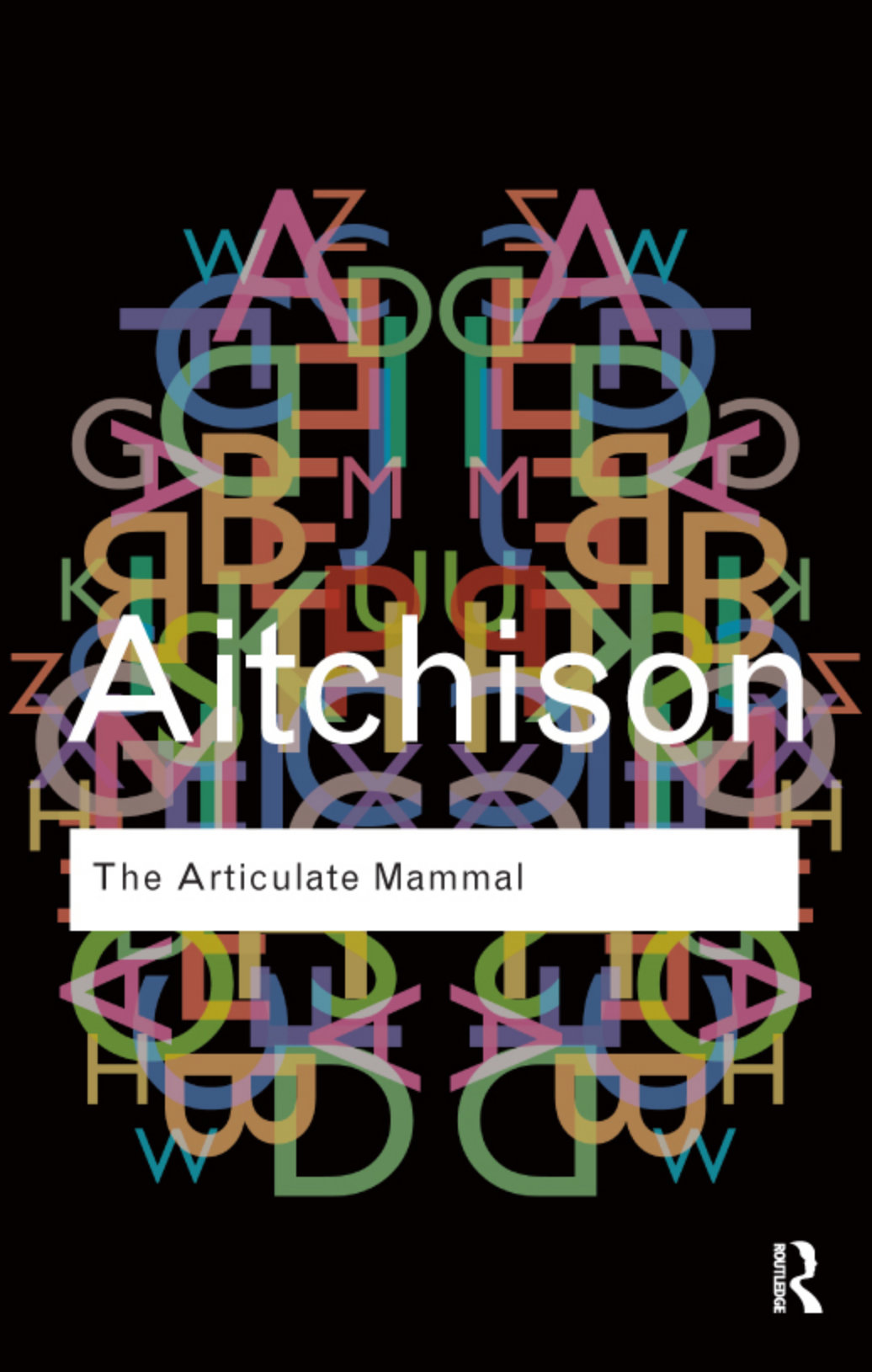

Aitchison
The Articulate Mammal
ROUTLEDGE

The Articulate Mammal

'An excellent and very welcome guide to psycholinguistics . . . highly recommended.'

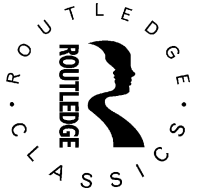
The Washington Post

'The reader's curiosity about the complexities of the mother tongue is kept right to the end.'

The Times Educational Supplement

'This is an excellent text which would give the undergraduate student as fine an introduction to the field of psycholinguistics as is available today.'

Choice



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Jean

Aitchison

The Articulate Mammal

An introduction to psycholinguistics

With a foreword by the author

London and New York

First published 1976 by the Academic Division of Unwin Hyman Ltd

First published by Routledge 2008

First published in Routledge Classics 2011
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

Simultaneously published in the USA and Canada
by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging in Publication Data
Aitchison, Jean, 1938–
The articulate mammal : an introduction to psycholinguistics / Jean, Aitchison ; with a foreword by the author.—Routledge classic ed.
p. cm.—(Routledge Classics)
Includes bibliographical references and index.
ISBN 978–0–415–61018–6 (pbk. : alk. paper)—ISBN: 978–0–203–82824–3 (e-book) 1. Psycholinguistics. I. Title.
P37.A37 2011
401'.9—dc22
2011003600

ISBN: 978–0–415–61018–6 (pbk)
ISBN: 978–0–203–82824–3 (ebk)

Typeset in Joanna
by RefineCatch Limited, Bungay, Suffolk

Contents

Foreword to the Routledge Classics Edition

Psychology and linguistics are sometimes claimed to have been first connected in the writings of Wilhelm Wundt (1831–1920), a 19th century psychology pioneer. His linking of the topics predated the label *psycholinguistics*, which came later. It was still in its early days in the 1960s, when it became an increasingly popular topic in psychology textbooks.

The Articulate Mammal, when it was first published (1976), was possibly the first introduction to psycholinguistics written from the point of view of a linguist, that is, a professional scholar of linguistics, the science of language. Its aim was threefold: first, to spread information about the biological nature of language, and to outline current work on how children acquire language; second, to explain the ideas of Noam Chomsky to non-linguists; and third, to summarize recent ideas on speech comprehension and production. The book received a batch of encouraging reviews, especially in the USA, where an American library journal selected it as one of its outstanding academic books of the year.

The information about the biological nature of language was based on the pioneering work of the biologist Eric Lenneberg, who had written a lucid and inspirational account in his groundbreaking book *Biological Foundations of Language* (1967). Lenneberg was possibly the first person to explain that language, much like walking or sexual behaviour, was biologically triggered. It was scheduled to emerge at a particular time in an individual's life, provided that the surrounding environment was normal, in that the child must hear language spoken around him/her. Lenneberg died unexpectedly in 1975, and I was pleased to be able to spread news of his work to a wider audience. (My book was already in press when Lenneberg's death was announced). *The Articulate Mammal* therefore not only made Lenneberg's ideas more widely

known, but also (hopefully) kept his name and findings in the minds of future generations.

Lenneberg was prescient in ways he could never have imagined. In the years since his death, the biological aspects of language and the brain have come to the forefront in research, as outlined in the latest (5th) edition of *The Articulate Mammal* (2008). First, and most importantly, brain scans have become the norm. These can not only provide new information about language and the brain, but can also support (or disprove) linguistic hypotheses.

In the earliest brain scans, the data obtained were fairly general. Scans could, for example, show up the density of brain tissue, which might aid in identifying a tumour. Later scans (summarized in chapter 3) provide a three-dimensional image of blood flow in the brain, which can reveal brain activity. Early scans were invasive, in that they required radioactive water to be injected into a vein in the arm. The subjects were asked to perform progressively more complicated tasks. For example, researchers might ask subjects to listen to words at one time, at another time to read them, and the brain areas activated were recorded and compared. Then subjects were asked to supply a verb for any nouns they heard or saw: the noun *hammer* might elicit the verb *hit*, or the noun *apple* the verb *eat*. This research suggested again that linguistic and neurological studies could usefully support one another.

But the study that caused the greatest interest was one which investigated verbs, comparing brain activation for regular past tense formations (e.g. *jumped*) with irregular ones (e.g. *sang*). The researchers found that irregular past tenses elicited a significantly greater amount of brain activity than the regular past tenses. This finding was no surprise to linguists, who had long ago concluded that past tenses of regular verbs are formed by the application of rules, but that irregular past tenses involve lexical memory. The importance of this finding was that it showed yet again that linguistic assumptions could now be checked by neurologists.

These days, brain scans are non-invasive and have become increasingly sophisticated. Functional magnetic resonance imaging (fMRI) is now widespread. The patient is placed in a scanner, and a painless (though noisy) procedure produces 3-D images of blood and oxygen in the brain. The main drawback (at the present time) is that these scans provide almost too much data, and researchers are still struggling to isolate the most relevant.

As these studies show, Lenneberg's work inspired huge steps forward, and neurolinguistics (language and the brain) is expected to take further leaps ahead in the future.

The work of Noam Chomsky provided another vital springboard for psycholinguistics, arising initially from his review of a book *Verbal Behaviour* (1957), whose author B.F. Skinner was a leading behavioural psychologist. Skinner had argued that, just as rats and pigeons could be trained to do a

series of complex tasks by means of 'operant conditioning' (trial-and-error learning), so human language learning could be explained in a similar way.

Chomsky wrote a witty and devastating review of this book, pointing out that the behaviour of trained rats is irrelevant to human language. Anyone who made ambitious assertions about language needed to know more about its basic nature, he argued. *The Articulate Mammal* begins (chapter 1) by summarizing the key points of Chomsky's review, and agreeing that he was essentially right when he said that anyone who made strong claims about language needed to understand it. *The Articulate Mammal* tries to do this by explaining both its biological nature (as explained above), and also by summarizing some of Chomsky's basic ideas.

In the influential 'classic' version of his work (1965), Chomsky put forward a new conception of a 'grammar'. In the past, he observed, linguists had written descriptive grammars, which had tried to describe an accumulation of already uttered sentences. But a person who has acquired a language has not simply memorized past sentences. Instead, he or she has internalized a set of 'rules' that allow him/her to produce and understand an indefinite number of novel utterances. Chomsky was interested in the workings of this internalized rule structure. In short, he hoped to encapsulate a speaker's knowledge of his/her language, rather than just their usage. This knowledge, he suggested (1965), might be captured best by a type of grammar he labelled a 'transformational' grammar', which had two levels of structure, deep and surface.

Chomsky's ground-breaking transformational grammar began (at that time) with a set of basic phrase structure rules. These outlined the essential underlying sentence structure. Then so-called transformations changed this 'deep' structure into the surface structure of a sentence.

Chomsky had promoted a new way of approaching the study of language. Yet some students found his writing difficult to understand. This student reaction to Chomsky prompted a chapter in *The Articulate Mammal* called 'Celestial unintelligibility: Why do linguists propose such bizarre grammars?' (chapter 8). This chapter, much enjoyed by students, was written as a fairy tale, about a mythical Emperor of Jupiter who became intrigued by the ability of a space-ship full of English speakers to communicate with one another. He arrested their captain, a man called Noam, who clarified how language worked. Noam explained by recounting in a simplified way how he had reached his idea of a transformational grammar. This chapter is still included in the latest edition of *The Articulate Mammal*, though with minor updating, including some extra comments about why transformational grammar has appeared to be abandoned by Chomsky in his latest work.

Chomsky himself has always denied that transformational grammar was related to sentence production. In his view, it encapsulated sentence relatedness, not sentence processing procedures.

Yet to psychologists, this type of grammar appeared (at first) to follow a sequence of steps which, they argued, (wrongly) might be viewed as the way in which speakers prepared a sentence for utterance. The rise and fall of transformations in the minds of psychologists is described in chapter 10, 'The white elephant problem'.

In spite of Chomsky's warnings that transformational grammar was primarily about sentence relatedness, George Miller, a prominent psychologist and a professor at Harvard University, conducted a series of experiments in the 1960s to test the relevance of transformations to speech processing. He explored whether the sequence of rules used in the grammatical derivation of a sentence corresponded to the psychological steps that are executed when a person processed that sentence.

Miller reasoned that if transformations affected processing time, this could be measured. He therefore checked how long it took to match a simple active declarative sentence such as *Joe warned the old woman* with its passive *The old woman was warned by Joe,* or its negative *Joe didn't warn the old woman,* or, lastly, passive and negative together. Just as he had hoped, he found (initially), that it took twice as long to match a simple sentence such as *Joe warned the old woman* to one which differed by two translations (passive and negative) such as *The old woman wasn't warned by Joe,* as it did to match a sentence with either a negative or passive alone. He and his fellow psychologists were jubilant, and the so-called 'correspondence hypothesis' – the idea that a transformational grammar corresponded to a person's processing of language was (briefly) enthusiastically embraced.

But then disillusion crept in. Numerous transformations were found which certainly did not take up processing time. In some cases, the version closest to the deep structure took longer to process. For example, a sentence *John runs faster than Bill* took less time to process than a similar meaning sentence which was nearer to the deep structure, *John runs faster than Bill runs*. Eventually, the correspondence hypothesis was abandoned. Reluctantly, psychologists accepted that transformational grammar was not relevant to speech production

Chomsky has changed his mind repeatedly over the way in which linguists should handle language, and in the last two decades of the twentieth century proposed several new versions of transformational grammar, each one more abstract than the last, and (to the average student), harder and harder to understand. His latest version even abandoned just about all transformations! He claimed that he was no longer interested in looking at individual constructions, instead he was trying to find basic laws of nature, the linguistic equivalent of the law of gravity. *The Articulate Mammal* in its latest edition (chapter 5) has tried to explain (in outline) Chomsky's newer views.

But just because Chomsky's ideas have become more wide-ranging and abstract, this is not necessarily true of the views of all linguists. Others have

argued that language is a complex interweaving of linguistics with other cognitive abilities. The origin of language has become a trendy topic and multiple books are beginning to be published, showing how the various human cognitive abilities are interwoven.

Meanwhile, language processing has not been forgotten, and psycholinguists have continued to explore speech comprehension, as well as speech production. These topics are outlined in chapter 10 and 11 of *The Articulate Mammal*. And a key to much of this is turning out to be the lexicon, the human word store. Humans, it seems, rarely acquire words as single packages, apart from a few names of people and objects. Instead, they often learn them alongside words frequently found with them. *The Articulate Mammal* refers to some of this work, but also refers readers to my own book on the topic: *Words in the Mind: An Introduction to the Mental Lexicon* (3rd edition 2003, 4th edition in preparation), Oxford: Blackwell.

Overall, psycholinguistics is in a healthy state. Study of the biological basis of language is still in a vigorous state of development, both via studies of the brain, and the origin of language. Chomsky is no longer the key force he once was, though it is still important to understand his contribution to linguistics, as it broadened the topic out into a general study of human linguistic ability, and how much of it might be preprogrammed. These days, researchers are moving into even wider questions, trying to understand how our various cognitive abilities link together. The next century will be an exciting one, as all these various strands (hopefully) come together.

Preface to the First Edition

Some years ago, I gave an evening course entitled 'Psycholinguistics'. I was quite amazed at the response. A large, eager and intelligent group of people arrived, many of them with a serious reason for wanting to know about the subject. There were speech therapists, infant school teachers, an advertising executive, a librarian, an educational psychologist – to name just a few of those whose jobs I noted. There were also parents interested in understanding how children acquire language, and one student who wanted to know how she might help a relative who had lost her language as a result of a stroke. In addition, there were a number of men and women who said they 'just wanted to find out more about language'.

The Articulate Mammal was written for the members of that class, and for others like them: people like me who would like to know why we talk, how we acquire language, and what happens when we produce or comprehend sentences. The book is also intended for students at universities, polytechnics and colleges of education who need an introduction to the subject. It cannot, of course, provide all the answers. But I have tried to set out clearly and briefly what seem to me to have been the major topics of interest in psycholinguistics in recent years, together with an assessment of the 'state of play' in the field at the moment. I hope it will be useful.

I am extremely grateful to a number of scholars who made helpful comments on the manuscript. In particular, and in alphabetical order, Michael Banks of the London School of Economics, David Bennett of the School of Oriental and African Studies, Paul Fletcher of Reading University, Jerry Fodor of the Massachusetts Institute of Technology, Phil Johnson-Laird of the University of Sussex, Geoffrey Sampson of Lancaster University, and Deirdre Wilson of University College, London.

The book would probably have been better if I had taken more notice of their comments – but as the suggested improvements were often contradictory, it was difficult to decide whose opinion to accept. In cases of doubt, I preferred my own, so I am wholly responsible for any errors or oversimplifications that the text may still contain.

My thanks also go to Irene Fekete, the evening-course student (and Hutchinson's executive) who persuaded me to write this book.

Let me add a brief note on style. In English, the so-called 'unmarked' or 'neutral between sexes' pronoun is *he*. Had I used this all the way through *The Articulate Mammal*, it might have given the misleading impression that only male mammals are articulate. I have therefore tried to use an equal number of *he*s and *she*s in passages where a 'neutral between sexes' pronoun is required.

Jean Aitchison
London, 1975

Preface to the Fifth Edition

In the thirty plus years since this book was first published, psycholinguistics has increased considerably, both in popularity and in the amount written about it. It has expanded like a young cuckoo, and is in danger of pushing some more traditional interests out of the nest. Or, to take another metaphor, it has behaved like an active volcano, belching out an increasing lava-flow of important findings which have poured out over almost all areas of linguistics and psychology, and have – to some extent – changed the shape of the landscape.

Luckily, many of the questions asked remain the same, though many more answers have been proposed. It is clearly impossible to include all the new developments in this revised edition. I have, however, attempted to outline those which seem most relevant to the issues discussed in this book. No chapter remains unaltered, and some have undergone substantial additions and/or changes. For example, human 'mind-reading', the ability to understand the intentions of others, is turning out to be a key property underlying language (Chapters 2–3). Huge steps forward have been taken in understanding the brain, largely due to the increased sophistication of modern brain scans (Chapter 3). Chomsky's ideas are still recognized as playing a foundational role in modern psycholinguistics, but are these days being pushed out of the limelight by the work of a younger generation of scholars (Chapter 5). Verbs have continued to take centre stage in children's acquisition of language (Chapter 7) and in speech comprehension (Chapter 10). And so on, and so on. In addition, numerous new references have been added. I hope this new edition will enable readers to keep up with what is happening in the field at the moment.

As before, I am grateful for the skill and help of those at Routledge, especially (for this edition) Nadia Seemungal.

Jean Aitchison
London, 2007

I find my position as an articulate mammal bewildering and awesome
Would to God I were a tender apple blawssom

Ogden Nash

Introduction

Psycholinguistics is sometimes defined as the study of language and the mind. As the name suggests, it is a subject which links psychology and linguistics. The common aim of all who call themselves psycholinguists is to find out about the structures and processes which underlie a human's ability to speak and understand language.

Both psychologists and linguists are involved in studying psycholinguistics. As one group of researchers has noted:

> The name says it all . . . it is simultaneously psychology and linguistics. At the heart of the discipline, therefore, is the relationship between these two fields, each of which can boast centuries of research tradition . . . By contrast, psycholinguistics itself is relatively young . . . psycholinguistics as we understand it today and as a discipline with its own name has only been in existence since the mid-twentieth century.
>
> (Cutler *et al.* 2005: 1)

(A complete list of references quoted in the text is contained in the References on pp. 246–69.)

Both psychologists and linguists can be classified as social scientists, so in one way their approach has long been similar. All social scientists work by forming and testing hypotheses. For example, a psycholinguist might hypothesize that the speech of someone who is suffering from a progressive disease of the nervous system will disintegrate in a certain order, perhaps suggesting that the constructions the patient learned most recently will be the first to disappear. This hypothesis will then be tested against data collected from the speech of someone who is brain-damaged. This is where psychologists and

linguists sometimes differ. Psychologists test their hypotheses mainly by means of carefully controlled experiments. Linguists, on the other hand, test their hypotheses mainly by checking them against spontaneous utterances. They feel that the rigidity of experimental situations sometimes falsifies the results. Neither way is right or wrong. Provided that each side is sympathetic to and interested in the work of the other, it can be a great advantage to have two approaches to the subject. And when the results of linguists and psychologists coincide, this is a sure sign of progress.

Most introductory books published so far have been written by psychologists. A few have even argued that the name 'psycholinguistics' should be restricted to psychological experiments on language. This book is an attempt to provide an introduction to the subject from the linguist's point of view – although inevitably and rightly, it includes accounts of work done by psychologists. It also covers some of the work done by both linguists and psychologists under the broad umbrella label 'language and mind', or (more recently) 'cognitive linguistics'. This book does not presuppose any knowledge of linguistics – though for those who become interested in the subject, a number of elementary books are suggested on pp. 240–5.

Psycholinguistics is in many ways like the proverbial hydra – a monster with an endless number of heads: there seems no limit to the aspects of the subject which could be explored. This is a rather unsatisfactory state of affairs. As one researcher expressed it: 'When faced with the inevitable question, "What do psycholinguists do?" it is somehow quite unsatisfactory to have to reply, "Everything" ' (Maclay 1973: 574). Or, as another psychologist put it:

> Trying to write a coherent view of psycholinguistics is a bit like trying to assemble a face out of a police identikit. You can't use all of the pieces, and no matter which ones you choose it doesn't look quite right.
>
> (Tanenhaus 1988: 1)

In this situation, it is necessary to specialize fairly rigidly. And amidst the vast array of possible topics, *three* seem to be of particular interest:

1 *The acquisition problem* Do humans acquire language because they are born equipped with some special linguistic ability? Or are they able to learn language because they are highly intelligent animals who are skilled at solving problems of various types? Or could it be a mixture of these two possibilities?
2 *The link between language knowledge and language usage* Linguists often claim to be describing a person's representation of language (language *knowledge*), rather than how that knowledge is actually *used*. How then does usage

link up with knowledge? If we put this another way, we can say that anybody who has learned a language can do three things:

1	Understand sentences.	LANGUAGE
2	Produce sentences.	USAGE
3	Store linguistic knowledge.	LANGUAGE KNOWLEDGE

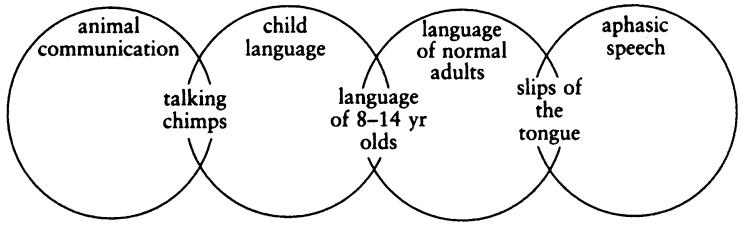
Many pure linguists claim to be interested in (3) rather than (1) or (2). What psycholinguists need to know is this: do the types of grammar proposed by linguists really reflect a person's internalized knowledge of their language? And how do people make use of that knowledge in everyday speech?

3 *Producing and comprehending speech* What actually happens when a person produces or comprehends a chunk of speech?

These are the three questions which this book examines. It does so by considering four types of evidence:

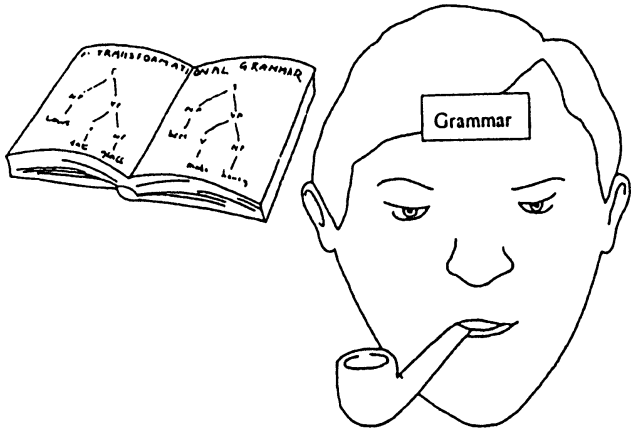
1 animal communication;
2 child language;
3 the language of normal adults;
4 the speech of aphasics (people with speech disturbances).

As the diagram below shows, these are not watertight compartments. Each type of evidence is connected to the next by an intermediate link. Animal communication is linked to child language by the 'talking chimps' – apes who have been taught a language-like system. The link between child and adult language is seen in the speech of 8- to-14-year-olds. The language of normal adults is linked to those with speech disturbances by 'speech errors', which occur in the speech of all normal people, yet show certain similarities with the speech of aphasics.

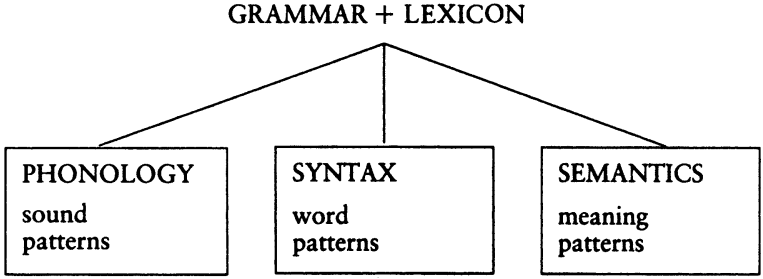


Before moving on to the first topic, the acquisition problem and the question of linguistic knowledge, we must make a few comments about the use of the word *grammar*.

We assume that, in order to speak, every person who knows a language has the grammar of that language internalized in their head. The linguist who writes a grammar is making a hypothesis about this internalized system, and is in effect saying, 'My guess as to the knowledge stored in the head of someone who knows a language is as follows. . . .' For this reason, the word *grammar* is used interchangeably to mean both the internal representation of language within a person's head, and a linguist's 'model' or guess of that representation.



Furthermore, when we talk about a person's internalized grammar the word *grammar* is being used in a much wider sense than that found in some old textbooks. It refers to a person's total knowledge of their language. That is, it includes not just a knowledge of *syntax* (word patterns) but also *phonology* (sound patterns), *semantics* (meaning patterns), as well as the *lexicon* (the mental dictionary) which ties everything together.



Increasingly, linguists are finding that syntax and semantics are intrinsically linked together, and cannot easily be separated. It is far easier to split off phonology. Syntax and semantics together form the essence of any language. They, alongside the lexicon, will therefore be the basic concern of this book. Phonology will mostly be omitted, and only referred to where it illuminates syntactic and semantic problems.

Perhaps here we need to mention also a vast and woolly subject which is *not* the concern of this book – the relationship of language to thought. Although it is clear that thought is *possible* without language, it seems that people *normally* think in terms of their language. That is, a person's thoughts are 'pre-packaged' into words and grammatical categories. This means that when we are discussing production and comprehension, we shall not spend time discussing an abstract layer of 'concepts' which some people have assumed to exist at a level 'above' language. When discussing, say, producing speech, we shall take it for granted that the first thing a person tells herself to do is, 'Select the relevant words and syntax' rather than 'Package together concepts and see if they can be translated into language'. In other words, if it is necessary to take sides in the controversy as to which came first, language or thought, we are more on the side of the nineteenth-century poet Shelley, who said 'He gave men speech, and speech created thought' than that of the eighteenth-century lexicographer Samuel Johnson, who claimed that 'Language is the dress of thought.' Consequently, the vast and fascinating area known as 'cognitive linguistics', which links language with thought, will only intermittently be mentioned – though reading suggestions will be added in the Suggestions for Further Reading on pp. 240–5.

Another voluminous topic which is not discussed in this book is that of 'communicative competence'. In recent years, a number of psychologists have made the rather obvious point that children do not merely acquire the structural patterns of their language, they also learn to use them appropriately within various social settings. Therefore, it is argued, psycholinguists should pay as much attention to social context as to language structure itself, particularly as children in the early stages of speech are heavily dependent on their surroundings. This work is interesting and important, and most people nowadays agree wholeheartedly that it is useless to consider child utterances in a vacuum. However, humans, if they so wish, are able to rely on structure alone when they communicate. They often manage to comprehend and produce quite unexpected and inappropriate utterances. In fact, it might even be claimed that the ultimate goal of language acquisition is to lie effectively, since 'real lying . . . is the deliberate use of language as a tool . . . with the content of the message unsupported by context to mislead the listener' (De Villiers and De Villiers 1978: 165). This book, therefore, takes more interest in the steps by which this mastery of structure is attained, than in the ways in which utterances fit into the surrounding context.

Finally, I have tried not to repeat material from other books I have written, though occasional references and outline notes are inevitable, particularly from *Words in the Mind: An Introduction to the Mental Lexicon* and *The Seeds of Speech: Language Origin and Evolution*.

1

THE GREAT AUTOMATIC GRAMMATIZATOR

Need anything be innate?

> He reached up and pulled a switch on the panel. Immediately the room was filled with a loud humming noise, and a crackling of electric sparks . . . sheets of quarto paper began sliding out from a slot to the right of the control panel . . . They grabbed the sheets and began to read. The first one they picked up started as follows: 'Aifkjmbsaoegweztpplnvo qudskigt, fuhpekanvbertyui-olkjhgfdsazxcvbnm, peruitrehdjkgmvnb, wmsuy. . . .' They looked at the others. The style was roughly similar in all of them. Mr Bohlen began to shout. The younger man tried to calm him down.
>
> 'It's all right, sir, Really it is. We've got a connection wrong somewhere, that's all. You must remember, Mr Bohlen, there's over a million feet of wiring in this room.'
>
> 'It'll never work,' Mr Bohlen said.
>
> Roald Dahl, *The Great Automatic Grammatizator*

Every normal human being can talk. So the average person tends to think that there is little or nothing mysterious about language. As the linguist Noam Chomsky has pointed out:

> We lose sight of the need for explanation when phenomena are too familiar and 'obvious'. We tend too easily to assume that explanations must be transparent and close to the surface . . . As native speakers, we have a vast amount of data available to us. For just this reason it is easy to fall into the

> trap of believing that there is nothing to be explained. Nothing could be further from the truth . . .
>
> (Chomsky 1972a: 25–6)

But the mysterious nature of human language becomes more apparent when one realizes that no one has yet managed to simulate the language ability of a human being. Computers can play chess, sort bank statements, and even talk about limited topics such as cubes, squares and cones. But we are far from producing a 'great automatic grammatizator' which could unaided hold conversations on any topic. Why is this? Perhaps we should think about language more carefully.

NATURE OR NURTURE?

When people start thinking about language, the first question which often occurs to them is this: is language *natural* to humans? – in the same way that grunting is natural to pigs, and barking comes naturally to dogs. Or is it just something we happen to have *learned*? – in the same way that dogs may learn to beg, or elephants may learn to waltz, or humans may learn to play the guitar.

Clearly, in one sense, children 'learn' whatever language they are exposed to, be it Chinese, Nootka or English. So no one would deny that 'learning' is very important. But the crucial question is whether children are born with 'blank sheets' in their head as far as language is concerned – or whether humans are 'programmed' with an outline knowledge of the structure of languages in general.

This question of whether language is partly due to *nature* or wholly due to learning or *nurture* is often referred to as the *nature–nurture* controversy, and has been discussed for centuries. For example, it was the topic of one of Plato's dialogues, the *Cratylus*. Controversies which have been going on for literally ages tend to behave in a characteristic fashion. They lie dormant for a while, then break out fiercely. This particular issue resurfaced in linguistics in 1959 when the linguist Noam Chomsky wrote a devastating and witty review of *Verbal Behavior*, a book by the Harvard psychologist B.F. Skinner (Skinner 1957; Chomsky 1959). This book claimed to 'explain' language as a set of habits gradually built up over the years. According to Skinner, no complicated innate or mental mechanisms are needed. All that is necessary is the systematic observation of the events in the external world which prompt the speaker to utter sounds.

Skinner's claim to understand language was based on his work with rats and pigeons. He had proved that, given time, rats and pigeons could be trained to perform an amazing variety of seemingly complex tasks, provided two

basic principles were followed. First, the tasks must be broken down into a number of carefully graduated steps. Second, the animals must be repeatedly rewarded.

In a typical experiment, a rat was put in a box containing a bar. If it pressed the bar, it was rewarded with a pellet of food. Nothing forced it to press the bar. The first time it possibly did so accidentally. When the rat found that food arrived, it pressed the bar again. Eventually it learned that if it was hungry, it could obtain food by pressing the bar. Then the task was made more difficult. The rat only got rewarded if it pressed the bar while a light was flashing. At first the rat was puzzled. Eventually it learned the trick. Then the task was made more difficult again. This time the rat only received food if it pressed the bar a certain number of times. After initial confusion, it learned to do this also. And so on, and so on.

This type of 'trial-and-error' learning was called *operant conditioning* by Skinner, which can be translated as 'training by means of voluntary responses' (the word 'operant' means a voluntary response rather than an automatic one). Skinner suggested that it is by means of this mechanism that the vast majority of human learning takes place, including language learning:

> The basic processes and relations which give verbal behaviour its special characteristics are now fairly well understood. Much of the experimental work responsible for this advance has been carried out on other species, but the results have proved to be surprisingly free of species restrictions. Recent work has shown that the methods can be extended to human behaviour without serious modification.
>
> (Skinner 1957: 3)

All one needed to do in order to understand language, he said, was to identify the 'controlling variables', which would enable us to predict specific utterances. For example, in the same way as it was possible to say that a rat's bar-pressing behaviour was partly 'under the control' of a flashing light, so a feeling of hunger might 'control' or predict a human utterance such as 'Please pass the bread and butter.' Or the presence of a beautiful painting might call forth the exclamation, 'Oh how beautiful.' Or a bad smell might cause one to exclaim 'Oh what a terrible smell.' A French notice, such as '*Ne touchez pas*', might result in one saying, 'That means "Don't touch".' And if a child said 'Hickory dickory dock', you are likely to continue 'The mouse ran up the clock.' In theory, Skinner saw no difficulty in linking up any particular set of words which a human might wish to produce with an identifiable external happening.

In practice, the matter is far from simple, as Chomsky pointed out. Chomsky made two major criticisms of Skinner's work. First, the behaviour

of rats in boxes is irrelevant to human language. Second, Skinner fundamentally misunderstood the nature of language.

THE IRRELEVANCE OF RATS

Chomsky pointed out that the simple and well-defined sequence of events observed in the boxes of rats is just not applicable to language. And the terminology used in the rat experiments cannot be re-applied to human language without becoming hopelessly vague.

For example, how do you know that someone is likely to say 'Oh what a beautiful picture' when looking at a beautiful painting? They might say instead, 'It clashes with the wallpaper', 'It's hanging too low', 'It's hideous.' Skinner would say that instead of the utterance being 'controlled' by the beauty of the picture, it was 'controlled' by its clash with the wallpaper, its hanging too low, its hideousness. But this reduces the idea of 'control' to being meaningless, because you have to wait until you hear the utterance before you know what controlled it. This is quite unlike the predictable behaviour of rats which could be relied upon to respond to certain stimuli such as a flashing light with a fixed response.

Another problem was that the rats were repeatedly rewarded. It is quite clear that children do not receive pellets of food when they make a correct utterance. However, the idea of reward or *reinforcement* (since it reinforces the behaviour that is being learned) can in humans be naturally extended to approval or disapproval. One might suppose that a parent smiles and says 'Yes dear, that's right' when a child makes a correct utterance. Even if this were so, what happens to this idea of approval when there is nobody around, since children are frequently observed to talk to themselves? Skinner suggested that in these cases children automatically 'reinforce' *themselves* because they know they are producing sounds which they have heard in the speech of others. Similarly, Skinner assumed that someone like a poet who is uttering words aloud in an empty room will be 'reinforced' by the knowledge that others will be influenced by the poetry in the future. So reinforcement seems a very woolly notion, since an actual reward need not exist, it need only be imagined or hoped for. Such a notion is certainly not comparable to the food pellets given to rats when they make a correct response.

Studies by Roger Brown and his associates provided even more problems for Skinner's notion of reinforcement. After observing mother–child interactions they pointed out that parents tend to approve statements which are *true* rather than those which are grammatically correct. So a boy who said 'Teddy sock on' and showed his mother a teddy bear wearing a sock would probably meet with approval. But if the child said the grammatically correct utterance

'Look, Teddy is wearing a sock', and showed his mother a bear *without* a sock, he would meet with disapproval. In other words, if approval and disapproval worked in the way Skinner suggested, you would expect children to grow up telling the truth, but speaking ungrammatically. In fact the opposite seems to happen (Brown *et al.* 1968).

Another example of a problem which crops up in trying to match rat and human behaviour is that of defining the notion of *response strength*. When a rat has learned to respond to a particular external happening, the extent to which it has learned the lesson can be measured in terms of the speed, force and frequency of the bar-pressing. Skinner suggested that similar measures of response strength might be found in some human responses. For example, a person who was shown a prized work of art might, much to the gratification of the owner, instantly exclaim 'Beautiful!' in a loud voice. Chomsky pointed out:

> It does not appear totally obvious that in this case the way to impress the owner is to shriek 'Beautiful' in a loud, high-pitched voice, repeatedly, and with no delay (high response strength). It may be equally effective to look at the picture silently (long delay), and then to murmur 'Beautiful' in a soft low-pitched voice (by definition, very low response strength).
>
> (Chomsky 1959: 35)

Chomsky used these and similar arguments to show the irrelevance of Skinner's experiments to the problem of understanding language. Perhaps 'irrelevance' is too strong a word, since there are areas of language where habit forming works. For example, some people invariably say 'Damn' if they drop a raw egg, or 'Good night' when they are going to bed, or 'London transport gets worse every day' when standing at a bus-stop. And there is one sad character in a Beatles' song who only ever says 'Good morning':

> I've got nothing to say but it's OK
> Good morning, good morning, good morning.

But apart from trivial exceptions such as these, language is infinitely more complex and less predictable than Skinner's theory would suggest.

Of course, just because Skinner's ideas were over-simple does not automatically mean that Chomksy's ideas were right. Maybe both Skinner's and Chomsky's views are outdated. Now, in the twenty-first century, we know a lot more about language and its special qualities, partly because Chomsky in particular inspired so many to take language seriously as a key to understanding the human mind, and to work on it further.

THE NATURE OF LANGUAGES

What is there about language that makes it so special? There are a large number of human activities such as learning to drive or learning to knit which seem to be learnt in the same way as bar pressing by rats. Why not language also?

Chomsky pointed out some of the special properties of language in his review of Skinner's book, where he suggested that Skinner was not in a position to talk about the causation of verbal behaviour, since he knew little about the character of such behaviour:

> There is little point in speculating about the process of acquisition without a much better understanding of what is acquired.
>
> (Chomsky 1959: 55)

Chomsky has since discussed the nature of language in a number of places (e.g. Chomsky 1972a, 1986, 1995b 2000, 2002). One point which he stressed is that language makes use of *structure-dependent operations*. By this he means that the composition and production of utterances is not merely a question of stringing together sequences of words. Every sentence has an inaudible internal structure which must be understood by the hearer.

In order to see more clearly what is meant by a *structure-dependent* operation, it is useful to look at *structure-independent* operations.

Suppose a Martian had landed on earth, and was trying to learn English. She might hear the sentence:

AUNT JEMIMA HAS DROPPED HER FALSE TEETH DOWN THE DRAIN

as well as the related question:

HAS AUNT JEMIMA DROPPED HER FALSE TEETH DOWN THE DRAIN?

If she was an intelligent Martian, she would immediately start trying to guess the rules for the formation of questions in English. Her first guess might be that English has a rule which says, 'In order to form a question, scan the sentence for the word *has* and bring it to the front.' Superficially, this strategy might occasionally work. For example, a sentence such as:

PETRONELLA HAS HURT HERSELF

would quite correctly become:

HAS PETRONELLA HURT HERSELF?

But it is clearly a wrong strategy, because it would also mean that the Martian would turn a statement such as:

THE MAN WHO HAS RUN AWAY SHOUTING WAS ATTACKED BY A WASP

Into:

*HAS THE MAN WHO RUN AWAY SHOUTING WAS ATTACKED BY A WASP?

which is not English. (An asterisk denotes an impossible sentence.)

Looking at the Aunt Jemima sentence again, the Martian might make a second guess, 'In order to form a question, bring the third word to the front.' Once again, this might superficially appear to work because a sentence such as:

THE ALLIGATOR HAS ESCAPED

would correctly become:

HAS THE ALLIGATOR ESCAPED?

But it is obviously accidental that this type of rule gets the right result, because it also produces a number of non-sentences:

SLUGS ARE SLIMY

would become:

*SLIMY SLUGS ARE?

And:

MARY HAS SWALLOWED A SAFETY PIN

turns into:

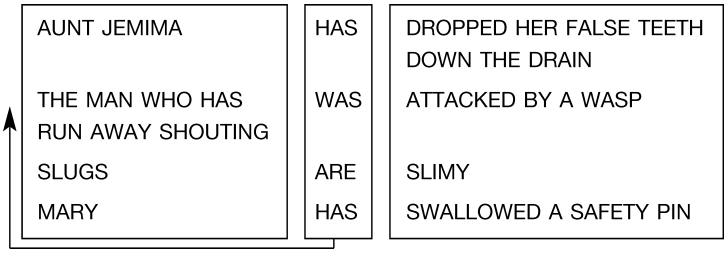
*SWALLOWED MARY HAS A SAFETY PIN?

The Martian went wrong in her guesses because she was trying out structure-independent operations – manoeuvres which relied solely on mechanical counting or simple recognition procedures without looking at

the *internal* structure of the sentences concerned. In order to grasp the principles of question formation, the Martian must first realize that:

> AUNT JEMIMA, THE MAN WHO HAS RUN AWAY SHOUTING, SLUGS, MARY

each behaves as a unit of structure. The number of words within each unit is irrelevant, so no amount of counting will produce the right result for question formation. In these sentences (though not in all English sentences) the solution is to take the word which follows the first unit and bring it to the front:



This may seem an obvious solution to people who already know English – but it is not at all clear *why* language should behave in this way. As Chomsky pointed out:

> The result is . . . surprising from a certain point of view. Notice that the structure-dependent operation has no advantages from the point of view of communicative efficiency or 'simplicity'. If we were, let us say, designing a language for formal manipulations by a computer, we would certainly prefer structure-independent operations. These are far simpler to carry out, since it is only necessary to scan the words of the sentence, paying no attention to the structures which they enter, structures that are not marked physically in the sentence at all.
>
> (Chomsky 1972b: 30)

Yet, amazingly, all children learning language seem to know automatically that language involves structure-dependent operations. On the face of it, one might expect them to go through a prolonged phase of testing out Martian-like solutions – but they do not. This leads Chomsky to suggest that humans may have an innate knowledge of this phenomenon:

> Given such facts, it is natural to postulate that the idea of 'structure-dependent operations' is part of the innate schematism applied by the mind to the data of experience.
>
> (Chomsky 1972b: 30)

This knowledge, he argued (somewhat controversially), 'is part of the child's biological endowment, part of the structure of the language faculty' (Chomsky 1988: 45).

The structure-dependent nature of the operations used in language is all the more remarkable because there are often no overt clues to the structure. Experiments carried out by psycholinguists have made it clear that listeners do not have to rely on auditory clues for interpreting the main structural divisions. For example, Garrett *et al.* (1966) constructed two sentences which each contained the words:

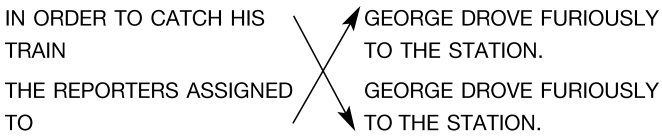
GEORGE DROVE FURIOUSLY TO THE STATION:

1 IN ORDER TO CATCH HIS TRAIN GEORGE DROVE FURIOUSLY TO THE STATION.
2 THE REPORTERS ASSIGNED TO GEORGE DROVE FURIOUSLY TO THE STATION.

In the first sentence, it is GEORGE who is driving furiously. In the second, it is the REPORTERS. In order to understand the sentence, the listener must (mentally) put the structural break in the correct place:

IN ORDER TO CATCH HIS TRAIN	GEORGE DROVE FURIOUSLY TO THE STATION.
THE REPORTERS ASSIGNED TO GEORGE	DROVE FURIOUSLY TO THE STATION.

Just to check that the listeners were *not* using auditory clues, the experimenters recorded both these sentences on to tapes. Then they cut the words GEORGE DROVE FURIOUSLY TO THE STATION off each tape, and spliced them to the *other* sentence:



They then played the newly spliced tapes to students – but into one ear only. In the other ear the students heard a click, which was placed in the middle of a word, for example, GEORGE. The students were then asked whereabouts in the sentence the click had occurred. The interesting result was that in their reports students tended to move the location of the click in the direction of the structural break:

←

IN ORDER TO CATCH HIS TRAIN GEORGE DROVE FURIOUSLY TO THE STATION

→

THE REPORTERS ASSIGNED TO GEORGE DROVE FURIOUSLY TO THE STATION.

This indicates clearly that listeners impose a structure on what they hear for which there is often *no* physical evidence.

Another point made by Chomsky (1959) and others is that simple slot-filling operations are inadequate as explanations of language. It has sometimes been suggested that anyone learning language allocates to each sentence a number of 'slots' and then fits units of structure into each hole, for example:

1	2	3
BEES	LOVE	HONEY
I	WANT	MY TEA
MY BROTHER	HAS HIT	ME

No one would deny the existence of such substitutions and their value in language learning. But the problem is that there is a lot more going on besides, which cannot be accounted for by the 'slot' idea: 'It is evident that more is involved in sentence structure than insertion of lexical items in grammatical frames' (Chomsky 1959: 54). For example, look at the following sentences:

PERFORMING FLEAS	CAN BE	AMUSING
PLAYING TIDDLYWINKS	CAN BE	AMUSING

As soon as we try to find other words to fit into the slot occupied by *can be*, we run into problems. *Are* fits in with the first sentence but not the second, whereas *is* fits in with the second but not the first:

PERFORMING FLEAS	ARE	AMUSING
*PERFORMING FLEAS	IS	AMUSING
*PLAYING TIDDLYWINKS	ARE	AMUSING
PLAYING TIDDLYWINKS	IS	AMUSING

If slot-filling was the sole principle on which language worked, one would not expect this result. In fact, slot-filling makes it quite impossible to explain how the listener knows, in the sentences where the centre slot is filled by *can*

be, that it is the fleas who are performing, but that it is not the tiddlywinks who are playing. But examples of 'constructional homonymity' (as Chomsky calls such superficially similar utterances) are by no means rare.

Even more inexplicable from a slot-filling point of view are sentences which can be interpreted in two different ways:

CLEANING LADIES CAN BE DELIGHTFUL:

1 LADIES WHO CLEAN CAN BE DELIGHTFUL.
2 TO CLEAN LADIES CAN BE DELIGHTFUL.

THE MISSIONARY WAS READY TO EAT:

1 THE MISSIONARY WAS ABOUT TO EAT.
2 THE MISSIONARY WAS ABOUT TO BE EATEN.

Sentences such as these indicate that merely filling a grammatical frame may be only part of what is happening when we speak. Such examples led Chomsky in the 1960s to suggest that language might be organized on two levels: a *surface* level, in which words are in the place where they actually occur, and a *deep* level, in which words are located in their 'proper' place in the slot structure.

Chomsky's arguments that a 'deeper' level of syntax underlay the surface level were interesting, but not necessarily right. Other explanations are possible, as he himself later stressed (Chomsky 1995b). The important point is that the differing interpretations of the ambiguous sentences described above can *not* be explained by means of the bar-pressing antics of rats, nor by means of simple slot-filling operations. Some more complex procedure is involved.

So far, then, language can be said to be structure-dependent – and the types of structure-dependent operations involved seem to be complex.

Creativity is another fundamental aspect of language which is stressed repeatedly by Chomsky. By this, he seems to mean two things. First, and primarily he means the fact that humans have the ability to understand and produce novel utterances. Even quite strange sentences, which are unlikely to have been uttered before, cause no problems for speakers and hearers:

THE ELEPHANT DRANK SEVENTEEN BOTTLES OF SHAMPOO, THEN SKIPPED DRUNKENLY ROUND THE ROOM.

THE AARDVARK CLEANED ITS TEETH WITH A PURPLE TOOTHBRUSH.

This means that it is quite impossible to assume that a person gradually accumulates strings of utterances throughout their life and stores them ready for use on an appropriate occasion. And as well as producing new grammatical sequences, anyone who has mastered a language is automatically able to discard deviant utterances which they may never have met before. Sequences such as:

*HE WILL HAD BEEN SINGING

or:

*GIRAFFE UNDER IN WALKS GORILLA THE

will be rejected instantaneously by any normal speaker of English.

Chomsky also used 'creativity' in a second, subsidiary sense to mean that utterances are not controlled by external happenings. The appearance of a daffodil does not force humans to shriek 'Daffodil'. They can say whatever they like: 'What a lovely colour', 'It's spring, I must remember to clean my car', or 'Why do flowers always give me hay fever?'

Most humans are so used to these properties of language that they no longer seem odd – but they have not yet been fully explained. Chomsky spoke of 'this still mysterious ability' when referring to the creative nature of human speech:

> Having mastered a language, one is able to understand an indefinite number of expressions that are new to one's experience, that bear no simple physical resemblance and are in no simple way analogous to the expressions that constitute one's linguistic experience; and one is able with greater or less facility to produce such expressions on an appropriate occasion, despite their novelty and independently of detachable stimulus configurations, and to be understood by others who share this still mysterious ability. The normal use of language is, in this sense, a creative activity. This creative aspect of normal language is one fundamental factor that distinguishes human language from any known system of animal communication.
>
> (Chomsky 1972a: 100)

Chomsky stressed that the creative aspect of language is *normal*. Humans produce novel utterances all the time, and anybody who does not is likely to be brain damaged:

> It is important to bear in mind that the creation of linguistic expressions that are novel but appropriate is the normal mode of language use. If some indi-