SOFTWARE AND MIND

Andrei Sorin

EXTRACT

Chapter 3: *Pseudoscience*
Section *The New Pseudosciences*

This extract includes the book's front matter and part of chapter 3.

This section analyzes the mechanistic fallacies common to behaviourism, structuralism, and universal grammar, and shows that these famous theories are pseudoscientific.

The entire book, each chapter separately, and also selected sections, can be viewed and downloaded free at the book's website.

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SOFTWARE AND MIND

The Mechanistic Myth and Its Consequences

Andrei Sorin

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Don't you see that the whole aim of Newspeak is to narrow the range of thought?… Has it ever occurred to you … that by the year 2050, at the very latest, not a single human being will be alive who could understand such a conversation as we are having now?

George Orwell, *Nineteen Eighty-Four*

Disclaimer

This book attacks the mechanistic myth, not persons. Myths, however, manifest themselves through the acts of persons, so it is impossible to discuss the mechanistic myth without also referring to the persons affected by it. Thus, all references to individuals, groups of individuals, corporations, institutions, or other organizations are intended solely as examples of mechanistic beliefs, ideas, claims, or practices. To repeat, they do not constitute an attack on those individuals or organizations, but on the mechanistic myth.

Except where supported with citations, the discussions in this book reflect the author's personal views, and the author does not claim or suggest that anyone else holds these views.

The arguments advanced in this book are founded, ultimately, on the principles of demarcation between science and pseudoscience developed by philosopher Karl Popper (as explained in "Popper's Principles of Demarcation" in chapter 3). In particular, the author maintains that theories which attempt to explain non-mechanistic phenomena mechanistically are pseudoscientific. Consequently, terms like "ignorance," "incompetence," "dishonesty," "fraud," "corruption," "charlatanism," and "irresponsibility," in reference to individuals, groups of individuals, corporations, institutions, or other organizations, are used in a precise, technical sense; namely, to indicate beliefs, ideas, claims, or practices that are mechanistic though applied to non-mechanistic phenomena, and hence pseudoscientific according to Popper's principles of demarcation. In other words, these derogatory terms are used solely in order to contrast our world to a hypothetical, ideal world, where the mechanistic myth and the pseudoscientific notions it engenders would not exist. The meaning of these terms, therefore, must not be confused with their informal meaning in general discourse, nor with their formal meaning in various moral, professional, or legal definitions. Moreover, the use of these terms expresses strictly the personal opinion of the author – an opinion based, as already stated, on the principles of demarcation.

This book aims to expose the corruptive effect of the mechanistic myth. This myth, especially as manifested through our software-related pursuits, is the greatest danger we are facing today. Thus, no criticism can be too strong. However, since we are all affected by it, a criticism of the myth may cast a negative light on many individuals and organizations who are practising it unwittingly. To them, the author wishes to apologize in advance.

Contents

Preface

This revised version (currently available only in digital format) incorporates many small changes made in the six years since the book was published. It is also an opportunity to expand on an issue that was mentioned only briefly in the original preface.

Software and Mind is, in effect, several books in one, and its size reflects this. Most chapters could form the basis of individual volumes. Their topics, however, are closely related and cannot be properly explained if separated. They support each other and contribute together to the book's main argument.

For example, the use of simple and complex structures to model mechanistic and non-mechanistic phenomena is explained in chapter 1; Popper's principles of demarcation between science and pseudoscience are explained in chapter 3; and these notions are used together throughout the book to show how the attempts to represent non-mechanistic phenomena mechanistically end up as worthless, pseudoscientific theories. Similarly, the non-mechanistic capabilities of the mind are explained in chapter 2; the non-mechanistic nature of software is explained in chapter 4; and these notions are used in chapter 7 to show that software engineering is a futile attempt to replace human programming expertise with mechanistic theories.

A second reason for the book's size is the detailed analysis of the various topics. This is necessary because most topics are new: they involve either

entirely new concepts, or the interpretation of concepts in ways that contradict the accepted views. Thorough and rigorous arguments are essential if the reader is to appreciate the significance of these concepts. Moreover, the book addresses a broad audience, people with different backgrounds and interests; so a safe assumption is that each reader needs detailed explanations in at least some areas.

There is some deliberate repetitiveness in the book, which adds only a little to its size but may be objectionable to some readers. For each important concept introduced somewhere in the book, there are summaries later, in various discussions where that concept is applied. This helps to make the individual chapters, and even the individual sections, reasonably independent: while the book is intended to be read from the beginning, a reader can select almost any portion and still follow the discussion. In addition, the summaries are tailored for each occasion, and this further explains that concept, by presenting it from different perspectives.

The book's subtitle, *The Mechanistic Myth and Its Consequences*, captures its essence. This phrase is deliberately ambiguous: if read in conjunction with the title, it can be interpreted in two ways. In one interpretation, the mechanistic myth is the universal mechanistic belief of the last three centuries, and the consequences are today's software fallacies. In the second interpretation, the mechanistic myth is specifically today's mechanistic *software* myth, and the consequences are the fallacies *it* engenders. Thus, the first interpretation says that the past delusions have caused the current software delusions; and the second one says that the current software delusions are causing further delusions. Taken together, the two interpretations say that the mechanistic myth, with its current manifestation in the software myth, is fostering a process of continuous intellectual degradation – despite the great advances it made possible.

The book's epigraph, about Newspeak, will become clear when we discuss the similarity of language and software (see, for example, pp. 409–411).

Throughout the book, the software-related arguments are also supported with ideas from other disciplines – from the philosophies of science, of mind, and of language, in particular. These discussions are important, because they show that our software-related problems are similar, ultimately, to problems that have been studied for a long time in other domains. And the fact that the software theorists are ignoring this accumulated knowledge demonstrates their incompetence.

Chapter 7, on software engineering, is not just for programmers. Many parts

(the first three sections, and some of the subsections in each theory) discuss the software fallacies in general, and should be read by everyone. But even the more detailed discussions require no previous programming knowledge. The whole chapter, in fact, is not so much about programming as about the delusions that pervade our programming practices, and their long history. So this chapter can be seen as a special introduction to software and programming; namely, comparing their true nature with the pseudoscientific notions promoted by the software elite. This study can help both programmers and laymen to understand why the incompetence that characterizes this profession is an inevitable consequence of the mechanistic software ideology.

The book is divided into chapters, the chapters into sections, and some sections into subsections. These parts have titles, so I will refer to them here as *titled* parts. Since not all sections have subsections, the lowest-level titled part in a given place may be either a section or a subsection. This part is, usually, further divided into *numbered* parts. The table of contents shows the titled parts. The running heads show the current titled parts: on the right page the lowest-level part, on the left page the higher-level one (or the same as the right page if there is no higher level). Since there are more than two hundred numbered parts, it was impractical to include them in the table of contents. Also, contriving a short title for each one would have been more misleading than informative. Instead, the first sentence or two in a numbered part serve also as a hint of its subject, and hence as title.

Figures are numbered within chapters, but footnotes are numbered within the lowest-level titled parts. The reference in a footnote is shown in full only the first time it is mentioned within such a part. If mentioned more than once, in the subsequent footnotes it is abbreviated. For these abbreviations, then, the full reference can be found by searching the previous footnotes no further back than the beginning of the current titled part.

The statement "italics added" in a footnote indicates that the emphasis is only in the quotation. Nothing is stated in the footnote when the italics are present in the original text.

In an Internet reference, only the site's main page is shown, even when the quoted text is from a secondary page. When undated, the quotations reflect the content of these pages in 2010 or later.

When referring to certain individuals (software theorists, for instance), the term "expert" is often used mockingly. This term, though, is also used in its normal sense, to denote the possession of true expertise. The context makes it clear which sense is meant.

The term "elite" is used to describe a body of companies, organizations, and individuals (for example, the software elite). The plural, "elites," is used when referring to several entities within such a body.

The issues discussed in this book concern all humanity. Thus, terms like "we" and "our society" (used when discussing such topics as programming incompetence, corruption of the elites, and drift toward totalitarianism) do not refer to a particular nation, but to the whole world.

Some discussions in this book may be interpreted as professional advice on programming and software use. While the ideas advanced in these discussions derive from many years of practice and from extensive research, and represent in the author's view the best way to program and use computers, readers must remember that they assume all responsibility if deciding to follow these ideas. In particular, to apply these ideas they may need the kind of knowledge that, in our mechanistic culture, few programmers and software users possess. Therefore, the author and the publisher disclaim any liability for risks or losses, personal, financial, or other, incurred directly or indirectly in connection with, or as a consequence of, applying the ideas discussed in this book.

The pronouns "he," "his," "him," and "himself," when referring to a gender-neutral word, are used in this book in their universal, gender-neutral sense. (Example: "If an individual restricts himself to mechanistic knowledge, his performance cannot advance past the level of a novice.") This usage, then, aims solely to simplify the language. Since their antecedent is gender-neutral ("everyone," "person," "programmer," "scientist," "manager," etc.), the neutral sense of the pronouns is established grammatically, and there is no need for awkward phrases like "he or she." Such phrases are used in this book only when the neutrality or the universality needs to be emphasized.

It is impossible, in a book discussing many new and perhaps difficult concepts, to anticipate all the problems that readers may face when studying these concepts. So the issues that require further discussion will be addressed online, at *www.softwareandmind.com*. In addition, I plan to publish there material that could not be included in the book, as well as new ideas that may emerge in the future. Finally, in order to complement the arguments about traditional programming found in the book, I have published, in source form, some of the software I developed over the years. The website, then, must be seen as an extension to the book: any idea, claim, or explanation that must be clarified or enhanced will be discussed there.

The New Pseudosciences

The Mechanistic Roots

In the following subsections, we are going to examine some of the greatest mechanistic delusions of our time. I ignore here the fads that emerge continually in the human sciences – fads like those we encountered in "Scientism" in chapter 1. Although any one of these delusions can be shown to display the characteristics of a pseudoscience, examining them would be an interminable task. I will single out, instead, three major theories – or, rather, systems of theories – which are among the most influential intellectual movements of our time: the psychological theory of behaviourism, the social theory of structuralism, and the linguistic theory of universal grammar. The first two are now defunct, but the third one is still drawing a large number of believers.

Unlike the lesser fads, which last only a few years and attract relatively few scientists, the three theories I have selected for study dominated their respective fields for many decades. Also, their founders and supporters are world-famous scientists: men like Noam Chomsky, B. F. Skinner, Jean Piaget, and Claude Lévi-Strauss are among the best-known intellectuals of the twentieth century. As these three delusions became major research programs, they are good examples of the new pseudosciences. The discussion, however, is not meant to be a complete study of their fallacies. What I want is only to bring out their common characteristics (which they also share with the *software* pseudosciences, as we will see in chapter 7): their mechanistic foundation, and their dishonest methods. Here is a summary of the common characteristics.

Scientists who uphold these theories regard mechanism as undisputed truth. That is, the possibility of arriving at a useful solution or explanation through reductionism and atomism is not taken as hypothesis, but as established fact. It is this dogmatic attitude that prevents them from accepting the evidence later, when their theories fail. They notice a structure – a certain regularity, or uniformity, or pattern – in the phenomenon they are investigating, and immediately conclude that this structure can form the basis of a mechanistic theory.

The structure they noticed is, of course, one of the structures that make up the complex phenomenon. Their mistake is to assume that its interactions with the other structures can be ignored. They believe that a *simple* structure (their mechanistic theory, which reflects the one structure they noticed in the phenomenon) can provide a useful approximation of the *complex* structure

(the whole phenomenon). When they base their theory on one structure, when they assume that it alone can represent the phenomenon, these scientists commit the fallacy of reification: they extract that structure from the complex whole, and thereby sever its interactions (which are, in fact, the most important part of the phenomenon). And even when they do recognize that one structure alone cannot represent the phenomenon, they still expect to find a mechanistic theory, by somehow combining several structures.

The mechanistic nature of the theory can manifest itself in one or more of these features: the use of atomistic and reductionistic concepts; the use of hierarchical concepts or diagrams, of neat systems of things within things; the use of other precise diagrams, or rules, or methods, or mathematical representations. As we know, all these models are logically equivalent to a simple hierarchical structure. Mechanistic theories, in the end, always claim the same thing; namely, that a precise and relatively simple diagram, or formula, or procedure can describe and explain a complex phenomenon. They claim, in other words, that it is possible to find a deterministic representation for an indeterministic phenomenon.

Up to this point, the scientists are only guilty of wishful thinking. They are convinced that a mechanistic approximation can explain their phenomenon, so they naively emulate the methods employed in fields like physics or astronomy, where mechanistic approximations are indeed useful. But when their theory proves to be inadequate, instead of abandoning it, they forsake their responsibility as scientists and turn it into a pseudoscience: they search for confirmations; they ignore or suppress the falsifications; and, to deal with those falsifications that cannot be denied, they incorporate them into the theory.

Specifically, the scientists repeatedly expand the theory by adding various features, principles, and conditions to make the falsifying situations appear to be part of it. They coin pretentious terms for these modifications, to make them look like novel and important concepts, when in reality their function is to reinstate old, informal concepts – precisely those concepts that the original theory had tried to exclude. Often, they describe the modifications with terms like "transformation" or "normalization," borrowed from mathematics; but, whereas in mathematics these are exact operations, in pseudoscience they are makeshift, artificial conversions, invented in order to bring the falsifying instances into the range of events that the theory can be said to account for.

It is the mechanistic dogma, in the final analysis, that fosters these pseudosciences. Even when an idea starts as an honest attempt to explain a phenomenon, even if it starts as a falsifiable and testable concept, the belief in mechanism is bound to make it unfalsifiable. If a theory is grounded on mechanism and mechanism is accepted unquestioningly, a falsifying instance

is necessarily interpreted as an anomaly, a rare exception. Its supporters, therefore, see nothing wrong in ignoring the falsification, or in modifying the theory to cope with it. They verify their theory and confirm that it does indeed obey the mechanistic principles. So the theory, they conclude, cannot possibly be wrong. If its predictions are contradicted by a certain event, something must be wrong with that event; or perhaps the theory needs an adjustment.

Now, if these falsifications were limited to a few cases, they would indeed be exceptions, and the mechanistic theory would provide a useful approximation. But in mechanistic delusions the falsifications never cease, and the theory must be modified again and again to match reality. It then becomes an unfalsifiable, and hence worthless, concept. Its supporters, though, do not consider this activity to be dishonest, or unprofessional, or illogical. On the contrary: because the mechanistic ideology has redefined science to mean the pursuit of mechanistic concepts, even when these concepts are useless, an activity that tries to save a mechanistic theory from refutation is seen as the very model of scientific work.

Behaviourism

1

The first of the modern mechanistic pseudosciences was the psychological theory known as *behaviourism*. There aren't many behaviourists left today, but for more than half a century, and as late as the 1960s, behaviourism was the dominant school in academic psychology, especially in American universities. In addition, behaviourism had a profound influence on sociology and the other human sciences.

Described as *behavioural science* – the science of human behaviour – behaviourism was seen by its advocates as an effort to turn psychology into an exact science, like physics. Psychological theories, the behaviourists claimed, will not be as successful as the theories of the exact sciences as long as they deal with the subjective and unscientific concept known as the mind. The exact sciences deal with real entities – entities that can be observed and measured. So, if psychology is to become an exact science, we must stop searching for theories of the mind, and confine ourselves to the study of human *behaviour*; namely, those human acts that can be observed, measured, and subjected to experiments.

Behaviourism, thus, rejected the traditional subjects of psychology – consciousness, knowledge, intelligence, memory, volition, emotions, beliefs, desires, fears, etc. These phenomena, the behaviourists say, are nothing but the

combination of some elementary units of behaviour; and, once we identify those units, we will be in a position to describe with precision all human acts. As in physics, therefore, we must trust the principles of reductionism and atomism, and search for the smallest bits of behaviour, the simplest human acts that can be observed: reflexes, blinking of eyelids, the movement of a finger or limb, and the like. These elementary acts are the behavioural atoms: the building blocks from which all human acts are made up, including those complex acts we attribute to intelligence. Behaviourism asserts, in other words, that there are no hidden, private, internal processes – processes requiring the invention of a concept like the mind. All human acts can be explained as a combination of simple mechanical processes, which can be observed and assessed objectively by an experimenter.

Human beings learn to display a particular combination of behavioural atoms by interacting with their environment. The basic unit of interaction is the *stimulus-response* mechanism, or S-R: an event in the environment provides the stimulus, and the organism produces the response. The responses are the behavioural atoms just mentioned; and the stimuli are the simplest events that can be perceived by the organism with its senses (the presence of a certain object, or light, or sound). When the organism is exposed to various stimuli and tries various responses, it gradually discovers certain associations between the stimuli and the responses. The associations it discovers are those that produce pleasant experiences or prevent unpleasant ones. The phenomenon whereby the organism establishes these associations is called *reinforcement*, and is taken to be a propensity of all organisms. The process whereby an organism acquires a certain set of S-R units is called *conditioning*.

The connections between stimuli and responses – the S-R units – are thus the basic elements from which all interaction between the organism and its environment is made up. The interaction is assumed to be strictly sensori-motor: the stimuli affect the senses, and the responses are muscular or glandular reactions. Ultimately, all human acts can be explained through a reduction to combinations of S-R units. There is nothing else.

The era of behaviourism started in 1913, when John B. Watson, generally viewed as its founder, published his "behaviourist manifesto": the proclamation that psychology must be practised as an objective science, and that its goal must be, not just to observe, but to predict and control human behaviour. In other words, the task of psychologists is to study and manipulate human minds, just as other scientists study and manipulate physical entities.

Historically, behaviourism was a continuation of the mechanistic theories

of mind originated two centuries earlier by John Locke, David Hume, and David Hartley. These theories, which later became known as associationism, maintained that all knowledge can be explained as combinations of various knowledge atoms connected through stronger or weaker associations.

The early behaviourists gained additional confidence from the work of physiologist Ivan Pavlov, who investigated the process of conditioned reflexes in dogs: after learning to associate the presence of food with a certain stimulus (a specific sound or image), the dog would salivate even when this stimulus alone, without any food, was presented. This seemed to prove the stimulus-response theory – for *reflex* responses, at least. The behaviourists also liked the theory of Edward Thorndike, who experimented with cats and explained their learning behaviour as nothing more than trial and error and conditioning – a process that requires no intelligence.

Although even this limited evidence was later shown to be tenuous, the behaviourists saw nothing wrong in extrapolating it to explain, not only *all* animal behaviour, but also *human* behaviour, and even human *intelligence*. Thus, experiments with animals – especially rats – and a preoccupation with their simplest acts became the distinguishing features of behaviourism. For several decades, scientists were trying to understand human intelligence by studying the behaviour of rats through trivial experiments in which the animals were rewarded with food for performing some simple acts.

An endless variety of such experiments were designed, all for the purpose of studying and measuring with precision the process of animal conditioning. One ingenious device, for instance, invented by Skinner and known as the Skinner box, consists of a small cage equipped with a mechanism that releases a food pellet into a tray when the animal inside presses a lever. It also includes means for automatically controlling this reward and for counting and recording the animal's attempts. Through such experiments, scientists can determine the rate of learning and extinction of various patterns of behaviour under different conditions.

The behaviourists justified their experiments with animals by claiming that human behaviour, while more complex than the behaviour of rats, is not *qualitatively* different; it is only a more complicated combination of the same atoms of behaviour. The purpose of their experiments is to restrict the animal's environment so as to isolate and study these atoms. Obviously, we cannot subject *people* to experiments in a laboratory. But, whether we study animals or humans, at the lowest levels we are observing the same phenomena. Just as the same bricks are used to build both small and large buildings, the atoms that make up animal behaviour can also be used to explain *human* behaviour.

2

Behaviourism did not work, of course. It failed to explain even the behaviour of rats, let alone that of humans. It was successful only in those experiments that created a highly impoverished, artificial environment – an environment in which the animals were almost forced to display the kind of responses the experimenters expected of them. When observed in their natural environment, the animals' behaviour remained quite unpredictable, and the behaviourist theories were useless.

Like all mechanistic delusions, behaviourism extracted from the complex structure that constitutes the phenomenon in question (animal or human intelligence, in this case) a simple structure (the patterns of visible behaviour, in this case), assuming that one structure could explain the whole phenomenon. Now, there is no doubt that animals and humans are affected by their environment, that they sense stimuli and exhibit responses, and that there exists a process of associations and reinforcement which occurs somehow in conjunction with their experiences. But these patterns and regularities cannot be extracted and studied in isolation. They are only *some* of the structures that make up the existence of animals and humans, and when studying them on their own we ignore their interactions with the other structures. This is why the behaviourist model can only account for the simplest kind of behaviour – the kind for which the interactions with the other structures are indeed weak enough to be ignored.

Even for a mechanistic theory, behaviourism was very naive. In particular, it tried to explain everything with *chains* of S-R units, rather than structures of elements within elements. It claimed, in effect, that a trivial two-level hierarchy (S-R units as terminal elements and behaviour as the top element) can account for all knowledge and intelligence. Unlike most mechanistic theories, it did not try to build large, multilevel hierarchical models, so it did not even exploit fully the concepts of reductionism and atomism.

We must not be surprised that such a naive theory did not work. But let us see how, instead of admitting that it was refuted by evidence, its supporters turned it into a pseudoscience. First, they adopted the simple tactic of looking for confirmations and ignoring the falsifications. They designed their experiments not as severe tests, not as attempts to *falsify* the theory, but as means to *verify* it; specifically, as means to produce the results they wanted to see. Since they wanted to confirm that behaviour can be reduced to simple elements, their experiments consisted in creating restricted environments, in which the rats could perform *only* simple acts (pressing a bar, for instance). When the

environment was more complex (finding their way in a maze, for instance), the rats frequently displayed unexpected and more intelligent behaviour, which could not be readily explained. Since Thorndike wanted to prove that the only way cats can learn is by trial and error, he designed his experiments so that the only way to solve the problem was by trial and error. In other experiments, when confronted with different challenges, cats were shown to act more intelligently.[1]

The tactic, thus, consisted in simplifying and restricting the experimental environment until the animals' behaviour was reduced to a small number of trivial, isolated acts, at which point the scientists could indeed confirm their hypothesis of behavioural atoms. In this artificial environment, models based on S-R chains did indeed provide a useful approximation of behaviour, but only because, out of the whole range of normal behaviour, the animals were restricted to isolated S-R structures. It was this limited behaviour that the model explained. When used to explain their normal, natural behaviour, which includes many interacting structures, the model failed.

Another tactic used by behaviourists to confirm their conditioning theories was, obviously, the choice of animals. Rats and pigeons were the preferred subjects in their experiments precisely because it was found that these creatures, being particularly docile and rather stupid, were most likely to display the kind of behaviour these theories postulated.

While the behaviourists were busy confirming over and over their theories with contrived experiments, their critics had no difficulty finding falsifications. The most common problem was the failure to reproduce in the real world the results observed in artificial laboratory conditions. If exposed to conditioning experiments while in their natural environment, animals ranging from pigs to whales were found to behave unpredictably, contradicting the laboratory theories.[2] These falsifications were ignored by behaviourists. Also ignored were the "experiments on experimenters," which showed that the laboratory measurements of rat performance that were so confidently accepted by everyone were in fact biased, and merely reflected the expectations of the individual experimenters.[3]

So for half a century, while the world believed that these scientists were studying human psychology, what they were studying was not even animal psychology, but some technicalities related to experiments designed to confirm

[1] Arthur Koestler, *The Act of Creation* (New York: Macmillan, 1964), pp. 568–571.

[2] Kellar Breland and Marian Breland, "The Misbehavior of Organisms," cited in Lawrence LeShan, *The Dilemma of Psychology: A Psychologist Looks at His Troubled Profession* (New York: Dutton, 1990), pp. 76–78.

[3] R. Rosenthal and K. L. Fode, "The Effect of Experimenter Bias on the Performance of the Albino Rat," cited in Koestler, *Creation*, p. 568.

their fantasies: "In spite of the impressive mathematical apparatus, and the painstaking measurements of 'rates of response,' 'habit-strength,' 'fractional anticipatory goal-responses,' and the rest, rarely in the history of science has a more ambitious theory been built on shakier foundations."[4]

3

Let us examine next how behaviourists used the other pseudoscientific tactic to make their theory unfalsifiable: repeatedly modifying the theory by incorporating into it the falsifying situations. The original theory postulated that all behaviour can be reduced to chains of S-R units, and that both the stimuli and the responses are small, atomic units, which can be observed and measured experimentally. Apart from trivial experiments, however, behaviour could not be reduced to S-R chains, and responses could not be reduced to elementary movements. Thus, because the evidence did not agree with the theory, behaviourists made the theory agree with the evidence – by expanding it to account for those situations that it could not explain. Also true to the pseudoscientific tradition, they invented impressive terms to describe the extensions. This served to mask the fact that the extensions were not new features but reversals of the original claims. What the extensions accomplished, essentially, was to reinstate the complex and inexplicable capabilities traditionally attributed to a mind – capabilities which had been specifically excluded earlier, because they could not be measured or reduced to atomic units.

For example, to account for the unaccountable responses, Edward Tolman held that there are two kinds of behaviour: higher levels, or *molar*, and lower levels, or *molecular*; and only the molecular levels can be explained with S-R units. Behaviour at the molar level is an *emergent* phenomenon and cannot be reduced to, or explained in terms of, molecular units. Edwin Guthrie invented a similar concept: the movements of the organism are low levels of behaviour, while the complex acts are high levels; and acts cannot be explained in terms of movements alone. These extensions introduced some mysterious processes between the stimulus and the response, which explained previously unexplainable responses only by remaining unexplained themselves, and were therefore a radical departure from the original goal of strict reductionism.

Tolman also introduced the concept of *intervening variables*. These variables – described as subjective and unexplainable phenomena that somehow occur between the stimulus and the response – served to revive the traditional,

[4] Koestler, *Creation*, p. 568.

informal concept of *mental* acts. The informal concept of *drives* was also revived, and was profitably employed to explain certain types of behaviour. And to combat the limitations of the atomic behavioural units, Tolman introduced "sign-Gestalt expectations," which used the *holistic* concepts of Gestalt psychology – a reversal of the *atomistic* principles of behaviourism.

So, little by little, the traditional psychological concepts were reinstated, and were incorporated into behaviourism in the guise of new features. The behaviourists continued to use S-R chains to explain trivial responses, and reverted to the traditional, informal concepts whenever they had to describe complex forms of behaviour.

By the time of B. F. Skinner, the last and best known of the great behaviourists, the countless "enhancements" made the theory sufficiently different from its original version to earn it the title *neobehaviourism*. Skinner added his own enhancements, of which the most important was a complete obliteration of the original meaning of stimuli and responses. And, although in his experiments he never progressed beyond chains of simple S-R units with rats and pigeons, he confidently extrapolated these results into the most fantastic theories of human knowledge and human society.

Thus, in his Skinner boxes he managed to shape the behaviour of pigeons so as to make them perform some relatively complex and unusual acts; for example, walk to a certain wall of the box and peck at a coloured disk there. He achieved that by reinforcing, in several stages, various movements which the bird had performed randomly in the direction of the disk, thus creating a chain of conditioned S-R units that looked like one purposeful act. From successes such as this, Skinner boldly concluded that everything human beings learn is also in the form of simple S-R chains, and human acts that appear purposeful or intelligent are only illusions, just as the pigeon's act was an illusion.

He could not confirm this hypothesis, nor describe how various intelligent or creative acts can be reduced to chains of S-R units. What he did instead was modify the meaning of "stimulus" and "response" to match whatever acts had to be explained. For his rats and pigeons, these terms retained their original meaning of elementary sensations and movements. But for human behaviour, the terms expanded to include, respectively, such complex acts as reading a letter and then reacting emotionally to its contents, or being threatened with a weapon and then surrendering one's wallet, or noticing merchandise displayed in an alluring fashion and then purchasing something. Thus, the concept of stimulus and response became so vague that it could account for any human act, thereby rendering the whole theory unfalsifiable. Moreover, the requirement to reduce complex acts to combinations of behavioural atoms – to the movement of a finger or an eyelid, for example – was forsaken. By now behaviourism had completely abandoned its original goal of being an exact

science of behaviour. Judged by their own standards, the behaviourists were now mere charlatans.

Using the new, high-level concept, Skinner even managed to describe linguistic performance (which behaviourists called "verbal behaviour") as nothing but stimuli and responses. Again, he makes no attempt to reduce language-based communication to elementary S-R units (which might be the movement of the tongue or lips, or the vibration of the eardrum). Instead, stimulus and response refer now directly to such complex behaviour as creating and understanding sentences, formulating a challenging question, or returning an intelligent answer. Skinner's naive views of language attracted a scathing criticism from linguist Noam Chomsky, in a review that became somewhat of a classic.[5]

Some say that the demise of behaviourism was hastened by Chomsky's criticism and the rising popularity of his own theories of mind; others say that it was the rise of cognitive science and the theories that depict the mind as a computing device. Either way, the shift exemplifies a spectacle common in the academic world: one pseudoscience is replaced with another; one popular theory is displaced by another, which seems very different, when in reality both are rooted in the mechanistic culture and suffer therefore from the same fallacy – the belief that non-mechanistic phenomena can be represented with mechanistic models.

Structuralism

1

The movement known as *structuralism* was popular in one form or another for much of the twentieth century, especially in Europe. It flourished in the 1960s and 1970s, and had adherents even in the 1980s. Few remember it today. Structural linguistics, however, which acquired a life of its own through the work of Noam Chomsky, continues to dominate the study of language; I treat it, therefore, as a separate pseudoscience (see the next subsection, "Universal Grammar").

The structuralists noticed that, despite their immense variety, human activities, languages, societies, customs, and institutions display many regularities. The reason for this uniformity, the structuralists say, is that all human acts are governed ultimately by the working of the brain. Thus, since human brains

[5] Noam Chomsky, "A Review of B. F. Skinner's *Verbal Behavior*," *Language* 35, no. 1 (1959): 26–58.

are the same everywhere, from the most primitive societies to the most advanced, we should not be surprised to find the same patterns in the various aspects of their cultures.

Up to this point, the structuralist idea is quite sensible. When expressed informally, it is neither ambitious nor original. This modest idea, however, is only the *basis* of the structuralist philosophy. The important claim is that the biological characteristics of the brain can be described mathematically. These characteristics constitute, as it were, an alphabet of human propensities; and, once we discover this alphabet, we will be able to depict with precision every human accomplishment as a function of the human propensities.

The structuralists claim, in other words, that it is possible to represent mathematically all human capabilities; and, since the various types of human activities are in the end combinations of these capabilities, they too can be represented mathematically. Human activities, therefore, are no different from the phenomena studied by physics or chemistry. Thus, anthropologist Claude Lévi-Strauss, the most famous structuralist, claimed that the customs of all societies that ever existed are nothing but "certain combinations from a repertoire of ideas which it should be possible to reconstitute [and depict as] a sort of periodical chart of chemical elements, analogous to that devised by Mendeleev. In this, all customs, whether real or merely possible, would be grouped by families and all that would remain for us to do would be to recognize those which societies had, in point of fact, adopted."[1]

We recognize structuralism as one of those mechanistic theories that attempt to reduce to mathematics the complex phenomena studied by the human sciences. Structuralism is especially ambitious, though, in that it does not limit itself to one discipline, but claims that *all* human activities can be reduced to *the same* mental operations. Disciplines like anthropology, linguistics, psychology, sociology, political science, and philosophy can be turned into exact sciences, no different from physics or chemistry, simply by discovering the elementary human propensities. One day, the structuralists say, we will be able to explain everything in the human universe – every sentence we utter, every custom and tradition, every piece of literature and folklore, every work of art, every musical composition, every type of social organization, and even our clothes fashions and our cooking and eating habits – with equations as precise as the equations of physics.[2]

[1] Claude Lévi-Strauss, *Tristes Tropiques*, p. 60, quoted in Howard Gardner, *The Quest for Mind: Piaget, Lévi-Strauss, and the Structuralist Movement* (New York: Knopf, 1973), p. 118.

[2] It must be stressed that these were actual claims, made as late as the 1970s and 1980s. Respected scientists were actually working on theories that attempted to represent mathematically these aspects of human life.

❖

Historically, structuralism has its roots in some of the linguistic theories proposed in the 1930s. Roman Jacobson, among others, showed that all languages share a set of common features. This, however, becomes evident only when studying the smallest elements of language: the sounds that make up phonemes. These sounds (the atoms of verbal communication) are based on a small set of elementary features. Moreover, it is possible to describe these features in terms of *binary opposites*: a phoneme is voiced or unvoiced, nasal or oral, etc. This discovery gave linguists hope that the phenomenon of language can be represented with a mechanistic model: since any sentence, in any language, can be expressed as a combination of phonemes, we should be able to reduce sentences to exact structures of sounds, and hence explain the phenomenon of language mathematically.

No one has achieved this, of course, and we know why. Language is a complex phenomenon, a system of interacting structures. The mechanists isolate these structures and study them separately, hoping to find one that can explain, alone, the complex phenomenon. The structure created by sounds plays indeed a part in language, but it interacts with the others: the meaning of words, the context in which we use a sentence, syntax rules, voice stress, and various knowledge structures present in the mind. It is impossible to explain the whole phenomenon of language with *one* structure, no matter how accurate that structure is. Thus, a theory that tries to represent language as sound structures alone is very naive – as naive as one, like Chomsky's, based on syntactic structures alone. If we view the richness of language as the large set of alternatives for the top element of a complex structure, then an isolated structure cannot explain language because it cannot account for all the alternatives: when we separate the structures we lose their interactions, and with them many of the alternatives.

But without waiting for a confirmation of the phoneme theory with actual languages, the structuralists extrapolated it to cover, not only language, but all human capabilities. Thus, Lévi-Strauss maintained that all aspects of culture, all human activities, can be seen as forms of communication, and hence as languages; and if all *languages* seem to be based on a small set of common elements, we should also expect to find an analogous set of common elements in all *cultures*. He then proceeded to analyze hundreds of myths and customs collected from primitive societies, searching for their common elements. This analysis, according to Lévi-Strauss, is a process of *decoding*. The various myths or customs may look very different from one another, and may appear disordered, complicated, or illogical, but this is because we only see their *surface structures*; it is their *deep structures* that we must study, and it is

at these low levels that we will discover the common elements. As in the phoneme theory, the atomic concepts of human knowledge form pairs of binary opposites: left/right, good/bad, male/female, day/night, up/down, cold/warm, and so forth. Myths and customs, and all other aspects of a culture, can be reduced to combinations of such binary concepts.

We can start with any myth or custom, therefore, and through a process of *transformations* we will arrive at a structure similar to that of another myth or custom, belonging perhaps to a different society. The transformations convert a surface structure – the story told by a myth, the costume worn by a woman, the painting or carving of an object, the rules observed in a certain social setting, the food eaten on a certain occasion – into the common, atomic concepts; that is, into one of the two parts of various pairs of opposites. At this low level, all myths, customs, traditions, and institutions reveal similar structures; and the chief component of these structures is a play between opposing themes. Since the atomic concepts, according to the structuralist theory, are a reflection of the basic capabilities of the mind, it seems that an important function of the brain is to classify experiences into opposite categories.

While anthropologists like Lévi-Strauss were analyzing myths and customs, other structuralists were using similar techniques to analyze works of art, of literature, or of historiography. Their goal was the same: to find the set of basic elements (the building blocks, or alphabet) from which a whole body of works is constructed. They tried to show, for instance, that the meaning of a novel, or poem, or painting is only a surface structure; that it can be reduced, through a process of transformations, to a deep structure; and that, at this level, we find the same atomic concepts as in another novel, or poem, or painting.

Psychologist Jean Piaget believed that all human intelligence can be reduced to a small set of binary operations that are very similar to the basic operations of mathematical logic. As we grow up, our mind acquires new operations and learns to combine them into more and more complex logical structures. This theory, he claimed, is all we need in order to explain how humans perform intelligent acts of increasing complexity.

To reduce intelligent behaviour to binary operations, Piaget suggested various transformations, analogous to those defined in modern algebra: "The algebra of logic can help us to specify psychological structures, and to put into calculus form those operations and structures central to our actual thought processes."[3] He tried to prove his theory by subjecting children of various ages to intelligence tests of increasing levels of difficulty. The purpose of these

[3] Jean Piaget, *Logic and Psychology*, p. xvii, quoted in Margaret A. Boden, *Piaget* (London: Fontana, 1979), p. 80.

experiments was to explain the intellectual development of the child in terms of basic logical operations. If, for example, a four-year-old child correctly solves a problem which a three-year-old child cannot solve, Piaget explains this progress by identifying some logical operators or transformations that are required to arrive at the solution, and concludes that they are only acquired by the mind at four.

The structuralists are fascinated by a rather trivial quality of binary operations: they can be combined to generate complex patterns while starting with operands that have only two values (*yes* and *no*, *0* and *1*, etc.). For example, certain problems and solutions can be represented with a hierarchical structure, if we employ this structure as a decision tree; that is, as decisions within decisions, where each decision involves two alternatives. We know that only *mechanistic* knowledge can be represented with simple hierarchical structures; but the structuralists believe that *all* knowledge can be reduced to such decision trees, and hence to the binary elements and operations known as Boolean logic (the same elements and operations used in digital circuits).

The inanity of the structuralist theories is evident in these silly analogies of minds to computers (which are far more naive than the ideas of artificial intelligence – themselves futile mechanistic pursuits, as we saw in chapter 2). Computers do indeed perform complex tasks by reducing them to simple binary operations, but the use of the word "binary" is the only thing that computer logic has in common with structuralism. Unlike the vague transformations of structuralism, computer operations can be explained completely and precisely, down to the last bit.

Thus, using terms and concepts borrowed from logic, Piaget describes the "Boolean operations" and "truth tables" that allegedly can be employed to explain human intelligence.[4] An important set of logical operations, for instance, which appears only in adult intelligent behaviour, is the "quaternary group" of operations called INRC (which stands for Identity, Negation, Reciprocity, and Correlativity, or inversion): "What we have here is a group of four transformations of which the operations of a two-valued propositional logic supply as many instances as one can form quaternaries from the elements of its set of subsets.… The group INRC has for its elements, not the 4 cases of a truth table for 2 variables, but the 16 combinations of its set of subsets (or, for 3 variables, the 256 combinations, and so on). Because of its greater complexity, the INRC group does not make its appearance psychologically until early adolescence, whereas … simpler models of groups of 4 elements are accessible to 7 and 8 year olds."[5]

[4] See chapter 4, p. 332 for a brief discussion of Boolean operations and truth tables.
[5] Jean Piaget, *Structuralism* (New York: Harper and Row, 1971), pp. 31–32 n. 9.

What Piaget is saying here is that, as our mental capabilities develop, we can handle problems that involve more facts and more combinations of facts, because we can process larger decision trees. This is undoubtedly true, but it doesn't follow that we can represent mental processes with mathematical logic. The reason, again, is that mental processes are complex structures: when our mind develops, we gain the capacity to handle, not just increasingly large decision trees, but *interacting* decision trees. The simple structures suggested by Piaget constitute, in effect, a mechanistic mind model; and, like all mechanistic approximations, in simple situations this model may well be adequate.

Lévi-Strauss, too, takes the binary operations of computers as evidence of the validity of structuralism. For example, after struggling to find some connection between the wind and a flatfish in a certain myth, he concludes that they both function as "binary operators," because both have *yes*/*no* qualities (the flatfish can be seen from one angle but not from another, and the wind can either blow or not). So, "we could only understand this property of the myth at a time when cybernetics and computers have come to exist in the scientific world and have provided us with an understanding of binary operations which had already been put to use in a very different way with concrete objects or beings by mythical thought."[6] It is hardly necessary to point out the absurdity of this comparison of myth logic to computer logic.

Edmund Leach is another structuralist fascinated by the binary operations of computers: "In some respects and in some circumstances, the products of expressive action (e.g. ritual sequences, mythological texts, poems, musical scores, art forms) show marked pattern similarity to the output of a digital computer, and when we attempt to decode such message-bearing systems we usually find that binary discriminations of the *yes*/*no* type are very prominent."[7] But the only "decoding" that Leach manages to perform through his analogy to computers is some speculative interpretation of a few isolated cultural elements, no better than the interpretation reached through any other type of analysis.

2

As pseudoscientific theories go, structuralism is not very sophisticated: it belongs to the category of pseudosciences that are unfalsifiable from the start. These theories, we saw earlier, manage to escape refutation by making claims

[6] Claude Lévi-Strauss, *Myth and Meaning* (New York: Schocken Books, 1979), p. 23.

[7] Edmund Leach, *Culture and Communication: The Logic by which Symbols are Connected* (New York: Cambridge University Press, 1976), p. 57.

so vague that any event appears to confirm them. In the case of structuralism, it is the concepts of transformations and binary opposites that are vague and make the theory unfalsifiable.

In mathematics, transformations are well-defined operations, but the structuralists employ this term freely, whenever they want to show that one aspect of culture is related to another. In particular, they don't restrict themselves to a *fixed* set of transformations; rather, for every pair of stories, customs, or works of art which they wish to relate, they feel free to invent, if necessary, a new type of transformation. Clearly, we can always find some common elements in different aspects of culture. So, if what we seek is *any* relation, with just a little imagination we can relate any stories, customs, works of art, and so forth. The transformations are meaningless, therefore, precisely because they are guaranteed to work: there are no aspects of culture that *cannot* be related through one transformation or another. This guarantee makes the concept unfalsifiable, and hence worthless.

This weakness was pointed out by many critics. Philip Pettit, for example, after analyzing structuralism in general and Lévi-Strauss's work in particular, concludes: "The objection to Lévi-Strauss's method … is that the sort of hypothesis that he puts up in the analysis of [myths] is just not falsifiable."[8] "The method is hardly more than a licence for the free exercise of imagination in establishing associations between myths."[9] Lévi-Strauss divides a myth into a number of elements, selecting those elements that best fit his purpose. Then, he relates them to the elements of another myth in any way he chooses: he may call them "equivalent," or "inverted," or "symmetrical," or anything else. In the end, "if the only constraints put on transformation are that it be achieved by a set of rules then anything can be transformed into anything: you make up the rules as you go along. Thus with a modicum of ingenuity, any two myths could be presented as transformations or versions of one another."[10]

Similarly, the concept of binary opposites is not restricted to a set of well-defined attributes, like left/right, male/female, or light/dark, but is extended to fit any situation. As a result, any number of contrasts can be found between the elements of a myth, or between the elements of two different myths. A particular animal, for instance, can be contrasted with a human; or, if a land animal, with a fish or bird; or, if it hunts by day, with one that hunts by night; or, if it has coloured stripes, with one that has no stripes; and so on. These pairs of attributes are indeed binary opposites, and they represent valid relations; but this doesn't mean that myths can be analyzed mathematically. The elements of myths have *many* such attributes, so myths are connected through many

[8] Philip Pettit, *The Concept of Structuralism: A Critical Analysis* (Berkeley: University of California Press, 1975), p. 88. [9] Ibid., p. 96. [10] Ibid., p. 90.

structures at the same time, one for each attribute. The totality of myths constitutes a complex structure.

The structuralists use terms like "isomorphism," "dimensions," "axes," and "matrices" to describe how the individual structures overlap and interact. But, while having a precise meaning in mathematics, these terms are only vague analogies in structuralism. Thus, Lévi-Strauss claims that "the algebra of the brain can be represented as a rectangular matrix of at least two (but perhaps several) dimensions which can be 'read' up and down or side to side like the words of a crossword puzzle."[11] The use of terms like "matrix," however, is the only thing that the "algebra of the brain" has in common with real algebra.

Using this sort of mathematics, Leach attempts to show that three stories from the Bible "have the same general structure and … reflect the same narrative impulse."[12] He presents the various elements of these stories in a complex diagram full of blocks and arrows that suggest binary opposites in three or four dimensions.[13] Most of these opposites are contrived, as usual, but even if we accept them the diagram has no mathematical meaning. It is hard to see the point in this kind of analysis, since those conclusions that make sense – the recurring theme of good and evil, for instance – can be reached without structuralism's mathematical pretences.

Lastly, Piaget's reduction of intelligence to mathematical logic has been shown by more than one critic to be inconsistent and ambiguous, and hence meaningless.[14] Thanks to the vagueness of his mathematics, however, the theory appears to be confirmed by almost any experiment. Thus, "it is often possible to amend Piaget's claims so as to take account of new, apparently conflicting, evidence. But this possibility may sometimes seem too strong for comfort, suggesting that his theory is so vague as to be virtually unfalsifiable."[15]

One reason why the structuralists fail to note the failure of their theories is that they always look for *confirmations*. We saw earlier that the correct way to assess a theory is by looking for *falsifications*; that is, by subjecting it to tests that attempt to *refute* it. Confirmations are worthless because, no matter how many we find, they cannot prove that the theory is valid.

The structuralists, thus, are convinced that all myths, customs, literature, etc., can be reduced to common structures through transformations, so they approach a new case, not by trying to show that it *cannot* be so reduced, but by *expecting* to find a common structure. As a result, when no meaningful interpretation is forthcoming, they keep analyzing it until they find *some*

[11] Edmund Leach, *Claude Lévi-Strauss* (Chicago: University of Chicago Press, 1974), p. 55.
[12] Howard Gardner, *The Quest for Mind: Piaget, Lévi-Strauss, and the Structuralist Movement* (New York: Knopf, 1973), p. 152. [13] Ibid., p. 153.
[14] Margaret A. Boden, *Piaget* (London: Fontana, 1979), pp. 82–83. [15] Ibid., p. 153.

similarity or contrast to another case. The harder it is to find a meaningful transformation, the closer that situation is to being a *falsification* of the theory. But the structuralists interpret even the most contrived analysis as confirmation: the structure is especially subtle, they say, and it takes a more complex transformation to decode it. Others, though, did not fail to notice the dishonesty of this procedure: "Not a few critics complain that Lévi-Strauss is *overly* clever; that he makes distinctions and syntheses where data are lacking or ambiguous; that he ignores information incompatible with his theories and overemphasizes the limited amount of information in their favour."[16]

In general, both Lévi-Strauss and Piaget have been criticized for employing imprecise terms, descriptions, and methodologies, for presenting as facts what are in reality subjective assessments, and for their inclination to interpret the results of experiments as confirmations of their theories when other explanations are also possible.[17]

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The structuralist movement is a particularly morbid manifestation of our mechanistic culture, and a vivid demonstration of the resulting corruption. It is not surprising that serious workers were outraged by structuralism's inane theories and its unwarranted claims to scientific status. Stanislav Andreski, for example, in his harsh criticism of Lévi-Strauss's ideas, calls his meaningless symbols and transformations "crazy formulae" and "pseudo-mathematical decorations,"[18] and the graphic depictions of sexual matters from the life of primitive peoples, with their transformation into pseudo-mathematical representation, "surrealist pornography."[19]

Andreski is especially annoyed by the immense popularity that such worthless theories have among intellectuals: "No doubt the chief reason why Lévi-Strauss's inconsequential musings about applications of mathematics to the study of culture have found such a wide acclaim is that they affect many people as hallucinogenic incantations.... One of the great attractions of this kind of poetry masquerading as science is that it would be very difficult to invent a topic more remote from everything that matters in social life, and better fitted for a non-committal conversation among pseudo-intellectual international bureaucrats of most divergent outlooks and loyalties."[20]

[16] Gardner, *Quest for Mind*, p. 158.
[17] Ibid., pp. 219–221.
[18] Stanislav Andreski, *Social Sciences as Sorcery* (London: André Deutsch, 1972), p. 133.
[19] Ibid., p. 135.
[20] Ibid., pp. 135–136.

Universal Grammar

1

The linguistic theory of Noam Chomsky, based on the concept known as *universal grammar*, is seldom mentioned without being called revolutionary; even its critics agree that it has revolutionized the study of language. More than that, its influence has spread into related fields, notably psychology and the philosophy of mind.

Although it has its origins in earlier theories of structural linguistics, Chomsky's theory, first developed in the 1950s, is much more rigorous – and much more ambitious. Chomsky is searching for a theory, or model, that would account for each and every grammatical sentence in a particular language; in other words, a formal system of rules that can generate (just like a native speaker familiar with that particular language) all correct sentences, while avoiding the incorrect ones. This kind of formal grammar, which emulates a native speaker's knowledge, he called *generative grammar*. Due to the nature of its rules, it is also known as *transformational grammar*.

The study of grammar is, for Chomsky, the most important part of linguistics, and he believes that the traditional and structuralist theories failed to provide an adequate explanation of language because they were not formal enough. His project calls for a *mathematical* analysis of grammar, which would eventually allow any sentence to be formally described as a precise structure of linguistic elements: "Mathematical study of formal properties of grammars is, very likely, an area of linguistics of great potential."[1]

After more than half a century, however, Chomsky's theory still doesn't work. It has gone through innumerable versions; it has spawned countless subtheories; it has grown into a fantastic array of rules and principles; but it still has not achieved its goal – a mechanistic model of the phenomenon of language. It can account for many aspects of language, of course, but this means very little: we know how easy it is to find mechanistic *approximations* of nonmechanistic phenomena. And the ultimate goal of Chomskyan linguistics remains as ambitious as ever: not an approximation, but a complete, formal description of all natural languages.

The fact that a theory which doesn't work can be so popular and influential in academic circles; its foundation on nothing more substantial than the observation of a few patterns and regularities; the practice of avoiding refutation by constantly expanding it to incorporate the falsifying instances; the

[1] Noam Chomsky, *Aspects of the Theory of Syntax* (Cambridge, MA: MIT Press, 1965), p. 62.

preoccupation with isolated mechanistic problems, the individual solution of which is interpreted as progress toward the explanation of the original, complex phenomenon – these characteristics make universal grammar an excellent example of the new pseudosciences.

A commonly expressed view is that, even if it will ultimately turn out to be mistaken, this theory will have made an invaluable contribution to linguistics by showing that it can be studied with the same methods as the exact sciences: "We must at least envisage the possibility that Chomsky's theory of generative grammar will be dismissed one day, by the consensus of linguists, as irrelevant to the description of natural languages.… I personally believe, and very many linguists will share this belief, that even if the attempt he has made to formalize the concepts employed in the analysis of languages should fail, the attempt itself will have immeasurably increased our understanding of these concepts and that in this respect the 'Chomskyan revolution' cannot but be successful."[2]

The fallacy of this view, of course, is that if the theory turns out to be mistaken it is precisely because mechanistic theories cannot explain the phenomenon of language. In this case, then, it will have made no contribution whatever to linguistics, nor to the understanding of the mind. Even more serious, we will see in the next section, is the fact that mechanistic delusions of this kind are causing great harm to society, by promoting a diminished view of our capabilities and responsibilities as individuals.

2

Chomsky maintains that our linguistic capacity has little to do with learning or culture. It is a biological trait, an *innate* human faculty: "The structure of particular languages may very well be largely determined by factors over which the individual has no conscious control and concerning which society may have little choice or freedom."[3]

Thus, Chomsky says, our language faculty is akin to an organ, and we must study it in the same way we study the function of organs. Every sentence we utter or comprehend is a reflection of this language organ, and it is possible to describe with mathematical precision the working of this organ by analyzing the structure of sentences. The task of linguistics, therefore, is to discover a model that can represent all the sentences that humans utter and comprehend when they use natural languages. This model will then help us to understand

[2] John Lyons, *Chomsky*, 3rd ed. (London: Fontana, 1991), p. 153.
[3] Chomsky, *Theory of Syntax*, p. 59.

how our mind processes language. And, since we probably have similar mental organs for performing other intelligent acts, the language model will also increase our general knowledge of the mind.

Chomsky is basing his hypothesis of an innate language faculty on a number of observations. For example, while the thousands of spoken languages and dialects appear very different from one another, on closer analysis they reveal common characteristics. Thus, sentences in all languages seem to have a neat hierarchical structure: they can be divided into distinct grammatical units (noun phrases, verb phrases, prepositional phrases, etc.), which can be further divided into parts (component phrases), then into words (nouns, verbs, adjectives, etc.), and finally into morphemes and phonemes (the smallest speech elements). Also, sentences in all languages can be modified to yield related forms: past or future tense, negative or passive meaning, etc. Languages may differ in the way the elements are combined into hierarchical structures, or in the way the modified forms are derived, but it seems that a small number of categories can account for all possible variations.

Another observation is how quickly and effortlessly children learn the particular language spoken in their community: without consciously studying the language, they acquire by the age of four or five a significant subset of the adult language, and by the age of twelve or fourteen practically the whole adult language. Thus, despite its complexity, children are capable of acquiring a language simply by being exposed to it – without having to learn its rules of grammar, and without even knowing that such rules exist. This fact contrasts, for example, with the lengthy and arduous learning process we must undergo to acquire a second language as adults. It also contrasts with the *general* mental development displayed by children: at an age when they are already proficient language users, their logical and mathematical abilities, for example, are still poor and can only be improved through painstaking learning.

We also note that all normal adults in a certain community manage to acquire the same language, despite otherwise great variations in level of education or in intellectual capabilities. It is also well known that a child will acquire whatever language he is exposed to: an English child growing up in a Japanese-speaking community will acquire Japanese just like a Japanese child.

But perhaps the most striking phenomenon is the *creativity* inherent in the knowledge of a language: individuals who acquired a language without even being aware of its rules of grammar can, nevertheless, produce an infinite number of original sentences that are grammatically correct. Also, they can instantly recognize whether a sentence they hear is grammatical or not (without being able to explain why), and they can understand the meaning of complicated sentences they have never heard before. Moreover, they accomplish this although the sentences they hear spoken in their community while

growing up, and through which they presumably learned the language, are usually an impoverished and incorrect sample of that language.

All these facts, says Chomsky, can be explained only if we assume that human beings possess, as part of their genetic structure, a *language faculty*. There is no obvious reason for different languages to share so many important characteristics, or, for that matter, to have those particular characteristics in the first place. But this is readily explained if we assume that they are all governed by the same factors: certain limitations of the human mind. An innate language capacity also explains why all humans acquire a language so quickly and easily: we become proficient language users without having to consciously learn the language because, in a sense, we already know the language. We don't learn to grow arms, or to breath, or to digest food. Our organs develop and perform specific functions without any participation from us, so why should language be different? Since verbal communication confers such obvious evolutionary advantages, the human body has evolved a specific language capacity, just as it has evolved so many other functions and organs.

The language faculty is unique to human beings; it is a species-specific aptitude, like dam building for beavers or navigation for migratory birds. We are born with the capacity to acquire language, but at the same time, because this aptitude is part of our genetic structure, we are severely restricted in the type of languages that we can acquire naturally. The similarities we observe in the various languages are a reflection of these restrictions.

Also, the fact that it is so much easier for a child to acquire at an early age the complex system of rules that make up a natural language – while having such a hard time acquiring a system like mathematics, which is simpler – points to the special position occupied by language in our mental capabilities. Our brain is wired, so to speak, for natural languages, but not for other knowledge systems. Actually, acquiring a language is not a learning process at all, but more akin to the growth of an organ. Although there are variations among individuals, just as there are variations in height or lung capacity, the basic language faculty is the same for all human beings. And since any human being can acquire any language, we must conclude that it is not the features specific to a particular language, but the characteristics common to all languages, that form the innate language faculty.

Chomsky calls this set of common characteristics *universal grammar*: "Let us define 'universal grammar' (UG) as the system of principles, conditions, and rules that are elements or properties of all human languages not merely by accident but by [biological] necessity.… Thus UG can be taken as expressing 'the essence of human language.' UG will be invariant among humans."[4]

[4] Noam Chomsky, *Reflections on Language* (New York: Pantheon Books, 1975), p. 29.

Children acquire so easily whatever language they happen to be exposed to because they don't actually have to *learn* the language: since they already possess the knowledge of universal grammar, all they have to do is find out, as it were, how universal grammar is implemented in that particular language.

Chomsky believes that one day we will discover the physiological roots of these innate mental functions in the brain. In the meantime, we should be able to discover the principles of universal grammar – discover, that is, a theory, or model, that exactly represents it – simply by studying the languages themselves.[5] In fact, it doesn't even matter which language we study: whether we start with English or Chinese or Latin, we should reach the same model, because universal grammar includes only what is common to all languages. The comparative study of languages can perhaps help us to discover their common characteristics, but otherwise we may as well search for the model of universal grammar by studying the language we know best. Thus, Chomskyan linguistic concepts are derived largely from English sentences.

3

Chomsky's notions of a language faculty are, of course, pure speculations. His entire theory is grounded on the innateness hypothesis, but few people notice that the hypothesis itself is necessary only in order to account for a mechanistic theory of language. Typical of mechanistic question-begging, Chomsky started with the *assumption* that there exists a mechanistic theory of language, was then compelled to contrive an innateness hypothesis to explain linguistic phenomena mechanistically, and finally used this hypothesis as warrant for his research program. (Grounding a theory on biological and evolutionary hypotheses, instead of presenting it as a body of speculations, makes it more respectable.) The idea whose truth needs to be proved – the existence of a mechanistic explanation of language – is used as the starting point, as an assumption. This circularity is blurred by the enormous number of technical and complex aspects, and by their formal and rigorous treatment, which make the theory look like a serious scientific pursuit when in reality it is just another mechanistic delusion.

It is because people don't appreciate how fantastic its claims are that this theory is taken seriously at all. It would be instructive, therefore, to analyze its fallacies in some detail. And there is a second reason why we must devote more time to this pseudoscience than we did to behaviourism and structuralism: since the mechanistic language delusions have contributed to our mechanistic

[5] Ibid., p. 36.

software delusions, this analysis will help us later to understand the fallacies of *software* mechanism. Language and software fulfil a similar function – allowing us to mirror the world in our mind and to communicate with it; so it is not surprising that they engender the same type of delusions. (We will study this similarity in chapter 4.)

Linguistics is concerned with the study of the various aspects of language, especially phonology, morphology, syntax, and semantics. Some theories stop at the level of phonemes, morphemes, or words, but Chomsky's generative grammar, like other modern linguistic theories, is concerned with the structure of entire sentences. Significantly, linguists do not attempt to study elements of language that are more complex than sentences; they do not try to interpret, for example, the meaning of an argument encompassing several sentences. This, they say, is the task of philosophy, not linguistics.

But in normal discourse the meaning of sentences depends usually on the context in which they are used. Thus, if linguistics restricts itself to the study of isolated sentences, it must admit that there are certain aspects of language which necessarily lie beyond its range of explanations. And indeed, most linguistic theories are content to study only *some* aspects of language. Chomsky, though, claims that it is possible to discover a formal model that provides a complete and exact explanation of *all* possible sentences; specifically, a model that generates all the grammatical sentences in a given language and avoids the ungrammatical ones. In other words, he claims that we can account for all possible uses of a language from its grammar alone, without being concerned with the contexts in which the language might be used. But does this claim make sense?

In normal speech we rarely use words in isolation, so we rarely express a simple, rigid meaning of a word. When used in sentences, words can have more meanings than one could deduce by studying the words in isolation; it is the interactions between words – the complex structures generated in the mind when we interpret sentences – that provide the additional information. Similarly, we seldom use isolated sentences; a sentence is normally part of a context, and its meaning is affected by the meaning of the other sentences, by the interaction between its words and those of the other sentences, and also by any number of factors involving the persons who utter and interpret the sentences.

Thus, while there is much that can be learned about language by studying individual words and sentences, we cannot expect to detect all the information that a sentence can convey by studying it in isolation, any more than we can detect all possible meanings of a word by studying it in isolation. Yet this is precisely what Chomsky is attempting to do. He criticizes those linguistic theories that are content with an incomplete and informal analysis of sentences,

and claims that it is possible to find an exact, mathematical model that accounts for all the information conveyed by a sentence. But how can a model based on isolated sentences accomplish this?

Chomsky studies isolated sentences because he knows that it is impossible to find a mechanistic theory for the whole phenomenon of language – which would be tantamount to searching for a mechanistic theory of all human knowledge. To recognize the futility of searching for a mechanistic representation of knowledge, we only need to recall the many attempts made by philosophers to find an exact correspondence between language and knowledge (we will examine some of these attempts in chapter 4). By studying isolated sentences, Chomsky reifies in effect small portions of language, and hence small portions of knowledge, from the complex phenomenon of human intelligence. By severing the interaction of these sentences with other knowledge structures, he gets closer to a mechanistic representation of language. But what he is studying now is no longer the whole phenomenon of language.

And Chomsky goes even further: not only does he extract individual sentences from their context, but he separates the syntax of the reified sentences from their semantics. Thus, he makes the bold claim that the syntax and the meaning of a sentence are independent structures and can be analyzed separately. As evidence, he notes the following two sentences: "colorless green ideas sleep furiously" and "furiously sleep ideas green colorless."[6] As speakers of English we recognize both sentences as meaningless, but for different reasons: the first sentence, although meaningless in many ways, is perfectly grammatical, while the second one is not; we can easily recognize certain syntactic elements in the first sentence, while in the second one we recognize none and end up treating each word as a separate phrase. It is as if we had a feeling of familiarity with the first sentence, but not with the second one, even though we hear both for the first time; we can memorize, for example, and recall the first sentence more easily than the second one.[7] This and other facts give Chomsky the confidence to postulate the independence of syntax from meaning. It is chiefly the syntactic structure of a sentence that determines how we interpret it: we feel more comfortable with the first sentence, although both are meaningless, because, being grammatical, our language organ can more readily cope with it.

Chomsky, thus, decided to ignore the meaning of sentences – their semantic aspect – altogether: universal grammar is independent of meaning, and we should be able to discover a precise and complete model of the language

[6] Noam Chomsky, *Syntactic Structures* (The Hague: Mouton, 1957), p. 15.
[7] Ibid., p. 16.

faculty without getting involved with the semantic interpretation of sentences. He agrees that we use both syntax and semantics to create and interpret sentences; but he argues that we can develop separately theories of syntax and of semantics.[8] In any case, syntax is the more important component, and it is the syntactic structure of sentences that is the essential element in a scientific study of language: "Despite the undeniable interest and importance of semantic and statistical studies of language, they appear to have no direct relevance to the problem of determining or characterizing the set of grammatical utterances."[9] "Grammar is best formulated as a self-contained study independent of semantics. In particular, the notion of grammaticalness cannot be identified with meaningfulness."[10]

The independence of syntax from meaning is, of course, just another hypothesis Chomsky had to adopt in order to find a mechanistic model of language. Thus, he observes that all attempts made by previous linguists to include aspects of semantics led to vague and unsatisfactory theories.[11] But, apart from a few examples and arguments, he made no serious attempt in his original theory to show why the two can be separated. He made it clear, in fact, that the main reason he prefers to view syntax as an independent subject is that this approach offers the only hope for a rigorous study of language: "The motivation for this self-imposed formality requirement for grammars is quite simple – there seems to be no other basis that will yield a rigorous, effective, and 'revealing' theory of linguistic structure."[12]

So, like the man who is looking for his keys under a streetlamp, not because that is where he lost them but because that is where there is light, Chomsky candidly admits that he is searching for a mechanistic theory simply because mechanistic theories are exact and "revealing." This they are, of course; but a revealing theory of *language* can be discovered only if there is something to reveal – only if language is indeed a mechanistic phenomenon.

❖

Whether it is the reification of individual sentences from a discourse or the reification of syntax or semantics from a sentence, the goal is to break down a complex knowledge structure into several simple ones – which can then be represented with mechanistic models. The phenomenon of language is the result of many interacting structures (see p. 110). It is easy to identify some of the structures that make up a sentence, but just because we can identify them it doesn't follow that we can explain language by studying them separately.

[8] Ibid., ch. 9. [9] Ibid., p. 17. [10] Ibid., p. 106.
[11] Ibid., pp. 93–94. [12] Ibid., p. 103.

Thus, structures like the syntax of a sentence, or the meaning of its words, or the context in which it is used, occur together; and they interact, because they share their elements. Moreover, their elements are not just the words, but also pieces of knowledge that, while not part of language, affect our interpretation of the sentence.

To convey the flavour of these issues, I will mention just one of the problems studied by Chomskyans – the problem of ambiguity. The sentence "John lost his book" can mean either that John lost his own book or that he lost another man's book. A generative grammar based on syntactic rules, like the one developed by Chomsky, can indeed resolve this ambiguity (by treating the sentence as one phonemic string generated from two different syntactic structures, one for each meaning). This may tempt us to conclude that we can account for multiple interpretations of a sentence with a model based on syntax alone, without depending on word meaning or the context in which the sentence is used. But the sentence "John lost his way," although syntactically identical to the previous one, can have only one meaning: losing his own way. And we can only account for this discrepancy with a model that uses *both* syntax and word meaning in the interpretation of sentences.[13]

The difficulties encountered by Chomsky and his followers, with the original theory as well as its innumerable variations, are due to the fact that the impoverished model of language he reached through repeated reifications cannot explain all possible sentences. His theory does indeed provide a mechanistic model of language, but only by failing to explain the *whole* phenomenon of language. The model ignores the interactions between structures, and it is these interactions that give language its richness. As is the case with all mechanistic delusions, Chomsky wishes to have both the richness of a complex phenomenon and the simplicity of a mechanistic model – an impossible goal. When he separated the complex phenomenon of language into simpler ones – when he severed the interactions – he renounced, in effect, the original project.

Chomsky's mechanistic theory of language is a fantasy, and we must not be surprised that it doesn't work. We should examine, though, how Chomsky and his followers react to its falsifications. The original concepts were expressed in the form of a falsifiable theory, and Chomsky himself recognizes the importance of falsifiability as a criterion of demarcation.[14] But, while *introduced* as a testable and falsifiable theory, universal grammar became unfalsifiable soon thereafter, when its defenders started to modify it in order to suppress the falsifications. The theory was turned into a pseudoscience, thus, by the

[13] For this example, as well as other, similar problems, see Chomsky, *Reflections on Language*, ch. 3. [14] Ibid., p. 37.

decision to *expand* it, rather than abandon it, each time an aspect of language was found that could not be accounted for through the existing principles.

4

Let us briefly review the original concepts. Chomsky's first model of a generative grammar consisted of three components: the phrase-structure component, the transformational component, and the morphophonemic component. The phrase-structure component provides the rules for generating *phrase markers*; these are the *underlying strings*, or *deep structures*, of linguistic elements. The transformational component provides a set of *transformational* rules, which convert the underlying strings into *surface structures* – the final, grammatical sentences. The morphophonemic component provides the interpretation rules for converting the surface structures into the phonemic strings that make up speech.

The rules of the phrase-structure component show us how to generate an underlying string as a hierarchical structure of lexical elements. Thus, a sentence is built from certain elements, those elements from smaller ones, and so on, down to the lexical atoms – the words and morphemes that make up the underlying strings. There are only about a dozen phrase-structure rules. Thus, the top element of the hierarchy is a sentence, *S*, and is derived by concatenating a noun phrase, *NP*, and a verb phrase, *VP*; *VP* is derived by concatenating a *Verb* and an *NP*; *Verb* is composed of an optional auxiliary, *Aux*, and an actual verb; *Aux* is a morpheme like *will* or *may*, or a form of the verbs *have* or *be*; and so on. By combining and repeatedly applying these phrase-structure rules, it is possible to generate an infinite number of underlying strings. And any string generated in this fashion will eventually result in a grammatical sentence.

An underlying string may have to be further modified, by applying one of the transformational rules. The transformations manipulate words and morphemes in various ways; for instance, they modify their relative position in the string. Transformations are required in order to generate sentence constructions like negation, passive voice, and past tense, which cannot be generated directly by the hierarchical phrase-structure rules. In other words, a transformational rule must be defined for each surface structure that cannot be derived directly from a deep structure.[15]

It must be emphasized that all these rules were specified in a formal and precise manner – precise enough, for example, to be implemented as

[15] Chomsky, *Syntactic Structures*, pp. 111–114.

a computer program. Chomsky recognized that the rules he described in his original model were imperfect, that they did not adequately define all grammatical English sentences; but he was convinced that a perfect model was attainable. In particular, he described only a small number of transformations. It was chiefly through transformations that the model was expected to improve in the future, as this concept seemed versatile enough to generate any sentence. We only need to analyze all possible sentence constructions, he believed, and determine the transformations that generate them, and we will end up with a formal definition of the whole English language.

5

The origin of the Chomskyan delusion is not without interest, and is worth therefore a short digression. The study of formal grammars and languages, along with the study of automata (abstract machines that are mathematically related to formal languages, in that they can generate or process statements expressed in these languages), formed a new and exciting field in the 1950s. The theories discovered in those days had immediate applications in the emerging discipline of computer science, in both hardware and software design. The theories of programming languages, in particular, and of compilers (the software tools that translate them into the lower-level languages of the hardware), were a direct application of the theories of formal languages.

Scientists saw great potential in the fact that a relatively simple system of specifications was all they needed in order to define a grammar or a machine, which could then generate an infinite number of different strings of elements. The principle behind this power is recursion: performing an operation with certain elements, then with the resulting elements, and so on. By nesting elements within elements hierarchically, scientists could build mathematical models of grammars or automata that displayed very complex behaviour while their definition remained completely specifiable and relatively simple.

It was natural perhaps to think that nothing lay beyond the capabilities of such mechanistic models. Reassured by the mathematical foundation of these concepts (established in the preceding two decades by pioneers like Alan Turing), and fascinated by the first computers (which were already demonstrating the practicality of these ideas), many scientists concluded that they had finally found the answer to the great mysteries of knowledge and mind: the capabilities of the models they had already built resembled some of the simpler capabilities of the mind; computers afforded the means to build models of any complexity; therefore, to attain a model with the full capabilities of the mind, they only needed to apply the same principles on higher and

higher levels. Mind mechanism – the belief that reductionism and atomism can explain the concept of mind – had entered the computer age.

Viewed from this perspective, Chomsky's fantasy is the linguistic counterpart of the other mechanistic mind fantasies of that period – fantasies which became known as artificial intelligence. The naive optimism of that period has been preserved for posterity through the ludicrous statements made by a number of scientists; namely, that computer models of the whole phenomenon of human intelligence would be attained within a few years (see p. 143).

It is significant that, although not directly involved, Chomsky always approved of the principles and goals of artificial intelligence. And it is quite irrelevant that Chomsky himself only worked on *models* of grammar: since his project calls for a complete and precise definition of natural languages, this definition could always be used to develop a computer program. Thus, his project too is, in effect, a search for a mechanistic model of mind, an attempt to replace human intelligence with software (the delusion we discussed in chapter 2).

Now, Chomsky had done some of the original work on formal languages, so he was familiar with the properties and capabilities of a series of grammars that had already been investigated – grammars called *regular* (or *finite-state*), *context-free*, *context-sensitive*, and *phrase-structure*.[16] Each one of these grammars is more powerful than the preceding one, in that it can generate a greater variety of statements. Context-free grammars, for instance, are more versatile than regular grammars, and are powerful enough to serve as the foundation of programming languages. The neat hierarchical structures of elements generated by context-free grammars are well-suited for the construction of software statements, modules, and applications, as they can grow to any size while remaining unambiguous and basically simple (and hence easily processed by compilers).

Chomsky showed that these grammars are too weak to generate all the sentences people use in a natural language like English, and he assumed that all we need for this task is a grammar that is even more powerful than the phrase-structure type. He also assumed that a formal grammar powerful enough to describe a natural language would be an extension of the existing grammars, just as each one of *those* grammars was an extension of the preceding one. His original model clearly reflects this belief: the phrase-structure component is the implementation of a grammar that was already understood, while the new, transformational component provides the extension (it modifies the resulting

[16] For a discussion of these grammars (including Chomsky's early contributions), see, for example, John E. Hopcroft and Jeffrey D. Ullman, *Formal Languages and Their Relation to Automata* (Reading, MA: Addison-Wesley, 1969).

strings so as to generate new types of sentences). The transformational rules were expected, in other words, to cope with all the differences between natural languages like English and simple, formal systems such as programming languages. The few transformations that Chomsky proposed were precisely specified, using a mathematical representation, just like the other rules that define formal grammars. He evidently hoped that, with additional work, it would be possible to discover a complete set of transformations, and the English language would be shown to be merely a more complex system than the others – something akin to a sophisticated programming language.[17]

This background also accounts for his view that grammar is independent of the *meaning* of words and sentences. A programming language, after all, can be defined without a knowledge of the actual applications that will eventually be created in that language. Similarly, a natural language must be studied "as an instrument or a tool, attempting to describe its structure with no explicit reference to the way in which this instrument is put to use."[18]

For Chomsky, then, there is a difference in degree, but not in kind, between human minds and the human environment that gives rise to natural languages, and the machines controlled by means of programming languages. This diminished view of humanity is an inevitable consequence of the mechanistic dogma.

6

Let us return to the main issue: the pseudoscientific nature of Chomsky's theory, the practice of modifying and extending it in order to escape refutation. The principal feature of the original theory was the claim that a natural language can be fully specified without taking into account the meaning of words and sentences or the context in which they are used. This idea, and hence the possibility of a formal definition of an entire language with a

[17] A computer program is a system of interacting structures, so what is completely specifiable is only the individual structures. The program's run-time performance depends on the interactions between these structures, and is therefore a non-mechanistic phenomenon. It is silly, therefore, to strive to reduce natural languages to a formal system resembling our programming languages, seeing that even computer programs, whose language *already is* a formal system, cannot have mechanistic models. What the mechanists fail to understand is that the software entities which make up a program, as much as the linguistic entities which make up a sentence, belong to several structures at the same time; and mechanistic models cannot represent the resulting interactions. We will study this problem in chapter 4. The mechanistic *software* theories are failing, therefore, for the same reason the mechanistic *language* theories are failing.

[18] Chomsky, *Syntactic Structures*, p. 103.

relatively simple system of rules and principles, is what made the theory famous. The subsequent development of the theory, however, consisted mainly in the discovery of types of sentences that *cannot* be explained without resort to meaning, followed by the modification of the theory to make it explain these sentences too. And this was usually accomplished by reinstating some *traditional* grammatical concepts, which do take meaning into account. The response to each falsification, in other words, was to turn it into a new feature of the theory. The following discussion is only a brief survey of this evolution, as it is impossible to mention here all the theories and sub-theories that have formed, at one time or another, the school of Chomskyan linguistics.

Just a few years after proposing his original theory, Chomsky introduced a series of major modifications.[19] (The new model became known as the *standard* theory.) There were changes in the phrase-structure component (now called the base component) and in the transformational component, but the most startling change was the introduction of a *semantic* component: deep structures were now processed both syntactically and semantically, so the resulting surface structures had both a syntactic structure and a meaning.

The new theory was more complicated than the original one, and more obscure. Neither theory worked – that is, neither went beyond a few examples and suggestions for future research – so both were mere speculations. But even as speculation, the new theory was a step backward: not only was its claim that semantics plays a role in the interpretation of sentences a blatant reversal of the original principles, but it left more questions unanswered. What was left for future research was not just some rules or transformations, as was the case earlier, but major problems in all sections of the model. We were now further away from a formal model of language, but this situation, instead of being recognized as a refutation of universal grammar, was interpreted as progress. What impressed people was, again, Chomsky's authoritative tone and the formal treatment of the problems; in other words, the fact that issues involving phrases, verbs, or pronouns were studied like issues in the exact sciences. The fact that few solutions were actually offered, and that most problems were merely stated, without even an attempt to solve them, made no difference.

Chomskyans allowed semantics into their grammatical model because they believed that a set of rules can be found to define with precision the relations between word meaning and syntax. No such rules exist, of course, but the search for them has been a major issue ever since. Chomskyans still do not admit that the interpretation of a sentence is related to the entire knowledge structure present in the mind, so in the new theory (and in all subsequent ones) they isolate various aspects of syntax, and search for ways to relate

[19] Chomsky, *Theory of Syntax*.

them formally to the meaning of words. To pick just one example, Chomsky proposed at one time a system of *concept categories* (animate or not, abstract or not, etc.) to determine whether the use of certain types of words is valid in specific situations.

The application of semantic rules to deep structures was eventually abandoned, and was replaced by a new model (known as the *extended standard* theory), in which the semantic functions are performed mainly on surface structures. But to retain the links to the syntactic structures, a complicated *trace* sub-theory was developed to allow the transfer of such information as the position of words in the sentence, from the deep structures to the surface structures. In the meantime, other linguists proposed a theory of *generative semantics*, which tried to build the meaning of sentences from the meaning of smaller elements.

None of these theories worked, so the next step was to replace the entire transformational philosophy, which was based chiefly on systems of rules, with a new model, based on *principles and parameters*. Chomsky argues now that languages can be described as sets of principles, where each principle can be implemented only as one of the alternatives permitted by universal grammar. All languages are basically the same, the only difference being in the implementation of these principles; and language acquisition consists in the unconscious discovery of the correct alternatives for a particular language. It is as if our language organ had a number of switches, all set at birth in a neutral position and ready to accept any value (from among the values permitted by universal grammar). What we do when acquiring the first language is set these switches to one value or another.

This is how Chomsky describes the new concept: "The principles are language-independent and also construction-independent; in fact, it appears that traditional grammatical constructions (interrogative, passive, nominal phrase, etc.) are taxonomic artefacts, rather like 'terrestrial mammal' or 'household pet.' These categories, with their special and often intricate properties, result from the interaction of fixed general principles, with parameters set one or another way. Language acquisition is the process of determining the values of parameters. There are no 'rules of grammar' in the traditional sense: rather, language-invariant principles and values for parameters of variation, all indifferent to traditional grammatical constructions."[20]

This text is typical of Chomsky's writing style: he is describing some linguistic fantasies, but by presenting these fantasies in an authoritative tone he makes them look like a scientific revolution.

[20] Noam Chomsky, "Chomsky, Noam" self-profile, in *A Companion to the Philosophy of Mind*, ed. Samuel Guttenplan (Oxford: Blackwell, 1995), p. 161.

The new theory, Chomsky declares, is "a conception of language that [departs] radically from the 2500-year tradition of study of language."[21] Unfortunately, while elements "of the picture seem reasonably clear" (to Chomsky, at least), "a great deal is unknown, and clarification of principles regularly opens the doors to the discovery of new empirical phenomena, posing new challenges. Though much less is understood, something similar must also be true of the lexicon, with the links it provides to the space of humanly accessible concepts and signals."[22]

Thus, Chomsky admits, what is "much less understood" than the part of which "a great deal is unknown" is (as always) the interaction between language structures and the other structures that make up human knowledge; in other words, the actual, complex phenomenon of language, as opposed to the reified, mechanistic phenomena studied by linguists.

Note again his authoritative tone, even as he is describing what are, in fact, mere speculations. For example, while admitting that we know practically nothing about a certain phenomenon, he confidently asserts that certain aspects are "reasonably clear," and that "something similar must also be true" of others. This is the same confidence that brought us the previous theories, all now forgotten. So now we have a new revolutionary theory that is mere speculations and doesn't work, to replace Chomsky's other theories that revolutionized linguistics though they were mere speculations and didn't work.[23]

Note also, in that passage, the statement about "new empirical phenomena" being regularly discovered and "posing new challenges." This assertion illustrates how pseudoscientific thinking distorts the idea of research – from an effort to discover the truth, to an effort to save a theory from refutation: "new empirical phenomena" is a euphemistic term for the falsifications of the theory, while the "challenges" constitute the search for ways to turn these falsifications into new features; that is, ways to expand the theory so as to account for them and thus escape refutation.

It is instructive to take a look at some of the principles that make up the new model:[24] *X-bar* theory deals with phrase structure and lexical categories and

[21] Ibid., pp. 160–161. [22] Ibid., p. 161.

[23] Like the previous theories, the new one did not last long. In the following years many of its principles were abandoned, and by the late 1990s another linguistic revolution – another batch of speculations – was being promoted: the so-called minimalist program.

[24] See, for example, Noam Chomsky, *Knowledge of Language: Its Nature, Origin, and Use* (Westport, CT: Praeger, 1986).

their mutual relationships. *Theta* theory deals with the thematic roles (agent, patient, goal) played by elements in a sentence. *Case* theory deals with the assignment of case (nominative, accusative, genitive) to noun phrases. *Control* theory deals with the subject of infinitival clauses (the relation between the missing subject and the other elements in the sentence). *Binding* theory deals with the problem of expressions that refer or not to the same entities as other expressions in the sentence (as in constructions involving pronouns or anaphors). *Bounding* theory deals with the movement of grammatical units from one place in the sentence to another (as when deriving passive or interrogative constructions).

What is immediately striking about these principles, or sub-theories, is that each one deals with a single, isolated aspect of grammar. There are many other, similar principles in the new model, and additional ones are known but little has been done to study them. New principles, Chomskyans say, will undoubtedly be discovered in the future. And to cover any grammatical cases that may remain unexplained no matter how many principles and sub-theories will be discovered, the concepts of *core* and *periphery* have been introduced.[25] Every language, it appears, has two types of grammatical constructions: the core is that part of language explained by universal grammar, while the periphery includes those aspects of language that somehow evolve outside the scope of universal grammar.

The theory, thus, has become blatantly unfalsifiable, as any conceivable sentence and any aspect of grammar is now guaranteed to be accountable: either it is explained by the known principles, or it will be explained by principles yet to be discovered, or it doesn't need to be explained at all, because it belongs to the periphery. Little by little, Chomskyan linguistics has turned into a full-fledged pseudoscience.

If we compare the new principles to the original theory, what we notice is the evolution from a simple and elegant model that made bold and sweeping claims, to a collection of distinct and rather complicated theories that deal with isolated and minute aspects of grammar. It is also interesting that these aspects are not unlike those studied by *traditional* grammars. So, if we ignore the new terminology, many of these concepts are in fact a reinstatement of older grammatical concepts, which had been excluded by the original theory when it claimed that a relatively simple system of rules can explain a whole language. And we must recall that it was its simplicity and elegance that made the original model so attractive in the first place. Thus, Chomskyan linguistics continues to benefit today from its original prestige, even though its current features and claims are, in many respects, the exact opposite of the original ones.

[25] Ibid., p. 147.

Chomskyans stress now the benefits of the "modular" approach to the study of language: each sub-theory forms an independent module, which can be studied separately, while the modules also interact and work together as one system – the language faculty. Chomskyans draw block diagrams to depict these mental language modules and their interactions; and they connect the blocks with arrows, and use terms like "input" and "output" to describe the alleged data flow in the mind. The entire language faculty is treated then as one module among the many modules of the mind (the other faculties), which are believed to be relatively independent while interacting and working together to produce intelligence. It is hardly necessary to point out the mechanistic nature of this model: Chomsky's study of language and mind looks now just like an engineering project whose difficulty was originally underestimated.

This evolution is typical of mechanistic delusions: Chomsky started with a fantastic claim – the claim that a fairly simple model can provide an exact and complete explanation for the phenomenon of language. To make such a claim, he had to *assume* that the phenomenon is mechanistic in nature; namely, that it can be explained by explaining separately the simpler phenomena which appear to make it up. This led to the reification of language from the whole phenomenon of human knowledge, the reification of syntax from the phenomenon of language, and, finally, the reification of individual aspects of syntax. The reductionistic procedure looks perfectly logical – if we forget that the mechanistic nature of the phenomenon is only a hypothesis. With this hypothesis, we can always break down a phenomenon into simpler and simpler ones. Eventually, we are certain to reach phenomena that are simple enough to explain with mechanistic models – with rules, diagrams, mathematics, etc.

It is clear, then, why Chomskyans believe that they are making progress. They keep finding explanations for isolated grammatical phenomena, and they believe that these explanations will one day be combined into an explanation of the original phenomenon. But language is a complex phenomenon. So even if one day they manage to identify all its constituent structures, their model will still not work, because mechanistic models cannot represent the *interactions* between structures.

It is interesting that the new theory specifically depicts language as the result of many *interacting* principles of grammar, all sharing the same linguistic elements. The theory describes, therefore, a complex structure; and these principles are, quite correctly, some of the simple structures that make up the phenomenon of language. Chomskyans, however, still fail to see that it is impossible to explain a complex structure by explaining separately its constituent structures. And they still fail to see that the phenomenon of language involves, not only grammatical structures, but many knowledge structures present in the mind.

7

Chomsky compares our current linguistic knowledge with our knowledge of physics before Galileo. He modestly admits, with each new model, that these are only beginnings, that there is much work left to be done. He believes that, just as Newton synthesized the knowledge of his time and discovered the laws of universal gravitation, a similar breakthrough will take place one day in linguistics, when someone will discover a unified theory of language.[26]

Chomsky's belief in language mechanism is unshakable: he does not doubt for a moment that the phenomenon of language can be explained, just like gravitation, through reductionism and atomism. Viewed in this light, the practice of modifying the theory to account for contradicting empirical evidence may look like a legitimate research method – a way to improve the theory. Recalling Popper's principles, however, the scientist must sincerely attempt to *refute* his theory. If he modifies it to avoid the falsifications, he does the opposite: he attempts to *save* the theory. The scientist must specify, when proposing his theory, what events or situations, if observed, would refute it. And if subsequent tests reveal such events or situations, the correct response is to declare that theory refuted, propose a *new* theory, and specify what events or situations would refute *it*.

If we keep this principle in mind, it becomes clear that Chomsky is not trying to refute his theory, but to save it. We must not be confused by his endless models; these models are not really new theories that replace previously refuted ones, but different versions of the *same* theory. Chomsky's theory is not just a formal model of grammar, but the system comprising a model of grammar *and* the idea of an innate universal grammar. One cannot exist without the other. The search for a mechanistic model of grammar is motivated by the innateness hypothesis – the hypothesis that humans possess a language faculty which is akin to an organ. *This hypothesis* is, in the end, Chomsky's thesis, what has made the whole theory unfalsifiable and hence pseudoscientific. The innateness hypothesis never changed, and it is in order to save *it* from refutation that all those models of grammar – all the theories, sub-theories, and principles – had to be invented, modified, and extended.

But why is the innateness hypothesis so important? Why does Chomsky defend it at all costs? Because, he frequently asserts, it is the only logical alternative. An innate language faculty is the only way to account for the ease

[26] See, for example, Noam Chomsky, *Language and Politics* (Montréal: Black Rose Books, 1988), p. 418.

and speed with which children learn a language, especially when we consider the impoverished sample they are exposed to; it is the only way to account for their ability to create correct sentences which have little resemblance to those they heard before; and so on. Since we can think of no other explanation, says Chomsky, we must accept the hypothesis of an innate language capacity.

But is it true that there are no alternative explanations? Only if we assume that language is a mechanistic phenomenon do we have to resort to an innateness hypothesis. If we admit that there are complex phenomena in this world – phenomena which cannot be explained through reductionism and atomism – then an alternative hypothesis is that the linguistic capability of humans is a complex phenomenon.

The circularity characteristic of mechanistic thinking is, again, obvious. Because he wishes to explain language with a mechanistic theory, Chomsky must conceive a second mechanistic theory: the innateness hypothesis (which is, in effect, the notion that there exists in the mind a thing whose operation can be described with precision). Then, he uses this hypothesis as warrant for his linguistic theory. Chomsky must assume both language mechanism and mind mechanism at the same time. One mechanistic assumption is adduced to justify another. The mechanistic philosophy is invoked to defend the mechanistic philosophy.

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Since the entire Chomskyan project is grounded on the innateness hypothesis, we should perhaps investigate the soundness of this hypothesis. In our discussion of skill acquisition, we concluded that it makes no sense to postulate the existence of specialized high-level mental functions (see "Tacit Knowledge" in chapter 2). We saw that the same model of mind can account for any skills: general skills acquired simply by belonging to a human society (using language, interpreting visual sensations, recognizing social contexts), and specific skills selectively acquired by each individual (playing chess, interpreting X-rays, programming computers). We develop the necessary knowledge by being exposed to the phenomena – that is, the complex structures – which embody that knowledge. Our mind discovers the simple structures (the regularities) in the information captured by the senses, and creates an approximate replica of the complex structures by discovering also the interactions.

Complex structures can exist only in the phenomena themselves and in the mind; they cannot be transferred directly into a mind, because our senses communicate with our environment only through simple structures (through systems of symbols or sounds, for instance). The complex structures formed in the mind manifest themselves as non-mechanistic knowledge: we can *use* this

knowledge, but we cannot precisely describe what we know. In other words, we cannot reduce this knowledge to simple structures. Non-mechanistic knowledge is the type of knowledge we possess when we reach expertise in a particular skill.

The human brain may well have some specialized low-level innate functions, like those found in simpler animals. And such functions may even take part in our verbal acts. But it is both absurd and unnecessary to postulate innateness in order to explain *high-level* mental capabilities; that is, to assume specialized faculties to account for *particular* skills, as Chomsky does.

It is absurd, first, from an evolutionary perspective: low-level functions, or instincts, play a dominant part in the behaviour of simple organisms, and the brain has evolved precisely in order to confer the advantages of learning. It makes no sense to assume that language – the most human-specific faculty, perhaps our most complex capability – is handled mostly by innate functions, while the *learning* functions of the brain, which have evolved specifically as an improvement over innate functions, play only a secondary part.

Another reason why the innateness hypothesis is absurd is that it leads to the conclusion that we possess a specialized faculty for each skill we can acquire. We might perhaps accept the innateness hypothesis for those skills acquired early in life by all humans – using language, recognizing faces, etc. But we saw that there is no fundamental difference between these natural skills and the skills related to a particular culture or occupation, which can be acquired at any age. All skills can be accounted for through a mind model based on complex knowledge structures.

Recall the skills we studied in "Tacit Knowledge." No one would suggest that we possess a specialized faculty for playing chess, or for interpreting X-rays, or for distinguishing chicks. Humans can acquire thousands of different skills, so we must conclude that the *same* mental capabilities are used in all of them. And if we can acquire so many skills using some generic mental capabilities, why do we have to assume that some other skills – like the use of language, which also can be accounted for by the same model of mind – are innate? The innateness hypothesis is unnecessary if we accept the existence of complex mental structures. Chomsky postulates specialized mental faculties, not because of any evidence that such faculties exist, but because this is what he needs for his mechanistic mind model.

And what about those linguistic phenomena Chomsky says can only be explained by an innate language capability? The fact that languages have so many common features, and the fact that children learn a language so quickly and easily, can be explained, just as Chomsky says, by an innate characteristic: our brain has developed the capability to process hierarchical knowledge structures. So this characteristic may well be reflected in our languages too: in

each one of the various structures, including the grammatical structures, that make up the phenomenon of language. What Chomsky chooses to interpret as a specialized *language* capability – the mind's capacity for hierarchical structures – is a *general* capability. It is a capability that can be observed in *all* mental acts.

For example, when we see a face we perceive its elements and attributes as structures, not as isolated parts; we don't notice one eye, then the chin, then the nose, then the other eye; we don't study the elements randomly, or left to right, but unconsciously perceive them as several facial structures that exist at the same time. An expert chess player doesn't perceive a position by examining the pieces on the board in a certain sequence, but by unconsciously recognizing many overlapping and interacting logical structures. Similarly, we don't make sense of a sentence by combining words randomly, or left to right, but by detecting structures of grammar and of meaning. We perceive *everything* as structures, but this is masked by the fact that these structures share their elements, so we perceive them simultaneously. As we saw in "Tacit Knowledge," only when *inexperienced* in a certain domain do we notice the individual structures separately.

As for the creative aspect of language – our capability to utter and comprehend an infinite number of sentences that only resemble, and only in unspecifiable ways, those we heard before – it too is not peculiar to linguistic skills, but common to all skills. The distinguishing aspect of expertise, we saw, is the capability to recognize new situations intuitively. As novices, we can only cope with a new situation mechanistically; that is, by following rules and by decomposing it into familiar elements. After a great deal of practice, however, when we reach expertise, we can cope with new situations directly, holistically. Expertise, therefore, permits us to cope also with *complex* situations, which cannot be precisely described as a combination of familiar elements.

Thus, we can recognize a familiar face from any angle, or from any distance, or in any light, or in a photograph; that is, when the image formed on the retina only *resembles* the previous images. And we cannot describe with precision how we recognized the new image, nor in what ways it resembles the previous ones. An experienced radiologist correctly interprets X-ray pictures that are necessarily only *similar* to others he saw previously. Expert chess players recognize positions that are only *similar* to previously encountered ones. To drive a car we must be able to handle random traffic situations, which at best *resemble* previously encountered ones. Moreover, we need this capability not only with specific skills, but to perform any intelligent act. We need it, in fact, just to behave normally in everyday situations; in this case we need it in order to recognize *contexts* that only resemble previous ones.

So, if this capability is used in all mental acts, why not also in the acquisition

of language? Language is a complex structure, and the child discovers its constituent structures, including the grammatical structures and their interactions, simply by being exposed to it – as is the case with other skills. Also like other skills, the child manages to cope with novel situations; that is, he can create and understand sentences that only *resemble* previous ones. The complex knowledge the child acquires in the case of language includes the grammar; so, as is the case with any non-mechanistic knowledge, he can benefit from his knowledge of grammar without being able to describe what he knows.

In conclusion, the innateness hypothesis – the foundation of Chomskyan linguistics – is not as solid as Chomsky believes. And without this foundation, his theory is left as just another mechanistic mind delusion: just another system of belief, and no more of a science than behaviourism or structuralism. Despite the preciseness observed by most Chomskyans in their work, their models can lead nowhere if the project itself is unsound. No matter how many rules or principles they study, or how successful they are in reducing each one to a formal representation, these reified structures cannot improve our understanding of the phenomenon of language, nor of the human mind. There is no innate language faculty, and universal grammar is a mechanistic fantasy.[27]

[27] More than a few thinkers have criticized Chomskyan linguistics, of course, sometimes with arguments very similar to those presented in the foregoing discussion. No criticism, however, and no falsifications, can affect the popularity of a mechanistic idea among the academic bureaucrats.