part pair

3.4. Type frequency and the Paradigm Cell Filling Problem

These results suggest levelling is merely a type of extension: inflectional patterns which are more common are more likely to be extended to new lexemes, whether they involve alternation or invariance. This is consistent with the view that analogical forms are created when speakers try to predict forms which they have not learnt, or which they fail to retrieve from memory quickly enough in performance (e.g. Bybee 1985).[9] In both levelling and extension, speakers tend to make predictions which are consistent with the linguistic evidence they have been exposed to.

The most sensible link between synchronic type frequency and diachronic productivity lies in performance, in what Ackerman et al. (2009: 1) have called the 'paradigm cell filling problem' (PCFP): 'what licenses reliable inferences about the inflected (and derived) surface forms of a lexical item?'. In languages where lexical items have extensive inflectional paradigms – like Greek, in which transitive verbs usually have 206 paradigm cells, at a conservative estimate – it is implausible that every native speaker will have encountered and individually remembered every inflected word for every lexeme. How, then, do speakers predict forms which they have not encountered, or which they have failed to remember?

Suppose a Greek speaker is trying to predict the aorist 1sg indicative active for a particular verb. She knows that it is likely to contain the past 'augment' *e-*, the perfective (active/middle) suffix *-s*, and the 1sg indicative ending *-a*, like the huge majority of aorist active 1sg indicative active forms. All that is needed is a lexical morpheme to attach these affixes to. If the rest of the

[9] The question of which forms are likely to be forgotten, and therefore replaced by new forms, is in theory independent from the question of how speakers predict new forms. These results mainly concern the second question.

paradigm is like PAÚŌ, with a single phonological expression of the lexical morpheme, the speaker has no choice but to select this one. There is still a small chance that she might get it wrong, but she has nothing else to go on. If there is more than one allomorph of the lexical morpheme in the rest of the paradigm, she is confronted with conflicting evidence, not all of which is equally valuable. The aorist active shares an LA with the future active in 57% of irregular verbs, but with the present in only 19%. This makes the future active better evidence than the present for our speaker, when there is a conflict between the two: if she predicts the LA of the the aorist active based on the future active forms, she will usually get it right, whereas if she bases it on the present, she will be more likely to make the wrong prediction.

On this account, when speakers make predictions which violate the existing conventions of the language, analogical forms are generated. These are likely to be dismissed as mistakes, and disappear as quickly as they came about. But when reasonable evidence points to the wrong conclusion, the same analogical forms will tend to be generated over and over again, and may be accepted by the community, eventually changing rather than violating linguistic convention. Because it is generally a good strategy to predict the LA of the aorist active from the future active, alternations between these two sets of paradigm cells are likely to be reduced over time. In other words, the higher the type frequency of a pattern of inflection, the better evidence it constitutes for the PCFP, and the greater its likelihood of spreading to new lexemes. When a pattern of inflection encompasses a whole paradigm – i.e. the full set of cells in a lexeme's paradigm – we call it an inflection class, but the principle should apply equally to inflectional patterns

involving subsets of paradigm cells, such as these patterns of lexical allomorphy in the Greek verb.

4. WHAT DETERMINES THE DIRECTION OF LEVELLING?

In order to predict the outcome of levelling, we need to know three things: 1) which alternations are likely to be levelled, 2) which patterns are likely to be extended (if there is more than one inflectional pattern involving invariance of the lexical morpheme), and 3) which LA will survive levelling, i.e. in what direction levelling will occur.

The answer to the first two questions seems to be the same: the highest type frequency patterns are most likely to be extended. Usually, in cases of levelling, the inflectional pattern which is being extended is the PAÚŌ pattern or one of its regular variants. This predicts nothing about the direction of levelling, though. In the example below, the paradigm of HÉLKŌ 'drag' was made to conform to the default pattern of inflection. This could have been achieved either by levelling of the future passive (A) or the present (B), with different formal results. In fact only (A) took place, whereas a present ***helkúō* is not attested.[10]

	hélkō	:	*helkusthḗsomai*
	'I drag'		'I will be dragged'
A. →	*hélkō*	:	*helkthḗsomai*
B. →	***helkúō*	:	*helkusthḗsomai*
Pattern:	LA-*ō*	:	LA-(*s*)*thḗ-s-omai*

Table 9: Two alternative directions of levelling in the paradigm of HÉLKŌ 'drag'

[10] Not, at least, until the 4th century. Modern Greek has both *élkō* 'drag' in the literal sense, and *elkúō* 'draw (attention/interest)'.

4.1. Results

Table 10 shows the frequency of levelling between ordered pairs of principal parts, relative to the probability of an alternation of the lexical morpheme for those two sets of paradigm cells (since levelling cannot take place between two paradigm cells which already share a LA). (b) gives the number of cases of levelling for the two principal parts in (a), and (d) expresses (b) as a percentage of the number of cases of allomorphy between them (given in (c)).

Some values in (d) are greater than 100%, because the table includes some additional data which was not part of the results of section 3. In some cases an analogical form is not replacing anything, because the paradigm in question was previously defective. If levelling is simply a type of extension, there is no longer any reason to exclude such examples from the data; they differ from cases of levelling only in that the new forms happen not to have had any predecessor. Because these examples are now included, the number of cases of levelling between two principal parts is no longer limited to the number of lexemes which had an alternation between the relevant cells in the paradigm. Although the value in (d) should correlate with the probability of levelling in a particular direction, it is not a direct measure of probability.

The data from here on also excludes examples of levelling which can also be regarded as extension of allomorphy, which were previously included, as discussed in section 3.2.2.2. A form like *gamḗsō* 'marry' (fut.) can be seen as extension from the present *gaméō* (cf. *philéō* ~ *philḗsō*) or levelling from e.g. the perfect active *gegámēka*. Including only the perfect active as a source of the change would downplay the role of the present, but including the present would mean that the results no longer concerned levelling exclusively.

Therefore, only examples of levelling which cannot also be seen as extensions of an alternation went into the results that follow.

a.Direction	b. # levelling	c.# alternation	d.% levelling
Perfect mp → Perfect	**16**	15	**106.67%**
Perfect → Perfect mp	**1**	15	**6.67%**
Aorist passive → Future passive	5	6	83.33%
Future passive → Aorist passive	1	6	16.67%
Aorist passive → Perfect	**18**	28	**64.29%**
Perfect → Aorist passive	**4**	28	**14.29%**
Future passive → Perfect	**11**	21	**52.38%**
Perfect → Future passive	**1**	21	**4.76%**
Aorist → Perfect	**17**	57	**29.82%**
Perfect → Aorist	**6**	57	**10.53%**
Perfect mp → Future passive	4	17	**23.53%**
Future passive → Perfect mp	2	17	**11.76%**
Perfect mp → Aorist passive	4	21	**19.05%**
Aorist passive → Perfect mp	3	21	**14.29%**
Aorist → Aorist passive	**10**	49	**20.41%**
Aorist passive → Aorist	**6**	49	**12.24%**
Future → Perfect	**15**	58	**25.86%**
Perfect → Future	**3**	58	**5.17%**
Future → Aorist	12	71	**16.90%**
Aorist → Future	9	71	**12.68%**
Future → Aorist passive	**12**	50	**24.00%**
Aorist passive → Future	**2**	50	**4.00%**
Future passive → Aorist	**6**	**37**	**16.22%**
Aorist → Future passive	**2**	**37**	**5.41%**
Future passive → Future	4	34	**11.76%**
Future → Future passive	3	34	**8.82%**
Perfect mp → Aorist	**6**	**48**	**12.50%**
Aorist → Perfect mp	**2**	**48**	**4.17%**
Future → Perfect mp	4	48	**8.33%**
Perfect mp → Future	2	48	**4.17%**
Present → Aorist passive	5	88	**5.68%**
Aorist passive → Present	1	88	**1.14%**
Present → Aorist	6	138	**4.35%**
Aorist → Present	1	138	**0.72%**
Present → Future passive	3	63	**4.76%**
Future passive → Present	0	63	**0.00%**
Present → Perfect	4	100	**4.00%**
Perfect → Present	0	100	**0.00%**
Present → Future	1	135	**0.74%**
Future → Present	1	135	**0.74%**
Present → Perfect mp	0	102	**0.00%**
Perfect mp → Present	0	102	**0.00%**

Table 10: The direction of levelling

In fig. 4, the black lines represent significant[11] patterns of influence through levelling. Lines with an arrowhead at either end represent roughly mutual

[11] Two factors are relevant to the significance (σ) of a directional asymmetry in levelling between two sets of paradigm cells X and Y: the proportional magnitude of the asymmetry, and the size of the sample of examples of levelling in both directions, from X to Y (α) and from Y to X (β). I used the formula $(|\alpha-\beta| / (\alpha+\beta)) \times (\alpha+\beta)^2$ as a measure of σ, and counted

influence. Asymmetrical tendencies are represented by black lines with a single arrowhead, representing the primary direction of influence. Most of these asymmetries involve the perfect active, whose LA is much more likely to be replaced by any other LA (47.17%) than to be extended (6.9%). In contrast the LA of the perfect mediopassive is much more likely to spread to other parts of the paradigm (27.65%), particularly the passive forms, than to be replaced (7.54%).

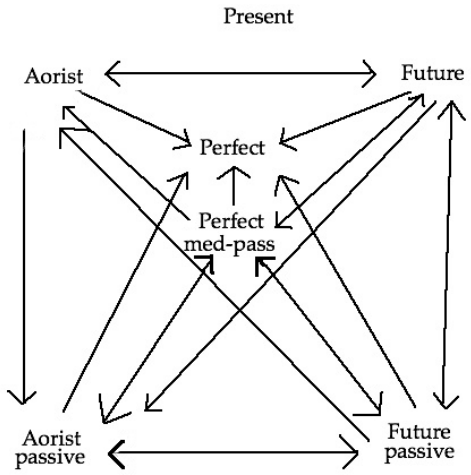


Fig. 4: The direction of levelling

4.2. Evidence for optimisation

4.2.1. Markedness. It has been observed, e.g. by Kuryłowicz (1949), that semantically unmarked forms tend to influence marked forms in analogical change. For instance, singulars are more likely to serve as the model for plurals, and the third person singular form of the verb is the most likely to serve as the model for other combinations of person and number. Similarly, without explicit reference to markedness, Mańcak (1958, 1978, 1980) proposed that indicative mood and present tense were more likely to bring about the remaking of other moods/tenses than vice versa.

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only principal part pairs for which $\sigma \geqq 50$ as having a significantly asymmetrical influence in fig. 4 (these are also highlighted with bold type in table 10).

Markedness may be important in some other patterns of levelling in Greek. A handful of irregular verbs had unpredictable alternations of the lexical morpheme which were conditioned by person and number, e.g. OÎDA 'know'. These alternations tended to be levelled in favour of the singular stem, giving the Hellenistic plural forms *oídamen*, *oídate* and *oídāsi* for earlier *ísmen*, *íste* and *ísāsi*. It does not help with this data, though: active voice is unmarked with respect to passive voice, for instance, but we find the passive LA spreading to active forms much more frequently than the other way round.

4.2.2. Morphosyntactic alignment. Since levelling by definition eliminates an allomorphic alternation, the overall effect is inevitably a general reduction of allomorphy, although individual examples of levelling may simply redistribute allomorphy rather than eliminating it. If HU is a genuine constraint rather than a trivially true description of the ultimate effect of levelling, we should expect levelling to redistribute meaningless alternations of form in such a way that meaning can be assigned to them. It is tempting to point to changes like (10) below as support for this theory. However, levelling is just as likely to destroy neat morphosyntactic alignment of allomorphy as it is to bring it about: cf. (11), where the LA *phug* was previously found in perfective (aorist) forms, but spreads to the future, complicating the morphological expression of tense and aspect. Alternations between the future and aorist active are levelled often, although they have no particular functional relationship to parallel their strong formal relationship.

(10) *édakon* 'I bit', *edékthēn* 'I was bitten' → *edákēn*

(11) *ephúgon* 'I fled', *pheugsomai* 'I will flee' → *phúgsomai*

4.2.3. Token frequency. Another possible explanation is in terms of token frequency of wordforms. Because speakers encounter frequent forms more often, they are more likely to remember them and less likely to need to predict them based on other forms. Therefore, we might expect the LAs of more frequent forms to spread to less frequent forms (as argued e.g. by Bybee 1985, 1988, 2006, Mańczak 1980, and in chapter 6 of this thesis). This is plausibly the reason that levelling from the aorist passive to the future passive is more common (83.33%) than vice versa (16.67%), since the future passive is relatively infrequent and often defective. It cannot be the whole story, though: the perfect mediopassive is relatively infrequent, but its LA is extended almost four times as often as it is replaced.[12]

4.2.4. Phonological informativeness. The fact that two forms share a common LA does not always mean that they are equally useful in predicting each other, because in Greek the following suffixes which express tense, aspect and voice can neutralise aspects of the phonology of the preceding stem. Therefore, we might expect forms where neutralisation is less likely to tend to influence

[12] In the absence of published statistics on the relative frequency of different parts of Greek verbal paradigms, I wrote a program which counts the total attestations in a sample corpus of three Classical authors (Aristophanes, Demosthenes and Plato) for the set of paradigm cells predicted by each principal part, using the Perseus project's (www.perseus.tufts.edu/hopper) digital editions of the texts, and its 'Morpheus' automatic parsing and lemmatising tool (www.perseus.tufts.edu/hopper/morph). The table below shows the results. Column A gives the total number of attestations of finite forms, while the figure in column B expresses this as a percentage of the total number of finite forms in the corpus. Note that the total for 'present' also includes imperfect forms, since these are predicted by the present; likewise the future and aorist active also include the middle, and the perfect active and mediopassive also include the pluperfect.

	A	B
Present	15763	67.54%
Future act.	1778	7.62%
Aorist act.	3777	16.18%
Perfect act.	1167	5.00%
Perfect mediopassive	379	1.62%
Aorist passive	421	1.80%
Future passive	54	0.23%
Total	23339	100%

forms with more neutralisation.[13] This hypothesis predicts exactly the opposite of what we have found: when the perfect active and perfect mediopassive share an LA, the perfect active is a better predictor of the perfect mediopassive than vice versa, because the perfect mediopassive forms neutralise voice, aspiration and manner of articulation of the stem-final consonant. Yet the perfect active LA was extended to the perfect mediopassive only once in the sample, whereas the perfect mediopassive LA was extended to the perfect active sixteen times.

4.3. Stem alliances

In theory the source of the LA in a form like *édēksa* (table 11) is ambiguous: it could be built on a single principal part such as the future *dḗksomai*, all of the other principal parts which already had the LA *dēk*, or any subset of these. Since principal parts themselves are standing in for sets of forms, it is even theoretically possible that *édēksa* was built on the aorist passive second person singular optative, the perfect mediopassive feminine singular dative participle, and the future passive infinitive. Because there is no obvious way of deciding between these myriad possible analyses, my policy so far has been to treat every potential source as equal. Now I will argue that this is not only pragmatic but also correct. For speakers predicting the LA for an unknown paradigm cell, every other cell in the paradigm contributes some degree of evidence. We can only make sense of the directional patterns when we look at the sum of this evidence, in terms of the structure of the whole paradigm.

[13] Albright (2008) argues that paradigms are organised around a single baseform, and that members of paradigms which contain the most contrastive information are preferred as baseforms.

	Present	Future	Aorist	Perfect med-pass	Aorist pass	Future pass
Stage 1:	*dákn-ō*	*dḗk-s-omai* →	*é-dak-on*	← *dé-dēk-mai* [*dēg*]	*e-dḗk-thē-n*	*dēk-thḗ-s-omai*
Stage 2:	*dákn-ō*	*dḗk-s-omai*	*é-dēk-s-a*	*dé-dēk-mai* [*dēg*]	*e-dḗk-thē-n*	*dēk-thḗ-s-omai*

Table 11: Levelling in the paradigm of DÁKNŌ 'bite'

Let us turn once more to the curious asymmetries involving the perfect active and mediopassive. For the LA of the perfect active, there are three options. It may have its own unique LA, as in the paradigm of PEÍTHŌ 'persuade' (table 12), where *poith* appears only in the perfect active *pépoitha*. Otherwise, it participates in two conflicting patterns of LA invariance, which I will call STEM ALLIANCES. It may share a LA with the perfect mediopassive, like BÁLLŌ 'throw'.[14] Alternatively, it may share an LA with the future or aorist active, like PHAÍNŌ 'appear' (it never shares an LA only with the present). It is under strong conflicting pressures to conform, both from the aorist and future subparadigms for the same voice, and from its perfect counterpart of the opposing voice. This makes it particularly susceptible to replacement: both the passive forms and the active forms (excluding the present) constitute good evidence for predicting the perfect active LA, so either is likely to supply the formal material for expressing the lexical meaning when new perfect active forms are created.

Present	Future	Aorist	Perfect	Perfect mp	Aor pass	Fut pass
peíth-ō	*peí-s-ō*	*é-pei-s-a*	*pé-poith-a*	*pé-pei-smai*	*e-peí-sthē-n*	*pei-sthḗ-s-omai*
báll-ō	*balé-ō*	*é-bal-on*	*bé-blē-k-a*	*bé-blē-mai*	*e-blḗ-thē-n*	*blē-thḗ-s-omai*
phaín-ō	*phan-ô*	*é-phēn-a*	*pé-phēn-a*	*pé-pha-smai*	*e-phán-ē-n*	*phan-ḗ-s-omai*

Table 12: Two conflicting stem alliances of the perfect active

[14] Its alliance with the the aorist passive and future passive is parasitic on its relationship with the perfect mediopassive. In only 2 out of 173 verbs in the sample does the perfect active share a LA with either the aorist passive or future passive without also sharing an LA with the perfect mediopassive, whereas in nine verbs it shares an LA with the perfect mediopassive which is not shared by the aorist/future passive, and in a further four verbs the perfect active and mediopassive share an LA while the aorist and future passive are defective.

In this respect, the perfect mediopassive is in the same boat as the perfect active. It too forms two conflicting alliances, with either the perfect active (e.g. THŪŌ 'sacrifice'; see table 13) or with the other passive forms (as in LEÍPŌ 'leave'). But unlike the perfect active, its LA is more liable to be extended than replaced.

Present	Future	Aorist	Perfect	Perfect mp	Aor pass	Fut pass
thū́-ō	*thū́-s-ō*	*é-thū-s-a*	*té-thu-k-a*	*té-thu-mai*	*e-tú-thē-n*	*tu-thḗ-s-omai*
leíp-ō	*leíp-s-ō*	*é-lip-on*	*lé-loip-a*	*lé-leip-mai*	*e-leíp-thē-n*	*leip-thḗ-s-omai*

Table 13: Two conflicting stem alliances of the perfect mediopassive

Crucially, though, the perfect mediopassive never has a unique LA, at least for verbs whose paradigms contain any perfect active, aorist passive, or future passive forms. In general, there is a higher probability that it will share an LA with other forms in the paradigm than tht the perfect active will. This makes it more useful for predicting other forms, which explains why it is more often the base for newly created forms. Table 14 lists each principal part by its degree of FORMAL INDEPENDENCE: the inverse of the mean of its dependency scores with each other principal part.[15] This correlates negatively ($r = -0.76$; $p = 0.047$) with a principal part's overall probability of being the source of levelling, i.e. the mean of every value in column (d) of table 10 for which it is the source of the LA.

[15] The formal independence score (I) for the present, for example, is caclulated as follows (D(X, Y) is the dependency score for the (sets of) paradigm cells X and Y):

$$I(pres.) = 100 - \left(\frac{\begin{pmatrix} D(pres.,\ fut.\ act.) + D(pres.,\ aor.\ act.) \\ + D(pres.,\ pf.\ act.) + D(pres.,\ pf.\ mp) \\ + D(pres.,\ aor.\ pass.) + D(pres.,\ fut.\ pass.) \end{pmatrix}}{6} \right)$$

Principal part	Formal independence (%)	%levelling from
Present	82.63	3.26
Future	51.05	14.11
Aorist	51.54	12.20
Perfect	47.39	6.90
Perfect mp	39.47	27.65
aorist passive	38.89	29.88
future passive	39.20	18.13

Table 14: Formal independence and probability of being the source of levelling for each pair of principal parts

If we add formal independence into the equation, the patterns of levelling which we have observed start to make sense. In fig. 5, font size represents degree of formal independence. The shaded areas represent significant (non-parasitic) stem alliances. The opacity of the shading represents the strength of these alliances: the darker the box connecting a set of principal parts, the more likely they are to share a LA.

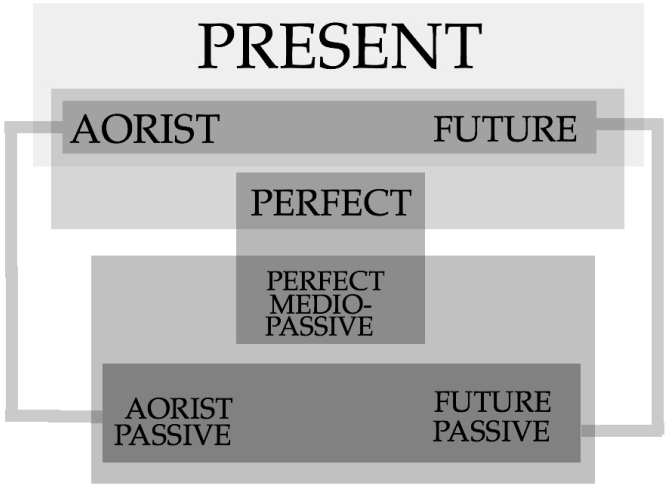


Fig. 5: Stem alliances in the Greek verb

This model provides an explanation for some of the directional tendencies. There is a higher probability that the perfect mediopassive will influence the perfect than the other way round, because it is backed up by a strong alliance with the passive forms. That is to say, when speakers are predicting perfect active forms, the evidence of the perfect mediopassive for the LA is not only

strong on its own, but it is highly probable that it will be bolstered by the evidence of the aorist passive and future passive. The perfect active provides equally good evidence for the perfect mediopassive as vice versa (or better, if we take into account neutralisation of stem-final consonants), but it is less probable that its evidence will be confirmed by other forms in the paradigm, because its other stem alliances are comparatively weak. The perfect active is particularly susceptible to replacement because it has two different alliances in opposing directions: it is under pressure from both the future and aorist active and the perfect mediopassive. The general direction of levelling runs from the less formally independent forms to the more formally independent forms: from the bottom of fig. 5 to the top.

Token frequency probably also plays a role: the aorist passive and future passive have almost the same degree of formal independence, but the aorist passive is much more frequent than the future passive.[16] This explains why levelling from the aorist passive to the future passive is more common than vice versa. Neither semantic markedness nor formal markedness appear to play any significant role in these patterns; to the extent that markedness seems to be important for explaining other data, it is not clear whether it influences change directly or indirectly, e.g. via frequency or predictiveness.

Further investigation is needed to determine exactly how these various factors contribute to levelling and how they weigh against each other. These results suggest, however, that the likelihood and direction of levelling can be predicted surprisingly well even if we only take into account the formal properties of paradigms.

[16] Chapter 6 will give further evidence for the influence of token frequency on morphological change.

5. CONCLUSIONS

Discussions of analogy usually assume, explicitly or implicitly, that the relevant patterns of influence are not between individual paradigm cells, but sets of paradigm cells. These results show that for this data, the relevant patterns of influence are not between the subsets of paradigm cells defined by the conventional principal parts, but the subsets of paradigm cells defined by stem alliances, i.e. by the patterns of distribution of lexical allomorphs. There are three important points to be made about these stem alliances:

1. They may be **morphomic**: they do not necessarily align neatly with morphosyntactic distinctions. The diachronic persistence and extension of morphomic patterns has been well documented, e.g. by Maiden (2004), (2005). Morphomic patterns of distribution, which connect a single unit of form to disparate meanings, obviously undermine Humboldt's universal. They also create problems for morphological segmentation, because of the difficulty of assigning a meaning to morphomic stems.

2. They are **probabilistic**: all of the implicational patterns involving the distribution of lexical allomorphy in Greek involve probabilities between 0 and 1. This suggests that speakers are sensitive not only to the all-or-nothing patterns of morphological implication which characterise inflection classes (e.g. Wurzel's (1987) implicative paradigm structure conditions), but also to gradient distinctions of probability between competing patterns of implication. This is more compatible with an exemplar-based theory, where the relative weight of each implicational pattern follows from the proportion of stored exemplars for which it holds true.

3. They **intersect**: the same set of paradigm cells can participate in more than one mutually exclusive stem alliance. We saw this with the perfect

mediopassive, which may inherit its stem either from the perfect active, or the future and aorist passive, if it does not have its own dedicated stem. This shows that verbal paradigms in Greek do not have a uniform implicational structure, which is merely overridden to various degrees by irregular verbs. In other words, Greek verbs differ not just in how many principal parts are required, or how many mutually unpredictable pieces you have to cut the paradigm up into, but also in where the cuts lie. In the terminology of Finkel and Stump's (2007) classification, this system is 'non-isomorphic' (64-65).

These qualities make the implicational patterns involving stem alliances difficult to model with conventional rule-based approaches, which see inflected words as no more than the ephemeral outputs of grammatical rules. Because inflected words are not stored permanently in memory, the rules which generate a word from its constituent parts have no access to information about inflectionally related words. Similarly in most modern word-and-paradigm theories, the derivation of each form in a lexical paradigm from its root is isolated from the derivational history of other forms in the paradigm. These results are more compatible with a view of morphology as a set of implicational relationships between fully inflected wordforms stored in memory, which are extended in morphological change. Blevins (2006) draws a distinction between the former type of approach, which he terms CONSTRUCTIVE, and the latter, which he calls ABSTRACTIVE, in that it views the word as the fundamental stored unit of language, and sub-word units like stems and affixes as abstractions arising from the arrangement of words into paradigms. This approach was typical of pre-Bloomfieldian linguistics, and ultimately originates in the Hellenistic

grammatical tradition, which also underlies the traditional presentation of the Greek verb in pedagogic grammars (Blevins 2013).

The kind of lexical allomorphy typical of Greek verbal paradigms involves a one-to-many relationship of meaning to form. If morphological change were guided by a universal preference for a one-to-one alignment of meaning and form, there are two ways this suboptimal state of affairs could be resolved: either (i) by eliminating allomorphy in favour of a one-to-one relationship of (lexical) meaning to form, or (ii) by redistributing the allomorphy in a way that neatly aligns with morphosyntactic distinctions, creating a biunique many-to-many relationship of (morphosyntactic) meaning to form (table 15).

	Meaning – form
Classical Attic (one-to-many, many-to-one)	SPEAK.imperfective — *leg* SPEAK.perfective — *ep* SPEAK.future — *ere*, *rhē*
(i) One-to-one	SPEAK — *leg*
(ii) Many-to-many	SPEAK.imperfective — *leg* SPEAK.perfective — *ep* SPEAK.future — *rhē*

Table 15: possible resolutions of HU violations in the paradigm of LÉGŌ 'speak'

Section 3 showed that although (i) takes place often, it depends on the synchronic prevalence of models in the same way that extension of allomorphy does, speaking against its separate implementation via Universal Grammar. (ii) does not fit with the diachronic data, as we saw in section 4: the language seems to be in no hurry to reshuffle the distribution of lexical allomorphs into morphemic patterns. The future and aorist active have a

strong formal relationship with each other, which is exaggerated over time, but a weak semantic relationship; their formal alliance has arisen through historical coincidence. Some stem alliances line up well with morphosyntactic distinctions – the perfect mediopassive, aorist passive and future passive are united by their ability to express passive voice, for example – but their diachronic tendency to influence the perfect active obscures the morphological expression of voice rather than making it clearer.

These results highlight the importance of the predictive structure of paradigms, which is formal and language-specific rather than universal, in determining morphological change. They do not rule out the possibility that there are other factors guiding change, but they explain the facts well enough to place the burden of proof on those who claim so.

I have suggested that these observations are most compatible with a usage-based explanation, in terms of the evidence available to speakers faced with the PCFP. If change to inflectional morphology happens through speakers making predictions for unknown paradigm cells, it follows that the predictiveness of paradigms will tend to increase over time. This can be seen as a kind of optimisation, but it has an advantage over accounts which attribute this optimisation to innate properties of the language faculty, because it does not multiply entities beyond familiar concepts such as memory, pattern recognition and prediction, which are part of our ordinary language for talking about other areas of cognition.

Chapter 5: The distribution of affix allomorphy

We saw in chapter 1 how the generative attempt to constrain morphological change by the requirement that it should simplify grammar ultimately failed (1.5). This was in large part because of the theoretical status of the word in generative morphology of the 1960s and 70s. Because inflected words were seen merely as the output of grammatical rules, with no permanent existence, the paradigm was unavailable as a level at which to draw generalisations about morphological change. In more recent work on morphology the paradigm has returned from theoretical exile (1.6), but modern word-and-paradigm theories have focussed on the task of synchronic description rather than constraining diachrony. One strand of work has looked for the limits to which languages tolerate inflectional deviations, such as inflection class phenomena, from a maximally memory-efficient biunique relationship between meaning and form.

In this chapter, I will consider one influential answer to this question by Carstairs-McCarthy, who has proposed various universal constraints on the synchronic distribution of inflectional allomorphy within paradigms. Although these are synchronic constraints, they also make testable predictions for diachrony. My aim in this chapter is to test both the synchronic constraints and their diachronic implications, by examining whether they are met by the distribution of inflectional allomorphy in Classical Greek verbal paradigms, and whether they can be plausibly seen to motivate subsequent restructuring of these paradigms.

I will argue that both synchronic and diachronic evidence from Greek speaks against Carstairs-McCarthy's constraints, primarily because of the

overlapping distribution of the word-final suffixes which mark person and number in Greek verbs, which I discussed in chapter 2 (3.2), which is parallel to the distribution of morphomic stems (1.4). I will argue that this approach fails because although it makes reference to the paradigm, it is like the generative approach in drawing its constraints at the level of grammar, conceived as a set of relationships between sub-word units and inflected words. In chapter 6 I will suggest an alternative analogical approach, which models morphology as a set of relationships between fully inflected words, and draws constraints at the surface level.

1. ARE THERE UNIVERSAL CONSTRAINTS ON THE DISTRIBUTION OF ALLOMORPHY?

This chapter will test four constraints proposed by Carstairs-McCarthy (1998) against the evidence of the synchronic distribution, and subsequent diachronic redistribution, of the Greek verbal endings. Although more recent work by Carstairs-McCarthy (e.g. 2010) uses a different framework and terminology,[1] I will follow the version of the hypothesis set out in Carstairs-McCarthy (1998), because this makes specific, testable predictions for Greek.

The four constraints are listed and paraphrased in table 1. This section will explain each constraint in the order listed, and consider what predictions they make for the distribution of inflectional allomorphy in the Greek verb.

[1] Carstairs-McCarthy (2010) maintains the empirical claims of his earlier 'No Blur' principle (1994), which in (1998) is derived from the principle of contrast (1.1, this chapter) and the exclusive disjunction bar (1.4). Instead of attributing the principle directly to synonymy avoidance, he now attributes it to a new principle of 'vocabular clarity', by which speakers reconcile the existence of synonymy with their inherent aversion to it (e.g. in multilinguistic situations), by assigning synonyms to distinct and non-overlapping vocabularies.

Principle of contrast	*Every affix has a unique meaning specification* (1.1)
Complementarity bar	*The meaning specification of an affix may only make reference to positive features* (1.2)
Unmarked property bar	*The meaning specification of an affix may only make reference to marked features* (1.3)
Exclusive disjunction bar	*A disjunction 'a or b' in the meaning specification of an affix must be interpretable as an inclusive disjunction 'a and/or b'* (1.4)

Table 1: Four constraints proposed by Carstairs-McCarthy (1998)

Carstairs-McCarthy proposes these constraints in order to explain cross-linguistic tendencies of paradigm structure, but ultimately, they are constraints on affix meaning. He derives them from universal constraints on lexical semantics, acting via language acquisition (figure 1).

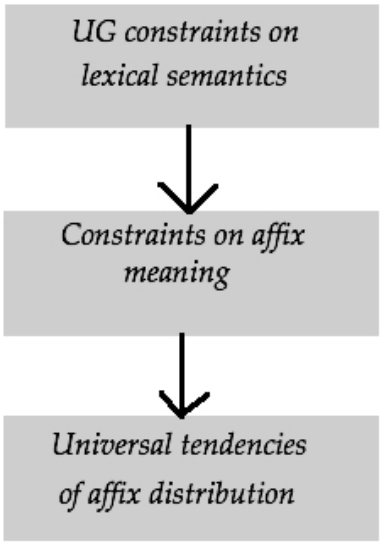


Fig. 1: The causal structure of Carstairs-McCarthy's constraints

This looks at first glance like support for the view that inflectional affixes are stored in the lexicon along with lexical morphemes, but because on Carstairs-McCarthy's view an affix's meaning determines its distribution within paradigms, the constraints can equally be read as constraints on rules of exponence which add affixes to lexical roots or stems (Carstairs-McCarthy is

explicitly neutral on this point).[2] Either way, they are drawn at the level of sub-word units.

Throughout this chapter I will deliberately favour analyses which give Greek the best chance of meeting these constraints, in order to give them as fair a test as possible. In section 2, I will argue that despite these compromises, Classical Greek violates these constraints so outrageously as to cast significant doubt on their validity, using a few case studies of Greek person-number suffix allomorphy. In section 3, I will argue that they also fail to explain the diachronic redistribution of inflectional allomorphy in Greek.

1.1. The Principle of Contrast

The principle of contrast – 'every two forms contrast in meaning' – is a lexical semantic constraint proposed by Clark (1993) to explain the fact that synonymy is rare in language. Since true synonyms do occasionally occur (e.g. *nearly* and *almost*) the principle cannot be inviolable, but evidence suggests that it is an assumption that children make during language acquisition.[3]

In the context of inflection, Carstairs-McCarthy takes 'meaning' to include morphosyntactic features like case, which are relevant only to sentence meaning, as well as morphosyntactic features which are relevant to the semantics of the word (sometimes called 'morphosemantic' features), such as

[2] 'Superficially, my findings may seem to give comfort to… the lexical-affix theorists. But… the findings are really neutral between the two viewpoints, because the terminology which we normally use in discussing lexical semantics is arbitrary in a crucial fashion. Instead of talking about words having meanings, we could just as well talk about lexical content being realized in words. So the four constraints and their motivation are orthogonal to the dominant debate in inflectional theory' (1998: 21).

[3] 'Evidence amply confirms two expectations which the principle generates: that there should be very few exact synonyms among the vocabulary learned in infancy when vocabulary acquisition is most rapid, and that when children under experimental conditions are faced with ascribing a suitable meaning to an invented word they will not interpret it as synonymous with any word they already know' (Carstairs-McCarthy 1998: 3).

number in nouns. As it applies to inflectional morphology, then, Clark's (1993) expression of the principle of contrast can be restated as 'every affix has a unique meaning specification', where 'meaning specification' refers to a set of features such as [plural, dative].

This is the most important of the four constraints, because in its inflectional capacity, it is responsible for determining the distribution of allomorphy. If more than one affix has the specification [plural, dative], for example, it is unclear which candidate should be selected by dative plural paradigm cells. If we allow the principle of contrast to be violated, a full account of every affix in the language, each with a meaning specification, no longer determines the distribution of each affix within the lexical paradigms of the language. On either a lexical-affix or a realisational interpretation (see note 2), this means that the account will fail as a model of speaker competence, since speakers are able to predict exactly in which paradigm cells of which lexemes each individual affix occurs.[4]

Taken at face value, it looks like the principle of contrast cannot possibly apply at the sub-word level, because it appears to rule out allomorphy. Inflectional allomorphy is a very common phenomenon in many languages, including Greek, as we saw in chapter 2 (3.2). Table 2 lists the 59 word-final suffixes which compete to realise only six permutations of three persons and

[4] Carstairs-McCarthy (1994: 747-8) appears to implicitly endorse this argument when discussing criteria for regarding two patterns of inflection as distinct classes. If we require that two classes exhibit a contrast in which affixes they select, but regard as nondistinct patterns which merely have a contrast between an affix and its absence (i.e. a zero affix), we can accommodate data from English which otherwise contradicts the no-blur principle. He nonetheless decides against this analysis, because it means that inflection class no longer determines how a lexeme inflects: 'the main attraction of the No Blur Principle from the point of view of language acquisition is that it seems to narrow down the options for the inflectional behavior of previously unencountered lexemes in a clearcut and straightforward fashion… But if the contrast between an affix and its absence does not entail distinctness of inflection class, no such secure conclusion is possible… The fact that two items are nondistict inflectionally, by this criterion, will still leave considerable room for difference in their inflectional behavior'.

two numbers in verbs.[5] This allomorphy is conditioned in part by lexeme (cf. *paú-ō* 'I stop', *dídō-mi* 'I give'), which demonstrates efficiently that at least some of it is true allomorphy, and not merely cumulative realisation of person and number along with other morphosyntactic features relevant to the verb, such as tense and aspect.

1sg	2sg	3sg	1pl	2pl	3pl
-ō, -mi, -on, -a, -ē, -omai, -ōmai, -mēn, -n, -mai	*-eis, -ēis, -s, -es, -as, -ēs, -ēi, -o, -ou, -sai, -so*	*-ei, -ēi, -Ø, -e(n), -ein, -etai, -ētai, -to, -eto, -tai, -si*	*-omen, -ōmen, -men, -amen, -emen, -ometha, -metha*	*-ete, -ēte, -te, -ate, -esthe, -ēsthe, -sthe*	*-ousi, -ōsi, -en, -on, -an, -āsi, -esan, -ontai, -ōntai, -nto, -onto, -san, -ntai*

Table 2: Greek person/number suffix allomorphs

To deal with such phenomena, Carstairs-McCarthy argues, we must broaden our conception of 'meaning' within the domain of inflection, to include various types of *paradigmatic* information: that is, information about how the same lexeme is inflected in other contexts.[6] Paradigmatic information (e.g. inflection class membership) does not qualify as 'meaning', in the everyday sense of the term. However, both 'meaning' as commonly construed and paradigmatic information like inflection class are useful to children acquiring language, in that they increase the number of unencountered inflected forms they are able to predict. Learning that the suffix *-s* means 'plural' in English, for example,

[5] I have ignored the dual number here and throughout this chapter, because it is relatively rare compared to the singular and plural, and because it disappears quickly after the Classical period.

[6] Carstairs-McCarthy (1994, 2002) also allows for the meaning specification of a morpheme to include syntagmatic information – i.e. information about how *other* items inflect in the *same* context – for example, gender in adjectives, or which stem alternant a suffix appears with. I will not discuss this possibility in this chapter, because it does not help with the Greek data I examine here. The choice of person-number suffix does not determine stem choice in Greek, or vice versa (ch. 2: 3). so including stem alternant as a feature in the meaning specifications of affixes would only increase the number of exclusive disjunctions (1.4).

enables learners to predict the plural forms of most nouns. Learning that an affix is associated with a particular inflection class, on the other hand, enables them to predict other inflected forms of the lexeme to which it is attached.

1.1.1. Paradigmatic 'meaning'

Suppose affix *a* and affix *b* are 1pl allomorphs: that is, they both realise the morphosyntactic feature set [1st, plural]. In order to avoid violating the principle of contrast, we must look for some element of paradigmatic meaning to distinguish them. If each is unique to a single inflection class, their meaning specifications can be given as e.g. [1st, plural, class A], [1st person, plural, class B], making them distinct. Allowing the meaning of an affix to include inflection class information thus makes it possible for a language to obey the principle of contrast, despite having allomorphy.[7]

Importantly, though, it does not *necessarily* imply obedience to the principle of contrast. Consistency with the principle of contrast hangs on whether the allomorphy is distributed in such a way that it is possible to give a unique meaning specification to each affix which is consistent with Carstairs-McCarthy's other constraints, namely the complementarity bar (1.2), the unmarked property bar (1.3), and the exclusive disjunction bar (1.4). Together, these constraints make testable predictions about the distribution of inflectional affixes in languages. I will explain each constraint fully in due course, but the following example will give a preview of how they interact with the principle of contrast.

[7] See chapter 2, footnote 7, for a precise definition of the term 'allomorphy' and discussion of its differing uses.

	A	B	C	D
Case 1	*a*	*b*	*c*	*b*
Case 2	*d*	*d*	*e*	*e*

Table 3: Hypothetical inflection classes in language L

Suppose a hypothetical language L has two cases 1-2, and four inflection classes A-D, with five affixes *a-e* distributed as in table 3. Of the three case 1 allomorphs, *a* and *c* uniquely identify classes A and C respectively, so can be specified as [case 1, class A] and [case 1, class C] without any violation of the principle of contrast. At first sight it looks as though *b* should be specified [case 1, class B or class D]. However, the exclusive disjunction bar[8] (1.4) rules out this analysis: the disjunction 'class B or class D' cannot be an inclusive (and/or) disjunction, because class B and class D are mutually exclusive values for the same inflection class variable. However, in this situation we have recourse to the 'elsewhere principle' (1.4.2): if more than one form or operation is available in a given context, the most specific is preferred. *b* can therefore be specified simply as [case 1]; lexemes in classes A and C will preferentially select *a* and *c* in case 1 paradigm cells by the elsewhere principle, and *b* will be chosen by default in classes B and D.

In case 2, neither of the two allomorphs *d* or *e* uniquely identify inflection class. Therefore, it is impossible to assign them both a unique meaning specification which does not violate the exclusive disjunction bar. If we specify *d* as [case 2] we must specify *e* as [case 2, class C or class D], but if we treat *e* as the default we must introduce an exclusive disjunction into *d*'s specification.

[8] The exclusive disjunction bar forbids the meaning specification of an affix from including any statement '*a* or *b*', where 'or' cannot be interpreted as an inclusive disjunction ('and/or'), either because such an interpretation makes the wrong predictions for the situation '*a* and *b*', or because *a* and *b* are mutually incompatible values for the same variable. See further discussion in 1.4.

This pattern of inflectional allomorphy violates what Carstairs-McCarthy (1994) calls the 'no-blur' principle: for any set of allomorphs, at most one can fail to uniquely identify inflection class. In (1998), Carstairs-McCarthy argues that the no-blur principle follows from the principle of contrast and the exclusive disjunction bar. Therefore, languages like L should either be ruled out, or under strong diachronic pressure to change their ways.

1.1.1.1. Affixal inflection class in Greek

As we saw in chapter 2 (3.2), affix allomorphy in Greek is more complicated than many systems which have been described in terms of inflection class, such as those analysed in Carstairs' early work on paradigm economy.[9] In 1.1.1.1-3, I will give an analysis of the Greek system which is most likely to conform to Carstairs-McCarthy's constraints, in order to give them the fairest possible test.

Although it is not usually described in terms of inflection classes, the affix allomorphy in table 2 is not random: each verbal lexeme consistently selects a particular suffix to realise person and number in each of its finite paradigm cells. In principle, the existence of affixal inflection classes depends on how much lexemes agree in their patterns of affix selection (see chapter 2: 2.1-4). In theory, we can imagine a language where each lexeme had its own unique pattern, so that the fact that we find any particular allomorph in a given cell would always leave us none the wiser about which allomorph to expect in any other cell. By contrast, in languages with inflection classes, at least some affixes

[9] For example, Carstairs (1983) illustrates his paradigm economy principle using examples of affixal inflection systems in Latin, Hungarian, Zulu, Dyirbal and German. All of these systems can be described in terms of inflection classes, identified by principal parts between which implicational relationships exist, in a way that is not possible for Greek verbs (see ch. 2: 3).

identify which class a lexeme belongs to, thereby telling us which allomorphs the lexeme selects in its other cells. The existence of inflection classes in a language thus depends in part on the number of patterns of allomorph selection being significantly lower than the upper bound provided by the number of lexemes of the relevant word class.[10]

Table 5 lists unique patterns of person-number allomorph selection for the sample of Greek verbs with irregular lexical allomorphy used in chapter 4 (3.2.1).[11] As with lexical allomorphy, the PAÚŌ pattern overwhelmingly predominates. Because lexical and affix allomorphy are independent (chapter 2: 3), not all verbs which follow this pattern in their person-number suffix selection also follow its pattern of invariance of the lexical morpheme: 107 verbs in the sample are entirely regular in their selection of endings, e.g. TRÉPHŌ 'rear' (table 4).

Present	Future	Aorist	Perfect	Perfect m-p	Aor. pass.	Fut. pass.
*tréph-**ō***	*thrép-s-**ō***	*é-thrép-s-**a***	*té-troph-**a***	*té-thrap-**mai***	*e-tráph-ē-**n***	*thrép-s-**omai***
*paú-**ō***	*paú-s-**ō***	*é-pau-s-**a***	*pé-pau-k-**a***	*pé-pau-**mai***	*e-paú-sthē-**n***	*pau-sthḗ-s-**omai***

Table 4: Principal parts of TRÉPHŌ 'rear' and PAÚŌ 'stop'

[10] Another upper bound is defined by the product of the number of allomorphs in each cell. For example, a hypothetical language has two singular affixes *a* and *b*, and two plural affixes *c* and *d*. These are selected by 4 noun classes as below. In this language there are only $2^2 = 4$ patterns of allomorph selection, but since no affix identifies a noun as belonging to any of the classes 1-4, there are no grounds to include inflection class information in the meaning of any affix. Because of the small number of cells in noun paradigms in this language, this formal bound on the number of inflection classes is likely to be much lower than the upper bound provided by the number of nouns. This theoretical maximum rises exponentially with the number of cells in the paradigm for which there is allomorphy. Greek verbal paradigms have over 200 cells, many of which have two or three allomorphs, so the theoretical maximum defined this way will be far greater than the number of verbs.

Class	1	2	3	4
Sing.	a	b	b	a
Pl.	c	c	d	d

[11] Ignoring the dual and imperative, and excluding some impersonal verbs which have too few cells in their paradigms to allow segmentation.

E.g.	Number of verbs[12]
paúō	107
leipō	32
deíknūmi	19
peíthō	10
gignṓskō	6
dídōmi	3
hístēmi	1
óllūmi	1
sbénnūmi	1
eimi 'be'	1
eîmi 'go'	1
oîda 'know'	1

Table 5: Relative type frequency of patterns of person/number affix selection

Ignoring one-off patterns which only apply to a single verb, we are left with six patterns, exemplified above by PAÚŌ, LEIPŌ, DEÍKNŪMI, PEÍTHŌ, GIGNṓSKŌ, and DÍDŌMI. For these six groups of verbs, the rest of their paradigms can be reliably predicted by four principal parts: several fewer than the seven needed to determine lexical allomorphy.

Class	Present active indicative 1sg	Aorist active indicative 1sg	Aorist active indicative 1pl	Aorist middle indicative 1sg
paúō	*-ō*	*-a*	*-amen*	*-mēn*
leípō	*-ō*	*-on*	*-omen*	*-omēn*
deíknūmi	*-mi*	*-a*	*-amen*	*-mēn*
peíthō	*-ō*	*-a*	*-amen*	*-omēn*
gignóskō	*-ō*	*-n*	*-men*	*-mēn*
dídōmi	*-mi*	*-a*	*-men*	*-mēn*

Table 6: Affixal principal parts

[12] The numbers given here represent the type frequency of each pattern in the sample of 183 common irregular verbs listed in Morwood (2001), which I used as the basis for my sample in chapter 4 (3.2.1). These are intended to give a very rough idea of the relative type frequency of each class in the full set of Greek verbs, which is of course much larger (the TLG wordlist contains 14210 verbs). Because it is biased towards irregular verbs, the numbers underestimate the relative type frequency of the *paúō* pattern, and because it is biased towards verbs which have a high enough token frequency to be worth memorising, it probably overestimates the relative type frequency of some high token-frequency patterns (e.g. that of *dídōmi*). It is impossible to obtain an unbiased sample, however, because only relatively high token frequency verbs tend to have enough forms in their paradigms attested to judge securely which class they belong to.

Table 6 gives the exponents of person and number for a representative cell of each of four subsets of paradigm cells (see table 6), such that the exponent of person and number in the representative cell determines the exponent of person and number for every other cell in its subset. These affixes function like principal parts (ch. 2: 2.2). While each principal part enables us to predict full forms in a given subsection of the paradigm, each of these affixal principal parts enables us to predict the exponent for a particular set of morphosyntactic variables (person and number), in a given subset of paradigm cells.

Table 7 below summarises the patterns of implication underlying the inflectional allomorphy described in chapter 2 (3.2). The first singular suffixes[13] have been chosen as representative forms, following the conventional presentation of principal parts, but this is an arbitrary convention: any cell in each of these sets would do. The only exception is the aorist active 3sg, where the allomorph *-e(n)* is consistent with both 1sg *-a* or *-on*, and 2sg *-as* or *-es*. All paradigm cells which do not meet any of the descriptions in the right-hand column of table 6 consistently select a single person-number suffix, irrespective of lexeme.

Cell	Predicts person-number suffixes of:
Present active indicative 1sg	[imperfective, active/middle/passive, indicative/optative]
Aorist active indicative 1sg	[aorist active indicative singular]
Aorist active indicative 1pl	[aorist active indicative plural] [aorist active optative 1sg]
Aorist middle indicative 1sg	[aorist active/middle indicative]

Table 7: Predictive domains of the affixal principal parts in table 6

[13] These are sufficient for predicting the plural forms, except for the aorist active 1sg *-a*, which corresponds to plural *-men, -te, -san* in a small number of verbs, rather than the more usual *-amen, -ate, -an*. Therefore table 6 also includes both the first person singular and plural for the aorist.

The affixes in table 6 are a distillation of the unpredictability of person-number allomorphy, which reduce it to a maximally economical four variables. Therefore, if the principle of contrast applies to all affixes in the language, it should apply to this reduced subsystem of principal parts.

Class-identifying affixes are shaded in grey. To satisfy both the principle of contrast and the exclusive disjunction bar, one allomorph at most can fail to identify inflection class. This is because only one of a set of allomorphs can be unmarked for inflection class, and selected by the relevant lexemes by the elsewhere principle. In order to satisfy the principle of contrast, something must be added to the meaning specification of each of the remaining allomorphs, to differentiate them from the default and from each other. But because they are allomorphs, there are no morphosyntactic features available which could differentiate them. The only solution is to add different class-identifying information to each of their meaning specifications. The exclusive disjunction bar (1.4) precludes adding statements like 'class A or class B', however. This means that each allomorph which is not a default must uniquely identify a single inflection class.

An example will make clearer how this works in practice. Table 6 shows that the aorist active indicative 1sg has three allomorphs: *-a*, *-on*, and *-n*. *-on* is only found in the class of verbs which inflect like LEÍPŌ, so we can give it the preliminary meaning specification below (1).

(1) *-on*: [1st, singular, perfective, past, active, indicative, *leípō*-class]

Likewise *-n* is unique to the group of verbs which inflect like GIGNŐSKŌ, so we can add '*gignőskō*-class' to its meaning specification (2).

(2) *-n*: [1st, singular, perfective, past, active, indicative, *gignőskō*-class]

That leaves only *-a* unaccounted for. Because it appears in the 1sg aorist active indicative cells of three verb types – represented in table 5 by PAÚŌ, DEÍKNŪMI, and PEÍTHŌ – we cannot include any class-identifying information in its specification, without disobeying the exclusive disjunction bar. However, we can treat it as a class-default (3) without any unpleasant consequences, because the meaning specifications of both of its allomorphs are differentiated from it by class-identifying information.

(3) *-a*: [1st, singular, perfective, past, active, indicative]

A cursory look at table 6 reveals that very few of the affixes in it are class-identifiers. In fact, the aorist active 1sg is the only cell for which every allomorph can be given a meaning specification that satisfies both the principle of contrast and the exclusive disjunction bar. This is because the classes themselves are only minimally different from each other. Each class differs from another class in a single subsection of its paradigm, which can be clearly defined by some set of morphosyntactic features: LEÍPŌ is different from PAÚŌ only in the aorist, and PEÍTHŌ is only different from PAÚŌ in the aorist middle. For this reason I argued in chapter 2 (3.2) that these patterns of affix allomorph selection are not inflection classes, in the usual sense of the word.

In (1), *'leípō*-class' was allowed to feature in the meaning specification for the suffix *-on*, because it is uniquely associated with the group of verbs which select the same person-number allomorphs as LEÍPŌ throughout their

paradigms. However, since LEÍPŌ is only minimally different in its inflection from the other classes, most of the paradigmatic information conveyed by the feature *'leípō*-class' is actually redundant, from the point of view of language acquisition. Recall that the justification for including paradigmatic information as part of the meaning of affixes was that it is useful to children acquiring languages. A child can infer, when they encounter the suffix *-on* in an aorist form, that the lexeme to which it is attached inflects like LEÍPŌ. However, LEÍPŌ inflects like PEÍTHŌ in the aorist middle, and like PEÍTHŌ, PAÚŌ and GIGNŐSKŌ in the imperfective (represented by the 1sg present active indicative in table 5). Because the affixes selected in these paradigm subsections are shared by more than one class, they must be class defaults. Therefore, the feature *'leípō*-class' only gives *useful* information about how to inflect the lexeme in the aorist active.

Given this fact, there seems no good reason to forbid non class-identifying affixes from including paradigmatic information in their meaning specifications. For example, the aorist active indicative 1pl suffix *-amen* reliably licenses prediction of all other aorist active cells of a lexeme, in exactly the same way as 1sg *-on*, even though it is associated with more than one class.

In order to give Greek the best chance of complying with the four constraints proposed in Carstairs-McCarthy (1998), I will therefore divide the paradigm cells in which there is allomorphy into three 'slabs', following Carstairs-McCarthy (1987): the aorist active slab, the imperfective slab, and the aorist middle slab. I will treat the kappatic aorist pattern, which has the suffixes of the weak aorist in the singular, and the root aorist in the plural (and optative 1sg), as a 'mixed' inflection class for the aorist active slab, following Carstairs-McCarthy (1983: 127).

1.1.1.2. 'Slab' inflection classes

The way a verb inflects in its present/imperfective, aorist active, and aorist middle cells are independent variables (although *-on*/*-omen* in the aorist active implies *-omēn* in the aorist middle, but not vice versa). This can be accommodated by treating each of these groups of paradigm cells as separate 'slabs': essentially, subsets of paradigm cells whose allomorph choices can be reduced to a single variable. Different inflection class features are relevant in different slabs, and convey paradigmatic information about how the verb inflects in the other cells of the same slab.

In this new framework, all the affixes in table 6 become class-identifiers, and can potentially feature paradigmatic information in their meaning specifications. Thus the meaning of a person-number affix may make reference to inflection class features such as +thematic or +strong (chapter 2: 3.2). Moreover, it has the advantage of bringing into the system two verbs, SBÉNNŪMI and ÓLLŪMI, which were previously dismissed as one-off patterns, but can now be seen as statistically rare combinations of inflection class features for different slabs (table 8).

Verb:	Present/imperfective slab	Aorist active slab	Aorist middle slab
paúō	Thematic (*-ō*)	Weak (*-a*)	*-mēn*
leipō	Thematic (*-ō*)	Strong (*-on*)	Strong (*-omēn*)
deíknūmi	Athematic (*-mi*)	Weak (*-a*)	*-mēn*
peíthō	Thematic (*-ō*)	Weak (*-a*)	Strong (*-omēn*)
gignṓskō	Thematic (*-ō*)	Root (*-n*)	None
dídōmi	Athematic (*-mi*)	Kappatic (weak in singular indicative, root elsewhere)	*-mēn*
óllūmi	Athematic (*-mi*)	Weak (*-a*)	Strong (*-omēn*)
sbénnūmi	Athematic (*-mi*)	Root (*-n*)	*-mēn*

Table 8: Inflection class features in three paradigmatic 'slabs'

1.1.1.3. Screeveshapes and screeveshape-identifiers

In addition to 'slab' inflection class features like +thematic or +root, Carstairs-McCarthy allows another type of paradigmatic information to feature as part of the meaning of an affix, which he calls 'screeveshape'. In chapter 2 (3.2.1-3) we saw that there is considerable overlap between the person-number endings in different parts of verbal paradigms in Greek. For example, the endings *-on, -es, -e(n), -omen, -ete, -on*, which we find in the imperfect active indicative of all verbs (4), are also found in the aorist active indicative of verbs with strong aorists, like LEÍPŌ (5).

(4) *éleipon éleipes éleipe(n) eleípomen eleípete éleipon*
'I/you (sg)/he/we/you (pl)/they were leaving'

(5) *élipon élipes élipe(n) elípomen elípete élipon*
'I/you (sg)/he/we/you (pl)/they left'

Carstairs-McCarthy (1998: 8), following Aronson (1982), calls a group of paradigm cells which differ from each other only in person and number a

'screeve'. This is essentially the same concept as a 'slab', but one in which certain morphosyntactic variables (in this case person and number) are unfixed. A 'screeveshape' is a distinct set of allomorphs which occupy a screeve. The thematic imperfect/strong aorist screeveshape is found in two screeves: the past perfective active indicative (5), and the past imperfective active indicative (4).

In Carstairs-McCarthy's terminology, a 'screeveshape identifier' is an affix which uniquely determines affix selection for the other cells in its screeve. Because affixes are often shared between multiple screeveshapes in Greek, not every affix is a screeveshape identifier, as table 9 illustrates. For the thematic imperfect/strong aorist screeveshape (a), the 3sg ending *-e(n)* is shared by the weak aorist (b) and the perfect (c), while the 1pl *-omen* and 2pl *-ete* are shared by the thematic present/future screeveshape (d). In screeveshape (a), only the endings of the 1sg, 2sg and 3pl are screeveshape identifiers, because they only appear in one screeveshape.

	1sg	2sg	3sg	1pl	2pl	3pl	Found in (active indicative)
(a)	*-on*	*-es*	*-e(n)*	*-omen*	*-ete*	*-on*	Thematic imperfect, Strong aorist
(b)	*-a*	*-as*	*-e(n)*	*-amen*	*-ate*	*-an*	Weak aorist
(c)	*-a*	*-as*	*-e(n)*	*-amen*	*-ate*	*-āsi*	Perfect
(d)	*-ō*	*-eis*	*-ei*	*-omen*	*-ete*	*-ousi*	Thematic present, future

Table 9: Four screeveshapes

Screeveshape, like inflection class, is a kind of paradigmatic information. In the same way that class-identifying affixes make it possible to predict which affixes a lexeme selects in the remaining cells in its paradigm (or slab), screeveshape identifiers enable affix prediction of the equivalent cells for other

combinations of person and number.[14] By the same justification, we can allow screeveshape information to feature in the meaning specification of a screeveshape-identifier.

However, since screeveshape identifiers are likely to convey information about a far smaller number of paradigm cells than class identifiers, we must be careful that screeveshape actually conveys non-redundant information before allowing it to feature in an affix's meaning specification. In Greek the aorist indicative active endings *-a, -as, -en, -amen, -ate, -an* (table 8: b) are identical to the perfect indicative active endings (c) except for the 3pl *-an*. Because the other endings are shared by two screeveshapes, they have to be accounted for as screeveshape-defaults; any other account will necessarily involve an exclusive disjunction. But since non-screeveshape identifiers must always be defaults, the only non-redundant information a screeveshape identifier can supply is about other screeveshape identifiers. In the case of 3pl *-an*, although it is a screeveshape identifier, it is the only screeveshape identifier in its screeveshape, and therefore the only paradigmatic information it supplies is redundant: the other endings it tells you how to inflect are defaults, and the only non-default in the screeveshape is itself. If the meaning specification of an affix is allowed to refer to itself, the claim that every affix can be given a unique meaning specification becomes trivial.

For different reasons, Carstairs-McCarthy (1998: 15) suggests that a screeveshape should only be allowed to feature in the meaning specification of an affix if it contains more than some percentage of screeveshape-identifiers.

[14] While a class-identifying affix for a particular slab enables prediction of a concrete set of paradigm cells belonging to that slab, the paradigmatic information given by a screeveshape-identifying affix involves a free variable: it enables us to predict cells of the same screeve, whatever it may be, for other values of person and number. For example, finding *-on* in the 1sg past imperfective active indicative enables us to predict *-es* in the 2sg past imperfective active indicative, while finding *-on* in the 2sg past perfective active indicative equally enables us to predict *-es* in the 2sg past perfective active indicative (Table 8, a).

Despite being somewhat arbitrary, some boundary is clearly needed, and Carstairs-McCarthy suggests 50% tentatively on empirical grounds. If we follow this, only 5 of the 17 screeveshapes (also highlighted grey) contain more than 3 screeveshape-identifiers, making them eligible to feature in the meaning specification of an affix (table 10).[15]

1sg	2sg	3sg	1pl	2pl	3pl	No. screeveshape-identifiers
-ō	*-eis*	*-ei*	*-omen*	*-ete*	*-ousi*	3
-ō	*-ēis*	*-ēi*	*-ōmen*	*-ēte*	*-ōsi*	4
-mi	*-s*	*-*	*-men*	*-te*	*-en*	0
-on	*-es*	*-e(n)*	*-omen*	*-ete*	*-on*	3
-a	*-as*	*-e(n)*	*-amen*	*-ate*	*-an*	1
-a	*-as*	*-e(n)*	*-amen*	*-ate*	*-āsi*	0
-ē	*-ēs*	*-ei(n)*	*-emen*	*-ete*	*-esan*	5
-omai	*-ēi*	*-etai*	*-ometha*	*-esthe*	*-ontai*	3
-ōmai	*-ēi*	*-ētai*	*-ōmetha*	*-ēsthe*	*-ōntai*	5
-mēn	*-o*	*-to*	*-metha*	*-sthe*	*-nto*	1
-omēn	*-ou*	*-eto*	*-ometha*	*-esthe*	*-onto*	4
-n	*-s*	*-*	*-men*	*-te*	*-san*	0
-mai	*-sai*	*-tai*	*-metha*	*-sthe*	*-ntai*	4
-mēn	*-so*	*-to*	*-metha*	*-sthe*	*-nto*	1
-mi	*-s*	*-si*	*-men*	*-te*	*-āsi*	0
-n	*-s*	*-*	*-men*	*-te*	*-en*	0
-a	*-as*	*-e(n)*	*-men*	*-te*	*-san*	0

Table 10: Screeveshapes and screeveshape-identifiers in the Greek verb

1.2. The complementarity bar

The complementarity bar forbids the semantic specification of a form from including any statement of the form 'not *p*', where *p* is some element of meaning. In the domain of inflection, this means that the specification for an

[15] Because the dual number and imperative mood have been excluded from this study, table 9 overestimates both the number of screeveshape identifiers, and the number of screeveshapes which contain more than 50% screeveshape identifiers. This gives Carstairs-McCarthy's constraints a better chance of working, because more affixes can be saved from violating the principle of contrast by including screeveshape information in their meaning specifications. Despite this, as we shall see in section 3, screeveshape information is of little use when attempting to assign a unique value to each affix, because most affixes are shared by multiple screeveshapes.

affix can only make reference to positive features, like +past, rather than negative features, such as -past or 'nonpast'.

Lexical semanticists distinguish gradeable antonyms like 'rich' and 'poor' from complementary antonyms like 'legal' and 'illegal', where the antonym of a word X can be exhaustively stated as 'not X'. The complementarity bar is based on Carstairs-McCarthy's claim that complementary antonymy does not exist in lexical semantics, but is always a purely pragmatic phenomenon (1998: 5). In the case of 'legal' and 'illegal', a sentence like 'murder is more illegal than theft', Carstairs-McCarthy argues, is not semantically anomalous; an all-or-nothing distinction between 'legal' and 'illegal' is merely imposed in most contexts by the institutional framework of a legal system. Complementarity is thus always a matter of the way the world is, rather than lexical semantics.

One might object that this argument is spurious: it is equally possible to claim that the complementary interpretation of antonyms like 'legal' and 'illegal' is primary, and the gradeable interpretation is pragmatic, or indeed that the distinction between semantics and pragmatics is unhelpful in this context, because tendencies of lexical semantics are likely to be caused by facts about the way the world is. For the purposes of testing Carstairs-McCarthy's constraints, I will put aside scepticism and accept the complementary bar as written, while bearing in mind that it may be necessary to sacrifice it in order to satisfy the other constraints, which receive stronger support from lexical semantics.

1.2.1. Complementarity and voice in Greek

It is not always clear which morphosyntactic values should be considered positive and negative, particularly where intermediate categories appear to exist, as with voice. Semantically, Greek has three categories of voice: active, middle, and passive (chapter 2: 1.1). Person-number suffixes are partly responsible for conveying voice, but they usually mark only a binary distinction between active (e.g. 6) and mediopassive (7-8). In imperfective and perfect forms, the contrast between middle and passive is not made at the level of the word, but left up to syntax (e.g. 7, where the presence of a direct object ensures middle interpretation of the mediopassive suffix *-omai*) or speech context (8).

(6) *loú-ō* *t-á* *himáti-a*
WASH-1sg THE-pl.acc CLOTH-pl.acc
'I wash the clothes'

(7) *loú-omai* *t-á* *himáti-a*
WASH-1sg.mediopassive THE-pl.acc CLOTH-pl.acc
'I wash my clothes', 'I wash the clothes for my profit'

(8) *loú-omai*
wash-1sg.mediopassive
'I wash myself' OR 'I am being washed'

In the future tense, the choice of suffix marks only the distinction between active and non-active, but the distinction between middle and passive is made clear by the choice of stem (9-11).

(9) *lū́-s-ō*

FREE-fut-1sg

'I will free (someone/something)'

(10) *lū́-s-omai*

FREE-fut-1sg.mediopassive

'I will free myself', 'I will free for my profit (i.e. ransom)'

(11) *lu-thḗ-s-omai*

FREE-pass-fut-1sg.mediopassive

'I will be freed'

Only in the aorist does the choice of suffix mark a three-way distinction between active, passive and middle (12-14).

(12) *é-pau-s-a*

past-STOP-perfective-1sg.**act**

'I stopped (someone/something)'

(13) *e-pau-s-á-mēn*

past-STOP-perfective-null-1sg.**mediopassive**

'I stopped myself'

(14) *e-paú-sthē-n*

past-STOP-**pass**-1sg

'I was stopped'

The middle voice encodes a number of values, including reflexive, benefactive, reciprocal, and various unaccusative senses.[16] There is a reasonable case to be made that it is semantically intermediate between the active and passive (hence the term 'middle'): like the active, the subject initiates or performs the action of the verb, and like the passive, the subject is affected by the action of the verb (table 11).[17]

	Agentlike subject	Patientlike subject	Meaning
Active	Yes	No	Active
Passive	No	Yes	Passive
Middle	Yes	Yes	Reflexive, reciprocal, unaccusative, benefactive

Table 11: An analysis of voice in Greek as the product of two binary distinctions

If we follow this line of reasoning, we can analyse the mediopassive suffixes, which can be found in both middle and passive forms, as marked for the semantic features which the middle and passive have in common. Let us call this feature +patientlike subject.

From the point of view of the complementarity bar, this leads to problems for the aorist, which is alone in having a different set of suffixes in the passive from either the active or middle (see 12-14 above). The suffixes of the aorist middle (13) are also used in various optative forms which can be interpreted

[16] See Allan (2003, 2015) for an overview of senses of the middle voice in Greek.

[17] This oversimplifies a large theoretical literature on the middle voice, since the details are irrelevant to the point I am making here. See e.g. Barber (1973), Bakker (1994) on the middle voice in Greek, and Kemmer (1993) for a cross-linguistic survey. It is generally agreed that the subject of a middle verb falls somewhere between a prototypical agent and patient. E.g. Mel'cuk (2006: 214): "the middle is not an 'ideal' voice and cannot be a part of the logical calculus of voices. It is a language-specific hybrid of various voice- and voice-like signifieds".

either as middle or passive. Therefore, these suffixes must be marked only as +patientlike subject (e.g. 15; cf. 16), and cannot additionally be marked as +agentlike subject.

(15) *pau-oí-mēn*
STOP-opt.imperfective-1sg.mediopassive
'I would stop (for) myself' OR 'I would be stopped'

(16) *paú-oi-mi*
STOP-opt.imperfective-1sg.active
'I would stop (someone/thing)'

But if so, the only feature available to differentiate the endings of the passive would be the negative of the semantic features which the middle and active have in common (i.e. -agentlike subject), violating the complementarity bar.

In this chapter I will treat both 'mediopassive' and 'passive' as positive features (i.e. +passive, +mediopassive, rather than -active), because this analysis is the most compatible with the complementarity bar, even if it is not the neatest analysis from the point of view of semantics.

Because mediopassive forms are capable of realising passive paradigm cells where there are no dedicated passive forms, it is necessary to assume that the feature +passive also implies +mediopassive. In other words, the feature '+passive' in a paradigm cell or the meaning specification of an affix can always be rewritten '+passive and +mediopassive'. By the 'elsewhere principle' (1.4.2), passive cells select mediopassive affixes in preference to active affixes, because the mediopassive affixes realise their feature

+mediopassive, but they still prefer passive affixes where they are available, because they realise both +passive and +mediopassive.

1.3. The unmarked property bar

The unmarked property bar states that the semantic specification of a form cannot make reference to any unmarked feature. This is based on the observation, first made by Jakobson (1939), that properties which are least marked within a category (in Kurylowicz's (1949) sense of 'sphere of usage' or Haspelmath's (2006) 'semantic markedness') also tend not to be overtly marked morphologically. A version of this principle is held to follow from a universal preference for iconicity in Natural Morphology (Dressler 1985, Mayerthaler 1981a, 1981b).

To give an example from lexical semantics, 'male' is unmarked in relation to 'female' in English, by virtue of the fact that words denoting males can also be used to refer to females, and in gender-neutral contexts. 'He' is used as a gender-neutral pronoun as well as a masculine one, 'dog' denotes the species as well as the male, while 'bitch' only applies to female dogs, and 'actors' may refer to any number of male and/or female actors, while 'actresses' can only refer to an exclusively female group. Thus, in words with morphologically marked gender such as 'actor'/'actress', 'lion'/'lioness' and 'hero'/'heroine', feminine gender is differentiated from masculine by the addition of an overt suffix.

In the context of inflection, this means that the meaning specification of an affix should make no reference to any unmarked value for a morphosyntactic variable. An affix cannot be given the specification +singular, for example,

because cross-linguistic evidence suggests that singular is the unmarked number. This leads to the expectation that an affix which is limited to an unmarked value for some morphosyntactic variable should be a default for that variable. Of the affixes in table 12, *b* can be specified [+1st, +plural], but the unmarked property bar forbids specifying *a* as [+1st, +singular]. Consequently it has to be a number-default, marked simply as [+1st]. By the elsewhere principle, the most specific compatible affix is selected in each paradigm cell. Therefore, *b* will be selected in preference to *a* in 1pl cells, and *a* will be selected by default in 1sg cells.[18]

1sg	1pl
a	*b*

Table 12: two hypothetical affixes

1.3.1. Markedness in Greek

Carstairs-McCarthy (1998: 7) follows Greenberg (1966) in assuming a universal set of unmarked members of inflectional categories, which tend cross-linguistically both to be semantically unmarked and to lack overt formal marking. Of the categories relevant to verbal inflection in Greek, I will follow

[18] Although Carstairs-McCarthy does not explicitly refer to it, both the complementarity bar and the unmarked property bar are clearly influenced by the theory of underspecification, which holds that feature representations should not make overt reference to predictable information. Underspecification theory was originally developed within phonology, and motivated by the desire to exclude redundancies from phonological representations in the lexicon. In the 1980s, building on ideas of the Prague school, the doctrine of radical underspecification – that representations may only make reference to marked members of binary feature pairs – was used to explain both universal and language-particular markedness effects in phonology (e.g. Kiparsky 1982b, Archangeli 1984). These ideas were soon extended to morphology (e.g. Lumsden 1987, Farkas 1990). Morphological underspecification depends on some version of the elsewhere principle (1.4.2) to explain how underspecified exponents are selected in unmarked paradigm cells/ syntactic nodes. Underspecification and the elsewhere principle are used to explain syncretism in virtually all modern WP theories (e.g. Anderson 1992, Stump 2001, Corbett and Frazer 1993), and underspecification is also a central tenet of Distributed Morphology (Halle & Marantz 1994). More recent treatments of syncretism in Optimality Theory (e.g. Müller 2011), which rely on ranked faithfulness constraints instead of underspecification and the elsewhere principle, differ mainly in terminology rather than substance from these accounts.

Carstairs-McCarthy and Greenberg in treating the values in table 13 as unmarked.

Variable	Unmarked value
Tense	present
Mood	indicative
Number	singular
person	3rd
Voice	active
±Perfect	-perfect[19]

Table 13: Unmarked values for morphosyntactic variables of the Greek verb

While Greenberg (1966) finds imperfective aspect unmarked with respect to perfective, it has also been argued that languages which make a grammatical distinction between perfective and imperfective aspect do not always choose a marked and unmarked member of the pair.[20] In Greek there is a good case to be made for the perfective as the unmarked aspect.[21] However, in order to give Carstairs-McCarthy's constraints the best chance of working, I will treat neither perfective nor imperfective aspect as unmarked, allowing either to count as part of the meaning of an affix.

1.4. The exclusive disjunction bar

Finally, Carstairs-McCarthy proposes a lexical semantic constraint against disjunctive meaning ('*a* or *b*, but not both'), on two grounds. The study of concept formation has shown that people in experimental conditions find it hard to learn disjunctively defined concepts (Bruner et al. 1956), and disjunctively defined words are very rare in languages.

[19] Carstairs-McCarthy (1998) does not mention the perfect, but I assume -perfect is unmarked by the complementarity bar (1.2).
[20] Dahl (1985).
[21] Garrett (2008).

On the other hand, inclusive disjunctions (‘*a* and/or *b*’, ‘at least one of *a*, *b*’) are common in lexical semantics. Carstairs-McCarthy gives an example from Jackendoff (1985), where the following pattern of acceptability judgements for the word *climb* appears to imply a disjunct meaning ‘upward or clambering’:

(17) a. The boy climbed up the tree.
b. The boy climbed down the tree
c. The snake climbed up the tree
d. *The snake climbed down the tree

Only (17d) is unacceptable, because both ‘clambering’ and ‘upward’ are excluded. The acceptability of (17a) shows that this is an inclusive disjunct: clambering upward is the prototypical reference of the word ‘climb’. On the other hand, languages lack words whose meaning can be defined as exclusive disjunctions: ‘either *a* or *b*, but not both’. This includes words meaning ‘*a* or *b*’, where ‘but not both’ is implied by the incompatibility of *a* and *b*. For example, ‘plum or banana’ is an unlikely meaning for a word, because an object cannot be both a plum and a banana.

The exclusive disjunction bar has two related implications for affix meaning. First, any disjunction must be interpretable as an inclusive disjunction: if an affix is given the meaning [+past or +subjunctive], it must be selected in past subjunctive cells, if they exist, unless another affix with a more specific meaning than [+past and +subjunctive] is available.

Secondly, if the meaning specification of an affix includes a statement [*a* or *b*], *a* and *b* must be compatible, in that it must be possible for a word to be both *a* and *b*. Thus [+indicative or +subjunctive] is unacceptable: because indicative

and subjunctive are mutually exclusive values for the mood variable, a word cannot be both indicative and subjunctive.

This kind of conceptual incompatibility is to be distinguished from language-specific incompatibility. Because Greek has no future subjunctive, '+future' implies '-subjunctive' and '+subjunctive' implies '-future' in a certain sense, but this is merely a contingent fact about Greek, and does not make [+future or +subjunctive] an exclusive disjunction. Therefore, [+future or +subjunctive] is a legitimate meaning for an affix, because it is possible *in theory* for a word to be both future and subjunctive, whereas [+plural or +singular] is not acceptable, because the meaning of 'plural' and 'singular' makes the two features logically incompatible.

1.4.1. Homomorphy in Greek

These constraints are meant to place limits on affix allomorphy, whereby formally different affixes appear in paradigm cells defined by identical morphosyntactic features. But they also have implications for the opposite situation, in which formally identical affixes appear in paradigm cells defined by different morphosyntactic features. I will refer to this situation as 'homomorphy'.

Homomorphy in Greek causes major problems for the exclusive disjunction bar, because the same suffix often turns up in cells defined by mutually incompatible morphosyntactic features. The 1sg suffix *-n*, for instance, appears in forms with both active and passive voice, indicative and optative mood, and perfective and imperfective aspect. This makes it extremely difficult to give each suffix a meaning specification that accounts for all the cells in which it

occurs, but does not falsely predict its occurrence in cells where it is not found, without admitting very convoluted exclusive disjunctions.

Carstairs-McCarthy (1998: 17-18) discusses a similar situation in the Latin verb, where the first person singular suffix *-m* appears to demand a meaning [+subjunctive or +past or (+future and +3rd conjugation)]. This would violate the exclusive disjunction bar, since future and past tense are incompatible. Carstairs-McCarthy argues that 3rd conjugation future forms like *regam* 'I will rule' are in fact morphologically present subjunctive, but appear in future indicative cells via a 'referral' or 'take-over' (Carstairs-McCarthy 1987: 162-4). This is perhaps a plausible explanation for phenomena like deponency (see discussion in ch. 2: 3.2.2), but as we shall see, homomorphy is such a systematic feature of person-number suffix distribution in Greek that this would be an arbitrary solution to the problems it causes.

Homomorphy is essentially a special case of morphomicity (see ch. 2: 2.6). Discussion of morphomes has focussed on lexical stems whose distribution is defined in terms of mutually exclusive morphosyntactic features, but which persist across lexical paradigms (Aronoff 1994, Maiden 2004). Greek shows that just the same thing can happen with affixes. This is a distinct phenomenon from syncretism, where a morphosyntactic contrast is neutralised in certain contexts. Latin makes a distinction between nominative and vocative case only in second declension nouns, while in the other declensions the nominative and vocative are syncretic, i.e., they are expressed by the same word. The situation in Greek is different, as the examples below show (18-23). The suffix *-n* appears in both active (20-22) and passive (19), indicative (19, 20, 22) and optative (21), and imperfective (22) and perfective (19, 20, 22) forms. Yet none of the three

verbs fail to make a distinction at word level between active/passive (18-19), indicative/optative (20-21), or imperfective/perfective (22-23).

DÍDŌMI 'give'

(18) *didō-mi*

GIVE-1sg.active

'I give'

(19) *e-dó-thē-**n***

past-GIVE-pass-1sg

'I was given'

BAÍNŌ 'go'

(20) *é-bē-**n***

past-GO-1sg

'I went (indic.)'

(21) *baíē-**n***

GO.opt-1sg

'I went (opt.)'

DEIKNŪMI 'show'

(22) *e-deíknu-**n***

past-SHOW-1sg

'I was showing'

(23) *é-deik-s-a* 'I showed'

past-SHOW-perfective-1sg.active

1.4.2. The elsewhere principle and defaults

The 'elsewhere principle' has been widely used in phonology and morphology, and is traced back to the Sanskrit grammarian Pāṇini by Anderson (1992: 132). In terms of Carstairs-McCarthy's framework, it can be stated as follows:

(24) *A paradigm cell selects the affix which realises the maximum number of its features.*

In other words, a paradigm cell selects the most specific available affix. Specificity is defined by the number of features referred to in the affix's meaning specification which also belong to the set of features associated with the paradigm cell, including both morphosyntactic and inflection class features.

If the meaning of an affix includes a disjunction, the number of features applicable to a specific paradigm cell may be fewer than the total number of features in the affix's meaning specification. The paradigm cell in fig. 2 should select affix *a*, because *a* expresses three of its morphosyntactic features, while *b* expresses only two, although the specifications for both *a* and *b* refer to three features in total.

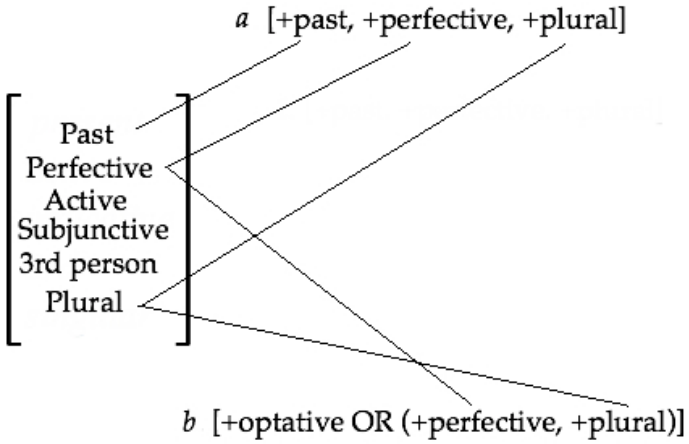


Fig. 2: Affix selection by a paradigm cell

The most specific affix for a paradigm cell may leave a number of its morphosyntactic features unexpressed. Affix *a* in fig. 2 expresses past tense, perfective aspect and plural number, but not 3rd person, active voice, or subjunctive mood. It is therefore a person, voice and mood default. Since the unmarked property bar forbids the meaning specification of an affix from making reference to unmarked properties, we should expect defaults to be selected by unmarked paradigm cells: present cells should select affixes which are unmarked for tense, etc.

I have described the pattern of inflection exemplified by the verb PAÚÕ in Greek as a 'default' class, in the sense that it is diachronically productive, and it is the class to which loanwords and newly coined words tend to belong. 'Default' in Carstairs-McCarthy's terminology has a different and independent sense;[22] it is not a requirement that all affixes selected in the most productive class are class-defaults, i.e., unmarked for inflection class. If a productive inflection class selects an affix which is not a class-default, however, the no-blur principle implies that this affix should be inhibited from spreading to

[22] See Carstairs-McCarthy (2008) for discussion of these different sense of 'default'.

other inflection classes. German *-s* is the plural allomorph selected by loanwords and neologisms, but *-en* is the 'default' in that it is only plural affix which is selected by more than one inflection class, and therefore must be given a meaning specification which makes no reference to inflection class. According to Carstairs-McCarthy (1994: 764), this explains why *-s* never encroaches on *-en* to give e.g. **Helds* for *Helden* 'heroes': this would create a situation where more than one plural allomorph is selected by multiple inflection classes, making it necessary to give at least one of these affixes a meaning specification with an exclusive disjunction, e.g. [+plural and (class I or class II)].

The elsewhere principle makes it easier to avoid violating the exclusive disjunction bar, the unmarked property bar, and the complementarity bar. In the hypothetical language of table 14, affix *a* appears in case 1 and case 2, but not case 3. This seems to imply a meaning specification [class I and (+nom or +acc)], or [class I and -gen], violating either the exclusive disjunction bar or the complementarity bar respectively. We can get round this by giving it the specification [class I], making it a case-default, and specifying *b* as [class I & +gen]. *b* will then be selected in the genitive of class I nouns by virtue of having a more specific meaning, and *a* will be selected elsewhere.

Similarly, *c* appears only in the nominative case, which is the unmarked case for nouns. In order to avoid giving it the meaning [class II & +nom], which would violate the unmarked property bar, it is necessary to make it a class-default. This means that *d* and *e* must be marked as +acc and +gen, respectively.

The elsewhere condition is not a universal solution, since only one affix can be a default for a given variable. If class I selected *d* in the genitive instead of *e*,

we would have a problem, since the meaning specification for *d* would require either an exclusive disjunction ([Class II & (+acc. or +gen)]) or a violation of the complementarity bar ([Class II & -nom]).

Class	I	II
Nom.	*a*	*c*
Acc.	*a*	*d*
Gen.	*b*	*e*

Table 14: a hypothetical pattern of allomorph distribution

2. A SYNCHRONIC TEST OF CARSTAIRS-MCCARTHY'S CONSTRAINTS

Assigning a meaning specification to all 59 person-number suffixes in table 2 is an extremely complicated undertaking, because the specification of each suffix depends on the specification of every other suffix in the system. In this section I will work through the task of assigning a meaning specification to just four Greek person-number suffixes. Despite the small size of this sample, it will amply illustrate the difficulties of coming up with an account of the distribution of person-number allomorphs which satisfies Carstairs-McCarthy's constraints.

For the sake of clarity, the figures in this section illustrate small excerpts of paradigms. For a full account of the distribution of each suffix, refer to the appendix.

2.1. -on

The suffix *-on* appears in four cells: the 1sg and 3pl of the active indicative past perfective, and the 1sg and 3pl of the active indicative past imperfective (fig.

3). As an initial hypothesis, we will give it the specification [+past], since it appears only in past tense cells. We omit +active and +indicative by the unmarked property bar, but assume that it will be selected in the active and indicative by the elsewhere principle.

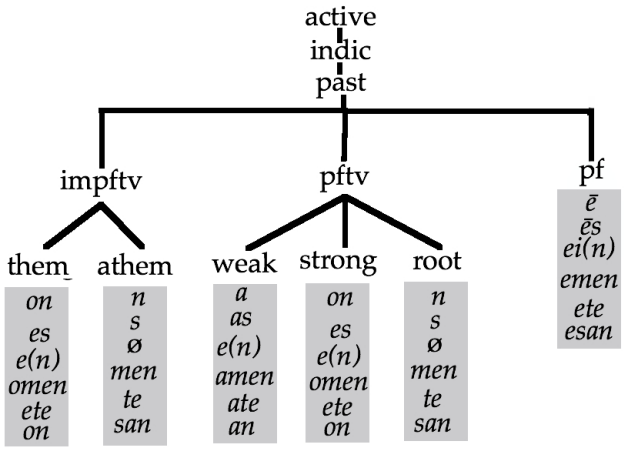


Fig. 3: The paradigmatic distribution of the suffix *-on*

From figure 3, the specification [+past] does not look specific enough: *-on* is found only in past cells, but it is not found in *all* past cells. It occurs only in the past imperfective and past perfective, and not in the past perfect (pluperfect). This seems to demand a violation of either the complementarity bar (a) or the exclusive disjunction bar (b).

Luckily, *-on* is chosen only by thematic verbs in the imperfective, and only by strong verbs in the perfective, so we can avoid these violations by giving it the specification in (c) or (d) below. Alternatively, we can simply designate it as [+past] (e), and assume it is selected in the strong aorist and imperfect by the elsewhere principle. In this case, each of its competitors must have some additional feature in its meaning specification to distinguish it from that of *-on,* and make it more specific than [+past]. Since each of its competitors can be

distinguished either by inflection class or the feature +perfect, it looks like it should be possible to make this work.

a) [+past & -perfect]

b) [+past & (+imperfective ∨ +perfective)]

c) [+past & (+imperfective ∨ +strong)][23]

d) [+past & (+perfective ∨ +thematic)]

e) [+past]

Whichever of analyses c-e we adopt needs to be amended to account for the fact that *-on* only appears in 1sg and 3pl cells. Ideally, we should be able to amend its specification to include [+1st ∨ +plural], since singular number and third person are unmarked. But since this is an inclusive disjunction – 'and/or' rather than 'either or' – it should also apply to the 1pl, where we in fact find a different suffix *-omen*. To limit its occurrence to the 1st singular and 3rd plural we have to violate the unmarked property bar by making explicit reference to third person, and the exclusive disjunction bar, by also making reference to 1st person, as in (f) below.

f) [(+1st ∨ (+3rd & +plural)) & +past]

The only solution is to leave the specification for *-on* unmarked for person and number, so that it is selected as a default in the 1sg and 3pl. This comes at the price of breaking the unmarked property bar twice in the specification for *-e(n)*

[23] [+Imperfective ∨ +strong] is a legitimate inclusive disjunction, because imperfective and strong are compatible values for separate variables. +Imperfective is a value for the aspect variable, and +strong is an inflection class feature contributed by the lexeme, which is relevant only in the aorist active slab. Imperfective cells in the paradigm of verbs with strong aorists will therefore be both +strong and +imperfective.

(2.2), which must then include (+3rd & +singular). We cannot leave both *-on* and *-e(n)* unmarked for person and number, because this would make it ambiguous whether the 3sg of the strong aorist and thematic imperfect should select *-on* or *-e(n)*. If we specify *-e(n)* only as +3rd or +singular, it ought to be selected in the 3rd plural or 1st singular, respectively, instead of *-on*.

Yet another alternative would be to accept the specification in (d) for *-on*, and leave *-e(n)* unmarked for person and number. I assume, however, that it is preferable to violate the unmarked property bar than the exclusive disjunction bar. The unmarked property bar was based on a statistical generalisation that semantic and formal unmarkedness tend to cooccur cross-linguistically, but general principles of markedness in individual languages may be superseded by local considerations: e.g. 'cow' denotes both the female of the species and the species itself, contrary to the usual marking of gender in English. It is possible to admit occasional violations of the unmarked property bar without too much damage to the theory as a whole. On the other hand, there are more principled reasons for the exclusive disjunction bar; it is in fact essential if the theory is to have any empirical repercussions at all. Without the exclusive disjunction bar, the principle of contrast is reduced to triviality, since a unique meaning specification can be given to each affix in any possible language, simply by stating all the paradigmatic contexts where it occurs in a list of exclusive disjunctions. Such a description would be equivalent in terms of economy to listing all the words in which each affix occurs, along with their meanings.

2.2. -e(n)

We have already established that the specification for *-e(n)* needs to include (+3rd and +singular). Amongst 3sg cells, it is found in the active indicative present perfect, and the active indicative past imperfective and perfective (fig. 4).

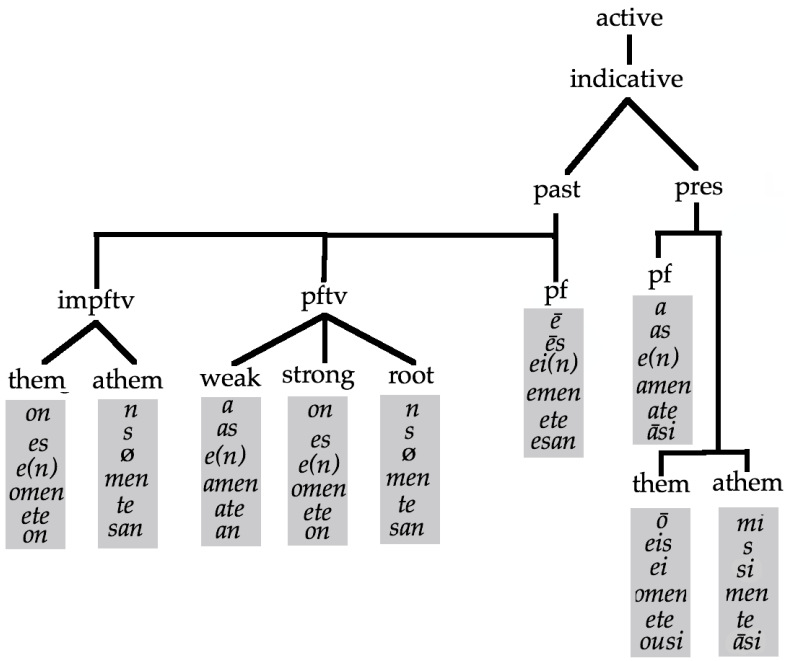


Fig. 4: The paradigmatic distribution of the suffix *-e(n)*

Within the past, *-e(n)* is found in both imperfective and perfective cells, and within the past perfective it is chosen by both weak and strong verbs. Therefore, it has to include +past in its specification (c); anything more specific is ruled out by the exclusive disjunction bar (e.g. (a) or (b)).[24] Note that this has the unfortunate consequence that we must give a specification to the zero suffix to prevent the 3sg past cells where it occurs from selecting *-e(n)* instead.

[24] In theory, it could be [+3rd & +singular & ((+past & (+thematic ∨ +perfective)) ∨ +perfect))], but this has no advantage over (d) above, since it also implies that thematic verbs should select *-e(n)* instead of *-ei(n)* in the past perfect 3sg. We cannot specify it as [+3rd & +singular], because that would leave no way of giving a specification for *-ei* which would not be preferentially selected in at least some of the cells where *-e(n)* is found.

This is problematic, as the typologically frequent cooccurrence of zero-marking and semantic markedness was the original motivation for the unmarked property bar (1.3).

a) [+3rd & +singular &(+past & (+thematic ∨ +weak ∨ +strong)]

b) [+3rd & +singular & +past & (+imperfective ∨ +perfective)]

c) [+3rd & +singular & +past]

This is still not adequate, because *-e(n)* also appears in the present perfect. Since its specification already includes +past, we cannot add (∨ +present), as this would violate both the unmarked property bar and the exclusive disjunction bar. So we have to amend +past to +past ∨ +perfect (d).

d) [+3rd & +singular & (+past ∨ +perfect)]

This introduces a further problem: if (+past ∨ +perfect) is an inclusive disjunction, we expect *-e(n)* to be found instead of *-ei(n)* in the 3sg pluperfect. Since *-ei(n)* is only found in the active indicative pluperfect 3sg, it seems to demand the specification in (e) below, which is no more specific than (d). We cannot add any extra morphosyntactic features to make its specification more specific, because the cell in which *-ei(n)* is found has no further morphosyntactic features which would distinguish it from the cells where *-e(n)* is found. However, *-ei(n)* is a screeveshape-identifier, and all the other suffixes in its screeveshape are unique to that screeveshape, with the single exception of 2pl *-ete*. Therefore we can legitimately rescue the situation by adding *+ei(n)-screeveshape* to its specification (f).

e) [+past & +perfect]

f) [+past & +perfect & +*ei(n)*-screeveshape]

2.3. -ō

The 1sg suffix *-ō* is found in the present indicative active of thematic verbs, the future active indicative, and all active and passive subjunctives (fig. 5).

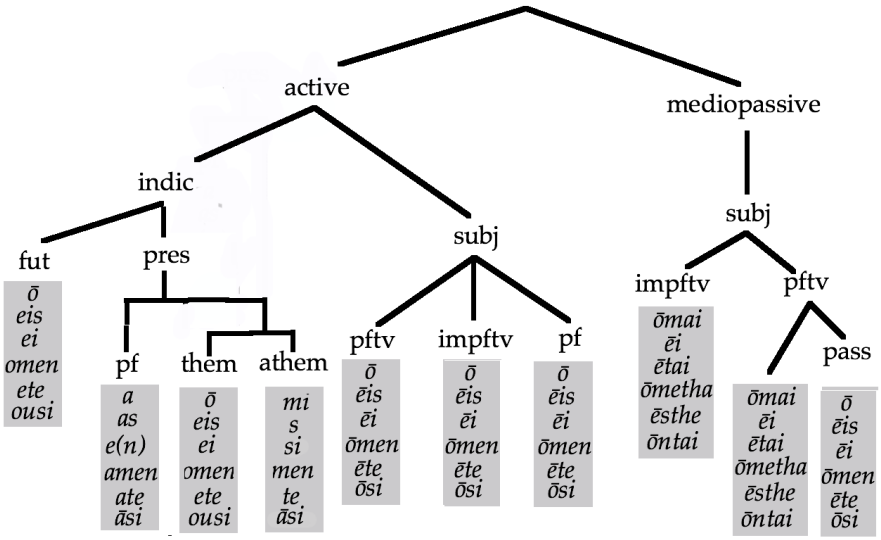


Fig. 5: The paradigmatic distribution of the suffix *-ō*

Within the active, we can characterise its distribution as in (a) below, without violating the complementarity bar or the exclusive disjunction bar.

a) [+1st & (+thematic ∨ +future ∨ +subjunctive)]

We can then account for its absence in the mediopassive subjunctive by giving its competitor, *-ōmai*, a more detailed specification:

b) [+1st & +subjunctive & +mediopassive]

The problem with this is that *-ō* is also found in the (perfective) passive subjunctive, where we should also expect *-ōmai*. This can only be solved by amending the specification of *-ō* to (c), which involves violating the unmarked property bar (+active) and the exclusive disjunction bar on two counts (+active ∨ +mediopassive, +active ∨ +passive).

c) [+1st & (+thematic ∨ +future ∨ (+subjunctive & (+active ∨ (+mediopassive & +passive))))]

(+Subjunctive & (+active ∨ +passive)) would be insufficient, because passive cells are necessarily mediopassive (see 1.2.1), making it ambiguous whether 1sg passive perfective subjunctive cells should select *-ōmai* by virtue of being 1st, mediopassive and subjunctive, or *-ō* by virtue of being 1st, passive and subjunctive.

2.4. -mi

The 1sg suffix *-mi* is found in the active indicative present of athematic verbs, and in various active optative cells (fig. 6).

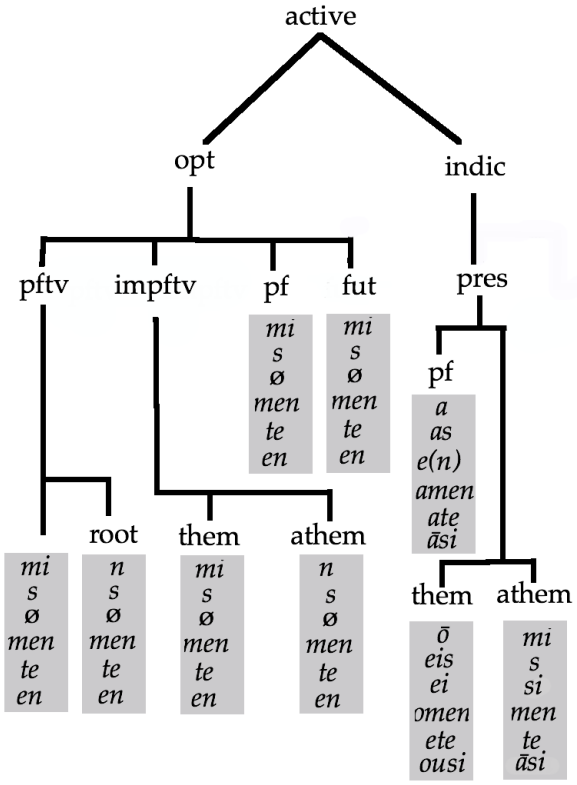


Fig. 6: The paradigmatic distribution of the suffix *-mi*

We cannot give it the specification in (a), because *-mi* is specifically absent from athematic optatives, and we cannot add screeveshape information to the specification of *-n* to get round this problem, as we did for *-ein*, since *-n* is not a screeveshape-identifier. We cannot make it a mood-default (b), because *-õ* is marked as $+1^{st}$ & +thematic, so should be selected in preference to the default in the thematic optative 1sg.

a) $[+1^{st}$ & (+athematic ∨ +optative)]

b) $[+1^{st}]$

Therefore there is no alternative but to violate the exclusive disjunction bar, by including both +athematic and +thematic in its specification (c).

c) [+1st & (+athematic ∨ (+optative & (+future ∨ +perfect ∨ +thematic ∨ +perfective))]

Even this does not narrow it down enough, because the athematic optative should qualify to select *-mi* by the first part of the disjunction (+1st & +athematic). We therefore need to qualify +athematic further by adding either +present (d), +indicative (e), or -optative (f). All three options introduce another exclusive disjunction, while (d) and (e) additionally violate the unmarked property bar, and (f) violates the complementarity bar.

d) [+1st & ((+athematic & +present) ∨ (+optative & (+future ∨ +perfect ∨ +thematic ∨ +perfective))]

e) [+1st & ((+athematic & +indicative) ∨ (+optative & (+future ∨ +perfect ∨ +thematic ∨ +perfective))]

f) [+1st & ((+athematic & -optative) ∨ (+optative & (+future ∨ +perfect ∨ +thematic ∨ +perfective))]

2.5. Conclusion

In this section, I have tried to assign a meaning specification to just a handful of the person-number affixes in table 2. Even for this small sample, it has been impossible to assign a meaning specification to each affix in accordance with the principle of contrast, without breaking the exclusive disjunction bar, and the unmarked property bar. This casts suspicion on at least three out of four of the constraints. However, it might still be possible to maintain them, if we can show that diachrony subsequently favoured changes which brought Greek

closer to complying with them.

3. DIACHRONY

This section will discuss a selection of changes to the distribution of these person-number affixes between classical Attic and the 4th century AD, and consider whether these changes are motivated by Carstairs-McCarthy's constraints. Although new allomorphy is occasionally introduced, the current of change is overwhelmingly in favour of the reduction of allomorphy. This makes Carstairs-McCarthy's constraints much more likely to be met by the streamlined verbal system which emerges in AD 400. If we look at these changes individually, however, they often introduce new violations. Therefore, I will argue, these constraints cannot be plausibly held to motivate the diachronic development of the system.

3.1. Thematisation of athematic verbs

Throughout the history of Greek, there is a tendency for athematic verbs to be replaced by thematic equivalents (see ch. 3: 1.7, 3.4). We know from comparative evidence that many verbs which were athematic in Indo-European had already been thematised by the earliest Greek. The eventual result of this tendency was to eliminate inflection class allomorphy of the person-number suffixes in the imperfective 'slab' of verbal paradigms.

Because so much Greek writing consciously imitates Classical Attic to a greater or lesser degree, it is hard to give a precise date for the final eradication of the athematic class. The verb *eimi* 'be', which resisted thematisation most

stubbornly, is finally remodelled as a deponent *eimai* in the early Middle Ages, by which time it is probably safe to say the athematic endings had disappeared elsewhere in spoken Greek. Before this, a variety of changes worked together to transfer athematic verbs gradually into the thematic class.

3.1.1. Thematisation of nu-verbs

A significant number of athematic verbs were characterised by the stem-suffix *nū*. Many of these verbs had thematised variants in Classical Greek, especially in Ionic. These thematised byforms (25) increasingly spread via Attic (*omnúō* is standard in Attic prose writers) to Koine Greek. These can be regarded as proportional extensions from the imperfective subjunctive and optative (26).

(25) *sbennúō* (⟵ *sbénnūmi*) 'I extinguish'

apólluō (⟵ *apóllūmi*) 'I kill'

zeugnúō (⟵ *zeúgnūmi*) 'I join'

deiknúō (⟵ *deíknūmi*) 'I show'

omnúō (⟵ *ómnūmi*) 'I swear'

(26)

paúōmen	: *paúomen*	= *deiknúōmen*	: ***deiknúomen***
1pl subj.	1pl indic.	1pl subj.	1pl indic.
paúoimi	: *paúō*	= *deiknúoimi*	: ***deiknúō***
1sg opt.	1sg indic.	1sg opt.	1sg indic.

Further forms in *-núō* are found in late Attic/Koine (27), and yet more materialise in the Roman period (28).

(27) *kerannúō* (⟵ *keránnūmi*) 'I mix'

kremannúō (⟵ *kremánnūmi*) 'I hang up'

(28) *anoignúō* (⟵ *anoígnūmi*) 'I open'

rhēgnúō (⟵ *rhḗgnūmi*) 'I shatter'

agnúō (⟵ *ágnūmi*) 'I break'

petannúō (⟵ *petánnūmi*) 'I fly'

After the raising of *u* and *ei* to [i], the second and third person singular forms in [íis]/[íi] were contracted to [ís], [í] by regular sound change (29). This generated analogical 1sg and plural forms in *-nṓ, -nómen, -néte, -noúsi* (30), and the present forms were then given a regressive accent (31).

(29) *deiknú-ei* [dikní-i] > *deikn-éi* [dikn-í]

SHOW-3sg

'he shows'

(30) *deiknú-ō* [dikní-o] ⟶ *deikn-ṓ* [dikn-ó]

SHOW-1sg

'I show'

(31) *deikn-ṓ, deikn-éi* ⟶ *deíkn-ō* [díkno], *deíkn-ei* [díkni]

3.1.2. Thematisation of suffixless athematics

The athematic verbs *títhēmi* 'I place', *híēmi* 'I throw' and *hístēmi* 'I stand' have contract thematic competitors *tithô, -hiô* and *histô* in Classical Ionic, which make some headway in late Attic. Like thematic verbs in *-núō* (26), these can be seen as proportional on the (contract) imperfective subjunctive (32).

(32)	*philô*	: *philô*	= *tithô*	: ***tithô*** (⟵*títhēmi*)
	1sg subj.	1sg indic.	1sg subj.	1sg indic.
	philêi	: *philéi*	= *tithêi*	: ***tithéi*** (⟵ *títhēsi*)
	3sg subj.	3sg indic.	3sg subj.	3sg indic.

These suffixless athematics previously had 'kappatic' aorists (see table 8), which alternated between the endings of the weak aorist and a stem characterised by final *-k* in the singular, and the endings of the root aorist and a shortened stem (without *-k*) in the plural (table 15).

	Weak aorist	Root aorist	Kappatic aorist
1sg	*épausa*	*égnōn*	*édōka*
2sg	*épausas*	*égnōs*	*édōkas*
3sg	*épause(n)*	*égnō*	*édōke(n)*
1pl	*epaúsamen*	*égnōmen*	*édomen*
2pl	*epaúsate*	*égnōte*	*édote*
3pl	*épausan*	*égnōsan*	*édosan*

Table 15: Three alternative sets of aorist suffixes

Starting in Ionic, third person plurals in *-kan* (*édōkan, éthēkan*), based on the singular forms, spread to late Attic. First and second plural forms in *-kamen* and *-kate* followed and became standard in Koine, assimilating the kappatic

aorist paradigm to that of the weak aorist. With the loss of distinctive vowel length (and with the help of the future *dṓsō*), the 3rd plural *édosan* was reanalysed as *édōsan*, and generated an alternative paradigm *édōsa, -as, -e(n)* etc. from AD i onwards.

3.1.3. Continued thematisation of athematic verbs

During the Hellenistic period, many of the remaining athematic verbs were transferred into the thematic class. Mostly examples can be seen as extensions from the aorist (33), except in the case of *dídōmi* (34).

(33) (a) *étaksa* 'I arranged' : *tássō* 'I arrange'

= *érrēksa* 'I broke' : ***rhḗssō*** 'I break' (⟵ *rhḗgnūmi***)**

(b) *enómisa* 'I thought' : *nomízō* 'I think'

= epétasa 'I flew' : ***petázō*** 'I fly' (⟵ *petánnūmi*)

(c) *eteinámēn* 'I stretched (mid)' : *teínomai* 'I stretch' (mid)

= *dunámēn* 'I was able' : ***dúnomai*** 'I am able' (⟵ ***dúnamai***)

(34) *paúomen* 'we stop' : *paúō* 'I stop'

= *dídomen* 'we give' : ***dídō*** 'I give' (⟵ *dídōmi*)

From AD i-ii, the aorists *ekrémasa* and *-epétasa* generate new contract thematic presents for *kremánnūmi/kremannúō* and *petánnūmi/petannúō* (35), while *pégnūmi* 'fix' gets a new present *péssō* (36).

(35) *egélasa* 'I laughed' : *gelô* 'I laugh'

= *ekrémasa* 'I hung' : ***kremô*** 'I hang'

= *epétasa* 'I flew' : ***petô*** 'I fly'

(36) *étaksa* 'I arranged' : *tássō* 'I arrange'

= *épēksa* 'I fixed' : ***pḗssō*** 'I fix' (⟵*pḗgnūmi*)

Other athematic verbs simply lost ground to existing thematic competitors: *légō* 'I say' is increasingly used instead of *phḗmi* (also 'I say'), Ionic *mísgō* 'I mix' replaces *meígnūmi* (later *smígō* by sound change), and *plḗthō* 'I fill', which was previously only used intransitively, replaces transitive *pímplēmi* in Hellenistic poetry.

3.1.4. Effect on the grammar

The increasing restriction of 1sg *-mi* to the optative looks at first glance to get rid of the problem we had in 2.4., that the meaning of *-mi* seemed to contain an exclusive disjunction 'optative or athematic, but not both'. If the transferral of athematic verbs to the thematic class had happened all at once, it would be possible to specify *mi* as [+1sg & +optative], eliminating the need for an exclusive disjunction. Unfortunately, this solution is only possible when the athematic class has disappeared entirely, which is only achieved hundreds of years after the gradual lexeme-by-lexeme thematisation of athematic verbs gets started (indeed thousands of years, if we include the pre-Classical thematisation). By the time the change is complete, the optative has fallen out of use, and there is no longer any need for an exclusive disjunction.

It is therefore implausible that the violation of the exclusive disjunction bar in the meaning specification of *-mi* motivates these changes. If Classical Attic was under a strong diachronic pressure to remove this violation of the exclusive disjunction bar, it could have done so relatively simply by replacing *-n* with *-mi* in the 1sg optatives of athematic verbs (37), making the exclusive disjunction an inclusive disjunction. This would be well motivated formally, since athematic verbs have the same suffixes in the other optative forms as all other verbs, except in the 1sg alone. This never occurs, however; in fact, the sporadic introduction of 3pl *-san* to athematic optatives actually increases athematic/thematic allomorphy in the optative (38).

(37)

Thematic	Athematic
paúoi-mi	***titheíē-n* ⟶ **titheí(ē)-mi**
paúoi-s	*titheíē-s*
paúoi	*titheíē*
paúoi-men	*titheî-men*
paúoi-te	*titheî-te*
paúoi-en	*titheî-en*

(38) *ébēn* : *ébēsan* = *titheíēn* : ***titheísan*** (⟵*titheîen*)

'I went' : 'they went' = 'I would put' : 'they would put

It might be objected that Carstairs-McCarthy's claims have nothing to say about how economically a language will get rid of violations of the exclusive disjunction bar, nor how long it will take, only that the violation will eventually be removed. If the elimination of the athematic class was Greek's

chosen solution to the problem caused by the distribution of *-mi*, the fact that it happened slowly and was eventually rendered redundant by the loss of the optative may be irrelevant. But even if all athematic verbs had been replaced with thematic equivalents in one go, instantaneously solving this particular problem, equally grave problems would have been created elsewhere. The meaning specification for 1sg *-ō* (2.3) included an inclusive disjunction [+thematic or +future or +subjunctive], to account for its appearance in both present and future, and indicative and subjunctive forms. If the distinction between athematic and thematic inflection had been lost instantaneously, the feature +thematic would no longer be available, and we would have to amend this to either [+present or +future or +subjunctive], or [+future or +indicative or +subjunctive]. Either solution violates the exclusive disjunction bar, because present/future and indicative/subjunctive are incompatible values for the same variable (1.4). Furthermore, by making reference to either present tense or indicative mood, they also violate the unmarked property bar. Thus, even if thematisation had been able to occur instantly, unimpeded by any external factors, it would have solved one problem only to introduce two more.

3.2. Pluperfect

From the fourth century BC, the pluperfect started to lose its own set of suffixes, and adopt the endings of the root aorist and the athematic imperfect (table 16). This was accompanied by a reanalysis of the 3sg suffix *-ei(n)* as part of the pluperfect stem, and subsequent spreading of this formative to the other person-numbers.

1sg	*epépauk-ē*		*epépaukei-n*
2sg	*epépauk-ēs*		*epépaukei-s*
3sg	*epépauk-ei*(*n*)	⟶	*epépaukei* (-ø)
1pl	*epepaúk-emen*		*epepaúkei-men*
2pl	*epepaúk-ete*		*epepaúkei-te*
3pl	*epepaúk-esan*		*epepaúkei-san*

Table 16: Changes in the pluperfect active

3.2.1. Effect on grammar

This change increases the degree of violation of the exclusive disjunction bar, even though it decreases allomorphy. Because the 3sg ending *-e*(*n*) (2.2) appears in both the past perfective (aorist) and the present perfect, we had to include the disjunction [+past or +perfect] in its meaning specification. To explain the fact that it does not also appear in the past perfect, i.e. the pluperfect, we had to refer to paradigmatic information about screeveshape in the specification for the 3pl pluperfect ending: [+past & +perfect & +*ein*-screeveshape], in order to make it more specific than that the specification for *-e(n)*. This was only legal because 3sg *-ei(n)* was a screeveshape identifier, and 5 out of 6 endings of its screeveshape were screeveshape-identifiers, satisfying the 50% minimum decided in 1.1.1.3.

The zero suffix is not a screeveshape identifier, and none of the other endings it patterns with are screeveshape identifiers. After it replaces *-ei(n)*, we no longer have any way of explaining why the pluperfect 3sg fails to select *-e(n)*, if its specification [+past or +perfect] is to be interpreted as an inclusive disjunction. The specification for -ø can be no more specific than [+past & +perfect], because there are no more morphosyntactic or paradigmatic features available to differentiate it from the aorist and (present) perfect. This means we must update the specification for *-e(n)* to [+past or +perfect, but not both], violating the exclusive disjunction bar.

This problem was eventually eliminated by the loss of the perfect as a grammatical category, including the past perfect (ch. 2: 4.1), via a semantic merger with the aorist. This is a common phenomenon cross-linguistically (Bybee et al 1994: 81), and there is no reason to think it is motivated morphologically, except by the formal overlap between the endings of the aorist and present perfect.

3.3. 3pls in -osan

The competing suffixes of the aorist active are summarised in table 17 below (see 1.1.1.2, and ch. 2: 3.2).

	1sg	2sg	3sg	1pl	2pl	3pl
Weak aorist (*épausa* 'I stopped')	*-a*	*-as*	*-e(n)*	*-amen*	*-ate*	*-an*
Strong aorist (*élipon* 'I left')	*-on*	*-es*	*-e(n)*	*-omen*	*-ete*	*-on*
Root aorist (*ébiōn* 'I lived')	*-n*	*-s*	ø	*-men*	*-te*	*-san*
Kappatic aorist (*édōka* 'I gave')	*-a*	*-as*	*-e(n)*	*-men*	*-te*	*-san*

Table 17: aorist active suffixes

We have already seen how the kappatic aorist merged with the weak aorist in 3.1.2. This is part of a long-term process of cross-contamination and eventual merger between the four sets of suffixes (see ch. 6: 2.2-3 for a more detailed account). While this merger is taking place, a new ending *-osan* frequently replaces 3pl *-on* in the strong aorist and imperfect from the third century BC onwards, showing influence from the root aorist 3pl *-san* (e.g. 39). This is eventually ousted by *-an* in the aorist, although it remains in the imperfect (the imperfect and aorist endings merge fully much later, in around the 9th century AD). Much more rarely, weak aorist 3pls in *-asan* are attested (e.g. 40).

(39) *ebál-osan* for *ébal-on* 'they threw'

(40) *eíp-asan* for *eîp-an* 'they spoke'

3.3.1. Effect on grammar

The distribution of *-on* caused problems because it appears both in the first person singular and the third person plural. This seems to require an exclusive disjunction [1st or (3rd & plural)], which would also violate the unmarked property bar by making reference to 3rd person. In 1.1, we sidestepped this problem by making *-on* a person and number default. This had the unpalatable consequence that 3sg *-e(n)* had to be given the meaning [+3rd & +singular], violating the unmarked property bar on two counts.

The replacement of *-on* by *-osan* in the 3pl gets us out of this bind: *-on* can be marked [+1st], and *-osan* can be marked [+plural], and *-e(n)* can be left unmarked for person and number. This form therefore supports the exclusive disjunction bar. A similar explanation can be made for *-asan*: from spelling mistakes and later sound-changes, we know that syllable-final nasals were sporadically realised in Greek. The 1sg ending *-a* and the 3pl *-an* would have sometimes been pronounced identically, and are in danger of merging entirely, creating the same problems for *-a(n)* as we encountered with *-on*.

3.4. Subjunctive

In Hellenistic Greek the endings of the present and future active became identical to those of the subjunctive active in most forms, owing to the loss of

distinctive vowel length and phonetic merger of *ei*, *ē* and *ēi* as [i] (see ch. 2: 4.1). By the mid-second century BC, the suffixes were distinct only in the 2nd and 3rd plural (table 18).

	Present/future act. indic.	vii BC Attic	Mid-ii BC	Subjunctive active	vii BC Attic	Mid-ii BC
1sg	*-ō*	[ɔ:]	[o]	*-ō*	[ɔ:]	[o]
2sg	*-eis*	[e:s]	[is]	*-ēis*	[ɛ:is]	[is]
3sg	*-ei*	[e:]	[i]	*-ēi*	[ɛ:i]	[i]
1pl	*-omen*	[omen]	[ome(n)]	*-ōmen*	[ɔ:men]	[ome(n)]
2pl	*-ete*	[ete]	[ete]	*-ēte*	[ɛ:te]	[ite]
3pl	*-ousi*	[o:si]	[usi]	*-ōsi*	[ɔ:si]	[osi]

Table 18: Merger of subjunctive and indicative active suffixes

The distinction was then neutralised in favour of the indicative endings (also in the mediopassive), making the present indicative and subjunctive identical, since they already shared a stem. The future active and aorist subjunctive, whose stems were both characterised by final *-s*, also became identical for most verbs. For the verbs which originally had distinct aorist and future stems, this allomorphy was levelled in favour of the aorist stem. The result was the loss of the future indicative and imperfective subjunctive, as distinct from the aorist subjunctive and the present indicative respectively. This was probably complete in spoken Greek by the Roman period, when the future starts to be renewed with auxiliary constructions (ch. 2: 4.2).

The aorist passive subjunctive had shared the suffixes of the active subjunctive. Like the active subjunctive, its suffixes merged with those of the present and future active indicative. Unlike the active, though, there were no preexisting indicative forms which were formally identical to the new-look subjunctives (table 19), so no functional merger could take place. The contrast

between indicative and subjunctive was therefore retained in the aorist passive, and the subjunctive mood was saved from complete extinction.

	Indicative			Subjunctive
Present active:	*paúō*	=	Imperfective active:	*paúō*
Future active:	*paúsō*	=	Perfective active:	*paúsō*
Aorist passive:	*epaústhēn*	≠	Perfective passive:	*epaústhō*

Table 19: Equivalences between indicative and subjunctive forms

3.4.1. Effect on grammar

2.3 showed how the meaning specification for the suffix *-ō* had to include an exclusive disjunction [+active ∨ (+mediopassive & +passive)], to account for its appearance in the active and passive subjunctive, but not the mediopassive. This problem applies equally to the other subjunctive active/passive endings: *-ēis*, *-ēi*, *-ōmen*, *-ēte* and *-ōsi*.

The merger of these suffixes with those of the future and present indicative active is neutral with regard to this violation of the exclusive disjunction bar: it merely transfers the need for an exclusive disjunction from one set of suffixes to another. In the 2nd and 3rd plural forms, the merger happens by morphological rather than phonological change. If the aorist passive subjunctive had selected the mediopassive instead of the active endings, at least in these forms, it would have eliminated the need for an exclusive disjunction.

To account for its appearance in the present indicative of thematic verbs, we gave *-ō* the feature +thematic (2.3), and to account for its non-appearance in thematic optatives, we gave its competitor *-mi* a more specific meaning which

made reference to both +thematic and +optative (2.4). For the other combinations of person and number, the optative has a single set of endings: *-s, -ø, -men, -te, -en.* Since these appear throughout the optative active, we can give them no more specific meaning than +optative. This leaves uncertainty about the thematic optative: should it select the endings *-s, -ø, -men, -te, -en* by virtue of their feature +optative, or should it select *-eis, -ei, -omen, -ete, -ousi* by the feature +thematic? While the latter set of suffixes are limited to the indicative, there is a reasonably acceptable solution to this problem: we can amend the specification [+thematic] to [+thematic and +indicative]. While this violates the unmarked property bar in making reference to indicative mood, it at least accounts for why they are not selected in optative cells.

Once these suffixes spread to the subjunctive, however, this causes a new violation of the exclusive disjunction bar, since we must specify them as [(+thematic & +indicative) ∨ (+subjunctive & (+active ∨ (+mediopassive & +passive)))]. We cannot simply remove reference to mood, because the feature +thematic is also relevant in the optative, so making them mood-defaults would lead to the false expectation that they should be selected in the thematic optative.

If they were less specific than the optative endings, this could explain why they are found in both the indicative and subjunctive but not the optative while still being unmarked for mood, but the only way of achieving this would be to leave them unmarked for everything other than person and number. This would fail to explain why they appear in the aorist passive subjunctive, since the equivalent mediopassive endings have to be marked as +mediopassive, and should therefore be preferred in the passive to a less marked set of suffixes.

All this could be regarded as a non-problem, because the optative is being lost during the same period as these subjunctive and indicative endings are merging. One could argue that the property '+optative' is no longer part of the morphosyntactic inventory of Greek, making it possible to treat the endings *-ō, -eis, -ei, -omen, -ete, -ousi* as mood-defaults. But if so, while the optative is still on its way out, we should expect to encounter optative forms with the mood-default endings that are found in the indicative and subjunctive, at least sporadically. In fact, forms like **pauoíete* (41) are never attested.

(41) *pau-oí-ete*
STOP-impftv.opt-2pl

4. Conclusions

In this chapter, I have deliberately adopted an analysis of Greek morphology which is as conducive as possible to the four constraints proposed in Carstairs-McCarthy (1998). Despite this compromise, section 2 showed that it is impossible to come up with a unique meaning specification for each person-number affix in Greek, in accordance with the principle of contrast, without breaking the exclusive disjunction bar, the complementarity bar, and the unmarked property bar.

4.1. Problems with deriving affix distribution from affix meaning

Even keeping the degree of violation to a minimum meant giving affixes extremely counter-intuitive and elaborate meaning specifications. Unless these meaning specifications are supposed to account for the part of speaker competence responsible for determining their distribution in paradigms, it is hard to see what the point of the whole exercise could be. But as an account of speaker competence, they are highly implausible. Because the specification of each affix in the system depends on the specification of every other affix, the number of possible analyses of the system is enormous, and the learner's task of weighing up all the candidate analyses for a word class with a large number of paradigm cells, like verbs in Greek, is tremendously computationally complex.

Even if learners are capable of coming up with analyses like (42) below, which we gave to the 1sg suffix *-ō* in 2.3, the number of disjunctions required makes it no more economical than listing the paradigm cells in which *-ō* appears, as in (43), which is essentially equivalent to giving exemplary paradigms, as in traditional word-and-paradigm grammars (ch. 2: 2).

(42) [+1st & (+thematic ∨ +future ∨ (+subjunctive & (+active ∨ (+mediopassive & +passive))))]

(43) [+1st, +thematic]
[+1st, +future]
[+1st, +subjunctive, +active]
[+1st, +subjunctive, +passive]

4.2. Lack of diachronic support

While speakers are in the process of acquiring correct meaning specifications for each affix, the intermediate forms which the model would predict are not supported by the diachronic evidence. For example, (42) contains the expression (+subjunctive & (+active ∨ (+mediopassive & +passive))). It was necessary to include the exclusive disjunction (active ∨ (+mediopassive & +passive)), to account for the fact that a different affix is selected in the mediopassive subjunctive from both the active and passive subjunctives. Had this not been the case, *-ō* could have been made a voice-default, as in (44), avoiding the need for an exclusive disjunction.

(44) [+1st & (+thematic ∨ +future ∨ +subjunctive)]

If the exclusive disjunction bar is a genuine constraint which influences language acquisition, (44) must have been a very tempting analysis for speakers trying to give a meaning specification to *-ō*. We would expect it to be adopted as a preliminary hypothesis by speakers who had not encountered the mediopassive subjunctive 1sg suffix *-ōmai*, or who had not yet settled on a specification for it. These speakers would naturally have extended the ending *-ō* to the mediopassive subjunctive.

Of course, we do not have any data on child language for Ancient Greek, but there seems to be at least some overlap between mistakes made by children during language acquisition and forms attested in language change (e.g. Hooper 1980). However, mediopassive subjunctives with the person-

number suffixes of the active and passive are never attested historically.

On the other hand, the changes that do occur offer little support to Carstairs-McCarthy's constraints. By the 4th century AD, the verbal system is closer to satisfying them, but this is primarily because large parts of the paradigm have been lost as the result of syntactic, semantic and phonological change (ch. 3: 4.1). This made verbal paradigms much smaller, which reduced the amount of homomorphy (1.4.1). However, in section 3 we saw that on individual examination of morphologically motivated changes to the distribution of person-number suffixes, most tend either to be neutral with regards to these constraints, or to introduce new violations.

The one exception is the introduction of the 3pl suffix *-osan* (3.3), which eliminated the need for an exclusive disjunction in the specification for *-on* (2.1), previously found in both the first person singular and the third person plural. In this case, the relevant level for the exclusive disjunction bar may be word meaning rather than affix meaning: it is not just that *-on* occurs in both 1sg and 3pl forms, but 1sg and 3pl forms containing *-on* are also identical in every other respect (45).

(45) *élipon* 'I/they left'
éleipon 'I/they were leaving'

It is intuitively plausible that diachrony favours the elimination of homophony within inflectional paradigms, because speakers have the conscious intention of being understood. Homophony threatens their ability to achieve that aim, especially homophony of lexically identical words with crucially different morphosyntax, where context is less likely to make the intended sense obvious

(cf. *bank*, 'edge of a river' or 'financial institution'). This is a single example, however; the opposite phenomenon is seen in the merger of the subjunctive and indicative (3.4). In this case, homophony between the 1sg forms of the imperfective active subjunctive and the present active indicative (*paúō*), and the perfective active subjunctive and the future active indicative (*paúsō*) was extended to the other persons and numbers, instead of being eliminated.

4.3. Why don't the constraints work for Greek?

These constraints are intended to limit inflectional allomorphy. But for Greek, the reason it is so difficult to come up with a meaning specification for each affix within Carstairs-McCarthy's constraints is not allomorphy, but homomorphy (1.4.1). In fact, inflection class allomorphy makes it easier to satisfy Carstairs-McCarthy's constraints, because it makes it possible for the meaning specification of an affix to refer to inflection class features as a proxy for morphosyntactic features which might introduce a violation of one of the principles if they were referred to directly. The problem is that there is systematic overlap between the sets of endings (or 'screeveshapes') which verbs select in different and morphosyntactically unrelated parts (screeves) of their paradigms (ch. 2: 3.2).

The exclusive disjunction bar and the principle of contrast, in their inflectional guise, make the same predictions for allomorphy as the earlier no-blur principle (Carstairs-McCarthy 1994). Both indicate that where affixal allomorphs are competing to realise the same set of morphosyntactic features, at most one allomorph should fail to identify a distinct inflection class.

Carstairs-McCarthy (1998) gives no-blur a principled rationale, by deriving it from independently motivated lexical semantic constraints.

A number of people have pointed out languages that appear to violate no-blur, e.g. Blevins (2004), Baerman (2012), Stump (2005) (see also defences of the principle by Cameron-Faulkner & Carstairs-McCarthy (2000), Carstairs-McCarthy (2010, 2014)). But as a general principle, its predictions for inflectional allomorphy seem to be borne out by cross-linguistic evidence: languages do not seem to distribute affixal allomorphy randomly, but tend to do so in such a way that there are reliable patterns of implication between affixes in distinct paradigm cells.

On the other hand, while the no-blur principle has nothing to say about homomorphy, the exclusive disjunction bar and the principle of contrast falsely predict that it should not occur. The fact that homomorphy is so prevalent in Greek shows that the principle of contrast and the exclusive disjunction bar cannot be the correct explanation for the empirical truth of the no-blur principle, irrespective of their validity in lexical semantics. If they are responsible for the fact that affixes tend to be associated with a single inflection class, they should also ensure that they are associated with a single set of values for morphosyntactic variables. If they are ultimately semantic constraints, their implications for morphosyntactic meaning must be at least as strong as their implications for paradigmatic 'meaning', like inflection class.

4.4. The status of paradigms

The purpose of Carstairs-McCarthy's constraints is to explain cross-linguistic tendencies of paradigm structure. However, the constraints themselves are

drawn at the level of affixes, rather than inflected words. We can interpret them in two ways. If they are construed in the spirit of Bloomfieldian item-and-arrangement morphology, they make restrictions on the meaning of affixes in the lexicon. If they are interpreted within a realisational framework, they are constraints on grammar: specifically, on the environments of exponence rules, which derive paradigms from roots or stems in the lexicon.

Under the realisational interpretation, their diachronic repercussions are similar to the claims made by generative work on analogy (ch. 2: 1.5). Both theories indicate that change should optimise grammar, but the conception of optimisation is different. The generativists argued that change should simplify grammar either by removing rules, or reducing the number of feature specifications referred to in rules. Carstairs-McCarthy's constraints predict that diachrony should optimise the environments of rules of exponence, by removing exclusive disjunctions and references to unmarked properties or negative feature values.

Unlike generativist work, Carstairs-McCarthy (1998) does not explicitly subscribe to any specific theoretical formalism, preferring a more abstract and descriptive approach grounded in very general semiotic principles. But despite its emphasis on paradigm structure, his work implicitly treats paradigms as epiphenomena. On either the lexical-affix or the realisational interpretation, inflected wordforms have no permanent status as stored units of language, and so the derivation of an inflected word cannot access other forms in its paradigm. It is this inability to refer to surface forms that ultimately makes both Carstairs-McCarthy's and Kiparsky's approaches inadequate either to explain or constrain morphological change.

All of the changes described in section 3 can be analysed as the extension of

surface relationships between full wordforms. If we adopt a model of morphology as a set of relationships between whole words stored in memory, as I suggested in chapter 4 (section 5), we would expect diachronic constraints to refer to properties of words, rather than affixes.

This model has the additional benefit that the no-blur principle, which was left unexplained at the end of section 4.3, follows naturally from the architecture of the grammar. If morphological productivity operates by speakers extending formal relationships between surface forms in exemplary paradigms, it follows that inflected words should tend to be reliable predictors of other forms in their paradigms. If so, it is unsurprising that much or all of this predictiveness should be replicated at the sub-word level.[25]

This idea will be developed in chapter 6, where I will begin to outline an analogical model of morphological change which can account for some of the changes described in section 3 of this chapter.

[25] See Blevins (2004), Ackerman & Malouf (2015) for different arguments for similar conclusions.

Chapter 6: the proportional model revisited

The patterns of change described in chapter 5 (3.1-5) make little sense as optimisations of grammar or of affix meaning, but they can all be seen as the extension of formal patterns between inflected words. The latter view of the mechanism of morphological change and productivity underlies the neogrammarian practice of representing morphological changes using analogical proportions (ch. 1: 1.3).

This gives us good reason to suspect that the model of morphological change and productivity behind the proportional notation is correct in its essentials. On the other hand, this brings us to the starting point of a new inquiry. On their own, the built-in constraints of the proportional notation are insufficient to narrow down the range of possible changes to the changes that actually occur (ch. 1: 1.4-5). To constrain morphological change, we need to know which patterns are likely to be extended, and which are likely to be overridden by change. We therefore need to supplement the proportional notation with some set of principles for ranking proportions relative to each other.

Chapter 4 showed that type frequency is one factor which encourages the diachronic spread of formal relationships between members of a paradigm. In this chapter, I will test another common claim: that patterns of implication from high token frequency forms to low token frequency forms are more likely to spread (e.g. Bybee 1985, 1988, Mańczak 1980). If this turns out to be true, it is further evidence in favour of the proportional model, since token frequency is a property of surface forms.

In section 2 of this chapter, I will demonstrate how token frequency can be used to supplement proportions in a way that makes the correct predictions about a set of changes involving the redistribution of aorist active suffixes. Before doing so, I will explore the assumptions underlying the proportional model, and contrast them with alternative theories of morphological competence.

1. 'CONSTRUCTIVE' VERSUS 'ABSTRACTIVE' APPROACHES

Analogical proportions are associated with a notion of word structure rooted in the ancient grammarians, which sees the word as the basic unit of language. Blevins (2006) labels this type of approach 'abstractive', in that it regards the morphological component of grammar as a set of abstract formal and functional relationships between fully inflected words stored in memory. An abstractive approach may still recognise sub-word units like stems and affixes, but these are seen as abstractions arising from the organisation of words into paradigms on the basis of shared formal and semantic features.

This approach was typical of the pre-Bloomfieldian tradition. Subsequently, linguistics turned towards a 'constructive' view of morphology, in which words are broken down into minimal meaningful units, which are held to be the basic stored units of language. Although subsequent theories of language have diverged radically in other respects from American structuralism, most have remained constructive in their approach to morphology. In both item-and-arrangement and item-and-process models, the eponymous 'items' are sub-word units. Inflected words are created either by putting these items together (item-and-arrangement) or

by applying rules, which encapsulate morpheme-like grammatical affixes, to stored lexical morphemes (item-and-process). Constructive descriptions of morphology are 'bottom-up', in that they derive words from smaller elements, whereas abstractive descriptions are 'top-down', in that they derive morphemes and other formatives from words.

1.1. Realisational models

Modern word-and-paradigm theories (e.g. Matthews 1972, Anderson 1992, 1992, Stump 2001, Aronoff 1994) recognise morphology as an independent component of grammar, while in generative linguistics the job of morphology tended to be divided between phonology and syntax. Moreover, they attribute a central role to the paradigm, which had no place in the generative school. Rules of exponence 'spell out' or 'realise' sets of morphosyntactic features associated with paradigm cells, deriving surface forms ready for syntactic insertion. Inflectional affixes are encoded as part of these rules, which operate on roots or stems in the lexicon.[1]

Modern word-and-paradigm theories also differ from morphemic approaches in that they regard the word as the minimum meaningful unit of language. Nonetheless, both schools are essentially constructive, in that they attribute sub-word units to the lexicon, and model the morphological component of grammar as a mapping from these sub-word units to surface forms.

[1] In Stump's paradigm function morphology (Stump 2001, Stewart & Stump 2007), rules of paradigm linkage connect cells in the 'content paradigms' of lexemes to cells in the 'form paradigms' of stems. Other theories account for stem allomorphy by means of lexically conditioned realisation rules.

Inflection class systems involve conditional exponence, whereby the realisation of certain morphosyntactic feature(s) depends on the separate realisation of other morphosyntactic feature(s) in other paradigm cells. In realisational models, the derivation of a word is isolated from other words in its paradigm.[2] Therefore, conditional exponence has to be captured by introducing arbitrary inflection class indices to stems, which condition the rule of exponence. Table 1 gives a realisational analysis of inflectional allomorphy in the Latin genitive singular (see ch. 2: 2.1).

Root	Realisation rule	Output
$ANIM_{2nd}$	X_{2nd} /[+gen, +sg] ⟶ Xī	*animī*
$CORN_{4th}$	X_{4th} /[+gen,+sg] ⟶ Xūs	*cornūs*
$PRINCEP_{3rd}$	XeC_{3rd}/ [+gen, +sg] ⟶ XiCis	*principis*

Table 1: Realisation rules for genitive singular forms of some Latin nouns

This kind of account does an adequate job of reproducing the synchronic effects of an abstractivist account using principal parts and exemplary paradigms (ch. 2: 2.2-3), but it makes different predictions for diachrony. In Latin, the genitive singular *senātūs* of the fourth declension noun *senātus* 'senate' was replaced by *senātī*. Because the other forms of *senātus* remain consistent with the 4th declension, this change cannot simply be analysed as a change to the inflection class index of the root SENĀT. We can get around this problem by adding a lexically specific realisation rule for SENĀT, but from the point of view of the architecture of the synchronic description, there is no reason the same change should not happen in the paradigm of PRINCEP 'ruler', generating a new genitive singular *principī*.

[2] In some realisational theories, 'rules of referral' (e.g. Stump 1993) introduce an element of interdependence between surface forms. These are brought in to deal with cases of syncretism (where some aspect of a surface form is identical to another surface form), rather than conditional exponence.

In an abstractive approach, this explanation is built into the synchronic architecture. This particular change can be seen as an extension of the relationship between the nominative and genitive singular forms in the paradigms of second declension nouns such as *animus* 'spirit'. This can be represented unproblematically in an analogical proportion (1), or schematically as in table 2. The schematic notation spells out what the proportional notation leaves implicit: a change *principis* ⟶ *principī* is less likely than *senātūs* ⟶ *senātī*, because the nominative singular *princeps* lacks the final sequence *-us*, and thus fails to meet the description of the input (Xus) in the schematic rule which derives *animī* from *animus*.

(1) *animus* : *animī* = *senātus* : ***senātī*** (⟵*senātūs*)

Nom. sg.	Analogical relationship	Gen. sg.
animus	Xus [+nom, +sg] ⟶ Xī [+gen, +sg]	*animī*
senātus		*senātī*

Table 2: Schematic rule deriving genitive singular from nominative singular forms

1.1.1 Summary

Table 3 summarises the main points of comparison between the constructive models of morphology discussed in the previous section, and an abstractive model that relies on analogy as the mechanism of productivity.

	Stored	Rules	Rule input	Rule output	
Item-and-arrangement	Morphemes (lexical and grammatical)	Separate component of grammar	Morphemes	Words	Constructive
Item-and-process	Lexical morphemes	Separate component of grammar	Lexical morphemes	Words	Constructive
Modern WP	Roots and/or stems	Separate component of grammar	Roots/Stems	Words (in paradigms)	Constructive
Proportional	Exemplary paradigms and diagnostic forms	Inherent in lexicon	Words	Words	Abstractive

Table 3: Constructive and abstractive models of morphology

1.2. The proportional model

An abstractive approach to morphology relies on analogy as the mechanism of production. Exemplary paradigms and diagnostic forms are stored in memory,[3] and the remaining forms are predicted by a process of pattern-matching. Analogical proportions are an idealised visual representation of this process. In a proportion of the form $a : b = c : x$, x represents an unknown form, while a and b represent the model on which it is to be predicted. A procedure for deriving the form of b from a is computed – for (1), this can be informally stated as 'exchange *-us* for *-ī*' – and applied to c, which stands in the same semantic relationship to x as a does to b.

For the neogrammarians, as we saw in chapter 1 (1.3.2), analogy was not just a mechanism of change, but also the mechanism by which conventional forms were produced. Thus, proportions were not just a useful shorthand, but an attempt to capture the psychological process underpinning all linguistic

[3] Traditional word-and-paradigm presentations state only the minimum number of forms necessary to enable full prediction of paradigms, which can be regarded as an idealisation for speaker competence, since psycholinguistic evidence suggests even predictable forms may be stored in memory (Baayen et al 1997, 2003). See further discussion in ch. 7: 2.1.

productivity. However, as a notational device, there is much that they leave implicit. As a result, the diachronic implications of the synchronic theory are imprecise.

When presented with an analogical proportion, the reader is left to guess to what extent the lexemes given as the model (items *a* and *b* in the proportion) and the environment of the change (*c* and *x*) are standing in for sets of lexemes. (1) could also have been based on any noun of the second declension, such as the word for 'slave', which inflects in the same way as *animus* (3), and it affected other words which like *senātus*, belong to the 4th declension, such as *arcus* 'bow' (4). Likewise the extent of the base (*a* and *c*) and the target (*b* and *x*) are not made explicit: (1) could equally be based on the accusative singular (2), and it also affected forms other than the genitive singular in some nouns (5).

	a	*b*	*c*	*x*
(2)	*animum*	*animī*	*senātum*	***senātī***
	spirit (acc. sg)	spirit (gen. sg)	senate (acc. sg)	senate (gen. sg)
(3)	*servus*	*servī*	*senātus*	***senātī***
	slave (nom. sg)	slave (gen. sg)	senate (nom. sg)	senate (gen. sg)
(4)	*servus*	*servī*	*arcus*	***arcī***
	slave (nom. sg)	slave (gen. sg)	bow (nom. sg)	bow (gen. sg)
(5)	*servus*	*servōrum*	*quercus*	***quercōrum***
	slave (nom. sg)	slave (gen. pl)	oak (nom. sg)	oak (gen. pl)

The only constraints which come implicitly with the proportional notation are that there must be some semantic relationship between *a* and *b* which also holds between *c* and *x*, and that there there must be a formal relationship between *a* and *b* which is capable of being extended to *c* and *x*. The relationship of *b* to *a* is a function; that is, a mapping from a set of inputs to a set of outputs, such that each element in the set of permissible inputs is

assigned to a single element in the set of outputs. In this case, the set of permissible inputs is the set of words which meet the semantic description [nominative, singular] and the formal description 'Xus'. (6) is rendered invalid by its failure to satisfy the formal description: since *princeps* lacks the final segment *-us*, we cannot 'exchange *us* for *ī*'.

(6)

a	*b*	*c*	***x***
animus	*animī*	*princeps*	**??**
spirit (nom. sg)	spirit (gen. sg)	ruler (nom. sg)	ruler (gen. sg)

1.2.1. An algorithm for completing analogical proportions[4]

The proportional notation relies on our ability to make an intuitive leap from a specific exemplar like *animus* : *animī* to a general function which relates its two members. It is worth examining precisely how this leap is made, since the abstract relationship between two related words can always be stated in a number of ways. In the previous section, we characterised the procedure for deriving *animī* from *animus* as 'exchange *-us* for *-ī*', but any of (i-vii) would work equally well.

(i) 'take the stem and add the suffix *-ī*' (illegal)

(ii) 'replace any input with *animī*' (trivially general)

(iii) 'remove *-s*, front, unround and lengthen the final vowel' (too general)

[4] In no sense is this algorithm intended to be an account of the procedure speakers actually adopt in the creation of analogical forms. It is useful for two reasons: firstly, it establishes that it is possible to give a coherent and precise functional definition of what many linguists would regard as the intuitive answer to a proportion. Secondly, giving an algorithmic definition of *x* opens up the possibility of modelling analogy computationally. In the second half of this chapter (section 2 onwards), I will use this algorithm to generate and analyse a large number of proportional analogies in an automatic fashion, which would be impractical to do manually.

(iv) 'replace the final syllable with *-ī*' (too general)

(v) 'replace the final two segments with *-ī*' (too general)

(vi) 'exchange *animus* for *animī*' (trivially specific)

(vii) 'exchange *-mus* for *-mī*' (too specific)

In this section I will outline an algorithmic method for solving a proportion of the form $a : b = c : x$ which identifies the intuitively correct analysis of the relationship between *a* and *b*, and excludes unintuitive analyses like i-vii.

1.2.1.1. Input variables

The input to this algorithm is a set of three words, whose role in the proportion is indicated by their variable labels *a*, *b* and *c*. Each of *a*, *b*, and *c* consists of a semantic description and a phonological description. The semantic description is a set of lexical and morphosyntactic features, and the phonological description is an ordered set of phonological segments and word boundaries.[5] The algorithm generates both a semantic and phonological

[5] For phonological descriptions I will use my own data structure, a type of set whose elements are phonological segments and initial and final word boundaries (represented by the symbol #). Two kinds of relationships pertain between its elements: (1) adjacency and (2) before/after ordering relationships (irrespective of distance). I will represent phonological descriptions in rounded brackets, e.g. (#ab,c,d). Adjacent elements are represented as adjacent (e.g. #ab), while non-adjacent elements have an intervening comma.

To find the union of two phonological descriptions *X* and *Y* (*X*∪*Y*), *X* and *Y* must have two word boundaries (#) between them, one initial and one final, and the absolute difference between the number of commas in *X* and *Y* must be no greater than 1. This ensures that there is only way of combining the two, such that the adjacency and ordering relations of all the elements of both, and the initial or final positions of word boundaries, are preserved.

E.g. (#a,c,e)∪(b,d,f#) = (#abcdef#).

To subtract a phonological description *X* from *Y* (*X*-*Y*), we remove each element in *X* from *Y*. Two conditions must hold true for this to have a single solution: *X* must be a subset of *Y*, whose elements have the same ordering (but not necessarily adjacency) relationships in *X* and *Y*, and if any element in *X* appears more than once in *Y*, it must be indexed (represented by a subscript numeral: see step c below). If an element in *X* appears more than once in *Y*, we remove the element in *Y* which has the same index as in *X*.

E.g. (#abcdd$_1$#) – (bc,d$_1$) = (#a,d,#)

description for *x*, by identifying shared elements in the semantic and phonological descriptions of *a*, *b*, and *c*, using three basic set operations: union, intersection, and subtraction. Analyses like (i) above are excluded by the fact that the phonological descriptions contain no information about morphological structure.

To make the explanation easier to follow, I will use simplified phonological descriptions consisting of sequences of segments in IPA notation. In order to incorporate various types of phonological analogy, such as (7) and (8), we can extend phonological descriptions by encoding each segment as an unordered set of phonological features, and organising segments into syllables with internal hierarchical structure, which may bear suprasegmental features such as stress. We then follow the same essential process as I will describe below, except that when calculating the intersection of two phonological descriptions (1.2.1.2), we systematically identify shared features in syllables, instead of matching segments.[6]

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[6] The algorithm presented in this section is unable to complete proportions which meet certain structural criteria: (1) where every segment in *a* is also present in *c*, and (2) where any two or more segments shared by *a* and *c* are adjacent in *a* but not in *c*, or vice versa. In these cases, it identifies the components of *x* correctly, but it is unable to put them together in the right order, because it fails to identify a position in β (see 1.2.1.4) to insert the segments in *b* which are not also in *a*.

Additionally, it cannot cope with proportions where the procedure for deriving *b* from *a* must make reference to non-substantial properties of phonological sub-sequences (3): that is, properties like being syllable-final, or having the same place of articulation as the following segment, in contrast to substantial properties like being *p*, or being a back vowel. For example, it cannot solve an equation like *dog* : *god* = *pan* : ***nap***, because it does not recognise that *d* in *dog* shares the property of being word-initial with *p* in *pan,* but has the property of being word-final in *god*. Similarly, it cannot deal with phenomena like reduplication or vowel harmony, which require recognising that segments are wholly or partially identitical to other segments in the same word. To accommodate these cases, a more sophisticated procedure for identifying similarities and differences between phonological sequences is needed.

In the field of artificial intelligence, more sophisticated analogical algorithms have been developed which share the essential nature of the algorithm that I present here – in that they generate a value or set of values for *x* by systematically identifying similarities and diffferences between the items of a proportion – but not the limitations listed above. For example, the algorithm of Lepage (1998) can deal with cases like (1) and (2), and cases like (3) can be dealt with using an algorithm by Delhay & Miclet (2005). I will present my own simpler and more limited algorithm here, because it is comparatively readable (for humans, rather than computers), while still being sufficient to accomodate the morphological phenomena considered in section 2 of this chapter.

(7) *recórd* (verb) : *récord* (noun) = *progréss* (verb) : *x* (*prógress* (noun))

(8) German *Mutter* 'mother' : *Mütter* 'mothers' = *Vater* 'father' : *x* (*Väter* 'fathers')

Table 4 shows the labels, phonological descriptions, and semantic descriptions for each item in the proportion *animus* : *animī* = *senātus* : *x*.

Word	Label	Phonological description	Semantic description
animus	*a*	(#animus#)	[SPIRIT, masculine, nominative, singular]
animī	*b*	(#animī#)	[SPIRIT, masculine, genitive, singular]
senātus	*c*	(#senātus#)	[SENATE, masculine, nominative, singular]

Table 4: input variables

1.2.1.2. Step 1: finding the intersection of a and c

The first step is to identify the maximum set of elements shared between *a* and *c* – that is, the intersection of *a* and *c* ($a \cap c$) – in both their semantic and phonological descriptions. We will assign this value to the variable α.

For the semantic description, the intersection is easy to find (table 5). We simply assign an empty set to α, iterate through the elements of *a*, and add each element to α if and only if it also appears in *c*.

Label	Semantic description	$\alpha = a \cap c$
a	[SPIRIT, masculine, nominative, singular]	[masculine, nominative, singular]
c	[SENATE, masculine, nominative, singular]	

Table 5: The semantic description of α

Because the phonological descriptions of *a* and *c* have inherent order, which we would like to preserve in α, finding their intersection is slightly more complicated. The value we would like to find for the phonological description of α is the largest ordered set of elements common to the phonological descriptions of *a* and *c*, such that:

1) each element in α has the same position in relation to every other element in α as it does in both *a* and *c*, irrespective of distance, except that;

2) if two segments are adjacent in both *a* and *c*, they will also be adjacent in α.

For example, the unordered set of all elements common to both (#animus#) and (#senātus#) would be {#,#,u,s,n}.[7] If we order these elements according to their relative position in (#animus#) and (#senātus#), we get (#,n,u,s,#). If we transform this ordered set to reflect the adjacency of its elements in (#animus#) and (#senātus#), we arrive at (#,n,us#), which is the value of α we are seeking.

We can find this value using an iterative segment-matching algorithm. I will describe below how this algorithm proceeds for (#animus#) and (#senātus#), and then summarise the structure of the algorithm in table 10.

[7] The shared segment *n* between *animus* and *senātus* might be regarded as irrelevant for this particular example. However, it is necessary to make the algorithm identify all shared material between *a* and *c*, in order to be sufficiently general to capture the full range of analogical changes (see also note 13).

Step a. First, we give the initial value () (an empty phonological description) to *α*.

Step b. We then align the last segment of *c*-*α*[8] with the first segment of *a*-*α* (on the first run, these values will be equivalent to *c* and *a* respectively), and note the length of the longest sequence of identical segments which are aligned. We then move *c*-*α* one place to the right, and repeat, until the first segment of *c*-*α* is aligned with the last segment of *a*-*α*. The number of alignments will be one fewer than the sum of the lengths of *a*-*α* and *c*-*α*, in terms of number of segments. These are enumerated in table 6.

Arrangement												Longest match
#s	e	n	ā	t	# u	a s	n #	i	m	u	s#	0
#	s	e	n	ā	# t	a u	n s	i #	m	u	s#	0
#	s	e	n	# ā	a t	n u	i s	m #	u	s	#	0
	#	s	e	# n	a ā	n t	i u	m s	u #	s	#	0
	#	s	# e	a n	n ā	i t	m u	u s	s #	# 		0
		# #	# s	a e	n n	i ā	m t	u u	s s	# #		**3**
		# #	a s	n e	i n	m ā	u t	s u	# s	# 		1
		#	a #	n s	i e	m n	u ā	s t	# u	s	#	0
	#	a	n #	i s	m e	u n	s ā	# t	u	s	#	0
	#	a	n	i #	m s	u e	s n	# ā	t	u	s#	0
#	a	n	i	m #	u s	s e	# n	ā	t	u	s#	0
#a	n	i	m	u #	s s	# e	n	ā	t	u	s#	1

Table 6: Finding the phonological description of *α* (first pass)

[8] See note 5 for rules on subtracting phonological descriptions.

Step c. After testing each alignment, we add the longest matching sub-sequence to α, including any matching word-boundaries. If there are any matching segments that occur multiple times in *a* or *c*, we add an arbitrary index to the matching segment in both α and *a* or *c*. Here, *s* occurs twice in *senātus*, so we amend the phonological description of *c* to (#senātus$_1$#), and add (us$_1$#) to α. Thus for *animus* and *senātus*, the value of α after the first pass of the matching algorithm will be (us$_1$#). We then recalculate *a*-α and *c*-α, to give (#anim) and (#senāt), and repeat step b, as shown in table 7.

Arrangement								Longest match
#s	e	n	# ā	a t	n	i	m	0
#	s	e	# n	a ā	n t	i	m	0
#	s	# e	a n	n ā	i t	m		0
	#	# s	a e	n n	i ā	m t		**1**
	# #	a s	n e	i n	m ā	t		**1**
	#	a #	n s	i e	m n	ā	t	0
#	a	n #	i s	m e	n	ā	t	0
#a	n	i #	m s	e	n	ā	t	0

Table 7: Finding the phonological description of α (second pass)

We now return to step c, adding the longest matching sequence to α, . In table 7 there are two alignments which contain equally long matching sequences. In this particular case it does not matter which we add to α,[9] so we will

[9] If we find more than one equally long matching sequence, we should add the longest matching sequence from the alignment which minimises the distance, measured by number

choose (#) at random. The value of α is now (#,us$_1$#), and we repeat the matching algorithm in step 1a with new values for *a*-α (anim) and *b*-α (senāt) (table 8).

Arrangement	Longest match
a n i m s e n ā t	0
a n i m s e n ā t	0
a n i m s e n ā t	0
a n i m s e n ā t	**1**
a n i m s e n ā t	0
a n i m s e n ā t	0
a n i m s e n ā t	0
a n i m s e n ā t	0

Table 8: Finding the phonological description of α (third pass)

Again we repeat step 1b, adding (n) to α, giving it a new value (#, n, us$_1$#). This time, when we subtract α from *a* and *c*, we are left with two discontinuous sets of sub-sequences: (a,im) and (se,āt), respectively.

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of segments, between the first and last segments in the alignment. This ensures that the maximum possible number of shared sequences between *a* and *c* will be found. For example, in the extract from table 7 below, the first segment of *c* in alignment 1 is in position 1, and the last segment of both *c* and *a* is in position 6, so the distance between them is 6 – 1 = 5. In alignment 2, the distance between the first and last segments is also 5. Therefore, in this particular case it does not matter in which order we add # and *n* to α.

Position in alignment:		1	2	3	4	5	6
Alignment 1	*a*		#	a	n	i	m
	c	#	s	e	n	ā	t
Alignment 2	*a*	#	a	n	i	m	
	c	#	s	e	n	ā	t

We then continue testing alignments (step 1a), this time comparing each item *a*-*α* with its ordinal counterpart in *c*-*α*: that is, we compare (a) with (se), and (im) with (āt) (table 9). We do not need to compare (a) with (āt), for example, because (a) comes before (n) in *animus*, but (āt) comes after (n) in *senātus*. Therefore, if we found a matching sub-sequence in the two, there would be no position in *α* where we could insert it that would preserve its position relative to *n* in both *animus* and *senātus*.

	Longest match		Longest match
#a #s e	0	i m ā t	0
#a #s e	0	i m ā t	0
		i m ā t	0

Table 9: Finding the phonological description of *α* (fourth pass)

Table 9 shows that repeating this process yields no further matches. At this point, we can settle on a final value for the phonological description of *α*.

Table 10 summarises the structure of this algorithm.

(Step a)	Let *α* = ()
(Step b)	For each alignment of (*a*-*α*) with (*b*-*α*), calculate the length of the longest continous sequence of matching segments.
(Step c)	If there are no matching sequences, yield *α*. Otherwise, add the longest continous matching sequence to *α*, preserving its position relative to the other elements of *α* in both *a* and *c*, and go back to step b.

Table 10: Summary of algorithm for finding the intersection of two phonological descriptions

The results of step 1 for *animus* : *animī* = *senātus* : *x* are summarised in table 11.

Label	Phonological description	Semantic description
a	(#animus$_1$#)	[SPIRIT, masculine, nominative, singular]
c	(#senātus$_1$#)	[SENATE, masculine, nominative, singular]
α	(#,n,us$_1$#)	[masculine, nominative, singular]

Table 11: The phonological and semantic description of *α*

α represents the input criteria for the function which relates *a* to *b*. Because it includes everything common to *a* and *c*, it rules out overgeneral interpretations of this function such as ii-v above, and because it excludes anything in *a* which is not common to *a* and *c*, it rules out overspecific interpretations like vi-vii. Note that the phonological or semantic description of *α* may be empty (or contain only word boundaries), in which case there will be no phonological (e.g. table 12) or semantic (e.g. table 13) input criteria for the function.

dog : *dogs* = *cow* : *x* (*cows*)		
Label	Phonological description	Semantic description
a	(#dɔg#)	[DOG, singular]
c	(#kaʊ#)	[COW, singular]
α	(#,#)	[singular]

Table 12: A proportion with an empty phonological description of *α*

demotion : *demote* = *emotion* : *x* (*emote*)		
Label	Phonological description	Semantic description
a	(#dɪmoʊʃən#)	[DEMOTE, noun][10]
c	(#ɪmoʊʃən#)	[EMOTION]
α	(#ɪmoʊʃən#)	[]

Table 13: A proportion with an empty semantic description of *α*

[10] The feature set [DEMOTE, noun] reflects the fact that *emotion* and *demotion* do not have the same feature structure. More probably we should represent the semantic description of *demotion* as having an internal hierarchical structure, but adopting this kind of feature structure would mean that the algorithm I describe would have to be more complex. This simplified representation suffices for this discussion, which focusses exclusively on inflection.

1.2.1.3. Step 2: Finding the complement of α with respect to a

The next step is to determine the complement of *c* with respect to *a*: that is, the set of all elements in *a* which are not found in *c*. We will assign this value to a variable *A*.

To find the semantic description of *A*, we can remove each element in the semantic description of *α* from the semantic description of *a*, of which it is a subset. Likewise, to find the phonological description of *A*, we remove each element in the phonological description of *α* from the phonological description of *a*. If *α* is empty, *A* will be identical to *a*. The results of step 2 are given in table 14.

Label	Phonological description	Semantic description
a	(#animus$_1$#)	[SPIRIT, masculine, nominative, singular]
α	(#,n,us$_1$#)	[masculine, nominative, singular]
A = a-α	(a,im)	[SPIRIT]

Table 14: The phonological and semantic description of *A*

1.2.1.4. Step 3: finding the complement of A with respect to b

The next step is to calculate the complement of *A* with respect to *b*: that is, the set of all elements in *b* which are not in *A*. We will assign this value to the variable β.

To find the semantic description of β, we can simply remove each element in the semantic description of *A* from the semantic description of *b*.

Similarly, to find the phonological description of β, we subtract each element in *A* from *b*. The results of step 3 for *animus* : *animī = senātus* : *x* are summarised in table 15.

Label	Phonological description	Semantic description
b	animī	[SPIRIT, masculine, genitive, singular]
A	(a,im)	[SPIRIT]
β = *b*-*A*	(#,n,ī#)	[masculine, genitive, singular]

Table 15: The phonological and semantic description of β

In cases where the function deriving *b* from *a* involves deletion or invariance, the phonological description of β will be empty (e.g. table 16).

dogs : *dog* = *pease* : *x* (*pea*)		
Label	Phonological description	Semantic description
b	(#dɔg#)	[DOG, singular]
A	(dɔg)	[DOG]
β = *b*-*A*	(#,#)	[singular]

Table 16: A proportion with an empty phonological description for β

If the proportion is ill-formed, the algorithm will fail to find a value for β, because it will be unable to locate all elements of *A* in *b*.[11] If no phonological description can be given to β (e.g. table 17), the algorithm will be able to predict a semantic description for *x*, but no phonological description. If no semantic description can be given to β (e.g. table 18), it will only be able to predict a phonological description for *x*.

[11] By the normal set-theoretic definition of a complement, it is valid to subtract an element *e* from a set *S* even if *e* is not a member of *S*. This leaves *S* unchanged. This algorithm uses a slightly different definition of complement, under which it is valid to subtract an element *e* from a set *S* if and only if $e \in S$. If the algorithm tries to subtract *e* from *S* when $e \notin S$, it will produce an error.

animus : *animī* = *princeps* : *x*		
Label	Phonological description	Semantic description
a	(#animus#)	[SPIRIT, masculine, nominative, singular]
b	(#animī#)	[SPIRIT, masculine, genitive, singular]
c	(#princeps#)	[RULER, masculine, nominative, singular]
α	(#,n,s#)	[masculine, nominative, singular]
A	(a,imu)	[SPIRIT]
β	**Error: (imu) not in (#animī#)**	[masculine, genitive, singular]

Table 17: A proportion which raises an error when finding the phonological description of β

cat : *catalogue* = *nun* : *x*		
Label	Phonological description	Semantic description
a	(#kæt#)	[CAT, singular]
b	(#kætəlɔg#)	[CATALOGUE, singular]
c	(#nʌn#)	[NUN, singular]
α	(#,#)	[singular]
A	kæt	[CAT]
β	(#,əlɔg#)	**Error: [CAT] not in [CATALOGUE, singular]**

Table 18: A proportion which raises an error when finding the semantic description of β

1.2.1.5. Step 4: solving for x

We now have everything we need to generate a phonological and semantic description for *x*. This is accomplished by finding the union of β with the complement of α with respect to *c* ((c-α)∪β): that is, the result of subtracting each element in α from *c*, and adding β to the result.[12] Table 19 shows the steps of this process for the phonological description.

[12] See note 5.

c	(#senātus$_1$#)
α	(#,n,us$_1$#)
c-α	(se,āt)
β	(#,n,ī#)
$x = (\text{c-}\alpha)\cup\beta$	(#senātī#)

Table 19: The phonological description of x

Table 20 goes through the same steps for the semantic description.

c	[SENATE, masculine, nominative, singular]
α	[masculine, nominative, singular]
c-α	[SENATE]
β	[masculine, genitive, singular]
$x = (\text{c-}\alpha)\cup\beta$	[SENATE, masculine, genitive, singular]

Table 20: The semantic description of x

The function which relates a and b can be expressed as an SPE-style rewrite rule by finding the intersection of α and β, using the same method we used in step 1, as illustrated in table 21. Elements shared by α and β are attributed to the environment of the rule, and the complements of this intersection in α and β correspond to the input and output of the rule respectively.

	Phonological description	Semantic description
α	(#,n, us_1#)	[masculine, nominative, singular]
β	(#,n,ī#)	[masculine, genitive, singular]
$\alpha \cap \beta$	(#,n,#)	[masculine, singular]
α-($\alpha \cap \beta$)	(us)	[nominative]
β-($\alpha \cap \beta$)	(ī)	[genitive]
Rule	us ⟶ ī / #,n,_#[13]	[nominative] ⟶[genitive] /[masculine, singular]

Table 21: Deriving an SPE-style rule from α and β

1.2.1.6. Summary

Table 22 summarises the formulas and intermediate variables of each step in the derivation from *a, b* and *c* to *x*. The final formula for *x* in set notation can be expanded and simplified as in (9); fig. 1 represents this formula with a Venn diagram.

(9) $x = (c-(a \cap c)) \cup (b-(a-(a \cap c)))$

$= ((b \cup c)-a) \cup (a \cap b \cap c)$

[13] If we abandon the idealisation that each proportion has a single lexeme as the model and target, and allow sets of words to feature in parts *a* and *c* of the proportion, the segment-matching algorithm will cease to assign trivial similarities between *a* and *c* (e.g. the segment *n* in *animus* and *senātus*) to the environment of the function which maps *a* to *c*. Thus including these features in the environment of the rule is not strictly necessary, but it gives an easy way to measure the closeness of *a* and *c,* in terms of number of shared segments or features. There is reason to suspect this is a factor which increases the viability of a proportion. For example, the suffixes of the weak aorist replace the suffixes of the strong aorist before they replace the suffixes of the imperfect in Greek, even though the strong aorist and imperfect suffixes are identical (see 2.3 below), plausibly because they are competitors in the same paradigm cells. The pattern exemplified by English *drive ~ drove* has spread to *dive* in some varieties of English, but not *arrive*, plausibly because *dive* and *drive* share the initial segment /d/.

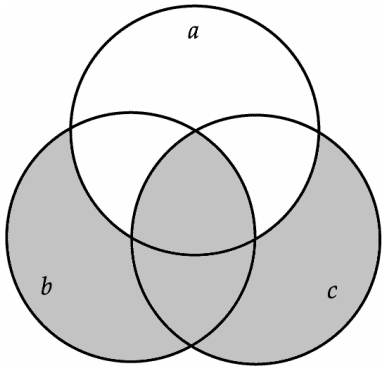


Fig. 1: Venn diagram representing the solution of a proportion $a : b = c : x$

Step	Variable name	Formula	Phonological description	Semantic description
Input	*a*	–	(#animus#)	[SPIRIT, masculine, nominative, singular]
Input	*b*	–	(#animī#)	[SPIRIT, masculine, genitive, singular]
Input	*c*	–	(#senātus#)	[SENATE, masculine, nominative, singular]
1	α	$a \cap c$	(#,n, us$_1$#)	[masculine, nominative, singular]
2	*A*	a-α	(a,im)	[SPIRIT]
3	β	b-A	(#,n,ī#)	[masculine, genitive, singular]
4	*x*	(c-α)$\cup\beta$	(#senātī#)	[SENATE, masculine, genitive, singular]

Table 22: Summary of input, output and intermediate variables of the algorithm

This algorithm puts the intuitive value of *x* on a systematic footing, which in turn enables the solving of analogical proportions to be automated. In the next section, I will develop a framework for computationally generating and solving a large number of proportions, and explore their statistical properties.

2. TESTING THE ROLE OF TOKEN FREQUENCY

In this section, I will use the algorithm described in 1.2.1 to generate all possible innovative forms which can be represented by an analogical proportion, for a population of Greek verbs with unpredictable allomorphy of the person-number suffixes of the aorist active indicative. I will then derive a measure of the probability of each analogical form from the relative token frequency of the base and target of all the proportion underlying each hypothetical form. This will test the hypothesis that (a) patterns of implication from high token frequency forms are more likely to spread diachronically, and (b) patterns of implication to low token frequency forms are less likely to spread diachronically.

Essentially the same claim has been made about markedness: that patterns of implication from unmarked forms to marked forms are most likely to be diachronically productive. I chose to test token frequency rather than markedness for several reasons. The concept of markedness is vague (see Haspelmath 2006), and it is not clear how it can be measured without circularity, while token frequency is in theory easily measurable. Lack of overt marking ('formal unmarkedness') often seems to coincide with high token frequency, and it is very possible that markedness effects are reducible to frequency effects (as claimed by Greenberg 1966).

2.1. Method

The first step in testing the role of token frequency is to identify a part of the paradigm in which a good range of analogical forms are attested, to use as a test case. I chose the aorist active subparadigm, which has the highest degree of person-number allomorphy in Classical Attic. I collected analogical forms involving the reduction of allomorphy in this subparadigm which are attested before 400 AD.

Then, I calculated all possible analogical proportions of the form $a : b = c : x$ for this set of competing suffixes, where *a*/*b* (the **model**) and *c*/*x* (the **destination**) represent groups of verbs with originally distinct person/number suffixes in the aorist active, and *a*/*c* (the **base**) and *b*/*x* (the **target**) represent distinct combinations of person/number.

		Base		*Target*
Model		a	:	b
Destination	=	c	:	*x*

Table 23: The anatomy of an analogical proportion

I then counted the number of these proportions which are successful, in that they make a prediction for *x* which is actually attested in the diachronic data. I obtained a measure of the probability of a proportion with a given person/number combination appearing in its base or target being successful, by expressing the number of times the relevant person/number combination appears in the base/target of a successful proportion as a fraction of the number of times it appears in the base/target of a possible proportion.

The final step was to obtain token frequency statistics for each person/number combination, and compare these with the probability of a

proportion generating an attested form for *x*, given that a particular person/number combination appears in its base or target.

2.2. Test case: aorist active suffixes

Classical Attic has four distinctions of inflection class in the aorist active, which select distinct but overlapping sets of suffixes to express person and number (ch. 2: 3.2). These are listed in table 24 in order of type frequency. In post-Classical Greek the perfect starts to merge semantically with the aorist, and eventually becomes synonymous with it (ch. 3: 4.1). In the Byzantine period, these five sets of suffixes merge into a single aorist active paradigm (table 25): while variation remains in the second and third plural cells, it is no longer conditioned by lexeme.[14]

	1sg	2sg	3sg	1pl	2pl	3pl
Weak aorist (*épausa* 'I stopped')	*-a*	*-as*	*-e(n)*	*-amen*	*-ate*	*-an*
Strong aorist (*élipon* 'I left')	*-on*	*-es*	*-e(n)*	*-omen*	*-ete*	*-on*
Root aorist (*ébiōn* 'I lived')	*-n*	*-s*	*ø*	*-men*	*-te*	*-san*
Kappatic aorist (*édōka* 'I gave')	*-a*	*-as*	*-e(n)*	*-men*	*-te*	*-san*
Perfect (*pépauka* 'I have stopped')	*-a*	*-as*	*-e(n)*	*-amen*	*-ate*	*-āsi*

Table 24: Classical aorist and perfect active suffixes

1sg	2sg	3sg	1pl	2pl	3pl
-a	-es	-e	-amen	-ete/ate	-an/asi

Table 25: Byzantine and Modern Greek past active suffixes

Before they merge completely, these suffixes influence each other in a variety of ways. We have already seen third plural forms in *-osan* (ch. 5: 3.3), which seem to be an extension of the formal relationship between first person

[14] The precise conditions of this variation in the Byzantine period are difficult to reconstruct, due to the limitations of the textual record (see Horrocks 2010: chapter 11, particularly 318-19).

singular and third person plural forms in verbs with root aorists to strong aorists (table 26).

		1sg		3pl
Root aorist		*ébēn*	:	*ébēsan*
Strong aorist	=	*ébalon*	:	*ebálosan*

Table 26: proportional representation of 3pl forms in *-osan*

2.3. Attested analogical forms

In Hellenistic Greek, the distinction between the strong and weak aorist paradigms is gradually lost. Strong aorist verbs with weak aorist endings are very common in this period (10). Less often the endings of the weak aorist spread to weak (11) and kappatic (12) aorist verbs, particularly in the second person.

(10) *épesan, epésamen* (for *épeson, epésomen* 'I/we fell)

(11) *égrapses* for *égrapsas* 'you (sg.) wrote',

(12) *édōkes* for *édōkas* 'you (sg.) gave'

In the early stages of this merger, third person plural forms in *-osan* are very common (13) (weak aorist 3pls in *-asan* (14) are only occasionally attested). This change affected both the thematic imperfect and the strong aorist, which select the same suffixes in Classical Greek. In the aorist, *-osan* quickly lost ground to *-an* (see above), but for a while it is the most frequent 3pl suffix. In the Septuagint, for example, *élthosan* outnumbers *élthan* by 122 counts to 9,

while in later papyri *élthan* is found 74 times, compared to only 6 counts of *élthosan*.

(13) *ebálosan* for *ébalon* 'they threw'

(14) *eîpasan* for *eîpan* 'they spoke'

Meanwhile, the present perfect is gradually becoming synonymous with the aorist. The endings of the perfect were distinct from those of the weak aorist only in the third plural forms (*-an*/*āsi*), and this distinction is frequently erased by the spread of *-an* from the weak aorist to forms with perfect stems (15).

(15) *elḗluthan* for *elēlúthāsi* 'they came/they have come'

This influence goes in both directions, however. The perfect 3pl suffix *-āsi* is also found in verbs with originally strong (16) and kappatic (17) aorists.

(16) *ḗlthāsi* for *ḗlthon* 'they came'

(17) *edṓkāsi* for *édosan* 'they gave'

The kappatic aorist had always shared the endings of the weak aorist in its singular forms. This paradigm started to assimilate to the weak aorist paradigm in late Attic, first with third plural forms in *-an* (18), which had

been attested even earlier in Ionic. These were followed by 1pl *-amen* and 2pl *-ate*, which become standard in Koine.

(18) *éthēkan, ethḗkamen, ethḗkate* for *éthesan, éthemen, éthete* 'they/we/you (pl.) placed'

After the loss of distinctive vowel length, the kappatic 3pl *édosan* (from *dídōmi* 'give') creates an alternative paradigm with stem-final *s* (19). This is also supported by the future *dōsō.*

(19) *édōsa, -as, -e, -amen, -ate* for *édōka, -as, -e, édomen, édote* 'I/you/he/we/you (pl.) gave'

The root aorist paradigm was later to disappear. For verbs which already had sigmatic competitors in Classical Greek (e.g. *ebíōsa/ébiōn* 'I lived', *éphthasa/éphthēn* 'I was first'), these simply gain ground and eventually replace their root aorist equivalents. For other root aorist verbs, perfects were increasingly used instead of aorists. Later, these perfects were remodelled with the aorist 'augment' *e-* for the perfect reduplicating prefix *Ce-*, on the model of the apparent interchangeability of augment and reduplication in certain verbs like *hístēmi* (*éstēka* 'I (have) stood', *éstēsa* 'I stood'). These changes take place beyond our cut-off point of AD 400, and will not be included in the data of the following sections.

2.4. Calculating possible proportions

It is necessary to make some assumptions about proportions in order to calculate the full set of changes which could have occurred in post-Classical

Greek. Firstly, I am assuming that sets of person/number suffixes are more likely to merge when they are already competitors in the same set of paradigm cells (see note 5). In other words, the greater the number of morphosyntactic features shared between *a* and *c*, the more likely a proportion is to generate an attested form for *x*. A formal relationship is more likely to spread to the aorist active, therefore, if it is attested in the aorist active for other verbs.

This assumption is built into my test, because I am only considering changes which involve analogical influence between aorist active allomorphs. Occasionally formal patterns do spread to parts of paradigms where they are not previously attested. For example, the 3pl ending *-san* spread to the pluperfect active (ch. 5: 3.2) from the aorist active/imperfect active/aorist passive. A superficial look at the development of Greek suggests that this is less common than influence between competitors in the same paradigm cells. By considering only aorist active allomorphs, I am controlling for this potential factor, in order to isolate the effects of token frequency as much as possible.

Given five patterns of aorist inflection (weak, strong, root and kappatic aorist and perfect), and six combinations of person and number, the maximum number of proportions of the form $a : b = c : x$ is 600.[15] I wrote a program to generate all these 600 proportions, and attempted to predict a

[15] This is calculated as follows:

10 ways of choosing 2 from 5 verb types
× 2 directions
× 15 ways of choosing 2 from 6 combinations of person/number
× 2 directions
= 600

$$\left(2 \times \binom{10}{2}\right) \times \left(2 \times \binom{6}{2}\right) = 600$$

value *x* for each of them, using a computer implementation of the algorithm described in 1.2.1.[16,17]

From this theoretical maximum, we must subtract the number of proportions which fail to make a unique prediction for *x* (e.g. 20; for these proportions, the algorithm in 1.2.1 generates an error).

(20) **élipon* : *élipes* = *épausa* : ??

I will also assume that there is a strong constraint against new forms which would violate surface phonotactics. For example, I am excluding 21-22 because the forms they generate have syllable-final nasals, which are not allowed in Attic, except at the end of a word. My program excluded these proportions by consulting a dataset of illegal phonological sequences each time it predicted a value for *x*, and discarding the proportions for which *x* contained an illegal sequence.

(21) *épausa* : *épausas* = *ébiōn* : **ébiōns*

(22) *épausa* : *epaúsamen* = *ébiōn* : **ebiōnmen*

[16] Because the items in these proportions are acting as representatives of patterns of inflection, rather than individual verbs, the values for *x* represent idealised types of innovative form, rather than individual forms. For example, both *élipas* 'you (sg.) left' (replacing *élipes*), and *ébalas* 'you (sg.) threw' (replacing *ébales*) represent tokens of the same type of form, in which the 2sg suffix of the weak aorist has been extended to verbs with original strong aorist paradigms. Because the historical record rarely attests full paradigms for each verb at a given point in time, I have only been able to make a binary distinction in this chapter between attested and unattested values for each *x*, irrespective of how many tokens of each type are attested. For most types, a large number of forms are attested, of which a few representative examples are given in 2.3. The paradigm of *édōsa* (2.3: 19) is the only example I have used where a single verb is affected.

[17] My implementation represents phonological sequences which are constant throughout individual aorist active paradigms (i.e. stems) with an arbitrary symbol, to improve the efficiency of the matching algorithm described in 1.2.1.2, while still replicating its results. I also represented vowel length using a separate symbol following the vowel segment, to incorporate possible changes involving vowel lengthening or shortening.

Finally, we want to exclude proportions which fail to generate new forms because they already hold true synchronically (e.g. 23). The purpose of computing the set of possible proportions is to see what sets those which predict attested forms apart from those which predict unattested forms. Clearly, the distinction between attested and unattested is meaningless for these proportions. My program excluded these proportions by searching for each *x* in a dataset of Classical Attic forms, and discarding proportions for which *x* is attested amongst these forms.

(23) *épausa* : *épausas* = *pépauka* : *pépaukas*

Subtracting these three groups of ineligible proportions from our upper bound of 600 leaves 241 possible proportions (table 27). Since multiple proportions can predict a single form (e.g. 24-25), the number of forms generated by these proportions is much fewer (100).

Maximum proportions	600
No prediction for *x*	- 209
Phonological violation	- 14
Already holds true	- 136
Total eligible proportions	**= 241**

Table 27: Calculating the number of possible proportions

(24) *élipe* : *élipes* = *épause* : *épausas* ⟶ ***épauses***

(25) *ébiō* : *ebíōs* = *épause* : *épausas* ⟶ ***épauses***

Of the 100 potential forms generated by these 241 eligible proportions, 22 are actually attested amongst the forms exemplified in section 2.3. These 22 forms correspond to 64 proportions (table 28).

	Proportions	Forms predicted
Potential	241	100
Attested	64	22

Table 28: Possible vs attested proportions/forms

Given a proportion with a particular person/number value appearing in its base or target, we can express the probability that it generates an attested form for x as the number of times that person/number value appears in the base/target of a possible proportion, divided by the number of times it does so in a successful proportion (table 29). This data is now ready to be compared with the token frequency of each person/number combination.

	1sg	2sg	3sg	1pl	2pl	3pl
a) Possible base	20	38	53	54	50	26
b) Possible target	59	34	29	27	28	64
c) Actual base	9	12	26	7	4	6
d) Actual target	4	8	1	11	13	27
e) $P(x \mid \text{base}) = \text{c/a}$	0.45	0.32	0.49	0.13	0.08	0.23
f) $P(x \mid \text{target}) = \text{d/b}$	0.07	0.24	0.03	0.41	0.46	0.42

Table 29: Likelihood of each person/number value appearing in the base/target of a successful proportion

I obtained statistics on the token frequency of each person/number using a program which runs the Perseus project's (perseus.tufts.edu) 'morpheus'[18] automatic parser on each word in their corpus of xml texts. The results are quite variable depending on which authors are included in the corpus (fig. 2-5), although the singular is always more frequent than the plural, and the third person is always more frequent than the first and second person. Naturally, written texts do not always reflect spoken language accurately. Of the authors available in Perseus' corpus, the works of Aristophanes are likely to be the best approximation to a spoken corpus, because they contain a high proportion of dialogue between a relatively wide variety of speakers, and because they are mostly written in relatively colloquial language. For these reasons I chose Aristophanes as the corpus for the token frequency statistics (fig. 5) to be compared with the result of the previous section.

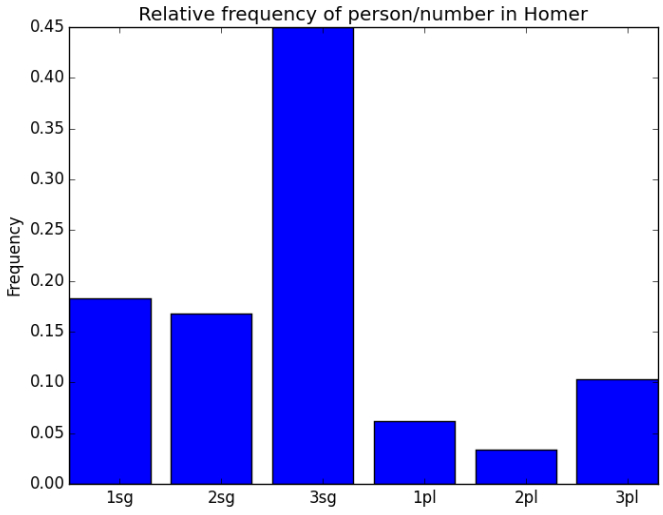


Fig. 2: Relative frequency of person/number values in Homer

[18] The Morpheus parser is not completely accurate, as it cannot distinguish separate words with identical spelling. Where morpheus comes up with more than one possible parse of a word, my program decides on one of these at random. Although this makes the results approximate, there is no reason to think they are systematically biased. Only words which my program parses as finite verb forms have contributed to the token frequency statistics of this chapter (excluding imperative mood, because it lacks first person forms).

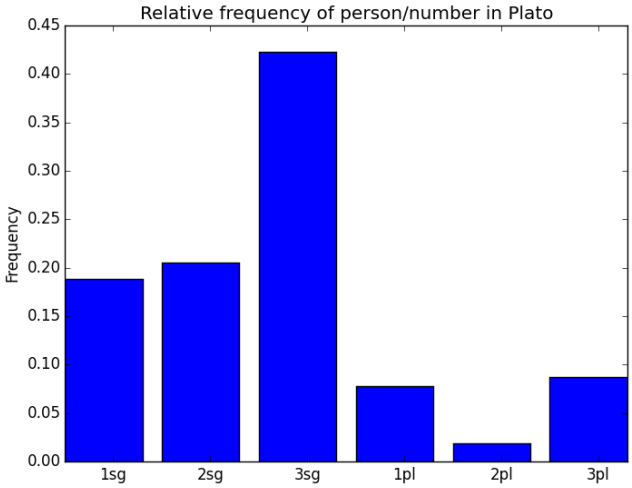


Fig. 3: Relative frequency of person/number values in Plato

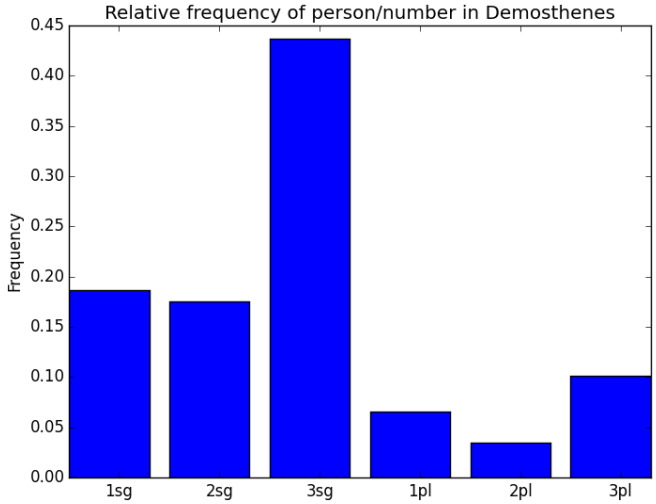


Fig. 4: Relative frequency of person/number values in Demosthenes

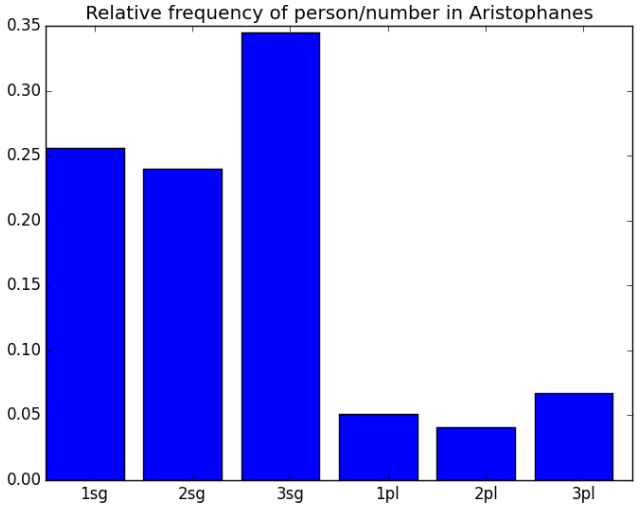


Fig. 5: Relative frequency of person/number values in Aristophanes

2.6. Correlation

The diagrams below show the correlation between the relative frequency of each person/number combination and its likelihood of serving as a base (fig. 6) and target (fig. 7) in a proportion that predicts an attested form. There is a strong positive correlation (r = 0.95, p = 0.0039) for base frequency, and a strong negative correlation for target frequency (r = -0.97, p = 0.0017). This correlation strongly supports the hypothesis that the viability of a proportion depends partly on the token frequency of the forms in its base and target.

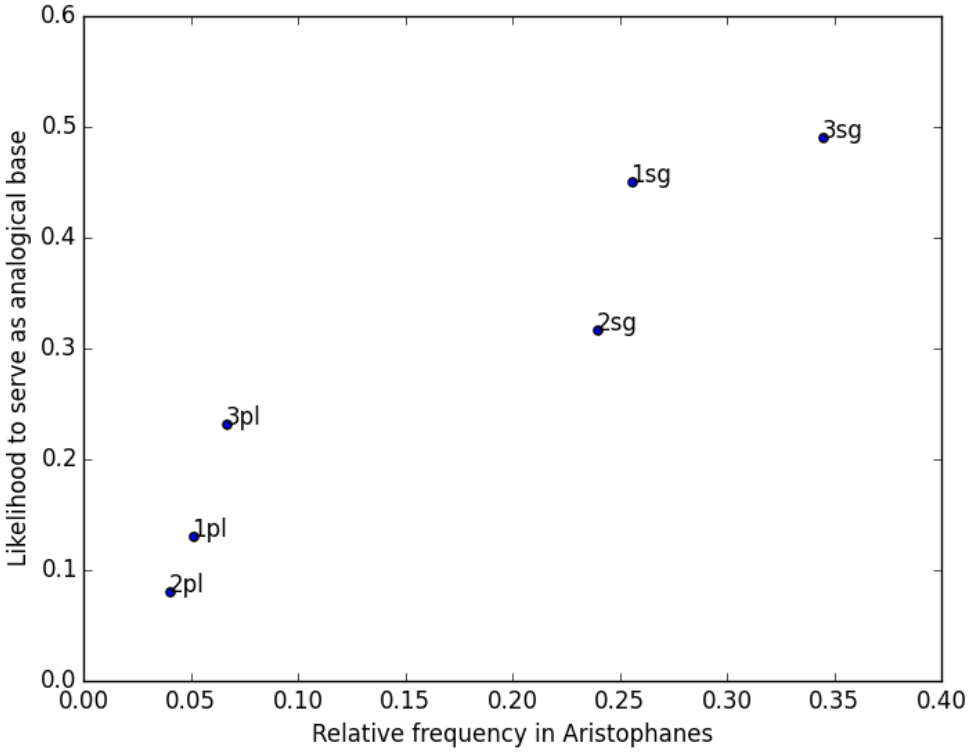


Fig. 6: Correlation between relative frequency and base likelihood

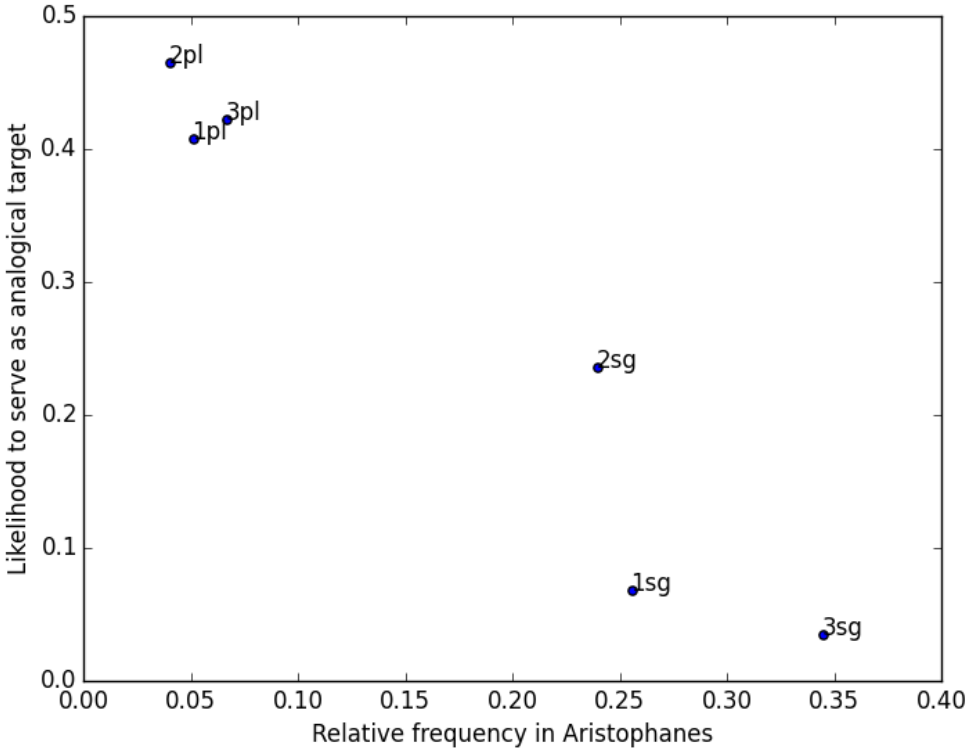


Fig. 7: Correlation between relative frequency and target likelihood

2.7. Extending the model

The previous section established that the likelihood of a form with a given person/number appearing in the base of a successful proportion correlates with the relative frequency of that person/number, and its likelihood of appearing in the target of a successful proportion correlates negatively with its relative frequency. From this we can get a measure of the probability that a proportion generates an attested form for *x*, by multiplying the relative frequency of the base by the complement of the relative frequency of the target (e.g. table 30).

	Correlates with	Value
$P(x \mid \text{base} = 1\text{sg})$	$F(1\text{sg})$	0.26
$P(x \mid \text{target} = 3\text{pl})$	$1\text{-}F(3\text{pl})$	0.93
$P(x \mid \text{base} = 1\text{sg} \ \& \ \text{target} = 3\text{pl})$	$F(1\text{sg}) \times (1 - F(3\text{pl}))$	**0.24**

Table 30: combining base and target frequency

But we actually want to know the probability of forms, many of which are generated by multiple proportions (table 31). It makes intuitive sense that forms supported by a greater number of proportions should have a higher probability of being attested, all other things being equal.

Form	Legitimate proportions	
édōkate 'you (pl) gave' (for *édote*)	8	*épausa : epaúsate = édōka : x* *pépauka : pepaúkate = édōka : x* *élipes : elípete = édōkas : x* *épausas : epaúsate = édōkas : x* *pépaukas : pepaúkate = édōkas : x* *ébiōs : ebíōte = édōkas : x* *épause(n) : epaúsate = édōke(n) : x* *pépauke(n) : pepaúkate = édōke(n) : x*
ēlthosan 'they came' (for *ēlthon)*	3	*ébiōn : ebíōsan = élthon : x* *ebíōmen : ebíōsan = élthomen : x* *édomen : édosan = élthomen : x*
****elípōsi*** 'they left' (for *élipon*)	1	*pepaúkamen : pepaúkāsi = elípomen : x*

Table 31: proportions underlying three hypothetical forms

Table 32 gives the probability measure for each of the three proportions underlying a form like *élthosan*. If analogical forms come about through speakers extending formal patterns of implication, and each proportion represents a formal pattern of implication, each of the proportions i-iii represent alternative ways for *élthosan* to come into existence. The probability of *élthosan* should, therefore, be a function of the probability of the

proportions underlying it: if one or more of them is extended, *élthosan* will be attested. The only situation in which *élthosan* is not attested is if none of them are extended.

	Base	Target	*F*(base) × (1-*F*(target))
i. *ébiōn : ebíōsan = élthon : x*	1sg	3pl	0.24
ii. *ebíōmen : ebíōsan = élthomen : x*	1pl	3pl	0.05
iii. *édomen : édosan = élthomen : x*	1pl	3pl	0.05

Table 32: Possible proportions underlying *élthosan*

The probability of *élthosan* should therefore correlate with the complement of none of the patterns of implication represented by proportions i-iii being extended. The formula for calculating the probability of at least one of a set of events occurring is given in 26, and the calculation for *élthosan* is shown in 27.

(26) $P(A \text{ or } B \text{ or } C) = P(\neg(\neg A \ \& \ \neg B \ \& \ \neg C)) = 1\text{-}((1\text{-}P(A)) \times (1\text{-}P(B) \times (1\text{-}P(C)))$

(27) $P(\text{élthosan}) = 1 - (P(\neg\text{i}) \times P(\neg\text{ii}) \times P(\neg\text{iii})) = 1 - (0.76 \times 0.95 \times 0.95) = \mathbf{0.31}$

If this is a valid measure of the probability of a form, we should expect the 22 attested forms in the sample to have a higher average probability score than the 78 hypothetical forms which are not attested. Furthermore, the distribution of forms between the attested and unattested group should be consistent with their probability scores: if ten events have a 10% probability, we expect[19] approximately one of them to occur, while if ten events have a 90% probability, we expect about 9 of them to occur. Therefore, if we divide the forms into groups according to the range of their probability scores, the

[19] More precisely, we expect the mean to approach 1 over a large number of trials.

proportion which are found in the attested rather than unattested section of the sample should increase with the probability score range.

In section 1.2 (2-5) I highlighted how the proportional notation does not make explicit the extent to which *a*, *b*, *c* and *x* are merely representative examples of the base, target, model and destination in a change. This method of calculating the probability of an analogical form deals with this vagueness by treating the probability of an attested form as a function of the viability of all possible proportions which could underlie it.

2.8. Results

These predictions are well supported by this data. The average probability score of the attested forms is significantly higher than that of the unattested forms (table 33).

	Sample size	Mean probability score	Median probability score
Attested	22	0.44	0.50
Unattested	78	0.23	0.25

Table 33: average probability scores for attested and unattested analogical forms

Fig. 8 shows the results of sorting the total sample of attested and unattested forms by probability score, and then dividing the sample into ten groups of ten observations each, the details of which are given in table 34. Each datapoint in fig. 8, and each column in table 34, represents one of these groups. The proportion of attested forms in each group is plotted on the *y*-axis, and the mean probability score in each group is plotted on the *x*-axis.

The plotted line shows the expected proportion of attested forms in each group, if the probability score were a direct measure of probability. Because

the number of attested forms in the sample is small relative to the unattested forms, and the total sample of hypothetical forms is skewed towards the bottom of the probability score range, it is unsurprising that the datapoints do not fit closely to the line, but as predicted, the ratio of attested to unattested forms in each group correlates with probability score. The correlation coefficient between the values on the *x* and *y* axes is 0.75.

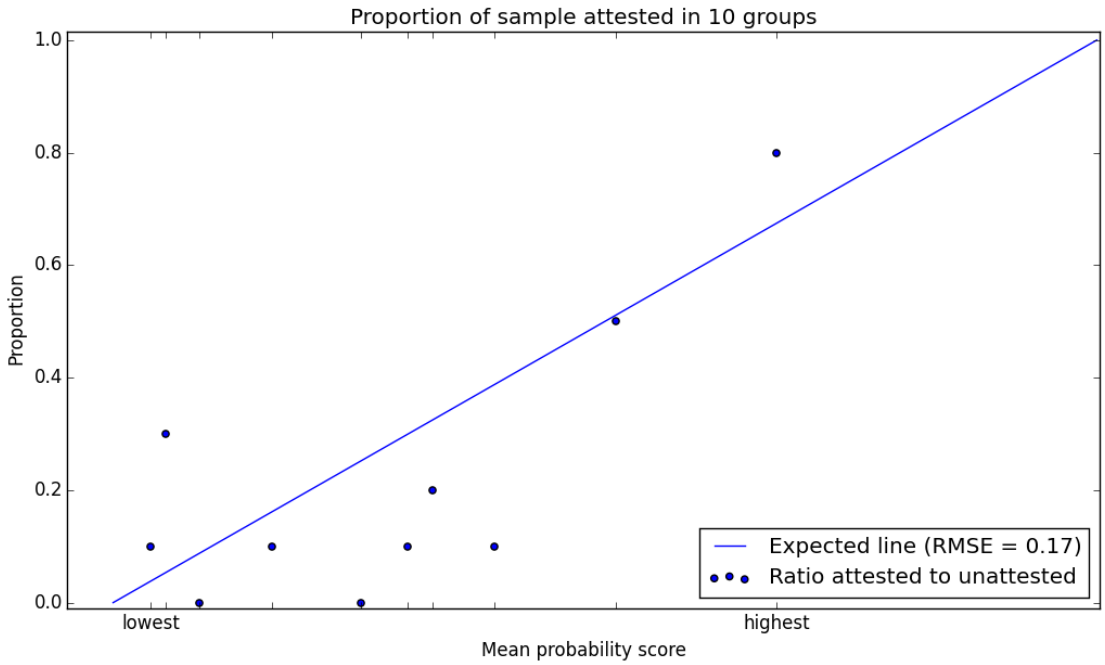


Fig. 8: Graph illustrating the relationship between mean probability score and the proportion of attested forms

Group	1	2	3	4	5	6	7	8	9	10
No. attested forms	1	3	0	1	0	1	2	1	5	8
No. unattested forms	9	7	10	9	10	9	8	9	5	2
P-score range of group	0-0.05	0.05-0.06	0.06-0.12	0.12-0.24	0.24-0.26	0.26-0.32	0.32-0.33	0.33-0.46	0.46-0.55	0.55-0.91
Mean P-score	0.038	0.054	0.087	0.161	0.252	0.300	0.324	0.387	0.511	0.675

Table 34: Number of attested forms and mean P-score of each group

2.9. Assessing the significance of the results

In the absence of a standard statistical method for assessing the significance of this result, I calculated the probability that the correlation shown in figure 8 is the result of mere chance, using a monte carlo simulation. I created a computer simulation which runs through the following steps for 100,000 trials, for each of two hypotheses under consideration. Step 1 generates a simulated diachronic dataset, while steps 2-4 obtain an equivalent measure for this simulated dataset to the measure I obtained for the actual diachronic dataset in 2.8.

Step 1. For each hypothetical analogical form $\boldsymbol{x}$ in my sample, a probability is assigned under one of two hypotheses $\boldsymbol{H}$: the null hypothesis ($\boldsymbol{H_0}$), and the alternative hypothesis ($\boldsymbol{H_1}$). A random number between 0 and 1 is generated. If this number is less than or equal to the probability of *x* being attested under *H* – $\boldsymbol{P(x \mid H)}$ – the form is marked as attested.

Step 2. The hypothetical forms are sorted by increasing probability score, according to the function described in 2.7 ($\boldsymbol{M}$).

Step 3. The sorted list is divided into ten groups of ten, and two values are calculated for each group:

(i) the proportion of forms marked as attested under *H* in step 1;

(ii) the mean probability score assigned by *M* in step 2.

Step 4. The correlation coefficient $\boldsymbol{r}$ for the two sets of values (i) and (ii) is calculated and stored.

We can assume that the mean probability of the 100 hypothetical forms is approximately 0.22, because 22 of the hypothetical forms actually occurred. This is consistent with the following two hypotheses, which were used to determine whether a form is marked as attested in step 1 of the simulation.

1) H_0 (the null hypothesis): every form *x* has a probability of 0.22.

$$\boldsymbol{P(x \mid H_0) = 0.22.}$$

2) H_1 (the alternative hypothesis): there is a linear relationship between the probability score assigned to a hypothetical form *x* by the model *M* described in 2.7, and its actual probability of occurring (the factor 0.788 adjusts the mean of $P(x \mid H_1)$ over all values of *x* to 0.22).

$$\boldsymbol{P(x \mid H_1) = M(x) \times 0.788}$$

This simulation makes it possible to accurately estimate and compare the probability of a correlation like or more like the observed one ($r = 0.746$) under each hypothesis, because the frequency distribution of values of *r* will approach the shape of its probability distribution over a large number of trials.

2.9.1. Results of the simulation

The results of the simulation clearly support H_1 much better than H_0. Under H_0, the expected value of *r* (the mean of the trials) is 0, i.e. no correlation. The probability that *r* is equal to or greater than the observed value (0.746) is 0.007. This value is obtained by calculating the proportion of values for *r* generated by the simulation which are equal to or greater than 0.746, and is

the one-tailed p-value of our test of the null hypothesis. The probability that the absolute value of r is equal to or greater than 0.746 is 0.013: this is the the two-tailed p-value of the test, which measures the probability of getting as strong or stronger a correlation than the observed one in either direction under the null hypothesis. Using either the one-tailed or the two-tailed test, these results are highly statistically significant. By comparison, under H_1, the expected value of r is 0.81 – close to the observed value – and the probability that r is equal to or greater than to 0.746 is 0.771. No value of r equal to or less than -0.746 was generated under H_1.

The following diagram shows histograms of the correlations generated by the simulation described above, under H_0 and H_1. Values of r are plotted on the x-axis, and frequency is plotted on the y-axis.

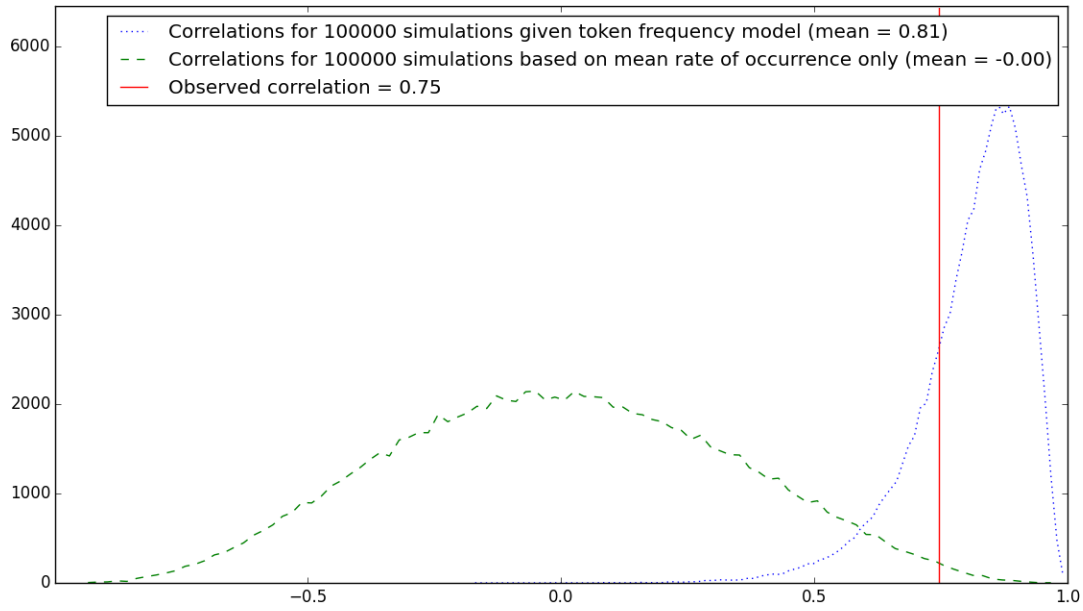


Fig. 9: Frequency distributions of values for r under the null and alternative hypotheses

3. CONCLUSIONS

The results of section 2 strongly support the hypothesis that the viability of an analogical proportion is partly a function of the token frequency of the forms which appear in the base and the target of the proportion, and that the probability of an analogical form is a function of the viability of the proportions which generate it. This is to be expected if analogical forms come about through speakers predicting forms which they have failed to learn or remember: high token frequency forms are more likely to be remembered and used for predicting new forms, while low token frequency forms are more likely to be forgotten and therefore replaced. It also fits with a growing body of psycholinguistic research (e.g. Baayen et al 1997, 2003) which shows that the speed with which inflected words are processed is a function of their token frequency, and suggests that there is competition in comprehension between on-the-fly morphological analysis and retrieving forms from memory as unanalysed wholes.

The role of token frequency confirms the essential insight behind analogical proportions: it suggests that what is really going on in this kind of morphological change is the extension of implicational relationships between fully inflected wordforms, rather than sub-word units and surface forms.

So far we have seen attempts to constrain morphological change under two different constructive frameworks. Both failed, because analogy turns out to have no consistent effect on the relationship between sub-word units and inflected words, at the level of individual changes. Under a constructive account, there is no reason why properties of the analogical base or model should have any influence on change, because these have no independent

existence in the synchronic framework; they are merely the output of the grammar. But type frequency of the model (ch. 4) and token frequency of the base (this chapter) are factors which influence the direction of change in Greek, which is inexplicable under a constructive account.

In theory, it is possible to concede an abstractive explanation of diachronic phenomena, while maintaining a constructive account of synchronic morphology. But the approach I have argued for, which derives diachronic tendencies from the synchronic organisation of language, has an advantage in both economy and psychological plausibility.

Chapter 7: Conclusions

In this chapter I will summarise the empirical findings (section 1) and theoretical conclusions (section 2) of this thesis, and suggest some worthwhile avenues for further research.

1. EMPIRICAL FINDINGS

1.1. *Optimisation-based approaches*

I have considered a number of different hypotheses about morphological change which share a teleological view of diachrony as bringing language closer to some supposedly ideal state. On the whole, the predictions made by these hypotheses have not been borne out in the diachronic data I have examined.

In chapter 4, I considered the common claim that analogical levelling is motivated by a preference for one-to-one alignment of meaning and form in language ('Humboldt's universal'). I showed that in Greek, the probability of levelling between any two paradigm cells correlates significantly with the synchronic type frequency of non-allomorphy between those paradigm cells. This suggests that levelling is simply a type of extension, where the formal pattern being extended happens to involve invariance rather than alternation. Therefore, it is superfluous to attribute the two diachronic phenomena to separate motivations.

In chapter 4 (4.2.1) I also considered the possibility that the direction of levelling is determined by semantic markedness, as claimed by Kuryłowicz's second law of analogy (1949): "analogical developments follow the direction 'basic form' → 'derived form', where the relationship between basic and derived forms is a consequence of their spheres of usage"[1] (similar claims are made in Jakobson 1939, Mańczak 1958, 1980). For the data I consider, this explanation cannot account for the usual direction of levelling. For example, the present is usually held to be the least marked tense cross-linguistically (Greenberg 1966), but the lexical allomorph of the present principal part is the least likely to spread to other forms in Greek. Likewise active voice is supposed to be universally unmarked with respect to passive, and has a wider 'sphere of usage' in Greek, but the more usual direction of levelling in my Greek data is from passive and mediopassive forms to active forms. Nonetheless, as a descriptive rule of thumb, it appears to be true that semantically unmarked categories are more likely to influence semantically marked forms than vice versa: in the data I consider in chapter 6, third person forms influence other forms more often than second or first person forms do, and the forms of the singular more often bring about the remodelling of the plural than vice versa. As I show in chapter 6 (section 2), this is better explained as a side-effect of token frequency than attributed directly to semantic markedness, confirming the analyses of Tiersma (1982), Bybee (1985, 1988), and indeed Greenberg (1966).

Chapter 4 also considered the claim of Albright (2008), following Vennemann (1979), that analogy favours the preservation of phonemic contrasts, by choosing forms which tend to preserve these contrasts as

[1] Translation by Hock (1986: 229-234).

analogical bases. This explanation could not account for the data presented in chapter 4. In particular, the perfect mediopassive was influential in levelling, even though it systematically neutralises the place, voice, and manner of articulation of the final consonant of the lexical morpheme. This may be because I deliberately excluded analogical forms which could plausibly be analysed as containing the same underlying lexical morpheme as the forms they were replacing, according to the criteria I explained in chapter 2 (1.5). This was in order to restrict my dataset to the levelling of strictly morphological rather than phonological alternations. It is possible that phonologically motivated analogical change is influenced by a preference for preserving phonemic contrasts, even if morphologically motivated change is not. This suggests that analogy affecting phonological and morphophonemic contrasts might behave differently from analogy affecting purely morphological alternations, which merits further investigation.

Another approach which I have mentioned, but not explicitly tested, is the view that language change is directed towards the maximisation of functional contrasts. This is exemplified by Kuryłowicz's (1949) law I, which states that analogy tends to maximise the formal expression of morphological contrasts, and V, which claims that analogical change prioritises the preservation of more important morphological contrasts over less important ones, should there be a conflict between the two. The former claim seems to be contradicted as often as not, for example by the patterns of levelling described in chapter 4, which often eliminated alternations of lexical allomorphy which were secondary indicators of tense and aspect. The latter hypothesis is untestable, in the absence of a principled method for establishing the relative importance of different morphological contrasts. It seems reasonable to

assume that morphosyntactic distinctions which are marked in a large number of languages are more essential than those which are rare. For example, syncretism between the first person singular and third person plural in a number of Greek forms was eliminated diachronically, first by the creation of an alternative 3pl suffix *-osan* (ch. 5: 3.3; ch. 6: 2.3). This involved a comparatively rare type of analogy where a pattern of formal implication is extended from the first person forms (ch. 6: 2.6). Plausibly, forms in *-osan* were favoured diachronically because they restored the possibility of marking a distinction between first person singular and third person plural subject (ch. 5: 4.2). This could have either predisposed speakers to creating forms in *-osan*, or, once such forms came into existence, their usefulness could have encouraged their sociolinguistic spread. Testing this hypothesis would be made complicated by the overlapping remits of morphology and syntax. In the history of Greek we have many examples of the loss of morphological distinctions, and their subsequent renewal by analytic constructions, e.g. the future, subjunctive, and perfect (ch. 3: 3.1-2; but see arguments for treating such periphrastic constructions as part of morphological paradigms in Ackerman et al. 2011, Ackerman and Stump 2004, Sadler and Spencer 2002, Stump 2002).

Finally, in chapter 5, I considered a set of claims by Carstairs-McCarthy (1998), which attributed his earlier Paradigm Economy Principle (1983, 1984, 1985) and No-Blur principle (1994) to wider-reaching constraints on the acquisition of lexical semantics, which limit the degree to which languages can deviate from Humboldt's universal by the requirement that affixal allomorphy should be distributed within paradigms in such a way that a unique meaning can be assigned to each allomorph. I found that the

synchronic system of Greek violates these constraints outrageously (ch. 5: 2), and diachrony makes the situation even worse in many cases (ch. 5: 3). This makes it impossible to argue that these constraints have explanatory force in morphological change. While the no-blur and paradigm economy principles seem to be more or less valid as descriptive observations about languages in general, I argued in chapter 5 that this is better explained as an epiphenomenon of the mechanisms of change (see 2.2 below).

1.2. Type frequency

In chapter 4, I demonstrated that the probability of levelling in any subset paradigm cells correlates with the synchronic type frequency of invariant expression of the lexical morpheme over that subset of paradigm cells, in a population of Greek verbs with unpredictable lexical allomorphy. This supports the common claim that diachronic productivity is primarily a function of type frequency (i.e. frequency amongst the lexical paradigms of the language), rather than token frequency (e.g. Baayen and Lieber 1991, Albright 2002b, 2009, Bybee 1995, 1999, Ernestus and Baayen 2003, Hay et al. 2004). Importantly, it is the type frequency of a pattern of formal implication between paradigm cells, rather than any particular form of marking, which correlates with productivity in this Greek data.

1.3. Predictive usefulness

In chapter 4 I introduced the concept of a 'stem alliance' (ch. 4: 4.3): a subset of paradigm cells which tend probabilistically to be realised by forms having

stems with an identical phonological expression of the lexical morpheme. Because the perfect active and perfect mediopassive principal parts are members of two intersecting stem alliances, I argued, they are particularly susceptible to be levelled. In general, the autonomy or 'formal independence' of a principal part – that is, its overall probability of containing a unique expression of the lexical morpheme – correlated negatively with its probability of being the source of levelling. This is explained by the relative strength of the evidence provided by different principal parts for speakers predicting the realisation of unknown paradigm cells. Principal parts which are part of strong stem alliances tend to have their evidence backed up by other evidence from elsewhere in the paradigm, making them more predictively useful. Forms which are part of stem alliances thus constitute better evidence for speakers confronted with the PCFP (see 2.2) than forms which have a high degree of formal independence.

A strand of recent work on paradigm structure (e.g. Moscoso del Prado Martín et al. 2004, Ackerman et al. 2009, Milin et al. 2009, Blevins 2013) uses information-theoretic measures to quantify intuitive notions of predictiveness and predictability. It would be interesting to see whether such measures can be profitably incorporated into the model I have outlined in chapter 6 (2.4-8). It may be that the predictive usefulness of a particular form for predicting the lexical allomorph of other forms can be reduced to other measures, since forms generated by analogical proportions where the base tends to share a lexical allomorph with many other forms will also tend to be supported by a greater number of proportions. All other things being equal, this should increase their probability of occurring in my model (see 1.5).

1.4. Token frequency

Chapter 6 demonstrated the influence of token frequency in morphological change. In this chapter I computationally generated a set of analogical proportions of the form $a : b = c : x$. I showed that the viability of an analogical proportion (i.e. its probability of making prediction for x which is actually attested in the diachronic data) correlates positively with the relative token frequency of the person-number value of the base (a and c), and negatively with the same value for the target (b and x) (ch. 6: 2.6). This reconciles the claims of Mańczak (1980) that high frequency forms are more likely to bring about the remaking of other forms, and Bybee (1985, 1995) that high token frequency forms are less likely to be involved in analogical change, because their high degree of autonomy reduces their participation in morphological networks. It is compatible with psycholinguistic evidence that token frequency correlates negatively with processing speed (e.g. Milin et al. 2009): high token frequency forms are more easily retrieved from memory as unanalysed wholes, and therefore less likely to need to be predicted.

1.5. Number of proportions

Building on the conclusions summarised in 1.4, I developed a measure of the probability of each unique analogical form in the set of hypothetical proportions, as a function of the viability of each of the proportions which generated it (ch. 6: 2.7-8). When I sorted these hypothetical forms and divided them into equally sized groups, I found that the proportion of attested forms in each group correlated with the mean probability score of the group. This

correlation constitutes strong evidence for the hypothesis that the probability of a form is partly a function of the number of proportions supporting it. This makes sense if we view each proportion underlying a form as a possible rationale for creating it: all other things being equal, the more ways there are for a form to come into existence, the higher its probability of being created should be.

2. THEORETICAL CONCLUSIONS

2.1. Mental storage of inflected words

I have argued for a synchronic model of morphology which is word-based, in that whole words, rather than sub-word units, are the basic linguistic units stored in memory. In chapter two (3.2.1-3), I argued that the synchronic distribution of person-number affixes in Greek verbal paradigms is more compatible with a word-based approach, because the same sets of person-number suffixes turn up repeatedly in morphosyntactically disparate sets of paradigm cells. In a theoretical framework which consigns affixes to the lexicon, it is impossible to give a meaning to these affixes which determines their distribution in paradigms, so we have to account for their distribution by extremely complicated and arbitrary rules. If we treat these patterns in the same way that syncretism has been dealt with in modern realisational theories, using rules of referral or a similar mechanism, we avoid listing each of these affixes multiple times as exponents of different groups of morphosyntactic features, but at the cost of arbitrarily privileging their appearance in particular paradigm cells as the default case (ch. 2: 3.2.1-3). A

word-based description can capture these patterns of distribution economically, using representative forms and exemplary paradigms.[2]

In chapters 4-6, I presented a number of diachronic arguments for this position. Chapter 4 showed that the type frequency of formal relationships between surface forms influences morphological change, and that stem alliances, a kind of probabilistic relationship between surface forms, are useful in explaining the direction of levelling. Chapter 6 showed that token frequency, which is a property of surface forms, is also influential in morphological change. In particular, the token frequency of the analogical base, which has no relevance on either a realisational or a morpheme-based model of morphology, showed a strong correlation with the probability of a proportion generating an attested form for x. All of this is inexplicable on a view of grammar which relates sub-word units to inflected surface forms, but

[2] Within a realisational framework, it is also possible to use arbitrary indices to capture these morphosyntactically disjunctive patterns of affix distribution. For example, the suffixes *-mai* (1sg), *-sai* (2sg), *-tai* (3sg), *-ntai* (3pl) appear systematically in two middle/passive 'screeves' (ch. 5: 1.1.1.3): present indicative paradigm cells of athematic verbs (ch. 5: 1.1.1.2), and present perfect paradigm cells of all verbs. This fact could be accommodated along the following lines, using one set of rules to add 'screeveshape' information to a set of stems via an arbitrary index (α), and another set of rules to define the phonological realisation of this index for particular person/number values:

i. $X_{athematic}$/[+mediopassive] ⟶ X_{α}
ii. X/[+mediopassive, +perfect] ⟶ X_{α}
iii. X_{α}/[+1st, +sg] ⟶ X*mai*
iv. X_{α}/[+2nd, +sg] ⟶ X*sai...*

This account succinctly defines the distribution of these sets of affixes within paradigms (i-ii), their phonological properties (iii-iv), and their relationship of mutual implication (via the index α, which acts like an inflection class index); cf. Round's (2015) distinction between *meromorphomes* (word components which recur in morphosyntactically disjunctive sets of paradigm cells), *metamorphomes* (distributional patterns of meromorphomes within paradigms), and *rhizomorphomes* (morphosyntactically and phonologically arbitrary paradigm types, such as inflection classes). Descriptively, this is equivalent to the principal parts and exemplary paradigms account I have argued for in this thesis. In my view the difference between the two approaches reflects different theoretical goals. For my purposes of explaining and constraining diachronic facts, and assimilating them into a theory of performance, I prefer a word-based account – which represents the formal, syntagmatic and paradigmatic properties of morphs with minimal formal baggage – for the reasons given in this thesis and summarised in this chapter. For other purposes, it may be more convenient to use a level of description that recognises morphological segments as built-in entities.

follows quite naturally from a view of grammar as a set of relationships between surface forms.

Traditional word-and-paradigm treatments of morphology harness the interdependence of words within paradigms to minimise the amount of information learners have to remember in order to predict full paradigms, using a single exemplary paradigm for each inflection class, and the minimal set of representative forms for each lexeme which make it possible to identify inflection class. This presentation, while similar in many respects to the theory of speaker competence I propose, is obviously an idealisation, since psycholinguistic evidence suggests even completely predictable surface forms may be stored (Baayen et al 1997, 2003). A more psychologically plausible model locates stored words in associative networks, connected by both formal and functional similarities: cf. the exemplar-based model of Bybee (1985, 2010), morphological modelling using connectionist networks (e.g. Rumelhart and McClelland 1986, Plunkett and Juola 1999, MacWhinney and Leinback 1991, Daugherty and Seidenberg 1994, Thyme 1993) and recent work which makes use of the notion of inheritance from computer science (e.g. Brown and Hippisley 2012, Corbett et al. 1993, Brown 1998). The relevant distinction may not be which forms are stored in memory and which are predicted, but how strong or accessible the memory representations of different forms are (e.g. Bybee 1985, 1995, 2006). Schreuder and Baayen (1995), Baayen et al. (1997) Clahsen et al. (2003) and Hay (2003) have argued for a dual-route processing model in which there is competition in comprehension between retrieval of full forms and morphological analysis. High token frequency forms are more likely to be retrieved whole, because they are can be accessed by memory more quickly. Similar competition between the retrieval of whole forms and

on-line creation in the production side of language could explain many of the effects observed in this thesis (see Bermúdez-Otero 2012 for a similar account within stratal optimality theory).

2.2. Language change as a byproduct of language use

I have suggested that the influence of type and token frequency in language change are best explained in terms of the Paradigm Cell Filling Problem of Ackerman et al. (2009). Formal changes to inflectional paradigms take place through speakers making predictions for paradigm cells whose conventional realisations they have never encountered, or which are insufficiently accessible to memory within the time constraints imposed by performance, using the evidence of forms they do remember. Speakers are more likely to remember frequent forms, and less likely to remember infrequent forms, which explains the fact that infrequent forms tend to be refashioned on the model of more frequent forms. The type frequency of a morphological pattern is a measure of its strength as evidence for predicting an unknown form: if a particular pattern of implication has a high type frequency amongst the lexemes of a language, the probability that a given lexeme whose inflection is unknown will follow the same pattern is high.

This account does not require that new forms come about exclusively during language acquisition, but nor does it rule out the possibility that they can. Studies which have compared the properties of child language with those of morphological change have had mixed results (see discussion and citations in Bybee 2010: 114 ff.), and it seems unlikely that child language is sufficiently prestigious for novel forms created by children to have a high probability of

being adopted by speech communities at large. If the source of new forms is not restricted to language acquisition, we need not assume that morphological change results only from the activity of native speakers. Indeed, the correlation between rapid geographical spread of a language and a move towards greater analyticity of structure (e.g. Trudgill 1992) suggests that second language acquisition by adults could be an important factor in analogical change.

2.3. Analogy as a mechanism of change

In chapter 6, I defended the proportional model of analogy as a psychologically real mechanism by which speakers extend formal patterns of implication inherent in a mental database of words. I outlined an algorithm to put on a systematic footing our intuitive ability to solve an analogical proportion of the form $a : b = c : x$ (ch. 6: 1.2.1), and used this to model the probability of an analogical form as a function of the viability of all the analogical proportions underlying it (ch. 6: 2.7-8).[3] In theory, proportional analogy might be a last-ditch mechanism for speakers predicting unknown forms, but have no relevance to synchrony. However, it is obviously preferable on the criterion of economy to attribute both the diachronic facts and synchronic productivity to the same mechanism, if possible. An analogical account of synchronic production also has the advantage of being compatible with a word-based theory of the lexicon, as discussed in 2.1.

[3] See e.g. Skousen (2012) for another approach to modelling analogy computationally.

2.4. Non-proportional analogy

So far, this account has left non-proportional analogy in the lurch. I can think of two possible strategies for incorporating it. One alternative would be to regard proportional analogy as just one form of reasoning that speakers use to solve the PCFP, and attribute non-proportional analogy to some other means of solving the same problem. One such means might be what Bybee (1995, 2010) and Bybee and Moder (1983) have called 'product-oriented schemas': essentially, productive generalisations about what forms realising particular semantic properties should look like, regardless of their relationships to other forms.[4] For example, (1) below could be attributed to a product-oriented schema which states that the last syllable of genitive singular forms of masculine nouns should be *-ou*. (2) could be attributed to a combination of product-oriented schemas, stating that the final syllable of present perfect active indicative forms should be *-ka,* and the initial syllable should be *e-*, as in *égnōka.*

(1)	*oînos*	:	*oínou*	
	'wine (masc.)' nom. sg		masc. gen. sg	
=	*neaníās*	:	*neaníou*	⟵ *neaníāo*
	'youth (masc.)' nom. sg.		gen. sg	

[4] Booij (2002) has also argued for the existence of morphological rules with constant output.

(2)	*égnōn*	:	*égnōka*	
	'I knew'		'I have known'	
=	*éktanon*	:	*éktanka*	⟵ *éktona*
	'I killed'		'I have killed'	

To explain (2), we must also assume an additional 'source-oriented' schema, stating that the expression of the lexical morpheme in the present perfect active indicative should be the same as that of the aorist active indicative. This seems to undermine the account of the lexicon given in 2.1, by necessitating mental storage of morphemes independently from the words in which they appear. However, a word-based account does not force us to deny that speakers associate particular parts of words with particular aspects of their meaning. The attribution of sub-word units of form to sub-word units of meaning can be achieved using essentially the same analogical mechanism described in chapter 6.

The most problematic aspect of this account is that it undermines the predictiveness of an analogical model, unless we can describe the conditions under which non-proportional analogy will occur (see ch. 1: 1.5). For example, it might be possible to show that product-oriented schemas are only used for the PCFP as a last resort, when the set of proportions which could generate a prediction for *x* are insufficiently viable or non-existent.

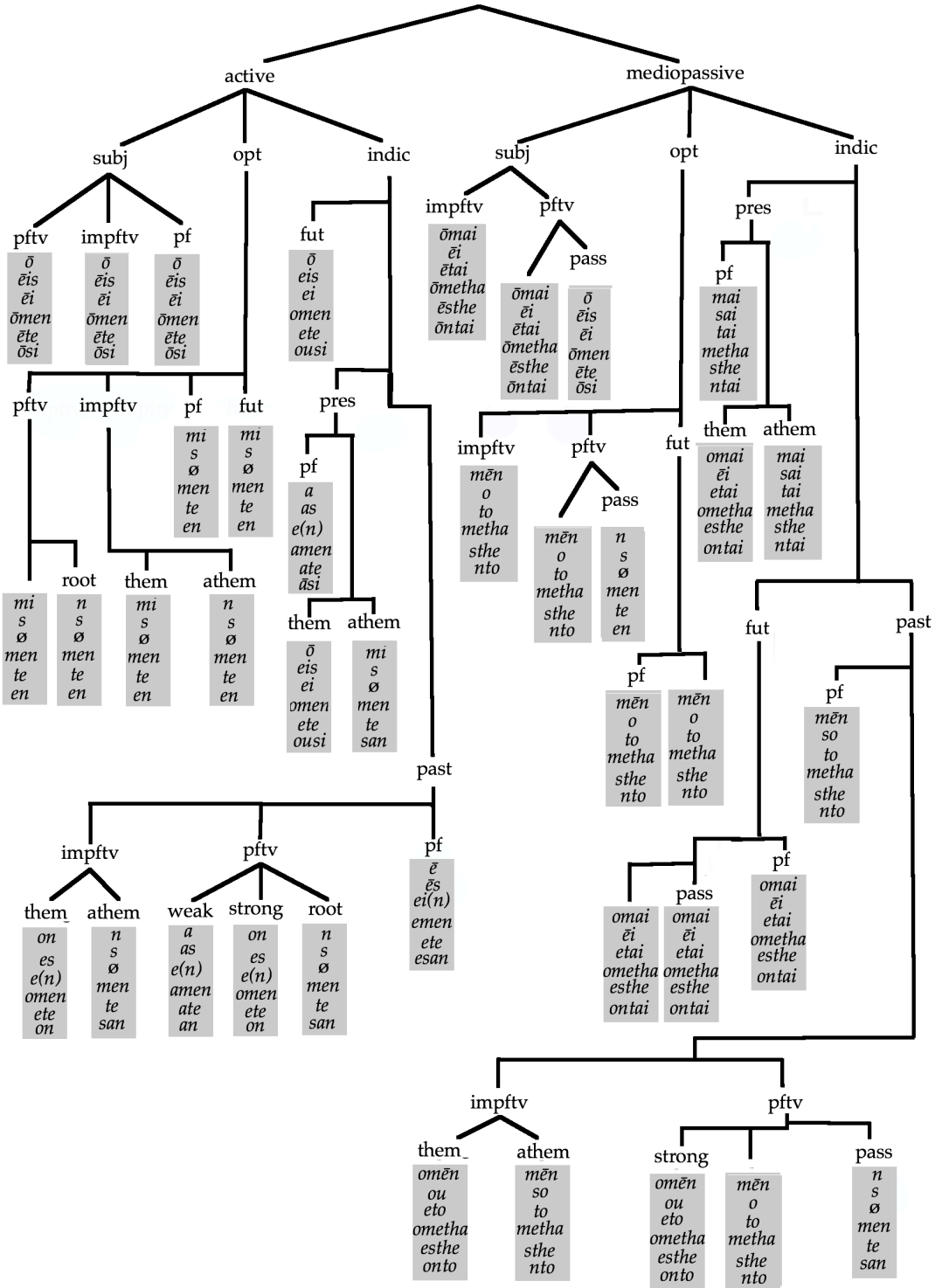
Another possibility is that a more complete model of proportional analogy will turn out to accommodate non-proportional analogy as a degenerate case of proportional analogy. In theory, the analogical algorithm I developed in chapter 6 (1.2.1) is capable of coming up with extremely general analyses of the relationship between *a* and *b* in a proportion, if *a* and *c* have little in common. For (1) above, for instance, it could come up with a rule 'take off the

final syllable and replace it with *-ou'* to derive *oínou* from *oînos*. If the phonological and semantic similarity of *a* and *c* is a factor which increases the viability of a proportion, as I suggested tentatively in chapter 6 (footnote 13), it could be that non-proportional analogy is simply a rare type of analogy, because the viability of proportions where the relationship between *a*/*c* is very general is very low. Testing this factor would help us decide between the two approaches to incorporating non-proportional analogy I have discussed, and may improve the analogical model developed in chapter 6.

2.5. The diachronic approach

This thesis opened with the claim that properties of language change have much to offer synchronic theories of language. By this point, I hope to have convinced the reader that the evidence of diachrony can and should be considered, if we wish to have a psychologically plausible theory of how language works synchronically. While there are good reasons for drawing a theoretical distinction between diachrony and synchrony, there is no reason to study the two in isolation: each can benefit greatly from the insights of the other. I have considered a tiny fraction of the diachronic evidence which is available, and my conclusions will no doubt be refined and improved by taking further data into account. These results demonstrate, however, that it is possible to test theories about language change, and that the outcomes of these tests can profoundly influence the way we look at synchrony.

Appendix: The distribution of person-number suffixes



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