

HISTORICAL SYNTAX

Types of explanation in history

DAVID W. LIGHTFOOT

Georgetown University

This article examines the ways in which explanation has been achieved in scientific work on language change over the last two hundred years. Explanations have come in many forms and at many levels and are greatly influenced by what are taken as the leading questions, which themselves have varied significantly since the early nineteenth century.*

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1. INTRODUCTION. Historical linguistics deals with HOW languages change, but the descriptive work has often been complemented by questions of explanation, practitioners frequently asking the WHY questions. This has been so from the very beginnings of the field, perhaps more than in other subfields of linguistics. Here I track some successes and failures of work on language change over the last two centuries, focusing on how explanations have been achieved and showing that explanation comes in many forms and at many levels. This cannot be a comprehensive account, of course, and I highlight events that have changed the kinds of explanations attained, discussing their successes and shortcomings.

A consideration of the history of efforts to explain aspects of change illuminates modern efforts, and vice versa.

2. THE BEGINNINGS. Work on language was elevated to a scientific level in the nineteenth century, and Sir William ‘Oriental’ Jones is often cited as the one who began the process. In 1786 he gave the Third Anniversary Discourse at the Asiatick Society of Bengal, where he was president. He spoke of Greek, Latin, and Sanskrit and noted that ‘no philologist could examine them all three, without believing them to have sprung from some common source, which, perhaps, no longer exists’ (Jones 1788). This observation was a minor part of a long discourse on the cultures of the Middle and Far East. Jones was no scientist; he was more interested in writing a history of the Asian people than in linguistics and held some quite unsustainable ideas about language relatedness (Poser & Campbell 1992), but his key idea was that the origin of Greek, Latin, and Sanskrit is not to be found in other, currently observable languages like Hebrew or Sanskrit but rather in an unrecorded language.

Others may have anticipated Jones’s idea (there is debate about how influential Jones was at the time; see Campbell 2001, Cannon 1990, Cannon & Brine 1995, Swiggers & Desmet 1996),¹ but there followed a century of work devoted largely to answering the diachronic question of how a given language came to be the way it was, and this was the beginning of scientific treatments of language. Revealing how German developed was the explanatory goal, and, toward the end of the century, Hermann Paul (1880:20) raised the possible objection that there could be another scientific way of studying lan-

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¹ Two people who had interesting early ideas about language relatedness, and particularly about the relationship of Sanskrit to Greek and Latin, are a Swedish student, Andreas Jäger (c. 1660–1730), and a Jesuit missionary, Gaston-Laurent Coeurdoux (1697–1779).

guage other than the historical, but dismissed it summarily: ‘Es ist eingewendet, dass es noch eine andere wissenschaftliche Betrachtung der Sprache gäbe, als die geschichtliche. Ich muss das in Abrede stellen’ (‘It has been objected that there is another view of language possible besides the historical. I must deny this’).

Languages were taken to be sociological entities, being clusters of properties shared by groups of speakers and lumped together as Greek, Spanish, and so forth. Furthermore, and a separate point, the properties were essentially lists of sounds, words, and morphemes, what modern linguists would regard as the PRODUCTS of the language system, with everything else attributable to either universal ‘logic’ or individually variable ‘habits’. Some work dealt with the distribution of words and morphemes, that is, ‘syntax’, but nineteenth-century syntax had no constituent structure and certainly no system, quite unlike twenty-first-century syntax. So there was not anything to have a history of other than words, their pronunciations, distribution, and meanings.

Similarly, if a language was a list of sounds and the like, there could be no significant synchronic generalizations, and the only major generalizations had to be historical. Hence Paul’s insistence that history was everything.

A central idea in the earliest work on language change was that if one could understand the sound changes that transform words as they are transmitted from generation to generation, so one might understand and explain the historical relationships among languages and how a language descended from an earlier one. Again, this was the explanatory goal, and a key idea was that of CORRESPONDENCES.

The words for ‘father’ vary widely in languages: Chinese *fuqin*, Japanese *titi-oya*, Basque *aita*, Finnish *isä*, and Korean *apeci*. However, the Romance languages show a much narrower range: French *père*, Spanish *padre*, Italian *padre*, Sardinian *patre*, Catalan *pare*, Portuguese *pai*, all transmogrifications of Latin *pater*. The Germanic languages have similar but different words: English *father*, Dutch *vader*, German *Vater*, Danish *fader*, Gothic *fadar*.

Here we see lexical correspondences, based on systematic meaning and sound relationships: the reflex of a certain sound in one language corresponds to a particular sound in another language in a regular way, manifested by a pattern of recurrent correspondences in a good number of cognate words.

From such correspondences, linguists concluded that Jones’s ‘common source’, the (unattested) protolanguage, had a word for ‘father’ that was a two-syllable word and in which the initial segment was a labial consonant, probably *p* (/p/ in Romance, /f/ in Germanic), followed by an open vowel and an alveolar consonant, then some kind of vocalic *r*. The reconstructed form and the associated changes into the forms of the daughter languages constitute an explanation for why Germanic is the way it is, particularly the form of *fadar* in Gothic.

Words are transmitted from one generation to the next, and they may change their form over time. That idea was taken up passionately in Germany, where scholars worked with correspondences and deduced many properties of the hypothetical source language that we now know as Proto-Indo-European (PIE).² By examining correspondences, linguists developed the comparative method, the only real basis for reconstructing the properties of a protolanguage. They postulated that languages are historically related to each other to different degrees, and that they can cluster in families. English and Dutch have more cognate words, and the cognate words are more similar to each

² There is no better account of nineteenth-century linguistics than Davies 1998, and Pedersen 1931 provides useful portraits of the major figures.

other, than English and Spanish, so English and Dutch are more closely related, even though they have many words that are not cognate.

Hoenigswald (1963) noted that, from the early nineteenth century, philologists began using tree diagrams to reconstruct the genealogy of manuscripts. We have nothing written in the hand of Thucydides or Cicero, just manuscripts, often medieval, written by later scribes. Those manuscripts differ from each other in many ways, and much ingenious detective work goes into figuring out what Thucydides or Cicero must have written, based on these indirect records. If manuscripts B and C have common peculiarities, then an intermediate manuscript that no longer exists is hypothesized. Family trees were constructed indicating the relationships between manuscripts.

One of the pioneers in this work was Friedrich Ritschl, teacher of August Schleicher. In 1863 Schleicher published a short book on Darwinian theory and postulated trees indicating the genetic relationship among language families, based on a rough quantification of cognate words. Such trees are comparable to classifications of botanical species and genera in the Linnaean system, so-called cladograms, and reflect the cross-disciplinary interests of the late nineteenth century.

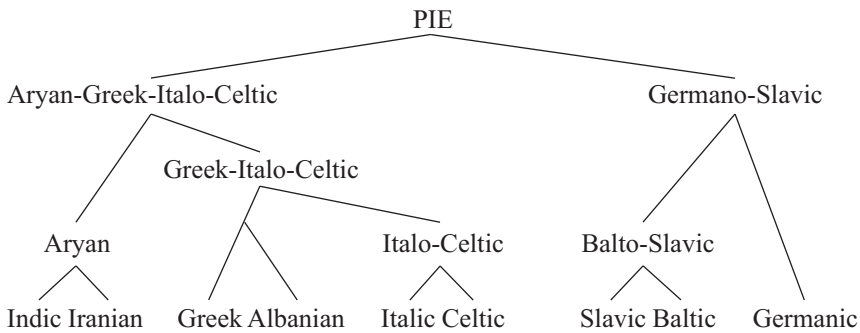


FIGURE 1. Schleicher's first IE tree.

Figure 1 shows Schleicher's tree for the earliest stages of the Indo-European languages. I have anglicized and modernized some of his labels. The tree is incomplete, of course: many languages not specified here fall under Germanic, and Celtic was subdivided into two groups, Brythonic and Goidelic, the former consisting of Cornish, Breton, and Welsh, the latter embracing Manx, Irish, and Scots Gaelic. The tree expresses the idea that, say, the Celtic languages are more closely related to the Latin-derived 'Italic' languages than the Slavic languages are to either. This was the first tree proposed for the Indo-European languages or, in fact, for any language family. We have no records for any of the parent languages, and we now doubt that Albanian and Greek represent any kind of unity, nor Italo-Celtic. Some features of Schleicher's tree remain undisputed, however, and many relationships not specified here have come to be established convincingly. Furthermore, cladograms flesh out the explanation of how Greek, Spanish, and so on came to be the way they are, specifying their global relatedness to other languages through historical descent.³

³ Again, in nineteenth-century thinking there was no other way of expressing language relatedness except the historical, reinforcing Paul's view that history is everything. Darwin (1874:60) wrote that 'Languages, like organic beings, can be classed in groups under groups; and they can be classed either naturally according to descent, or artificially by other characters'. So descent provides a natural way of thinking, and anything else would be artificial.

These trees suggest that languages split sharply and emerge suddenly in their full individuality. This, of course, is an idealization, and the splitting process is more gradual and complex, initiated by relatively minor divergences. Languages are dynamic systems and not organic entities: there is no linguistic distinction between a dialect and a language, so there is some arbitrariness in what we call a distinct language. We might say that the first change that affected, say, Latin and not any of the other languages is the bifurcation point, the point at which Latin suddenly splits. But that is not enough. Saying that French and Italian are descended from Latin glosses over the fact that they descended from different forms of Latin, and that ‘Latin’ is a cover term for many different forms of speech. As a result, the conventional tree models would require vast elaboration to be reconstructions of what happens in language change; the elaborated trees could not be stated in terms of gross sociological notions like French and Danish.⁴

Not only do these trees treat languages in the aggregate as if they were organic entities in the outside world, but they also capture only homologies, features ‘inherited’ from a common ancestor, and not ‘analogies’ (or ‘homoplasmy’), features arising independently through common responses to environmental similarities. Humans share hair and a warm-blooded physiology with chimpanzees and mice as a result of evolutionary history, or homology. Birds and bats, by contrast, fly by analogy; they have a very different evolutionary history, bats being mammals. Similarly, languages share features through a common ancestry AND because of common developments such as borrowings. This kind of commonality, due to factors other than a common history, is not expressed by linguistic trees. Common developments fall outside the explanatory range of cladograms and were the focus of efforts to develop a wave model of change (Schmidt 1872). Cladograms had explanatory value, but, being based on the results of the comparative method and correspondences, they were limited as models of change.

All retrospective sciences (evolutionary biology, physical anthropology, geology, archaeology, etc.) make the best inferences possible based on the evidence that has survived, and nineteenth-century linguists developed rich hypotheses about the elements of PIE. The further back we go, however, evidence becomes more indirect and there is more conjecture. The Indo-European and Semitic languages probably descended from a common source, which predated PIE, but it is difficult to be confident in what the words for ‘father’, ‘mother’, and so on were. Indeed, it is likely that human language evolved just once, in East Africa, and that all of the languages of the world derive from that single evolutionary step and are historically related (Larson et al. 2010). We believe this because the human language faculty appears to be uniform across the species; if it had evolved at different times in different places, one would expect to see different faculties in different groups, as one sees different visual systems that have different evolutionary histories.

However, trying to reconstruct very ancient superfamilies, like a common ancestor for Indo-European and Semitic, is precarious. Some of the reasoning is based on the genetic affinities of speakers, and this is quite dubious. South Indians are closely related to certain African groups genetically, but this tells us nothing about the languages, because linguistic and biological affiliations do not necessarily correlate. English remains a northwest European language, even though it is spoken by people from southeast Asia and Australia; and it would remain a northwest European language even if a cataclysm were to eliminate English-speaking communities outside the southern hemisphere.

⁴ Longobardi and Guardiano (2009) discuss language relatedness through sets of parameter settings, avoiding the pitfalls of the sociological conceptions.

Modern Hebrew is a Semitic language even though it has been influenced greatly by Indo-European languages.

The Nostratic superfamily has captured people's imagination and has been treated in long articles in popular magazines. The term is due to Holger Pedersen, but the idea of a superfamily goes back to the nineteenth century. Henry Sweet (1900) argued that the Indo-European family came from the same source as 'Ugrian' (Finno-Ugric), 'Altaic' (which included Turkic, Mongolian, Tungusic, and Japanese), and Sumerian. 'Nostratic' has changed over the years. A modern taxonomy (Bomhard 1990, 2008) includes Indo-European, Kartvelian (south Caucasus), Afro-Asiatic, Uralic-Yukaghir, Elamo-Dravidian, and perhaps Sumerian. Others have added a Korean-Japanese family and a new Chukchi-Eskimo group. From there it is a small step to 'Proto-World', which has also been advocated by more imaginative colleagues. Proponents of Proto-World assume monogenesis for all of the languages of the world AND assume that it can be demonstrated through the surviving properties of recorded languages. The first assumption is probably right, but the possibilities for reconstruction are too limited for us to know peculiarities from so far back (Ringe 1995).⁵

The central explanatory goal of the earliest work was to account for how a language became the way it was. Family trees explained why Germanic and Romance were similar but different in terms of their descent from a reconstructed protolanguage. Cladograms had limitations but succeeded to a degree and became a model for explanations in other disciplines emerging in the nineteenth century.

Work on the history of languages first became central in Germany, and it grew not only out of the key insight of Jones and others but also from the general intellectual movement of Romanticism. Within this line of thinking, von Goethe (1790) and his ideas about the primordial plant, the *Urform*, influenced von Humboldt and his ideas (1836) about 'organic form' in language. For some discussion, see Boeckx 2009, Chomsky 1966, Lightfoot 2006a, and McGilvray 2009. Those ideas helped to drive the deep desire for explanation that nineteenth-century philologists passed on to later generations of historical linguists.

3. SOUND LAWS. Nineteenth-century linguists studied similarities among cognate words, words derived from the same historical source; this enabled them to establish the historical relationships expressed in trees/cladograms, and then to establish the sound changes that derived one form from another historically. As the century progressed, they formulated historical 'laws' with ever greater precision. To get a taste of the enterprise, its explanatory successes and failures, let us consider the well-known shift in the Germanic consonant system, which became famous as 'Grimm's law', familiar from all introductory texts to historical linguistics.

In 1822 Jacob Grimm revised his *Deutsche Grammatik* by adding a 595-page account of the phonology of fifteen languages. He built on earlier work by Rasmus Rask and others and explicated the Germanic consonant shift. He observed that the ancient languages showed a voiceless stop where Germanic languages showed a corresponding fricative (*f*, *th*, *h*); where the ancient languages showed a voiced stop, Germanic showed a voiceless stop; and where the ancient languages showed an aspirate, Germanic showed an unaspirated voiced stop.

⁵ There has always been a tension in reconstruction work, some linguists claiming to be reconstructing prehistory and others taking reconstructions to be abstractions that express relationships among existing languages (see the debate between Lightfoot (2002a,b) and Campbell and Harris (2002)).

Grimm took the ancient languages to manifest the consonants of the hypothetical parent language, PIE, although the manifestation was not always direct. This meant that there were some changes between PIE and the ancient languages. Grimm was interested in the changes between PIE and early Germanic, viewing them as a cycle (*Kreislauf* ‘rotation’), as in Figure 2.

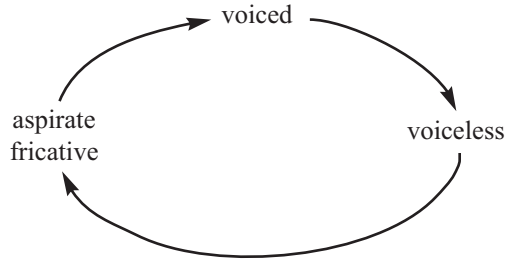


FIGURE 2. Grimm's *Kreislauf*.

The changes of this cycle explained why certain Gothic words were different from the correspondences in Latin, Greek, and Sanskrit, and construing the changes as a cycle indicated that Grimm saw them as part of a changing system, something bigger than the individual words.

There were exceptions, cases in which the hypothesized correspondences did not hold, but Grimm showed no interest in them. Others were more interested, however. Two generations of scholars sought to address the exceptions systematically, and these endeavors culminated with a discovery by Verner fifty years later.

There were three classes of exceptions. First, a voiceless stop did not change to an expected fricative if preceded by a fricative; so where the ancient languages had *est*, *esti*, and *asti* for ‘is’, Germanic shows *ist* (rather than the expected *isth*).

Second, the mathematician Hermann Grassmann showed ingeniously that PIE must have undergone a process whereby the first of two aspirates in a word was deaspirated (Grassmann's law); therefore the ancient languages showed deaspirated voiced stops in, for example, the initial segments of Sanskrit *duhitā* ‘daughter’ and *bod^hāmi* ‘offer’, so one is not surprised to find Gothic *dauhtor* and *biudan*, corresponding to PIE aspirates *d^h* and *b^h*. This rich hypothesis about PIE explained not only the shape of some Gothic words but also curious synchronic alternations in Greek and Sanskrit morphology, where stems changed shape under now predictable circumstances (e.g. ‘hair’ in Greek, nominative *t^hrik-s*, genitive *trik^h-os*), reaching a deep level of explanation.⁶

Third, in 1876 Karl Verner observed that certain voiceless stops in the ancient languages did not become voiceless fricatives in Germanic, as Grimm's law would lead one to expect, but became voiced stops. So Sanskrit *pitār*, Greek *patēr*, and Latin *pater* show two voiceless stops, indicating that the consonants for ‘father’ in PIE were *p-t-r*. The first of these stops behaved according to Grimm's law and became a fricative *f* in Germanic: Gothic *fadar*, English *father*, and so forth. The second stop, the *t*, did not, however, become a voiceless fricative; unexpectedly, it became a voiced stop *d* in Gothic. By contrast, the word for ‘brother’ worked as expected: Sanskrit shows a medial *t* (*b^hrātā*), which corresponds to a voiceless fricative in Gothic (*brōþar*). Verner showed that the different histories of the medial *t* in ‘father’ and ‘brother’ were a func-

⁶ Longobardi (2011) construes Grassmann's law as a synchronic property of PIE.

tion of the phonetics of the words: in one case the ancient accent preceded the *t* (*b^hrātā*), and in the other case it followed (*pitā*). This generalization, not surprisingly, entered the canon alongside Grassmann's law as Verner's law.

Verner's triumph in rendering Grimm's law exceptionless, alongside Brugmann's law of palatals and Osthoff's reconstruction of five vowels for PIE, made 1876 the *annus mirabilis* (Hoenigswald 1978), yielding the two theses of the Neogrammarians: sound change is regular and exceptionless, and it is phonetically conditioned. The Neogrammarians represented the conceptual culmination of the nineteenth century, and their ideas about exceptionless, phonetically conditioned changes limited the possibilities for change and thereby helped to explain why changes have the form that they have.

For example, a major contribution that had long-lasting effects was the emergence of ideas about the classes of sounds that might be affected by a historical change, and this contributed greatly to the notion of a natural class in subsequent work on the structure of phonological systems and inventories of features (for discussion, see Postal 1968 and much more). So Grimm's law affected voiceless stops and Grassmann's law affected aspirates, thereby constituting natural classes.⁷

4. PRINCIPLES OF HISTORY. The triumph of nineteenth-century linguists lay in describing phonetic changes that words undergo from generation to generation. Certainly the changes captured by Grimm's, Grassmann's, and Verner's laws played a major role in explaining how Gothic came to be what it was, descended from the reconstructed forms of PIE by virtue of those changes. This constituted a rich account of the prehistory of Gothic and led to ideas about possible and impossible sound changes, explaining why certain changes happen and others do not.

There were problems with the descriptions, however, and there were changes that were not phonetically conditioned—they were assigned to a different category of change, loosely defined as 'analogy'—and some changes, like those described in Grimm's law and the Great Vowel Shift of Middle English, were systematic, properties not just of individual sounds but of a larger system. Also, languages were, in effect, taken to be only collections of words and morphemes, and there was no work done on syntactic systems in anything like the sense in which we understand them today.⁸ Finally, referring to individual sound changes as 'laws' was a misnomer, as often noted, because they were not general laws like Boyle's law, and explanations were needed for why they took effect when and where they did. Therein lay the principal failure: by the end of the century there were impressive compilations of changes that had occurred, but no apparent reasons had been found for the changes—a failure in desired explanation.

Contemporary linguists struggled with this failure and paid much attention to matters of the explanation of changes, trying to go beyond the so-called laws to more general principles of history.

⁷ Neogrammarian ideas about possible sound changes were more explanatory than contemporary ideas about every word having its own history (Schuchardt 1885, Gillieron 1912, and Bartoli's Neo-Linguists described by Hall (1946) and by Bonfante (1947)). That work led to new descriptions of linguistic variation and change, showing how novel forms spread through a speech community and giving rise eventually to the modern sociolinguistic analyses of Labov and others. For animated discussion of these two approaches, see Bloomfield 1933.

⁸ There are titles that mention syntax, particularly Delbrück 1888, but also Behaghel 1923–28, Brugmann 1925, and, of course, the last three volumes of Brugmann & Delbrück 1886–1900, written by Delbrück and dealing with syntax. There was no notion of constituent structure nor any kind of system, however, and it was a word-based and taxonomic approach, treating the distribution of words and listing construction types in languages.

There were, at the time, two prominent models of general explanation: Newtonian mechanics and Darwinian selection. Newton saw phenomena as describable by deterministic laws of force and motion, such that all future states were, in principle, predictable in a ‘straight-line’, linear fashion from a complete knowledge of the present state. This inspired the notion of sound laws to describe the history of changes, and Franz Bopp even offered a mechanical explanation of vowel changes by invoking a ‘law of gravity’ and postulating that syllables had different ‘weights’ (for early discussion of such ideas, see Delbrück 1880).

Darwin was inspired by work on language history, and he, in turn, inspired linguists like Schleicher to treat languages as natural organisms, plants, and animals, identifying forces that would make languages fitter. Languages, like species, compete in a struggle for survival, and there were inexorable laws of change to be discovered.⁹ Darwin himself thought that languages tended to change in the direction of having shorter, ‘easier’ forms and that this could be explained by natural selection (Darwin 1874).

Nineteenth-century linguists knew that language reflected psychological properties, but, as often remarked, there was a strict demarcation between the work of linguists and that of psychologists, and contemporary ideas were problematic (Lightfoot 1999:Ch. 2). Grimm, for example, adopted a mystical belief in a Hegelian *Spracheist*, which had some existence above and beyond individuals. He explained his law of consonant shifts in terms of the psychology of Germans; it was

connected with the Germans’ mighty progress and struggle for freedom ... the invincible Germanic race was becoming ever more vividly aware of the unstopability of its advance into all parts of Europe ... How could such a forceful mobilization of the race have failed to stir up its language at the same time, jolting it out of its traditional rut and exalting it? Does there not lie a certain courage and pride in the strengthening of voiced stop into voiceless stop and voiceless stop into fricative? (Grimm 1848:417, 437; translation from Sampson 1980:30)

Linguists knew about work in psychology and philosophy, of course, and read Wilhelm Wundt and Heymann Steinthal, but generally they did not appeal to psychology to explain historical changes. Rather, there were independent principles of history to be found, a general directionality to the changes. Grimm’s, Grassmann’s, and Verner’s laws operated on the sounds of languages and were manifested in the relationship between corresponding words in different, historically related languages. They required a deeper explanation, and changes were taken to be DIRECTIONAL, as in biology, where the replacement of one species by another was taken to result from a mutation that yielded an organism more successful in the struggle for survival in a particular environment.

There was consensus that language change followed fixed developmental laws and that there must be a general direction to change, but there was active disagreement about what that direction was. Alongside Grimm-style appeals to the psychology of the Germanic race, Rask held that languages became simpler; Schleicher and others before

⁹ Linguists had spoken about languages as natural organisms for a long time, well before Darwin, and there is much to be said about the analogy between languages and species and about how the two notions were treated so similarly in nineteenth-century work. For all of his work on origins, Darwin contributed little to our understanding of what a species is, and the questions around what constituted a species were similar to those around what constituted a language as opposed to a dialect.

Similarly, in current work, biology has four principal criteria for whether organisms are members of the same species: morphological (features of form, behavior, and habitats), phylogenetic (the smallest monophyletic group in a genealogical tree), reproductive (can reproduce when mated), and biological (common genetic markers). Similar criteria indicate whether two systems belong to one language: they should have the same forms and operations, have the same historical sources, be mutually comprehensible, and have the same structural properties.

him identified a progression from isolating to agglutinating to inflectional types, although this was said to hold for preliterate societies, whereas Rask's drive to simplicity held for literate societies. Remember that linguistics was exclusively a historical science in the nineteenth century, so 'simple' was either an intuitive notion or, circularly, what languages changed to; there could be no independent definition of simplicity in the absence of synchronic generalizations.

By the end of the century, the data of linguistics comprised an inventory of phonetic and morphological changes occurring for no good reason and tending to progress in no agreed-upon direction. The historical approach had not brought a scientific, Newtonian-style analysis of language of the kind that had been hoped for; there was no predictability to changes, and the desired explanations had not been achieved. The psychological moves could not provide the necessary underpinning. Consequently, the program was not viable, and there was no science of language history that met nineteenth-century demands. The main problem was that the demands were too ambitious.

For all the talk of a general directionality, nineteenth-century linguists were not at ease with it; certainly their analyses allowed for particular, contingent factors. After all, under certain circumstances some forms of spoken Latin developed into some form of French, and under other circumstances other forms of Latin developed into Spanish and Sardinian; there was nothing intrinsic to Latin that made it develop into French.

As has been noted, the deterministic view of history, the idea that there are principles determining the way that history proceeds, is a hallmark of the nineteenth century. We have seen how it guided the study of language, and it played a role in the development of Darwinian ideas and in the domain of political history.¹⁰

Darwin read the linguists and vice versa, and Marx dedicated *Das Kapital* to Darwin. Marx too had an interesting theory of change, whereby ideas are socially embedded and are amended through conflict, through the clash of theses and antitheses. He understood social change and revolution in terms of small insults to a system building up until the system breaks. However, he built on eighteenth-century ideas that there is a political SCIENCE, a science of the relationships of human beings to each other and to their environment, and was very much a nineteenth-century thinker, caught up in notions of predestiny and determinism. He developed historical principles predicting that a feudal society must necessarily develop into a mercantilist society, a mercantilist into a capitalist society, capitalism into socialism, and socialism into communism. For Marx, the real task of economics was to explain how society evolved over time. At his funeral, Engels eulogized him: 'Just as Darwin discovered the law of evolution in organic matter, so Marx discovered the law of evolution in human history'.

5. TWENTIETH CENTURY. The nineteenth-century historicist paradigm—the notion that there are principles of history to be discovered, which would account for a language's development—was largely abandoned in the 1920s. Indeed, there was a virulent anti-historicism in the writing of structuralists like Franz Boas, Leonard Bloomfield, and Edward Sapir.¹¹ They worked on language change, showing that the comparative method could be applied to the unwritten, indigenous languages of North America; Bloomfield worked on the reconstruction of proto-Algonquian for most of his career. They also perpetuated many of the analytical procedures of historical linguists in their own synchronic work. However, they abandoned HISTORICISM and with it the earlier

¹⁰ For a general and powerful critique of historicism, see Popper 1957.

¹¹ A referee points out that Boas and Sapir adopted an approach known as 'historical particularism', rejecting the idea of a general, noncontingent directionality to change.

program of seeking to discover how languages came to be the way they are through general principles of directionality, like savagery proceeds to barbarism and then to civilization, or isolating languages become agglutinating. The historicist program was not really refuted or shown to be seriously inadequate; rather, it was abandoned as yielding diminishing returns. The paradigm had turned to psychology to avoid a built-in circularity and then collapsed because of the inadequacy of the psychology invoked.

While nineteenth-century linguistics was entirely historical, the twentieth century saw an enormous broadening of the scope of work on language, and language change was no longer the central focus. Work developed on articulatory phonetics, speech perception, language comprehension, language acquisition, sociolinguistics, computational linguistics, and much more. And analyses changed enormously. The Neogrammarians had a profound influence on the twentieth century: American structuralism essentially translated their two theses about historical change into principles for synchronic analyses, whereby abstractions were limited to surface, phonetic factors. Generative work deepened abstractions, however, and that had consequences for work on change explored by Kiparsky (1968), Postal (1968), and many others, and people began to think in terms of grammar change, change in an abstract system.

Work in sociolinguistics brought the revolutionary idea that linguists could observe change in progress by examining social variation and distinguishing the speech of different age groups, thereby revealing how innovations spread through a speech community (Labov 2001, Trudgill 2011).

Some work elaborated nineteenth-century ideas as work on language change moved beyond the history of European languages and expanded into many languages with few if any historical records, where changes had to be hypothesized through reconstructing earlier stages of the language. Hoenigswald (1960) sought to systematize the procedures for reconstruction, an important move given the centrality of reconstructed forms to the explanation of how languages got to be the way they are.

Early work in syntactic change, beginning in the latter decades of the twentieth century, continued the nineteenth-century concerns with a general directionality to change. This was particularly central in typological approaches to change in word order, where pure language types (SVO types, SOV types, etc.) were seen to be changing to other pure types by following a universal diachronic hierarchy in acquiring the features of the new type. Similarly, nineteenth-century linguists identified a tendency to ‘grammaticalize’; Meillet (1912) coined that term, subsequently refined by Kuryłowicz (1965), and modern work on grammaticalization THEORY (Hopper & Traugott 2003, Traugott & Trousdale 2010, etc.) translated that into a claim about a universal direction to change.

The synchronic work of the twentieth century developed ideas about the structures of language, going beyond ideas that languages were essentially just lists of elements. The second half of the century developed new approaches to syntax, distinguishing properties that are intrinsic to the organism from those that arise as a result of environmental influence, and distinguishing between external language in the world outside and internal systems that develop as part of an individual’s biological makeup. This research, construing a language faculty as part of human cognition, has brought new approaches to language acquisition, which, in turn, have opened new approaches to change over time.

There have been two major conceptual shifts: (i) the developing idea of an I-language, whereby individuals develop their own private, internal language, shaped by environmental experience and building on genetically prescribed principles and variable structures (Chomsky 1986), and (ii) the emergence of a cross-disciplinary

complexity science focusing on emergent properties and phase transitions in complex systems. This has opened new possibilities for explanation, and new work has solved some of the problems of nineteenth-century approaches to language change; linguists can now offer deep explanations for some changes of a kind that provide a useful model for complexity science dealing with change in other domains, but again there are limitations and puzzles remain. I turn now to that recent work.

6. POVERTY-OF-STIMULUS REASONING AND THE LINGUISTIC GENOTYPE. Under these conceptual shifts, the human brain becomes critical to an understanding of human behavior, and that raises perhaps the greatest mystery in all of science: how brain matter secretes (Darwin's word) the mental faculties where we have some understanding. Decades of work in emerging neuroscience tell us next to nothing about how that secretion takes place, and that will take new understanding of matter, the 'cognitive physiology' of Anderson & Lightfoot 2002.

If the leading questions are taken to concern the nature of the mind/brain, that is likely to have consequences for our understanding of how language systems, now seen as mental objects, change from generation to generation. We now explore such changes from that perspective.

Linguists who view the language faculty as part of human cognition, a property of the human mind/brain, aim to discover the information that is provided biologically for the development of an I-language in a child. There is much to be said about this, of course, but I draw attention first to an essential part of the methodology. If we can identify meaningful defining properties of I-languages, then that imposes limits on possible diachronic changes, and those limits, alongside the contingent environmental factors, explain why changes take the form they have.

Some syntacticians follow Gregor Mendel's reasoning from the poverty of the stimulus in identifying factors that must be built into the organism in advance of experience and cannot be derived from that experience. This entails that we postulate properties that hold of all humans intrinsically, and that affects the way we can address Darwinian questions about diachronic change. Let us start with acquisition matters.

When children develop language, they do not acquire English or Japanese but rather a private system that enables them to communicate. English is a sociological not a biological entity, and its sentences do not constitute a recursively enumerable set. This can be seen most easily by considering a sentence like *John might could drive* and asking whether it is a sentence of English; the answer is that it is in Alabama but not in Alaska, both part of the English-speaking world; it is generated by some internal, private systems and not by others.

Children do not just imitate what they hear but develop a system that is far richer than the fragmentary and limited speech that they encounter in their first few years. For example, they hear a finite number of utterances, and the system they develop must be finite but range over infinity; children develop an internal system that generates an infinite range of expressions. The system is RECURSIVE, and that property cannot be derived purely from experience. All human language systems have recursive, looping devices that permit structures of indefinite length, but no child ever heard an expression of indefinite length—they all ended. Children understand and use novel sentences all the time, and they do that by virtue of having a system that is inherently open-ended.

Furthermore, virtually every generalization breaks down in ways that are unlearnable by children, and the limits to generalizations illustrate the classical poverty-of-stimulus reasoning used by Mendel, which in turn illuminates intrinsic properties. For example,

children hear expressions with *is* in its full form (1a) or reduced (1b), and therefore they may deduce that there is an operation reducing *is* to *'s*. In 2a,b *is* is not reducible, however, and nobody would say **Kim's taller than Jim's* or **I wonder what the problem's with him*.

- (1) a. Kim is taller.
- b. Kim's taller.
- (2) a. Kim's taller than Jim is.
- b. I wonder what the problem is with him.

The limits to the generalization are not learnable, because children have no evidence for the NONOCCURRENCE of the latter cases. Mere nonoccurrence is not evidence for children, because they say many things they have not heard (for example, repeated WH-items like *What do you think what Susan ate?* are common). Furthermore, experimental work shows also that there is no learning here: children do not try out such forms in the way that they use *go-ed* or *foots*; somehow at the earliest stages when they can be tested, they just know. This is an example of what is meant by the poverty of the stimulus: what children hear is not rich enough to determine their eventual behavior.¹² That behavior is shaped in part by an internal component, much as the properties of Mendel's pea plants were subject to the requirements of internal factors, what he called genes, glossing over the distinction between information conveyed directly by genetic material and that following more indirectly from epigenetic processes.

Another poverty-of-stimulus problem: alongside 3, children hear forms without the clause introducer *that*, as in 4, and may deduce that there is an operation deleting *that*. However, 5a,b have no corresponding forms with a deleted *that*: **The car arrived yesterday Kay drove* or **Kay drove was obvious to all of us*. Again, nobody tells children that these forms do not occur, and children have no direct evidence.

- (3) a. Peter said [that Kay drove].
- b. The car [that Kay drove].
- c. It was obvious [that Kay drove].
- (4) a. Peter said [Kay drove].
- b. The car [Kay drove].
- c. It was obvious [Kay drove].
- (5) a. The car arrived yesterday [that Kay drove].
- b. [That Kay drove] was obvious to all of us.

Following Mendel, one might solve this poverty-of-stimulus problem by postulating information that is built into the organism, perhaps a condition on deletion, as in 6.¹³

- (6) Something may be deleted, if it is (in) the complement of an adjacent, overt word.

That Kay drove is the complement of the adjacent word in 3 but not in 5; in 5a it does not complete the meaning of the adjacent *yesterday*, and *that* may not delete. In 5b *that Kay drove* is not right-adjacent to anything, and *that* may not delete. In this way the

¹² *The Linguistic Review* devoted an issue to discussion of poverty-of-stimulus reasoning, but the lead article restricted its discussion to defective data and oddly excluded discussion of cases where there was an ABSENCE of relevant data (Pullum & Scholtz 2002:14–17). The cases discussed here all involve absence of relevant data.

¹³ For more details, see Lightfoot 2006b. It is not hard to see a functional motivation for restricting deletion sites to prominent positions, thereby facilitating language parsing: there are only certain places to look for deleted items.

general principle of 6 interacts with a general and learnable operation deleting clause introducers to distinguish what we say (e.g. 4) from what does not occur.

Similarly, 6 interacts with another general, learned property of English speakers: they allow the second of two identical verbs to be ‘gapped’ (*Fay saw Ray and Jim Tim*), and 6 distinguishes 7a from the nonoccurring 7b without *that*. In 7b *that Kim stayed* is the complement of an adjacent verb that is not pronounced or ‘overt’, and *that* does not delete.

- (7) a. Fay said that Ray left and Jim $\vee e$ [that Kim stayed].
 b. *Fay said that Ray left and Jim $\vee e$ [Kim stayed].

Postulating 6 as a general principle also allows us to understand the difference between 2 and the nonoccurring **Kim’s taller than Tim’s* and **I wonder what the problem’s with him* (8).

- (8) a. *Kim’s taller than Tim’s ~~tall~~.
 b. *I wonder what the problem’s ~~what~~ with him.

In 8a the understood (deleted) *tall* is not the complement of anything after *is* has been incorporated into the preceding word, nor the understood (deleted) *what* in 8b; therefore the deletions may not take place, and forms like 8 do not occur.

There is much more to be said about these analyses and a vast number of other phenomena in English and other languages explained by 6. Mendelian poverty-of-stimulus reasoning enables us to postulate three simple, learnable structures for which children have evidence in their everyday experience (9). These are the cues that are EXPRESSED by what children hear.¹⁴ Hearing a simple sentence like *Peter said Kay left* at the appropriate stage of development enables children to posit an empty complementizer, the structure 9a. Children in London and New York have such experiences in their external language, and children in Utrecht and Toulouse do not; therefore Dutch and French children do not acquire the structure 9a, because they have no relevant triggering experience in the external language they are exposed to.

- (9) a. $c e$
 b. $\vee e$
 c. DP + I

Similarly, hearing *Jay saw Ray and Jim Kim* would trigger 9b, and *Kim’s happy* triggers 9c. Children experience nothing to indicate the limits to these generalizations, and, under the view sketched here, they LEARN nothing more elaborate that blocks nonoccurring forms. Rather, the interaction of the learned structures in 9 with the general, preexisting principle in 6 yields the right distinctions.

7. SYNTACTIC CHANGE. A person’s internal language capacity is a complex system that depends on an interaction between learned operations and principles that are conveyed by the genetic material, directly and indirectly; those inherent principles are discoverable largely through poverty-of-stimulus arguments. The language capacity grows in children in response to the external language that they encounter, the source of the cues, and becomes part of their biology. If language growth in young children is viewed in this way, then we must and can explain language change over generations of speakers differently, in terms of the dynamics of these complex systems. In particular, we can ex-

¹⁴ For this cue-based, discovery approach to language acquisition by children, as distinct from grammar evaluation, see Lightfoot 1999, 2006a. Children seek cues that are provided by universal grammar and are expressed by sentences that require the cue in order to be parsed.

plain how languages shift in bursts, in a kind of punctuated equilibrium, and we can explain the changes without invoking principles of history.¹⁵

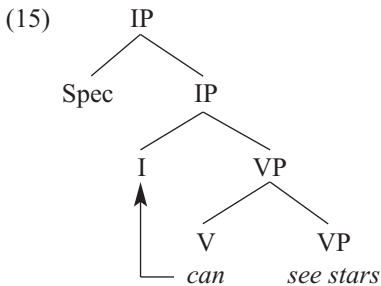
We view change as the emergence not of a new language like English but of a new private I-language in an individual. And that can happen only if children experience different PRIMARY LINGUISTIC DATA (PLD) in the external language to which they are exposed. So part of the explanation is to identify new properties in external (E-)language that trigger a new I-language in children.

Consider two structural shifts that English I-languages have undergone, two phase transitions that are now well understood.

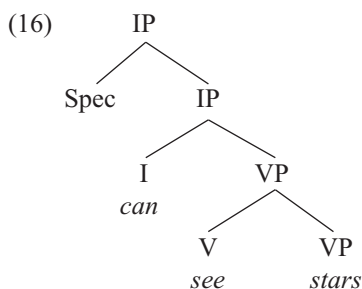
7.1. ENGLISH MODALS. Modern English has forms like 10a–14a but not 10b–14b.

- (10) a. He has understood chapter 4.
 b. *He has could understand chapter 4.
- (11) a. Understanding chapter 4, ...
 b. *Canning understand chapter 4, ...
- (12) a. He wanted to understand.
 b. *He wanted to can understand.
- (13) a. He will try to understand.
 b. *He will can understand.
- (14) a. He understands music.
 b. *He can music.

Earlier forms of English had the (b) forms, however, which were used by speakers up to Sir Thomas More in the early sixteenth century. More used all of the forms of 10–14, and the (b) forms occur in nobody's writing after him. There is good reason to believe that there was a single change in people's internal systems such that words like *can*, *could*, *must*, *may*, *might*, *will*, *would*, *shall*, *should*, and *do* were once categorized as more or less normal verbs, but then they were recategorized as Inflectional elements in all known I-languages of English speakers after the time of More. Before More, verbs like *can* moved to a higher Inflection position, as in 15, and after More they were generated directly as Inflectional elements and occurred in structures like 16, a single shift in the system, which was manifested by the simultaneous loss of the phenomena in 10b–14b, the phase transition; sentences like 10b–14b are not compatible with a system with structures like 16 (if aspectual markers are generated in Spec of VP, they cannot occur to the left of an Inflectional item (10b, 11b); there can only be one Inflectional item in a clause, and so one does not find 12b, 13b). The SINGULARITY of the change explains the PARALLELISM in the loss of phenomena. This change occurred only in English, and nothing comparable happened in any other European language.



¹⁵ Niyogi and Berwick (2009) provide a formal model of this approach.



If we ask why this or any other I-language change happened, there can only be one answer under this approach: children came to have different primary linguistic data as a result of a prior change in external language. We have a good candidate for the prior E-language change in this case.

Early English had complex morphological properties. For example, we find *fremme*, *fremst*, *fremþ*, *fremmaþ* in the present tense and *fremed*, *fremedest*, *fremede*, *fremedon* in the past tense of ‘do’; *sēo*, *siehst*, *siehþ*, *sēoþ* in the present tense for ‘see’; *rīde*, *rīst*, *rīt*, *rīdaþ* for the present tense of ‘ride’, and *rād*, *ride*, *rād*, and *ridon* for the past tense. There was a massive loss of verbal morphology in Middle English, however, beginning in the north of England (first appearing in the Lindisfarne Gospels) and due to intimate contact with Scandinavian speakers (O’Neil 1978). Again I skip interesting details (including a factor relating to the opacity of past-tense forms), but external language changed such that the modern modal auxiliaries like *can*, *shall*, and so on came to be morphologically distinct from other verbs, because as the members of the small preterite-present class, they lacked the one surviving feature of present-tense verb morphology, the *-s* ending of the third-person singular. The evidence indicates that they were recategorized in people’s internal systems because they had become formally distinct from other verbs. So we see domino effects: changes in what children heard, the newly reduced verb morphology, led to a different categorization of certain verbs (limited by the range of possible categories), which yielded systems (16) that were compatible with 10a–14a but not 10b–14b.

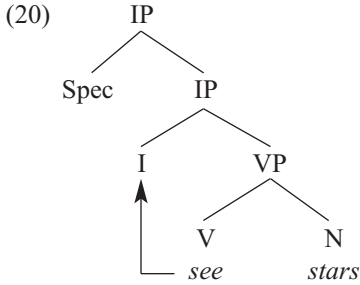
More was the last known speaker with the old system. For a period, both systems co-existed: some speakers had 15 and others had 16, the former becoming rarer over time, the latter more numerous. A large literature is now devoted to this kind of sociological variation, changing over time.

7.2. LOSS OF V-TO-I. A later major change was that English lost 17a–19a, another phase transition. Such forms occurred frequently in texts up through the seventeenth century, although diminishing over a long period in favor of the *do* forms of 17b–18b and the adverb-verb order of 19b.

- (17) a. *Understands Kim the analysis?
 b. Does Kim understand the analysis?
- (18) a. *Kim understands not the analysis.
 b. Kim does not understand the analysis.
- (19) a. *Kim reads always the newspapers.
 b. Kim always reads newspapers.

Again we can understand the parallelism of the three changes in terms of a single change in the abstract system, namely the loss of the operation moving verbs to a higher Inflection position (20; cf. 15). This is another change peculiar to English and not affecting many other European languages, whose systems have mostly retained the verb

movement operation.¹⁶ In present-day English, verbs do not move to the higher position and therefore cannot move to clause-initial position (17a), to the left of a negative (18a), or to the left of an adverb (19a). The equivalent movements continue to occur in French, Spanish, Dutch, and German systems.



This shift was due to two prior changes, and we see another domino effect. The first was the recategorization of modal verbs that we just discussed, and the second was the emergence, first in the Westcountry, of ‘periphrastic’ *do* forms as an alternative option for expressing past tense: *John did leave*, *John did not leave*, and so forth, instead of *John left* and *John left not* (Ellegård 1954 traces the spread of *do*, and McWhorter 2009 offers an interesting analysis, attributing the new *do* forms to Cornish influence). As a result of these changes affecting what children heard in external language, the Inflection position was occupied by modal auxiliaries and by *do* in internal systems and was not available as a target for verb movement in those instances. Thus, lexical verbs did not occur in that position as often as before the days of periphrastic *do* and before modal auxiliaries were no longer verbs, and as a result, the $_i[V]$ structure fell below the threshold that had permitted its acquisition by children; so it would appear.

As with the new Inflectional items, the two systems coexisted for a while, in fact for a longer period than with the earlier change: Shakespeare and other writers alternated easily between the competing old and new systems, sometimes using the old V-to-I forms and sometimes the new *do* forms, even within the same sentence.¹⁷

Again, this is too brief an account, but I hope to have made clear that two prior changes had the effect of reducing enormously children’s evidence for the $_i[V]$ structure, triggering a new internal system, and that three simultaneous but apparently unrelated changes were a function of a single change in the abstract system. One explains new I-languages in terms of new E-language, and new E-language in terms of domino effects and sociological factors like bilingualism in Scandinavian settlements and changes spreading from Cornwall.

8. MODERN EXPLANATIONS. Amorphous external language and internal SYSTEMS are different in kind, and the modern distinction between external and internal language is crucial; both play a role in explaining change (Lightfoot 2006a).

¹⁶ Vikner (1995) and others have argued that Mainland Scandinavian languages have lost V-to-I, despite verb-second main clauses, and Heycock et al. 2012 offers an interesting analysis of the loss to V-to-I structures in Faroese, examining the tail end of a change.

Haerberli and Ingham (2007) show that the apparent similarity in the distribution of negatives (18) and adverbs (19) is illusionary. Early Modern English *not* is not an adverb (contra Kroch 1989 and others) but is a NegP element.

¹⁷ One might ask why this change appears to have taken place more slowly than the category change affecting the modal auxiliaries. Perhaps it is easier for systems to coexist when they differ in terms of movement operations than it is for systems that differ in the categorization of certain words.

We have seen that the language capacity does not consist just of a set of words but is a complex adaptive system. Children are exposed to speech, and their biological endowment, a kind of toolbox, enables them to interact with their external linguistic experience, thereby growing a private, internal system that defines their linguistic capacity.

Since the systems are complex and adaptive, they involve particular abstractions, categories, and operations, and these, not the behaviors themselves, constitute the real points of variation and change. Phenomena do not change in isolation, but they cluster, depending on the abstract categories involved. As a result, change is bumpy and takes place in a kind of punctuated equilibrium. We explain the bumps, the clusters of changes, in terms of changes in the abstract system, as was illustrated in the two phase transitions outlined in the last section. If we get the abstractions right (mostly through poverty-of-stimulus arguments), we explain why phenomena cluster in the way they do.

Everybody's experience varies, and people's internal systems may vary, but not linearly. They also change over time, and sometimes variation in experience crosses thresholds and triggers the development of a different internal system. Children are sensitive to variation in initial conditions, in the terminology of chaos theory. We understand change in internal systems through the acquisition process, by virtue of children being exposed to different experiences. We explain changes in I-languages by identifying changes in the external language that children are exposed to such that the new experiences trigger different internal systems with different categories and operations. For example, after the comprehensive morphological changes of Middle English, young children had different experiences that led them to categorize words like *may* and *must* differently from verbs like *run* and *talk*. Assigning these words to a different category, Inflection, explains why 10b–14b all disappeared in parallel.

Under this approach, change is contingent, dependent on particular circumstances, and we explain why English underwent at this time two changes that other European languages have not undergone. English had peculiar morphological properties that were affected in peculiar ways by contact with Scandinavian speakers and that led to the new categorization. Other European languages were not affected in that way and underwent no change in category membership. If change is contingent like this, then there is no general direction to change, and there is no reason to believe that languages all tend to become simpler or more efficient. There are no general principles of history of the kind that nineteenth-century thinkers sought, and explanations are local.

Also, if change is sensitive to variation in initial conditions, then we can understand why the nineteenth-century enterprise of reconstructing prehistoric protolanguages met major obstacles, particularly in the structural, systematic aspects of language.

We can achieve deeper explanations for linguistic change than were possible in the nineteenth century, and the two changes sketched in the last section, reflecting work by many people, are now well understood. We assimilate the study of language change into study of the dynamics of complex systems in other domains, such as changes in species, physical environment, social organizations, economic systems, and so forth. We expect to find phase transitions, 'catastrophes', where many phenomena change in parallel: that happens when E-language changes to reach a tipping point where it triggers a different I-language in young children. And we expect to find 'emergent phenomena', new things emerging that are not determined directly by the initial conditions of language acquisition but follow from the properties of the complex, abstract system being acquired. Linguists can now offer deep explanations for such phase transitions, which may be a model for explaining phase transitions in other domains.

Where we are successful, we can identify particular elements of E-language triggering particular elements of I-language, something that has not been possible through synchronic syntax or experimental work on language acquisition (Lightfoot 2013).

There is much more to be said about the analyses sketched here, and one key idea, noted briefly, is that of competing grammars (Kroch 1989, 1994). When a catastrophe, a rapid, structural shift, takes place, it does not happen in one day. Rather, a new I-language emerges and takes over from the old one, sometimes over the course of a century or more (but typically not for a long period—see n. 17). Competing grammars explain the nature of variation within a speech community: one does not find random variation in the texts but oscillation between two (or more) fixed points. In general, writers either have all the forms of the obsolescent I-language or none.¹⁸

We may have achieved ideal explanations for certain syntactic changes in terms of how children acquire their I-language, but it is not clear that this mode of explanation extends to systematic phonological shifts like those of Grimm's or Grassmann's laws. It is unclear how new PLD could have triggered the systematic changes in Germanic consonants, and it may be that other forces are at work in phonology, where poverty-of-stimulus reasoning has not played a major role.¹⁹ Perhaps there are internal forces that drive sound change. For example, many changes can be understood in terms of an internal drive to simplify articulation: Latin *octo* has become Italian *otto*, Swedish *drikka* and *takka* have eliminated the nasal of 'drink' and 'thank', and English *family* has become *famly*. Listeners sometimes interpret what they hear differently from what was intended and change their pronunciation accordingly, reanalyzing the PLD. Often this is influenced by matters of group identity, people adopting new pronunciations as a way of identifying themselves with a group; such factors have not been shown to play a role in syntactic change.

Internal drivers may play a role in phonological change, but, in general, they are more limited in their explanatory power than the contingent, acquisition-based approach taken here and offer no grammatically based explanation for why the changes take place. In syntax, some have revived historicist claims and argued for 'UG (universal grammar) biases' as an internal driver to explain grammaticalization phenomena (Roberts & Roussou 2003, van Gelderen 2011). This enables them to unify some phenomena, which provides a level of explanation. The change of category membership for the English modals is a parade case of grammaticalization, but saying that it results from an internal drive or a UG bias gives no explanation for why it happened when it did nor under what circumstances and does not explain why the change has not happened in any other European language.

Invoking changes in the features to be checked on functional categories is also of limited explanatory value. It may explain why certain phenomena change in parallel but in itself gives no understanding of why the features changed and, given that we have no real theory of features, can be used indiscriminately.

The late nineteenth century was a remarkable period for cross-disciplinary work focusing on change, but it yielded limited explanations for language change. Cross-

¹⁸ At a synchronic level, competing grammars also provide a new understanding of apparent optionality of computational operations. If operations may be optional or obligatory, that presents severe learnability problems, because the need for obligatory operations is usually based on precluding what does not occur. That constitutes 'negative data', which are not available to young children. Positing competing grammars enables the elimination of an optional/obligatory distinction: rather, there are competing grammars, one allowing an operation, the other not.

¹⁹ For a recent argument that syntax and phonology are learned differently, see Heinz & Idsardi 2011.

disciplinary work on complex adaptive systems is leading to better explanations for phase transitions and emergent phenomena, drawing linguists, evolutionary biologists, economists, chemists, political scientists, environmentalists, and other scientists together more effectively even than in the remarkable convergence of the late nineteenth century. Where complexity SCIENCE moves beyond the level of metaphor and develops meaningful principles that might constitute a complexity THEORY, then it may usher in a new period that will achieve greater explanatory success, offering the prospect of cross-fertilization with complexity theories across the domains of physics, biology, linguistics, and the social sciences. For the moment, we have good explanations for syntactic change in some areas, and to that extent linguistics is again a lead science in our understanding of change and particularly for the big structural shifts characterized as catastrophes and phase transitions.

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Department of Linguistics
 Georgetown University
 Washington, DC 20057
 [lightd@georgetown.edu]

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