Introduction and Notes on the Text

Welcome to *Exploring Linguistic Science*! This textbook aims to introduce students to the scientific study of language, using the basic principles of complexity theory. The application of complexity to language highlights the fact that language is an ever-changing, ever-varied product of human behavior. We will begin with an introduction to the new science of complexity and its application to language. As we continue through the different areas of language study (i.e. how linguists talk about the sounds, meaning, and structure of languages) and the different ways that we experience language as speakers (in terms of cognition and the social aspects of language use), we address many theoretical perspectives. But we always come back to complexity.

As you read these chapters, note that key terms used in the study of language are found within each chapter in **bold**, with their definitions or explanations close by. These words can also be found in a list at the end of each chapter as Keywords. In terms of what you can *do* as you move through your exploration of linguistic science, we encourage you to dive into the Applications at the end of each chapter. We believe the best way to learn about language (and about the different approaches to the study of language) is by *doing*; therefore, at the close of each chapter, the reader can find a set of Applications that ask you to consider big questions and/or evaluate linguistic data in light of that chapter's discussion. Unlike traditional textbook "exercises," there isn't necessarily a "right answer" or "wrong answer" for these Applications; our goal is to get you to think, discuss, and explore the concepts and ideas (and data!) that we present. Following the chapter Applications, you can find a short list of relevant Further Reading, annotated to give you an idea of how these works relate to the topic of the chapter. Our hope is that, by engaging with the material in this book, the reader becomes aware of the academic dialog that takes place between purveyors of different perspectives on the study of language and, through that awareness, continues as an educated consumer, able to think critically and independently about what language is and how it works.

The key challenge for students and instructors in *Exploring Linguistic Science* will be the incorporation of complex systems into the mainstream coverage of linguistics. If you are not aware of this, you might think that the title refers to linguistic science as something fixed that everybody agrees about. Not so much. This book is always talking about "emergence," which is the key term from the study of complex systems. The science of complexity describes how massive numbers of random interactions can give rise to order – regularities that "emerge" from the interactions without specific causes. Complexity science is currently useful in physics, genetics, evolutionary biology, and economics, among fields that study large numbers of elements that interact with each other, but it is also a perfect fit for language. When we think of people as talkers, we can ask what happens when they mutually influence each other. The drive of twentieth-century linguistics to make the study of language more scientific as a logical system has never been as successful as linguists might have hoped. Speech, language in use, is first and foremost not a logical system but the output of a complex system, as demonstrated from first principles and copious evidence in Kretzschmar's *The Linguistics of Speech* (Cambridge, 2009) and *Language and Complex Systems* (Cambridge, 2015), and Burkette's *Language and Material Culture* (Benjamins, 2015). Emergence in languages continues wherever people are talking and writing, in every locality and in every kind of conversation or text. Thus in this book, while the text will talk about the common terms and concepts of contemporary language study and linguistics, the underlying story will be about continual emergence and re-emergence of lexical, phonological, grammatical, and discourse forms out of the interaction of speakers and the contingencies of their history.

1 A New Science

1 Introduction

We will begin our investigation of language and complex systems with Newton's cradle (Figure 1.1). Start with identical metal spheres suspended side by side along the same plane. Pull one sphere away and let it fall, and, when it hits the next sphere, it stops and the sphere on the opposite end then swings up in an arc that matches the swing of the first one. A series of "equal and opposite" arcs occurs no matter how many spheres are part of the initial swing, and the clack-clacking of the metal balls continues indefinitely. Whether you find this desktop toy meditative or annoying, it exemplifies Western understanding of cause and effect, action and reaction, a viewpoint we associate with classical mechanics.

Isaac Newton laid the foundations for **classical mechanics** in the late seventeenth century with a set of rules for a deterministic world in which the same objects subjected to the same forces always yield identical results. Newton's ideas grew out of Cartesian **reductionism**, the term used to describe Descartes' tendency to think of the world as being populated by large things made up of smaller parts, as machines composed of cogs, belts, and pistons. You can take a machine apart, separating it into its smaller parts, without losing the machine-like character of the collection. In several treatises written around the 1650s, Descartes famously described non-human animals as machines, a view made material in 1739 by watchmaker Jacques de Voucanson, who designed and built a "digesting duck" (Figure 1.2). In this model, the sum of the whole is equal to its parts and in order to understand something, you just need to take it apart. We know now that this approach might work for toasters, but it doesn't work for living, changing systems, such as animals or weather patterns. Or language.

Newton built his physical theories on a reductionist platform and the resulting laws of classical mechanics explain the motion of the planets, the path of pins struck by bowling balls, and yes, the rate at which an apple falls from a tree. However, more recent physics has seen this kind of deterministic and reductionist view fall short when dealing with things that are super small (such as subatomic particles) or super large (such as black holes). These phenomena are instead governed by quantum mechanics and quantum gravity, and classical mechanics has had to give way to a world made up of wave

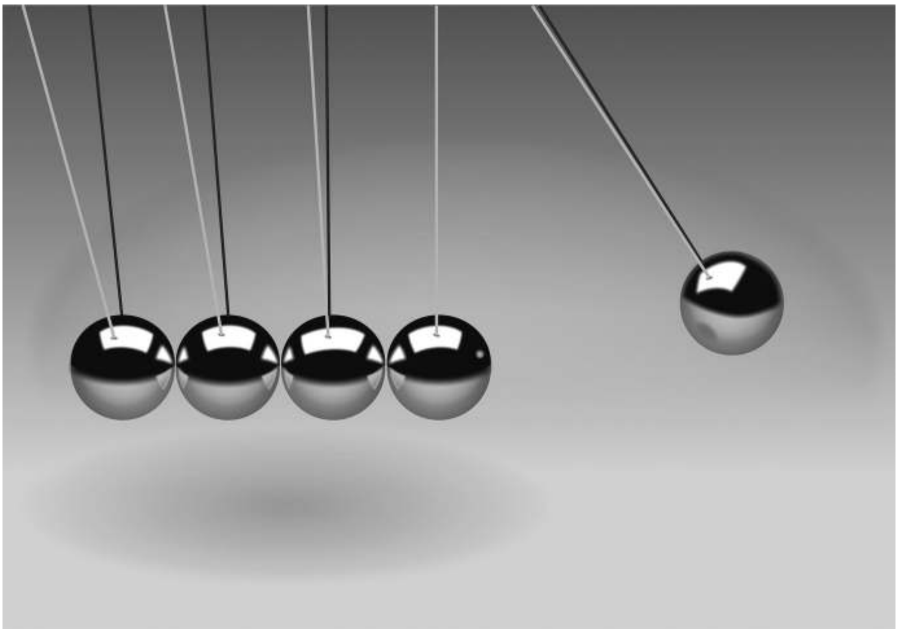

Figure 1.1 *Newton's cradle: Newton's laws of motion at work.*

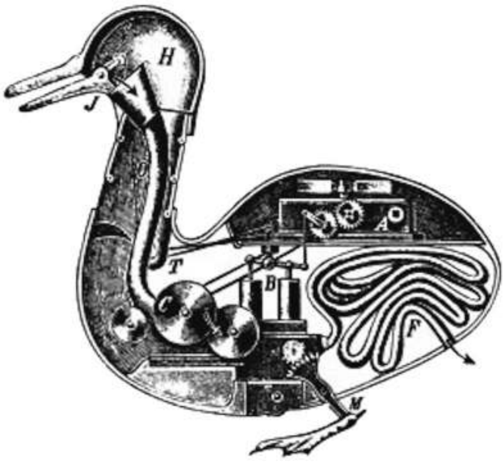

Figure 1.2 *The Voucanson duck, an automaton designed to reproduce animal digestion.*

functions, probability distributions, and uncertainty principles. It turns out that the designations "particle" and "wave" don't quite cover it. The future state of an object can't necessarily be predicted by its present state, though you can use probability distributions to hypothesize about possible future states. And you can only accurately measure one thing at a time.

The physical sciences may seem like a strange place to start a discussion about language, but the current shift in thinking about the physical world, from a reductionist view to one that is more holistic and probabilistic, is taking place in our thinking about language as well. Reductionism in linguistics can be witnessed in accounts of linguistic phenomena as combinations of only a few core concepts. It is not uncommon to hear language described as a molecular structure, with sounds as atoms, combining to make molecules of meaning, which then further combine into the elements of discourse. But language is more than the sum of its parts, and language has *a lot* of parts. Newton's Laws work just fine for swinging metal balls and for planets, and they work great for small sets of balls and planets, but when there are great numbers of interacting components, we can no longer predict how the classical laws will apply.

1.1 A New Science

In recent decades, really since the 1980s, **complex systems** has developed as a new science to work on problems where lots of components interact with each other. It turns out that, in a great many cases in the world around us, big clusters of components behave in similar, often unexpected ways. It turns out that patterns emerge from interactions among the components that cannot be predicted by mechanical laws. These patterns are probabilistic, in that they all have the same kind of distributional profile (or frequency profile) in terms of what all of the components are likely to do. The patterns also appear at different scales, so that it is possible to see a pattern for all of the components, and also to see that same pattern repeated for subsets of the components, down to just a few at a time. So, in the new science of complex systems, we expect to study the emergence of frequency profiles and scaling, rather than simple effects from simple causes.

One of the most interesting illustrations of emergence is described in the popular book *The Grand Design* by Stephen Hawking and Leonard Mlodinow, a book about contemporary theory in physics. Let's start with an example that's easy to imagine: If somebody were to throw tennis balls through a good-sized hole in a wall, one with a net behind it, all of the balls would be caught at about the same place in the net. Some would be a little off to the left, some a little to the right, with most of the balls in the middle. Physicists like Hawking and Mlodinow don't throw tennis balls through a wall into a net, but they do use a machine to shoot photons (particles of light) through a slit so that they are detected behind it. If somebody directs a stream of photons toward a barrier with one slit in it, the result is the same as throwing tennis balls through a gap in a wall. Most of the photons hit the detector right behind the slit, with some a little to the left and some a little to the right (Figure 1.3). Something interesting happens when you add another slit and shoot photons through two slits instead of just one. If you have two slits, the photons don't just hit the detector right behind each slit in unified patches as you might expect, like two instances of the "single slit." Instead, the photons make an alternating striped pattern all across the detector *because the photons take random paths to the detector*; they don't just travel straight routes through the slits like a tennis ball would. The pattern shown on the screen of Figure 1.3 emerges as photons fly through the slits and then interact with each other as they travel toward the detector.

The stripes on the detector are thus an interference pattern from the photons interacting with each other. Most of the photons go straight through the slits, but some of them take a different route. This is the frequency profile of the routes: A large number of them go straight through, but some go around the barrier, some go over the barrier, and a few go to the other end of the universe first before they hit the detector. If a great many photons are shot at the two slits and detector, a striped pattern is produced; any subset of the photons large enough to register also makes the same pattern. It turns out that very small things that behave together in large numbers, like photons or the smaller bits considered in quantum mechanics, act differently together than the way that larger things like balls and planets act individually. They interact in a complex system. Physicists like Hawking and Mlodinow have to consider how masses of components like photons or quanta behave, not just how the individual bits behave. And when they do, they use the evidence to develop their grand design for parallel universes. The new science of complex systems has turned out to be not only relevant for physics, but cutting-edge. Complexity helps us to explain something that does not come out as we expect it should, such as the pattern of photons behind two slits. Without a new science to help us, the results of the two-slit experiment would be mysterious, something we could not explain.

In this book, we will explain how the new science of complex systems helps us to understand human language. Planets and photons are physical objects, and they take part in complex physical systems. Language, however, is something that people use. Language is a complex adaptive system, where

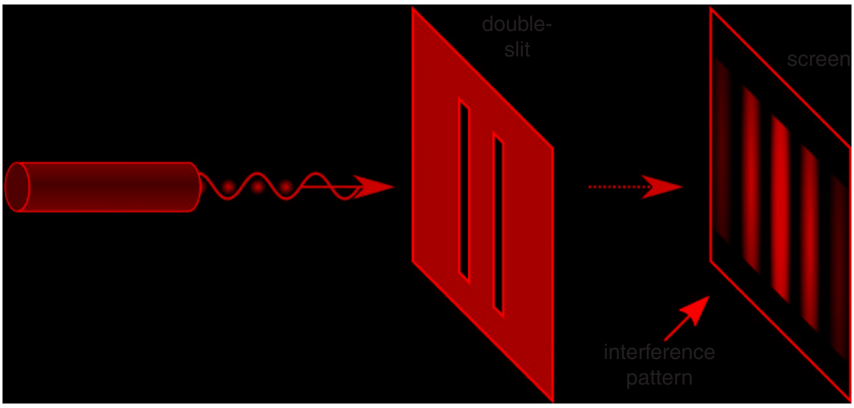

Figure 1.3 *The two-slit experiment.*

the speakers and writers who use it (the **agents**) interact with each other and change what they write or say depending on whom they interact with. Unlike planets or photons that interact but stay the same themselves, the agents change as they are involved in the complex system, which means that agents are able to use language differently in every **situation of use** for language. So, people can use their language differently when speaking to family members as opposed to teachers, or when writing a paper about English literature as opposed to a biology lab report. Speakers in Glasgow use language differently from speakers in Bristol, and both of them use language differently from speakers in London. Within London itself there are many sections of the city with different ways of speaking, sometimes influenced by the different ethnic backgrounds of the speakers. Situations of use for language can have a geographical aspect, or a social aspect, or what we might call a textual aspect, whether the texts are English papers vs. the lab reports, or family conversations vs. class discussions.

All of us are agents in the complex system of human language, and all of us adapt ourselves to the situations in which we have to use language. We all have a repertoire of what we can do with language, and we use components of our language – pronunciations, words, grammatical constructions – in different ways in different situations. Just as the photons arrange themselves in frequency profiles, patterns in language emerge from our interaction with other people in different situations of use. Frequency profiles in language reflect the components we tend to use with particular people/groups or in particular situations of use. As observers of language, we can measure these frequency profiles for each situation of use, or for whole social groups, or whole regions, or for a language overall. As with the two-slit experiment in physics, our understanding of complex systems helps us to understand something about language that would otherwise be mysterious, something we couldn't explain.

1.2 Prescriptive vs. Descriptive Views of Language

The complex systems view is not what is taught in schools about language. The general, popular understanding of language (in Britain and America, as well as other countries) is that there is a "right" way to speak and write language, a "correct grammar," if you will. At the same time, not very many people are willing to say that they typically use "correct grammar" themselves. This property of "correctness" that people attribute to their language is often cast as "Standard" English (or whatever language) and it is taught to children in elementary and secondary schools. Linguistic correctness has practically become a moral virtue, so that speakers and writers who do not use "Standard" language are not taken as seriously as people who do use it. This doctrine of correctness is called **prescriptive grammar**. Much the same way a doctor prescribes medicine in an attempt to improve the health of a patient, the prescriptive viewpoint aims to "repair" the language of its adherents. The assumption is, if there's a "right" way to use language, then there is also a "wrong" way. Since Standard English, or Standard other languages, are what get taught in the schools, all of us grow up with an idea of what that "right" way is, but most of us also grow up with the knowledge that, in many situations, we just don't use the Standard language, and if we think about it, we may feel bad about our language use. Or our teachers may imply that something is wrong with us when they give us bad marks in language arts classes.

Linguists, on the other hand, have pursued **descriptive grammar**. Rather than trying to tell people what to write, sometimes even how to talk, linguists are interested in talking about language as it is actually used. One could argue that this approach to language is an objective one, as opposed to the subjective statements made by prescriptivists about the "quality" of a person's language use. Note that linguists use the term **grammar** to refer to the collective rules of a given language, which includes pronunciation and **syntax** (how words are arranged into sentences), and, to an extent, meaning as well.

Historically, the field of linguistics is quite new. The beginnings of the discipline are often traced back to Sir William Jones, a British diplomat in India who, upon noting similarities between Sanskrit, ancient Hebrew, and ancient Greek, postulated that these languages were genetically related as part of a larger Indo-European family of languages. This comparative approach to the study of language grew into the historical linguistics of the nineteenth century, when scholars began in earnest to compare languages in an attempt to look for patterns to the changes that took place in related languages over time. The so-called Neogrammarians believed in a mechanistic view of language change, that changes in language over time were regular and predictable in the sense that, once you found the pattern, it applied in all cases. The Neogrammarians brought a scientific regularity to commentary on language that, before that time, had often been concerned with mystical questions about the seeming magical power of words in magic, or even spiritual/religious questions like what the first language was or what Egyptian hieroglyphics might mean. Around 1900, Ferdinand de Saussure, a linguist with Neogrammarian training, famously divided the early science of language into the study of ***langue*** (linguistic structure) as opposed to the study of ***parole*** (what people actually said) (Saussure 1972). At that time the means to record and analyze *parole* (i.e. to record what speakers were saying) were very limited, so Saussure preferred that the field of linguistics should focus on abstract and systematic rules that form the structure of language. Linguistics, then, from the early days of its development as an academic subject, focused on linguistic structure as its object of study, a tendency that greatly informed the development of the field and (for better or worse) still impacts language study today.

Two different basic approaches to grammar have been popular in American linguistics: **structuralism** and **generativism**. Both approaches are descriptive in nature – neither approach holds that there is a "right" way and a "wrong" way to use language – though the two schools of linguistic thought differ a good bit in terms of their methods and interests. Structuralists gather information about a language from a small number of speakers (sometimes just one or two), and attempt to describe the grammar of the language from what they say. It is not necessary to talk to more than a few speakers because the structuralist assumes that the speakers of a language are more or less alike in that, as members of the same **speech community**, they share a grammar. Structuralism is grounded in anthropological methodology in that these are linguists who go out into the field to gather data and then use that data to make generalizations about a particular group of speakers. Generativists, on the other hand, have worked more abstractly to study grammar as it contributes to the description of "universals" common to all languages. **Universal Grammar** (or **UG**), as it is called, is believed to be an innate set of rules that underlie all human languages. Generativists believe that the human brain is "hard-wired" with a set of principles from which the parameters of every human language can be derived. Further, generativism has focused on the creation of the smallest possible rule systems that could then "generate" all acceptable sentences of a language, according to grammaticality judgments of its speakers. Structuralist descriptions start small and get bigger, while generative descriptions start big and get smaller. Both approaches assumed, in line with Saussure, that there must be an underlying structure to language that helps explain how the speakers of a language learn/acquire language and then go on to use and understand it.

In Britain, on the other hand, linguists developed a quite different approach, one that focused on meaning rather than structure. So-called NeoFirthian linguists were interested in structure as it helps us to understand the meaning of utterances, but they broke away from Saussure and his focus on grammatical structure in favor of looking at the circumstances *outside* of the language that help to create meaning, in every situation of use. For them, meaning comes from repetition by speakers of common multiword patterns, each of which means more than the sum of its constituent parts (the separate words), which means that speakers understand each other as much by habit as by grammatical rules. In the NeoFirthian tradition, the only way to get at how language works is by the observation of real language, and the more real language that can be observed, the better. This has meant the early and continuous emphasis on linguistic **corpora** in Britain, large collections of real writing and speech that the advance of computer technology has made it possible to store and analyze.

At the same time that the structuralist, generative, and NeoFirthian approaches were developing in America and Britain, other European linguists went looking for local language in another way, as part of the

linguistic atlas movement. A linguistic atlas is exactly what it sounds like it would be: a map of where people use specific words or languages. Beginning in Germany and France, linguistic atlases surveyed speakers across large regions, and found that a language was quite different from place to place across a wide area. For English, there are two major surveys: The American effort is called the Linguistic Atlas Project (LAP), which began in 1929, and the British counterpart, the Survey of English Dialects (SED), which began after the Second World War. Linguistic atlases collected huge amounts of data, so much so that it was difficult to store and analyze the data until modern computers became available. The Atlas data underscored exactly how extensive language variation really was, and that fact has challenged the prevailing focus of American linguistics on grammar, and has also enriched the possibilities for the NeoFirthian focus on meaning. Beginning in the 1960s, the sociolinguistics movement (somewhat differently in Britain and America) has also generated large amounts of data about language variation, mostly focused on variation between social groups rather than across large regions. When linguistic atlas surveys and sociolinguistic projects are added to NeoFirthian corpora, all of the evidence about language variation demands that good descriptions of a language should take account of variation. How is it possible that we could have a single grammar of a language, yet at the same time have so much variation in how writers and speakers use the language?

1.3 Looking Ahead

The new science of complex systems gives us a way to answer that question. The next chapter will explain how complex systems work in much more detail, and then as the book continues, it will explain how a complex systems approach permits a different view of language and linguistics. Each chapter will introduce terms and concepts from linguistics as it has been practiced for many years, and then show how we can think differently about the same terms and concepts when we take a complex systems point of view. Finally, at the end of the book there are chapters that tell you how to do your own complex systems analyses. What you will find out from reading this book and trying out the exercises is that you can no longer think about language in quite the same way. The new science of complex systems is a revolutionary approach that explains problems in the understanding of human language, much as complex systems explains why Newton's Laws are not enough to enable us to understand some physical situations. More than that, complex systems provides an answer to the question of how what people actually say and write can be related to a grammar of their language.