HISTORICAL DICTIONARY OF QUOTATIONS IN COGNITIVE SCIENCE: A Treasury of Quotations in Psychology, Philosophy, and Artificial Intelligence

Morton Wagman

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Compiled by Morton Wagman

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Preface

There are many books of quotations. This volume is a highly specialized one for the new areas of cognitive science that include psychology, philosophy, and artificial intelligence. This is the only book of its type.

The quotations in this volume have been selected with regard to criteria of special interest to scholars, professionals, and graduate students in psychology, philosophy, and artificial intelligence. The selections have met one or more of the following criteria: appealing to special interest; being well expressed, succinct, apt, pithy, clever, insightful, fundamental, basic; summarizing; epitomizing; clearly stating a position; providing an overview; illuminating a special topic; defining goals, presenting a historical sketch of an area of research; reflecting divergent assumptions of scientists and scholars; contrasting methods and approaches; defining limitations in a conceptual area of research and theory; and, most important, being centrally foundational to the field.

The categories into which the quotations are divided represent nearly two hundred aspects of thought, and the more than four hundred quotations represent the product of the best thinking of scholars and scientists within these categories, which have to do with the thinking that psychology, philosophy, and artificial intelligence comprise. The quotations are, of course, the manifest product of the scholars' thought concerning some aspects of a category of thinking.

Scholars, professionals, and graduate and advanced undergraduate students in psychology, philosophy, artificial intelligence, and related disciplines who are looking for the best thought in the form of an epitomizing quotation concerning a specific topic or subtopic in cognitive science will find the book especially informative.

The book is organized by a categorized system of key phrases. In this format, each category title is followed by a key phrase, for example,

Analogy The Mathematical View; or Artificial Intelligence Three Goals of Artificial Intelligence. The key phrases epitomize the intellectual contribution of the quotations they introduce, which span classical civilization through the Renaissance and the Enlightenment to scientific modernity and the Information Age. The quotations, which vary in length from 10 words to 300 words, are followed by citations that provide source page numbers to enable the reader to locate the quotation and ascertain its context.

The organization of the categories, the key phrases, and the quotations, along with the author index, the subject index, and the bibliography, is intended to facilitate use of this volume. Thus, the categories in the text are arranged alphabetically, with each quotation appearing under a heading consisting of the category title and the key phrase. Within each category, quotations are arranged chronologically. The author index lists alphabetically the names of the authors of the quotations and the names cited within quotations. The subject index, which lists dictionary entries with page numbers in boldface, provides easy access to these category titles and key phrases. Appropriate cross-references for this data are cited.

Finally, the complete bibliography of the books from which the quotations are drawn will prove to be a valuable resource to interested readers.

Quality and recency of quotations are important selection criteria. Thus, outstanding intellectual developments in traditional artificial intelligence as well as in more recent connectionist paradigms are well represented. The best quotations from current theories in the philosophy of mind as well as influential quotations from venerable philosophical thought are included. Many of the quotations reflect contemporary developments in logic, language, and mathematical thought. Cognitive psychology, including memory, learning, reasoning, and problem solving, is well represented in many quotations. In short, this book is a treasury of thinking about thinking, a compendium of distinguished quotations in psychology, philosophy, artificial intelligence, and cognitive science.

Historical Dictionary of Quotations in Cognitive Science: A Treasury of Quotations in Psychology, Philosophy, and Artificial Intelligence is the most recent volume in a series of published and planned volumes with the consistent theme of developing intellectual grounding for establishing the theoretical and research foundations and the psychological and philosophical implications of a general unified theory of human and artificial intelligence (Wagman, 1991a, 1991b, 1993, 1995, 1996, 1997a, 1997b, 1998a,

1998b, 1998c, 1999, 2000). Each of the volumes contributes important aspects of this enterprise, and each reflects new theory, research, and knowledge in both human and artificial intelligence across the domains of problem solving, reasoning, analogical thinking, learning, memory, linguistic processes, and scientific creativity.

The volumes are mutually supportive, and all are directed to the same audience: to scholars and professionals in psychology, artificial intelligence, and cognitive science, and to graduate and advanced undergraduate students in these and related disciplines.

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HISTORICAL DICTIONARY OF QUOTATIONS IN COGNITIVE SCIENCE

A

ANALOG

Analog Contrasted with Rules and Representations

[A]n analog process is one whose behaviour must be characterised in terms of the intrinsic lawful relations among properties of a particular physical instantiation of a process, rather than in terms of rules and representations. (Pylyshyn, 1981, p. 157)

ANIMAL COMMUNICATION

The Existence of Lexical Syntax in Nonhuman Species Is Problematical

Given the widespread use of many subtly different, acoustically distinct vocalizations in different social situations, it seems logical to ask whether nonhuman primates or any other species ever combine vocalizations into compound utterances, and, if they do, whether they do so in accordance with a particular set of rules, or grammar. . . .

Sequences of animal vocalizations can be of two types. . . . *Phonological syntax* does not require that the acoustic elements being combined ever

be used in isolation or that they have any meaning when presented on their own. Further, it does not specify any relations between the meaning of elements and the meaning of calls created by their combination. By contrast, in *lexical syntax* the meaning of the compound call results from the sum of meanings of its constituent units. . . . To date, many studies of communication in animals have found evidence for phonological syntax; the existence of lexical syntax in nonhuman species is, however, much more problematical. (Cheney & Seyfarth, 1990, p. 125)

ANIMAL INTELLIGENCE

The Criterion of Insightful Behavior

We can . . . distinguish sharply between the kind of behavior which from the very beginning arises out of a consideration of the structure of a situation, and one that does not. Only in the former case do we speak of insight, and only that behavior of animals definitely appears to us intelligent which takes account from the beginning of the lay of the land, and proceeds to deal with it in a single, continuous, and definite course. Hence follows this criterion of insight: *the appearance of a complete solution with reference to the whole lay-out of the field*. (Köhler, 1927, pp. 169–170)

ANIMAL INTELLIGENCE

Signs Occasion Thought but Not Action

Signs, in [Edward] Tolman's theory, occasion in the rat *realization*, or *cognition*, or *judgment*, or *hypotheses*, or *abstraction*, but *they do not occasion action*. In his concern with what goes on in the rat's mind, Tolman has neglected to predict what the rat will do. So far as the theory is concerned the rat is left buried in thought: if he gets to the food-box at the end that is his concern, not the concern of the theory. (Guthrie, 1972, p. 172)

ANIMAL INTELLIGENCE

A New Insight Consists of a Recombination of Pre-existent Mediating Properties

The insightful act is an excellent example of something that is not learned, but still depends on learning. It is not learned, since it can be adequately performed on its first occurrence; it is not perfected through practice in the first place, but appears all at once in recognizable form (further practice, however, may still improve it). On the other hand, the situation must not be completely strange; the animal must have had prior experience with the component parts of the situation, or with other situations that have some similarity to it. . . . All our evidence thus points to the conclusion that a new insight consists of a *recombination of pre-existent mediating processes*, not the sudden appearance of a wholly new process. (Hebb, 1958, pp. 204–205)

ANIMAL INTELLIGENCE

Interpretation of Morgan's Canon

In Morgan's own words, the principle is, "In no case may we interpret an action as the outcome of the exercise of a higher psychical faculty, if it can be interpreted as the outcome of the exercise of one which stands lower in the psychological scale." Behaviorists universally adopted this idea as their own, interpreting it as meaning that crediting consciousness to animals can't be justified if the animal's behavior can be explained in any other way, because consciousness is certainly a "higher psychical faculty." Actually, their interpretation is wrong, since Morgan was perfectly happy with the idea of animal consciousness: he even gives examples of it directly taken from dog behavior. Thus in *The Limits of Animal Intelligence*, he describes a dog returning from a walk "tired" and "hungry" and going down into the kitchen and "looking up wistfully"

at the cook. Says Morgan about this, "I, for one, would not feel disposed to question that he has in his mind's eye a more or less definite idea of a bone."

Morgan's Canon really applies to situations where the level of intelligence credited to an animal's behavior goes well beyond what is really needed for simple and sensible explanation. Thus application of Morgan's Canon would prevent us from presuming that, when a dog finds its way home after being lost for a day, it must have the ability to read a map, or that, if a dog always begins to act hungry and pace around the kitchen at 6 P.M. and is always fed at 6:30 P.M., this must indicate that it has learned how to tell time. These conclusions involve levels of intelligence that are simply not needed to explain the behaviors. (Coren, 1994, pp. 72–73)

ART

The Hidden Order of Space and Time in Art

The concept of the primary process as the archaic, wholly irrational function of the deep unconscious, is now undergoing drastic revision. This revision, in Marion Milner's words, is due partly to the need for accommodating the facts of art. These facts suggest forcibly that the undifferentiated matrix is technically far superior to the narrowly focused conscious processes, if only because of its wider focus that can comprehend serial structures irrespective of their order in time and space. There is little that is primitive or infantile about Schoenberg's mastery in handling a theme without regard to its sequence in time. (Ehrenzweig, 1967, pp. 260–261)

ARTIFICIAL INTELLIGENCE

Programs and the Complexity of Human Mental Processes

In my opinion, none of [these programs] does even remote justice to the complexity of human mental processes. Unlike men, "artificially intelligent" programs tend to be single minded, undistractable, and unemotional. (Neisser, 1967, p. 9)

ARTIFICIAL INTELLIGENCE

Artificial Intelligence Is an Engineering Discipline

Future progress in [artificial intelligence] will depend on the development of both practical and theoretical knowledge. . . . As regards theoretical knowledge, some have sought a unified theory of artificial intelligence. My view is that artificial intelligence is (or soon will be) an engineering discipline since its primary goal is to *build* things. (Nilsson, 1971, pp. vii–viii)

ARTIFICIAL INTELLIGENCE

A Sceptical View of Artificial Intelligence

Most workers in AI [artificial intelligence] research and in related fields confess to a pronounced feeling of disappointment in what has been achieved in the last 25 years. Workers entered the field around 1950, and even around 1960, with high hopes that are very far from being realized

in 1972. In no part of the field have the discoveries made so far produced the major impact that was then promised. . . . In the meantime, claims and predictions regarding the potential results of AI research had been publicized which went even farther than the expectations of the majority of workers in the field, whose embarrassments have been added to by the lamentable failure of such inflated predictions. . . .

When able and respected scientists write in letters to the present author that AI, the major goal of computing science, represents "another step in the general process of evolution"; that possibilities in the 1980s include an all-purpose intelligence on a human-scale knowledge base; that awe-inspiring possibilities suggest themselves based on machine intelligence exceeding human intelligence by the year 2000 [one has the right to be skeptical]. (Lighthill, 1972, p. 17)

ARTIFICIAL INTELLIGENCE

Just as Astronomy Succeeded Astrology, the Discovery of Intellectual Processes in Machines Should Lead to a Science, Eventually

Just as astronomy succeeded astrology, following Kepler's discovery of planetary regularities, the discoveries of these many principles in empirical explorations on intellectual processes in machines should lead to a science, eventually. (Minsky & Papert, 1973, p. 11)

ARTIFICIAL INTELLIGENCE

Problems in Machine Intelligence Arise Because Things Obvious to Any Person Are Not Represented in the Program

Many problems arise in experiments on machine intelligence because things obvious to any person are not represented in any program. One

can pull with a string, but one cannot push with one. . . . Simple facts like these caused serious problems when Charniak attempted to extend Bobrow's "Student" program to more realistic applications, and they have not been faced up to until now. (Minsky & Papert, 1973, p. 77)

ARTIFICIAL INTELLIGENCE
The Meaning of a Symbolic Description

What do we mean by [a symbolic] "description"? We do not mean to suggest that our descriptions must be made of strings of ordinary language words (although they might be). The simplest kind of description is a structure in which some features of a situation are represented by single ("primitive") symbols, and relations between those features are represented by other symbols—or by other features of the way the description is put together. (Minsky & Papert, 1973, p. 11)

ARTIFICIAL INTELLIGENCE
The Principle of Artificial Intelligence

[AI is] the use of computer programs and programming techniques to cast light on the principles of intelligence in general and human thought in particular. (Boden, 1977, p. 5)

ARTIFICIAL INTELLIGENCE
Artificial Intelligence Recognizes the Need for Knowledge in Its Systems

The word you look for and hardly ever see in the early AI literature is the word knowledge. They didn't believe you have to know anything,

you could always rework it all. . . . In fact 1967 is the turning point in my mind when there was enough feeling that the old ideas of general principles had to go. . . . I came up with an argument for what I called the primacy of expertise, and at the time I called the other guys the generalists. (Moses, quoted in McCorduck, 1979, pp. 228–229)

ARTIFICIAL INTELLIGENCE

Artificial Intelligence Is Psychology in a Particularly Pure and Abstract Form

The basic idea of cognitive science is that *intelligent beings are semantic engines*—in other words, automatic formal systems with interpretations under which they consistently make sense. We can now see why this includes psychology and artificial intelligence on a more or less equal footing: people and intelligent computers (if and when there are any) turn out to be merely different manifestations of the same underlying phenomenon. Moreover, with universal hardware, *any* semantic engine can in principle be formally imitated by a computer if only the right program can be found. And that will guarantee *semantic imitation* as well, since (given the appropriate formal behavior) the semantics is "taking care of itself" anyway. Thus we also see why, from this perspective, artificial intelligence can be regarded as psychology in a particularly pure and abstract form. The same fundamental structures are under investigation, but in AI, all the relevant parameters are under direct experimental control (in the programming), without any messy physiology or ethics to get in the way. (Haugeland, 1981b, p. 31)

ARTIFICIAL INTELLIGENCE

There Are Many Types of Reasoning

There are many different kinds of reasoning one might imagine:

Formal reasoning involves the syntactic manipulation of data structures to deduce new ones following prespecified *rules of inference*. Mathematical logic is the archetypical formal representation.

Procedural reasoning uses simulation to answer questions and solve problems. When we use a program to answer *What is the sum of 3 and 4*? it uses, or "runs," a procedural model of arithmetic.

Reasoning by analogy seems to be a very natural mode of thought for humans but, so far, difficult to accomplish in AI programs. The idea is that when you ask the question *Can robins fly?* the system might reason that "robins are like sparrows, and I know that sparrows can fly, so robins probably can fly."

Generalization and abstraction are also natural reasoning process for humans that are difficult to pin down well enough to implement in a program. If one knows that *Robins have wings*, that *Sparrows have wings*, and that *Blue jays have wings*, eventually one will believe that *All birds have wings*. This capability may be at the core of most human learning, but it has not yet become a useful technique in AI. . . .

Meta-level reasoning is demonstrated by the way one answers the question *What is Paul Newman's telephone number?* You might reason that "if I knew Paul Newman's number, I would know that I knew it, because it is a notable fact." This involves using "knowledge about what you know," in particular, about the extent of your knowledge and about the importance of certain facts. Recent research in psychology and AI indicates that meta-level reasoning may play a central role in human cognitive processing. (Barr & Feigenbaum, 1981, pp. 146–147)

ARTIFICIAL INTELLIGENCE

Programs Are Beginning to Do Things That Critics Have Asserted to Be Impossible

Suffice it to say that programs already exist that can do things—or, at the very least, appear to be beginning to do things—which ill-informed critics have asserted *a priori* to be impossible. Examples include: perceiving in a holistic as opposed to an atomistic way; using language

creatively; translating sensibly from one language to another by way of a language-neutral semantic representation; planning acts in a broad and sketchy fashion, the details being decided only in execution; distinguishing between different species of emotional reaction according to the psychological context of the subject. (Boden, 1981, p. 33)

ARTIFICIAL INTELLIGENCE
The Synthesis of Man and Machine

Can the synthesis of Man and Machine ever be stable, or will the purely organic component become such a hindrance that it has to be discarded? If this eventually happens—and I have . . . good reasons for thinking that it must—we have nothing to regret and certainly nothing to fear. (Clarke, 1984, p. 243)

ARTIFICIAL INTELLIGENCE
The Thesis of Good Old-Fashioned Artificial Intelligence (GOFAI)

The thesis of GOFAI . . . is not that the processes underlying intelligence can be described symbolically . . . but that they *are* symbolic. (Haugeland, 1985, p. 113)

ARTIFICIAL INTELLIGENCE
Artificial Intelligence Provides a Useful Approach to Psychological and Psychiatric Theory Formation

It is all very well formulating psychological and psychiatric theories verbally but, when using natural language (even technical jargon), it is dif-

ficult to recognise when a theory is complete; oversights are all too easily made, gaps too readily left. This is a point which is generally recognised to be true and it is for precisely this reason that the behavioural sciences attempt to follow the natural sciences in using "classical" mathematics as a more rigorous descriptive language. However, it is an unfortunate fact that, with a few notable exceptions, there has been a marked lack of success in this application. It is my belief that a different approach—a different mathematics—is needed, and that AI provides just this approach. (Hand, quoted in Hand, 1985, pp. 6–7)

ARTIFICIAL INTELLIGENCE

Four Kinds of Artificial Intelligence

We might distinguish among four kinds of AI.

Nonpsychological AI

Research of this kind involves building and programming computers to perform tasks which, to paraphrase Marvin Minsky, would require intelligence if they were done by us. Researchers in nonpsychological AI make no claims whatsoever about the psychological realism of their programs or the devices they build, that is, about whether or not computers perform tasks as humans do.

Weak Psychological AI

Research here is guided by the view that the computer is a useful tool in the study of mind. In particular, we can write computer programs or build devices that simulate alleged psychological processes in humans and then test our predictions about how the alleged processes work. We can weave these programs and devices together with other programs and devices that simulate different alleged mental processes and thereby test the degree to which the AI system as a whole simulates human mentality. According to weak psychological AI, working with computer models is a way of refining and testing hypotheses about processes that are allegedly realized in human minds.

Strong Psychological AI

. . . According to this view, our minds are computers and therefore can be duplicated by other computers. Sherry Turkle

writes that the "real ambition is of mythic proportions, making a general purpose intelligence, a mind." (Turkle, 1984, p. 240)

The authors of a major text announce that "the ultimate goal of AI research is to build a person or, more humbly, an animal." (Charniak & McDermott, 1985, p. 7)

Suprapsychological AI

Research in this field, like strong psychological AI, takes seriously the functionalist view that mentality can be realized in many different types of physical devices. Suprapsychological AI, however, accuses strong psychological AI of being chauvinistic—of being only interested in human intelligence! Suprapsychological AI claims to be interested in all the conceivable ways intelligence can be realized. (Flanagan, 1991, pp. 241–242)

ARTIFICIAL INTELLIGENCE

Determination of Relevance of Rules in Particular Contexts

Even if the [rules] were stored in a context-free form the computer still couldn't use them. To do that the computer requires rules enabling it to draw on *just those [rules] which are relevant in each particular context*. Determination of relevance will have to be based on further facts and rules, but the question will again arise as to which facts and rules are relevant for making each particular determination. One could always invoke further facts and rules to answer this question, but of course these must be only the relevant ones. And so it goes. It seems that AI workers will never be able to get started here unless they can settle the problem of relevance beforehand by cataloguing types of context and listing just those facts which are relevant in each. (Dreyfus & Dreyfus, 1986, p. 80)

ARTIFICIAL INTELLIGENCE
Form and Content Are Not Fundamentally Different

Perhaps the single most important idea to artificial intelligence is that there is no fundamental difference between form and content, that meaning can be captured in a set of symbols such as a semantic net. (G. Johnson, 1986, p. 250)

ARTIFICIAL INTELLIGENCE
The Assumption That the Mind Is a Formal System

Artificial intelligence is based on the assumption that the mind can be described as some kind of formal system manipulating symbols that stand for things in the world. Thus it doesn't matter what the brain is made of, or what it uses for tokens in the great game of thinking. Using an equivalent set of tokens and rules, we can do thinking with a digital computer, just as we can play chess using cups, salt and pepper shakers, knives, forks, and spoons. Using the right software, one system (the mind) can be mapped into the other (the computer). (G. Johnson, 1986, p. 250)

ARTIFICIAL INTELLIGENCE
A Statement of the Primary and Secondary Purposes of Artificial Intelligence

The primary goal of Artificial Intelligence is to make machines smarter. The secondary goals of Artificial Intelligence are to understand what intelligence is (the Nobel laureate purpose) and to make machines more useful (the entrepreneurial purpose). (Winston, 1987, p. 1)

ARTIFICIAL INTELLIGENCE

Mathematical Logic Provides the Basis for Theory in AI

The theoretical ideas of older branches of engineering are captured in the language of mathematics. We contend that mathematical logic provides the basis for theory in AI. Although many computer scientists already count logic as fundamental to computer science in general, we put forward an even stronger form of the logic-is-important argument. . . . AI deals mainly with the problem of representing and using *declarative* (as opposed to *procedural*) knowledge. Declarative knowledge is the kind that is expressed as sentences, and AI needs a language in which to state these sentences. Because the languages in which this knowledge usually is originally captured (natural languages such as English) are not suitable for computer representations, some other language with the appropriate properties must be used. It turns out, we think, that the appropriate properties include *at least* those that have been uppermost in the minds of logicians in their development of logical languages such as the predicate calculus. Thus, we think that any language for expressing knowledge in AI systems must be at least as expressive as the first-order predicate calculus. (Genesereth & Nilsson, 1987, p. viii)

ARTIFICIAL INTELLIGENCE

Perceptual Structures Can Be Represented as Lists of Elementary Propositions

In artificial intelligence studies, perceptual structures are represented as assemblages of description lists, the elementary components of which are propositions asserting that certain relations hold among elements. (Chase & Simon, 1988, p. 490)

ARTIFICIAL INTELLIGENCE

Definitions of Artificial Intelligence

Artificial intelligence (AI) is sometimes defined as the study of how to build and/or program computers to enable them to do the sorts of things that minds can do. Some of these things are commonly regarded as requiring intelligence: offering a medical diagnosis and/or prescription, giving legal or scientific advice, proving theorems in logic or mathematics. Others are not, because they can be done by all normal adults irrespective of educational background (and sometimes by non-human animals too), and typically involve no conscious control: seeing things in sunlight and shadows, finding a path through cluttered terrain, fitting pegs into holes, speaking one's own native tongue, and using one's common sense.

Because it covers AI research dealing with both these classes of mental capacity, this definition is preferable to one describing AI as making computers do "things that would require intelligence if done by people." However, it presupposes that computers could do what minds can do, that they might really diagnose, advise, infer, and understand. One could avoid this problematic assumption (and also side-step questions about whether computers do things *in the same way* as we do) by defining AI instead as "the development of computers whose observable performance has features which in humans we would attribute to mental processes." This bland characterization would be acceptable to some AI workers, especially amongst those focusing on the production of technological tools for commercial purposes. But many others would favour a more controversial definition, seeing AI as *the science of intelligence in general*—or, more accurately, as the intellectual core of cognitive science. As such, its goal is to provide a systematic theory that can explain (and perhaps enable us to replicate) both the general categories of intentionality and the diverse psychological capacities grounded in them. (Boden, 1990b, pp. 1–2)

ARTIFICIAL INTELLIGENCE

The Computer Can Not Be a Model of the Mind

Because the ability to store data somewhat corresponds to what we call memory in human beings, and because the ability to follow logical procedures somewhat corresponds to what we call reasoning in human beings, many members of the cult have concluded that what computers do somewhat corresponds to what we call thinking. It is no great difficulty to persuade the general public of that conclusion since computers process data very fast in small spaces well below the level of visibility; they do not look like other machines when they are at work. They seem to be running along as smoothly and silently as the brain does when it remembers and reasons and thinks.

On the other hand, those who design and build computers know exactly how the machines are working down in the hidden depths of their semiconductors. Computers can be taken apart, scrutinized, and put back together. Their activities can be tracked, analyzed, measured, and thus clearly understood—which is far from possible with the brain. This gives rise to the tempting assumption on the part of the builders and designers that computers can tell us something about brains, indeed, that the computer can serve as a model of the mind, which then comes to be seen as some manner of information processing machine, and possibly not as good at the job as the machine. (Roszak, 1994, pp. xiv–xv)

ARTIFICIAL INTELLIGENCE

Computers Will Not Always Be Inferior to Human Brains

The inner workings of the human mind are far more intricate than the most complicated systems of modern technology. Researchers in the field of **artificial intelligence** have been attempting to develop programs that

will enable computers to display intelligent behavior. Although this field has been an active one for more than thirty-five years and has had many notable successes, AI researchers still do not know how to create a program that matches human intelligence. No existing program can recall facts, solve problems, reason, learn, and process language with human facility. This lack of success has occurred not because computers are inferior to human brains but rather because we do not yet know in sufficient detail how intelligence is organized in the brain. (Anderson, 1995, p. 2)

ASSOCIATION

Association Depends upon Organization

[Association has to be] given up as a special and independent theoretical concept. It is not more than a name for the fact that organized processes leave a trace picturing their organization and that in consequence of it reproductions are possible. . . . Our conclusion is, that association depends upon organization because association is just an after-effect of an organized process. (Köhler, 1930, p. 225)

ATTENTION

Focused Consciousness

Everyone knows what attention is. It is the taking possession by the mind, in a clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration of consciousness are of its essence. It implies withdrawal from some things in order to deal effectively with others[.] (James, 1890, pp. 403–404)

AUTOMATA
All Automata Have an Artificial Life

Nature (the Art whereby God hath made and governes the World) is by the Art of man, as in many other things, so in this also imitated, that it can make an Artificial Animal. For seeing life is but a motion of Limbs, the begining whereof is in some principall part within; why may we not say, that *all* Automata (Engines that move themselves by springs and wheeles as doth a watch) have an artificial life? For what is the Heart, but a Spring; and the Nerves, but so many Strings; and the Joynts, but so many Wheeles giving motion to the whole Body, such as was intended by the Artificer? Art goes yet further, imitating that Rationall and most excellent worke of Nature, Man. For by Art is created that great LEVIATHAN called a COMMON-WEALTH or STATE (in Latine CIVITAS) which is but an Artificiall Man; though of greater stature and strength than the Naturall, for whose protection and defence it was intended; and in which, the Soveraignty is an Artificiall Soul, as giving life and motion to the whole body. (Hobbes, 1651, p. 1)

AUTOMATA
A Basic Premise of Automata

It is a basic premise of automata that every procedure, no matter how complex, can be decomposed into a series of these elementary operations [that the automaton can perform]. (Wall, 1972, p. 254)

AUTOMATA
The Isomorphism of Automata and Grammars

The theory of automata and the theory of formal grammars are isomorphic in most important respects. (Wall, 1972, p. 254)

B

BEAUTY

Discovery and Invention Are Imperatively Guided by the Sense of Scientific Beauty

It is clear that no significant discovery or invention can take place without the *will* of finding. But with Poincaré we see something else, the intervention of the sense of beauty playing its part as an indispensable *means* of finding. We have reached the double conclusion: that invention is choice that this choice is imperatively governed by the sense of scientific beauty. (Hadamard, 1945, p. 31)

BEHAVIOR

Cognitions and Competencies Are Behavioral Concepts

Cognitions and competencies are behavioral concepts. They *do not* characterize anything nonpsychological, neurophysiological, electronic, hypothetical, or the like. They are aspects or attributes of behavior. No behavior is noncognitive. No behavior is without competence. Behavior,

itself . . . and please notice I do not say performance or overt action . . . is characterizable in terms of a set of parameters or attributes which fall into the categories cognition, competence, intention, and performance—all psychological, all behavioral, *nothing less*. (Bourne, 1973, p. 315)

BEHAVIORISM

A Person's Behavior Is Changed by Changes in the Contingencies of Reinforcement

A person is changed by the contingencies of reinforcement under which he behaves; he does not store the contingencies. In particular, he does not store copies of the stimuli which have played a part in the contingencies. There are no "iconic representations" in his mind; there are no "data structures stored in his memory"; he has no "cognitive map" of the world in which he has lived. He has simply been changed in such a way that stimuli now control particular kinds of perceptual behavior. (Skinner, 1974, p. 84)

BEHAVIORISM

Psychology as Viewed by the Behaviorists

Psychology as the behaviorist views it is a purely objective natural science. Its theoretical goal is the prediction and control of behavior. Introspection forms no essential part of its method nor is the scientific value of its data dependent upon the readiness with which they lend themselves to interpretation in terms of consciousness. The behaviorist, in his efforts to get a unitary scheme of animal response, recognizes no dividing line between man and brute. The behavior of man, with all its refinement and complexity, forms only a part of the behaviorist's total scheme of investigation. (Watson, quoted in Fancher, 1979, p. 319)

BIRTH ORDER

Birth Order and Ideological Trends

In science, birth-order effects are driven by the ideological implications inherent in new ideas. Theories that have socially radical implications tend to be championed by laterborns and rejected by firstborns. Theories that have socially conservative implications display the opposite trend: firstborns tend to back conservative innovations, whereas laterborns are among the most vocal opponents of this class of ideas. . . .

The linear relationship between birth-order trends and ideological tendencies makes my argument about birth order testable in a variety of ways. For example, socially conservative innovations that are championed by laterborns should never occur in history. The discovery of even *one* such episode with a significant trend would constitute a formidable challenge to my claims. Similarly, evidence of radical revolutions favored by firstborns is also not to be expected. When firstborns have "rebelled" in history, it has been to bring God back into the scientific picture or to reaffirm the social status quo. Firstborns favored eugenics because this reform movement seemed to rationalize socioeconomic disparities in terms of genetics. (The word *eugenics* comes from the Greek, meaning "well born.") Historically, firstborns have tended to support the notion that biology is destiny. Minority races, women, and laterborns have all typically resisted such deterministic notions. (Sulloway, 1996, pp. 130, 133)

BRAIN

Biological and Social Brain Development

Among the higher mammals the great development of neocortex occurs. In each group of mammals there is a steady increase in the area of the association cortex from the most primitive to the evolutionarily most recent type; there is an increase in the number of neurons and their

connections. The degree of consciousness of an organism is some function of neuronal cell number and connectivity, perhaps of neurons of a particular type in association cortex regions. This function is of a threshold type such that there is a significant quantitative break with the emergence of humans. Although the importance of language and the argument that it is genetically specified and unique to humans must be reconsidered in the light of the recent evidence as to the possibility of teaching chimpanzees, if not to speak, then to manipulate symbolic words and phrases, there are a number of unique human features which combine to make the transition not merely quantitative, but also qualitative. In particular these include the social, productive nature of human existence, and the range and extent of the human capacity to communicate. These features have made human history not so much one of biological but of social evolution, of continuous cultural transformation. (Rose, 1976, pp. 180–181)

BRAIN

Distinctive Evolutionary Properties of the Brain

[S]ome particular property of higher primate and cetacean brains did not evolve until recently. But what was that property? I can suggest at least four possibilities . . . : (1) Never before was there a brain so massive; (2) Never before was there a brain with so large a ratio of brain to body mass; (3) Never before was there a brain with certain functional units (large frontal and temporal lobes, for example); (4) Never before was there a brain with so many neural connections or synapses. . . . Explanations 1, 2 and 4 argue that a quantitative change produced a qualitative change. It does not seem to me that a crisp choice among these four alternatives can be made at the present time, and I suspect that the truth will actually embrace most or all of these possibilities. (Sagan, 1978, pp. 107–109)

BRAIN

The Evolutionary Increase in the Size of the Main Areas of the Brain

The crucial change in the human brain in this million years or so has not been so much the increase in size by a factor of three, but the concentration of that increase in three or four main areas. The visual area has increased considerably, and, compared with the chimpanzee, the actual density of human brain cells is at least 50 percent greater.

A second increase has taken place in the area of manipulation of the hand, which is natural since we are much more hand-driven animals than monkeys and apes. Another main increase has taken place in the temporal lobe, in which visual memory, integration, and speech all lie fairly close together. And the fourth great increase has taken place in the frontal lobes. Their function is extremely difficult to understand . . . ; but it is clear that they're largely responsible for the ability to initiate a task, to be attentive while it is being done, and to persevere with it. (Bronowski, 1978, pp. 23–24)

BRAIN

The Human Brain and Ethical Principles

The human brain works however it works. Wishing for it to work in some way as a shortcut to justifying some ethical principle undermines both the science and the ethics (for what happens to the principle if the scientific facts turn out to go the other way?). (Pinker, 1994, p. 427)

C

CATEGORIES
Two Principles of Category Formation

Two general and basic principles are proposed for the formation of categories: The first has to do with the function of category systems and asserts that the task of category systems is to provide maximum information with the least cognitive effort [("cognitive economy")]; the second has to do with the structure of the information so provided and asserts that the perceived world comes as structured information rather than than arbitrary or unpredictable attributes [("perceived world structure")]. Thus maximum information with least cognitive effort is achieved if categories map the perceived world structure as closely as possible. This condition can be achieved either by the mapping of categories to given attribute structures or by the definition or redefinition of attributes to render a given set of categories appropriately structured. (Rosch, 1978, p. 28)

CATEGORY
Categories Are Coded in the Mind in Terms of a Prototype of a Typical Category Member

Many experiments have shown that categories appear to be coded in the mind neither by means of lists of each individual member of the cate-

gory, nor by means of a list of formal criteria necessary and sufficient for category membership, but, rather, in terms of a prototype of a typical category member. The most cognitively economical code for a category is, in fact, a *concrete image* of an average category member. (Rosch, 1977, p. 30)

CAUSES

The Four Causes of Aristotle

Our curiosity about things takes different forms, as Aristotle noted at the dawn of human science. His pioneering effort to classify them still makes a lot of sense. He identified four basic questions we might want answered about anything, and called their answers the four *aitia*, a truly untranslatable Greek term traditionally but awkwardly translated the four "causes."

(1) We may be curious about what something is made of, its matter or *material cause*.
(2) We may be curious about the form (or structure or shape) that that matter takes, its *formal cause*.
(3) We may be curious about its beginning, how it got started, or its *efficient cause*.
(4) We may be curious about its *purpose* or *goal* or *end* (as in "Do the ends justify the means?"), which Aristotle called its *telos*, sometimes translated in English, awkwardly, as "final cause." (Dennett, 1995, p. 23)

CEREBRAL ACTION

Cerebral Activity Is Characterized by a Series of Hierarchies of Organization

I have devoted so much time to discussion of the problem of syntax not only because language is one of the most important products of human

cerebral action, but also because the problems raised by the organization of language seem to me to be characteristic of almost all other cerebral activity. There is a series of hierarchies of organization; the order of vocal movements in pronouncing the words, the order of words in the sentence, the order of sentences in the paragraph, the rational order of paragraphs in a discourse. Not only speech, but all skilled acts seem to involve the same problems of serial ordering, even down to the temporal coordination of muscular contractions in such a movement as reaching and grasping. Analysis of the nervous mechanisms underlying order in the more primitive acts may contribute ultimately to the solution of even the physiology of logic. (Lashley, 1951, pp. 121–122)

CLASS

Concerning the Class of Classes, and Contradictions

Concerning the class of classes, if you admit a contradiction in this concept, infinity will remain forever contradictory, and your works as well as Canto's have not resolved the philosophical problem. For there is a concept class and there are classes. Therefore, class is a class. (Russell [to Couturat, 17 January 1901], 1992, pp. 210–211)

COGNITION

Every Psychological Phenomenon Is a Cognitive Phenomenon

As used here, the term "cognition" refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. It is concerned with these processes even when they operate in the

absence of relevant stimulation, as in images and hallucinations. . . . [G]iven such a sweeping definition, it is apparent that cognition is involved in everything a human being might possibly do; that every psychological phenomenon is a cognitive phenomenon. (Neisser, 1976, p. 4)

COGNITION

Models of Cognition and Specific Architectures

Man is describable as a dual processor, dual memory system with extensive input-output buffering within each system. The input-output system appears to have substantial peripheral computing power itself. But man is not modeled by a dual processor computer. The two processors of the brain are asymmetric. The semantic memory processor is a serial processor with a list structure memory. The image memory processor may very well be a sophisticated analog processor attached to an associative memory. When we propose models of cognition it would perhaps be advisable if we specified the relation of the model to this system architecture and its associated addressing system and data structure. (Hunt, 1973, pp. 370–371)

COGNITIVE PROCESSES

Differential Characteristics of Automatic Processes and Controlled Processes

Automatic processes function rapidly and in parallel but suffer from inflexibility; controlled processes are flexible and versatile but operate relatively slowly and in a serial fashion. (Eysenck, 1982, p. 22)

COGNITIVE PSYCHOLOGY

Cognitive Processes Truly Exist

The basic reason for studying cognitive processes has become as clear as the reason for studying anything else: because they are there. Our knowledge of the world *must* be somehow developed from stimulus input. . . . Cognitive processes surely exist, so it can hardly be unscientific to study them. (Neisser, 1967, p. 5).

COGNITIVE PSYCHOLOGY

Cognitive Psychologists Construe the Abstract Mechanisms Underlying Behavior

The task of the cognitive psychologist is a highly inferential one. The cognitive psychologist must proceed from observations of the behavior of humans performing intellectual tasks to conclusions about the abstract mechanisms underlying the behavior. Developing a theory in cognitive psychology is much like developing a model for the working of the engine of a strange new vehicle by driving the vehicle, being unable to open it up to inspect the engine itself. . . .

It is well understood from the automata theory . . . that many different mechanisms can generate the same external behavior. (Anderson, 1980, pp. 12, 17)

COGNITIVE PSYCHOLOGY

Cognitive Psychology Does Not Deal with Whole People

[Cognitive psychology does not] deal with whole people but with a very special and bizarre—almost Frankensteinian—preparation, which con-

sists of a brain attached to two eyes, two ears, and two index fingers. This preparation is only to be found inside small, gloomy cubicles, outside which red lights burn to warn ordinary people away. . . . It does not feel hungry or tired or inquisitive; it does not think extraneous thoughts or try to understand what is going on. It is, in short, a computer, made in the image of the larger electronic organism that sends it stimuli and records its responses. (Claxton, 1980, p. 13)

COGNITIVE PSYCHOLOGY

Cognitive Psychology Has Not Succeeded in Making a Significant Contribution to the Understanding of the Human Mind

Cognitive psychology is not getting anywhere; that in spite of our sophisticated methodology, we have not succeeded in making a substantial contribution toward the understanding of the human mind. . . . A short time ago, the information processing approach to cognition was just beginning. Hopes were high that the analysis of information processing into a series of discrete stages would offer profound insights into human cognition. But in only a few short years the vigor of this approach was spent. It was only natural that hopes that had been so high should sink low. (Glass, Holyoak & Santa, 1979, p. ix)

COGNITIVE PSYCHOLOGY

Cognitive Psychology Seeks to Understand Human Intelligence and Thinking

Cognitive psychology attempts to understand the nature of human intelligence and how people think. (Anderson, 1980, p. 3)

COGNITIVE PSYCHOLOGY

The Rise of Cognitive Psychology Demonstrates That the Impeccable Peripheralism of Stimulus-Response Theories Could Not Last

The past few years have witnessed a noticeable increase in interest in an investigation of the cognitive processes. . . . It has resulted from a recognition of the complex processes that mediate between the classical "stimuli" and "responses" out of which stimulus-response learning theories hoped to fashion a psychology that would by-pass anything smacking of the "mental." The impeccable peripheralism of such theories could not last. One might do well to have a closer look at these intervening "cognitive maps." (Bruner, Goodnow & Austin, 1956, p. vii)

COGNITIVE SCIENCE

The Basic Idea of Cognitive Science

The basic idea of cognitive science is that intelligent beings are *semantic engines*—in other words, automatic formal systems with interpretations under which they consistently make sense. . . . [P]eople and intelligent computers turn out to be merely different manifestations of the same underlying phenomenon. (Haugeland, 1981b, p. 31)

COGNITIVE SCIENCE

Experimental Psychology, Theoretical Linguistics, and Computational Simulation of Cognitive Processes Are All Components of Cognitive Science

I went away from the Symposium with a strong conviction, more intuitive than rational, that human experimental psychology, theoretical linguistics, and computer simulation of cognitive processes were all pieces of a larger whole, and that the future would see progressive elaboration and coordination of their shared concerns. . . . I have been working toward a cognitive science for about twenty years beginning before I knew what to call it. (G. A. Miller, 1979, p. 9)

COGNITIVE SCIENCE

The Nature of Cognitive Science

Cognitive Science studies the nature of cognition in human beings, other animals, and inanimate machines (if such a thing is possible). While computers are helpful within cognitive science, they are not essential to its being. A science of cognition could still be pursued even without these machines.

Computer Science studies various kinds of problems and the use of computers to solve them, without concern for the means by which we humans might otherwise resolve them. There could be no computer science if there were no machines of this kind, because they are indispensable to its being. *Artificial Intelligence* is a special branch of computer science that investigates the extent to which the mental powers of human beings can be captured by means of machines.

There could be cognitive science without artificial intelligence but there could be no artificial intelligence without cognitive science. One final caveat: In the case of an emerging new discipline such as cognitive sci-

ence there is an almost irresistible temptation to identify the discipline itself (as a field of inquiry) with one of the theories that inspired it (such as the computational conception . . .). This, however, is a mistake. The field of inquiry (or "domain") stands to specific theories as questions stand to possible answers. The computational conception should properly be viewed as a research program in cognitive science, where "research programs" are answers that continue to attract followers. (Fetzer, 1996, pp. xvi–xvii)

COGNITIVE SCIENCE

The Nature of Cognitive Science

What is the nature of knowledge and how is this knowledge used? These questions lie at the core of both psychology and artificial intelligence. The psychologist who studies "knowledge systems" wants to know how concepts are structured in the human mind, how such concepts develop, and how they are used in understanding and behavior. The artificial intelligence researcher wants to know how to program a computer so that it can understand and interact with the outside world. The two orientations intersect when the psychologist and the computer scientist agree that the best way to approach the problem of building an intelligent machine is to emulate the human conceptual mechanisms that deal with language. . . . The name "cognitive science" has been used to refer to this convergence of interests in psychology and artificial intelligence. . . .

This working partnership in "cognitive science" does not mean that psychologists and computer scientists are developing a single comprehensive theory in which people are no different from machines. Psychology and artificial intelligence have many points of difference in methods and goals. . . . We simply want to work on an important area of overlapping interest, namely a theory of knowledge systems. As it turns out, this overlap is substantial. For both people and machines, each in their own way, there is a serious problem in common of making sense out of what they hear, see, or are told about the world. The conceptual apparatus necessary to perform even a partial feat of understanding is formidable and fascinating. (Schank & Abelson, 1977, pp. 1–2)

COGNITIVE SCIENCE

The New Field of Cognitive Science

Within the last dozen years a general change in scientific outlook has occurred, consonant with the point of view represented here. One can date the change roughly from 1956: in psychology, by the appearance of Bruner, Goodnow, and Austin's *Study of Thinking* and George Miller's "The Magical Number Seven"; in linguistics, by Noam Chomsky's "Three Models of Language"; and in computer science, by our own paper on the Logic Theory Machine. (Newell & Simon, 1972, p. 4)

COGNITIVE SCIENTISTS

Emphasis on the Uniqueness of Language Processes Separates Cognitive Scientists

A sizeable gulf in communication still exists between cognitive scientists who entered the field from AI or from the study of problem solving and concept-forming behavior, on the one side, and those who entered from a concern with language, on the other. . . . When the uniqueness of language processes as a human faculty is emphasized, as it has been by Chomsky . . . , the gulf becomes wider. (Simon & Kaplan, 1989, p. 5)

COGNITIVISM

Internal Cognitive Processes are Required to Explain Intelligent Behavior

Cognitivism in psychology and philosophy is roughly the position that intelligent behavior can (only) be explained by appeal to internal "cognitive processes." (Haugeland, 1981a, p. 243)

COGNITIVISM

The Cognitive Enterprise Rests on a Set of Unexamined Assumptions

Cognitive science is an interdisciplinary effort drawing on psychology and linguistics, and philosophy. Emboldened by an apparent convergence of interests, some scientists in these fields have chosen not to reject mental functions out of hand as the behaviorists did. Instead, they have relied on the concept of mental representations and on a set of assumptions collectively called the functionalist positions. From this viewpoint, people behave according to knowledge made up of symbolic mental representations. Cognition consists of the manipulation of these symbols. Psychological phenomena are described in terms of functional processes. The efficacy of such processes resides in the possibility of interpreting items as symbols in an abstract and well-defined way, according to a set of unequivocal rules. Such a set of rules constitutes what is known as a syntax.

The exercise of these syntactical rules is a form of computation. . . . Computation is assumed to be largely independent of the structure and the mode of development of the nervous system, just as a piece of computer software can run on different machines with different architectures and is thus "independent" of them. . . .

This point of view—called cognitivism by some—has had a great vogue and has prompted a burst of psychological work of great interest and value. Accompanying it have been a set of remarkable ideas. . . . I cannot overemphasize the degree to which these ideas or their variants pervade modern science. . . . But I must also add that the cognitivist enterprise rests on a set of unexamined assumptions. One of its most curious deficiencies is that it makes only marginal reference to the biological foundations that underlie the mechanisms it purports to explain. The result is a scientific deviation as great as that of the behaviorism it has attempted to supplant. (Edelman, 1992, pp. 13–14)

COMBINATIONS

Good Combinations Result from a Long Sequence of Combinatorial Mental Processing

The role of the preliminary conscious work . . . is evidently to mobilize certain of these [hooked] atoms [of thought], to unhook them from the wall and put them in swing. We think we have done no good, because we have moved these elements a thousand different ways in seeking to assemble them, and have found no satisfactory aggregate. But, after this shaking up imposed upon them by our will, these atoms do not return to their primitive rest. They freely continue to dance. . . . The mobilized atoms are . . . not any atoms whatsoever; they are those from which we might reasonably expect the desired solution. Then the mobilized atoms undergo impacts which make them enter into combinations among themselves or with other atoms at rest which they struck against in their course. . . . However it may be, the only combinations that have a chance of forming are those where at least one of the elements is one of those atoms freely chosen by our will. Now, it is evidently among these that is found what I called the *good combination*. (Poincaré, 1921, pp. 393–394)

COMMON GROUND

The Intrinsic Context for Understanding between Listeners and Speakers

The intrinsic context for a listener trying to understand what a speaker means on a particular occasion is the common ground that the listener believes holds at that moment between the speaker and the listeners he or she is speaking to. (Clark & Carlson, 1981, p. 319)

COMMON SENSE

The Necessary Minimum Knowledge of a Common-Sense System

Just constructing a knowledge base is a major intellectual research problem. . . . We still know far too little about the contents and structure of common-sense knowledge. A "minimal" common-sense system must "know" something about cause-effect, time, purpose, locality, process, and types of knowledge. . . . We need a serious epistemological research effort in this area. (Husserl, 1960, pp. 74, 124)

COMMUNICATION

When Communication Does and Does Not Break Down

When encoding a message the speaker uses special syntactic markers to point to those parts of the sentence he believes the listener already to be familiar with and to which he wants to tie more information. For his part, the listener uses these same syntactic clues to direct his attention toward the intended concepts in memory, thereby allowing communication to occur. Whenever the speaker misjudges the listener, or covertly intends to mislead the listener, and thereby breaks the given-new contract, communication breaks down. (Rumelhart, 1977, pp. 162–163)

COMPLEMENTARITY

The Creative Individual Is Complementary to the Society in Which He Lives

The creative individual is, in a sense, complementary to the society in which he lives, rather as a soloist in a concerto. Both the basic ideas of science and the key inventions of mankind have generally been conceived in the minds of individuals, while the effort to gain the data on which the ideas and inventions have been based, and the subsequent effort to turn them to good account, have required the contributions of many besides the inventor and originator of ideas. So the individual and the community are necessary to one another. . . . (R. V. Jones, 1985, pp. 323–324)

COMPLEXITY

The Derivational Theory of Complexity

[T]he derivational theory of complexity—the theory that the number of transformations operating in the grammatical derivation of a sentence provides a measure of the psychological complexity in comprehending or producing the sentence—cannot be sustained. (Bresnan, 1978, p. 2)

COMPUTER

Concise Definition of a Computer

A *computer* is an interpreted automatic formal system—that is to say, a *symbol-manipulating machine*. (Haugeland, 1985, p. 113)

COMPUTER

A Running Computer Is an Abstract Game

The game the computer plays out is regulated by systems of ideas whose range is bounded only by the limitations of the human imagination. The physically determined bounds on the electronic and mechanical events internal to the computer do not matter for that game—any more than it matters how tightly a chess player grips his bishop or how rapidly he moves it over the board. A computer running under the control of a stored program is thus detached from the real world in the same way that every abstract game is. (Weizenbaum, 1976, pp. 111–112)

COMPUTER METAPHORS

Misgivings about Computer Metaphors of the Human Brain

Within the AI community there is a growing dissatisfaction concerning the adequacy of sequential models to simulate the cognitive processes. . . .

For an example of the *dissimilarity* between computers and nervous systems, consider that in conventional computers . . . each piece of data [is] located in its own special space in the memory bank [and] can be retrieved only by a central processor that knows the address in the memory bank for each datum. Human memory appears to be organized along entirely different lines. For one thing, from a partial or a degraded stimulus human memory can "reconstruct" the rest, and there are associative relationships among stored pieces of information based on considerations of *context* rather than on considerations of *location*. . . . [I]t now appears doubtful that individual neurons are so specific that they are tuned to respond to a single item and nothing else. Thus, connectionist models tend to devise and use *distributed* principles, which means that elements may be selective to a range of stimuli and there are no "grandmother cells." . . .

Information storage, it appears, is in some ill-defined sense a function of connectivity among sets of neurons. This implies that there is something fundamentally wrong in understanding the brain's memory on the model of individual symbols stored at unique addresses in a data bank. . . .

A further source of misgivings about the computer metaphor concerns real-time constraints. Although the signal velocities in nervous systems are quite slow in comparison to those in computers, brains are nonetheless far, far faster than electronic devices in the execution of their complex tasks. For example, human brains are incomparably faster than any computer in word-nonword recognition tasks. (P. S. Churchland, 1986, pp. 458–459)

COMPUTER PSYCHOMETRICS

Problems and Benefits of Computer Testing

The computer is changing most aspects of [psychological] testing, bringing benefits and costs. Automation of test administration and interpretation is gaining ground, although it tends to reduce interaction between assessor and examinee—with consequent impoverishment of information on both sides. Supplying computer-generated "self-interpreting" reports to clients seems likely to invite misunderstanding, and to encourage overreliance on the test as authority. Persons not qualified as test interpreters are writing software for start-up companies in the field; the risks are obvious. On the positive side, if the computer is kept in an adjunct role it reduces testing costs, and its reports stimulate thought in the professional interpreter. Adaptive testing is paying off, and we are beginning to see new tasks, resembling video arcade displays, which have obvious potential. (Cronbach, 1990, p. xxiii)

COMPUTER PSYCHOTHERAPY

If the Computer Can Be Used to Treat Mental Suffering, Then There Is No Question of Its Value

It is dehumanizing to herd thousands of patients into mental hospitals where they will never see a doctor. . . . If a computer can provide therapeutic conversation, then there can be no hesitation in exploring these potentials. It may give us a chance to rehumanize people now being dehumanized by our . . . psychiatric systems. (Colby, quoted in Hand, 1985, pp. 9–10)

COMPUTERS

A Comparison of the Digital Computer and the Brain

The brain has been compared to a digital computer because the neuron, like a switch or valve, either does or does not complete a circuit. But at that point the similarity ends. The switch in the digital computer is constant in its effect, and its effect is large in proportion to the total output of the machine. The effect produced by the neuron varies with its recovery from [the] refractory phase and with its metabolic state. The number of neurons involved in any action runs into millions so that the influence of any one is negligible. . . . Any cell in the system can be dispensed with. . . . The brain is an analogical machine, not digital. Analysis of the integrative activities will probably have to be in statistical terms. (Lashley, quoted in Beach, Hebb, Morgan & Nissen, 1960, p. 539)

COMPUTERS

Computers Do Not Crunch Numbers, They Manipulate Symbols

It is essential to realize that a computer is not a mere "number cruncher," or supercalculating arithmetic machine, although this is how computers are commonly regarded by people having no familiarity with artificial intelligence. Computers do not crunch numbers; they manipulate symbols. . . . Digital computers originally developed with mathematical problems in mind, are in fact general purpose symbol manipulating machines. . . .

The terms "computer" and "computation" are themselves unfortunate, in view of their misleading arithmetical connotations. The definition of artificial intelligence previously cited—"the study of intelligence as computation"—does not imply that intelligence is really counting. Intelligence may be defined as the ability creatively to manipulate symbols, or process information, given the requirements of the task in hand. (Boden, 1981, pp. 15, 16–17)

COMPUTERS

Getting Computers to Explain Things to Themselves

The task is to get computers to explain things to themselves, to ask questions about their experiences so as to cause those explanations to be forthcoming, and to be creative in coming up with explanations that have not been previously available. (Schank, 1986, p. 19)

COMPUTERS

Some Limits of Artificial Intelligence

In *What Computers Can't Do*, written in 1969 (2nd edition, 1972), the main objection to AI was the impossibility of using rules to select only those facts about the real world that were relevant in a given situation. The "Introduction" to the paperback edition of the book, published by Harper & Row in 1979, pointed out further that no one had the slightest idea how to represent the common sense understanding possessed even by a four-year-old. (Dreyfus & Dreyfus, 1986, p. 102)

COMPUTERS

The Computer as a Humanizing Influence

A popular myth says that the invention of the computer diminishes our sense of ourselves, because it shows that rational thought is not special to human beings, but can be carried on by a mere machine. It is a short stop from there to the conclusion that intelligence is mechanical, which many people find to be an affront to all that is most precious and singular about their humanness.

In fact, the computer, early in its career, was not an instrument of the philistines, but a humanizing influence. It helped to revive an idea that had fallen into disrepute: the idea that the mind is real, that it has an inner structure and a complex organization, and can be understood in scientific terms. For some three decades, until the 1940s, American psychology had lain in the grip of the ice age of behaviorism, which was antimental through and through. During these years, extreme behaviorists banished the study of thought from their agenda. Mind and consciousness, thinking, imagining, planning, solving problems, were dismissed as worthless for anything except speculation. Only the external aspects of behavior, the surface manifestations, were grist for the scientist's mill, because only they could be observed and measured. . . .

It is one of the surprising gifts of the computer in the history of ideas that it played a part in giving back to psychology what it had lost, which was nothing less than the mind itself. In particular, there was a revival of interest in how the mind represents the world internally to itself, by means of knowledge structures such as ideas, symbols, images, and inner narratives, all of which had been consigned to the realm of mysticism. (Campbell, 1989, p. 10)

COMPUTERS

The Intentionality of Computers Is Essentially Borrowed, Hence Derivative

[Our artifacts] only have meaning because we give it to them; their intentionality, like that of smoke signals and writing, is essentially borrowed, hence *derivative*. To put it bluntly: computers themselves don't mean anything by their tokens (any more than books do)—they only mean what we say they do. Genuine understanding, on the other hand, is intentional "in its own right" and not derivatively from something else. (Haugeland, 1981a, pp. 32–33)

COMPUTERS

The Possibility of Computer Thought

[T]he debate over the possibility of computer thought will never be won or lost; it will simply cease to be of interest, like the previous debate over man as a clockwork mechanism. (Bolter, 1984, p. 190)

COMPUTERS

We Are Getting Better at Building Even Better Computers, an Ever-Escalating Upward Spiral

[I]t takes us a long time to emotionally digest a new idea. The computer is too big a step, and too recently made, for us to quickly recover our balance and gauge its potential. It's an enormous accelerator, perhaps the greatest one since the plow, twelve thousand years ago. As an intelligence amplifier, it speeds up everything—including itself—and it continually improves because its heart is information or, more plainly, ideas. We can no more calculate its consequences than Babbage could have foreseen antibiotics, the Pill, or space stations.

Further, the effects of those ideas are rapidly compounding, because a computer design is itself just a set of ideas. As we get better at manipulating ideas by building ever better computers, we get better at building even better computers—it's an ever-escalating upward spiral. The early nineteenth century, when the computer's story began, is already so far back that it may as well be the Stone Age. (Rawlins, 1997, p. 19)

COMPUTERS

Weak Artificial Intelligence and Strong Artificial Intelligence

According to weak AI, the principle value of the computer in the study of the mind is that it gives us a very powerful tool. For example, it enables us to formulate and test hypotheses in a more rigorous and precise fashion than before. But according to strong AI the computer is not merely a tool in the study of the mind; rather the appropriately programmed computer really is a mind in the sense that computers given the right programs can be literally said to *understand* and have other

cognitive states. And according to strong AI, because the programmed computer has cognitive states, the programs are not mere tools that enable us to test psychological explanations; *rather*, the programs are themselves the explanations. (Searle, 1981b, p. 353)

COMPUTERS

Why People Are Smarter Than Computers

What makes people smarter than machines? They certainly are not quicker or more precise. Yet people are far better at perceiving objects in natural scenes and noting their relations, at understanding language and retrieving contextually appropriate information from memory, at making plans and carrying out contextually appropriate actions, and at a wide range of other natural cognitive tasks. People are also far better at learning to do these things more accurately and fluently through processing experience.

What is the basis for these differences? One answer, perhaps the classic one we might expect from artificial intelligence, is "software." If we only had the right computer program, the argument goes, we might be able to capture the fluidity and adaptability of human information processing.

Certainly this answer is partially correct. There have been great breakthroughs in our understanding of cognition as a result of the development of expressive high-level computer languages and powerful algorithms. However, we do not think that software is the whole story.

In our view, people are smarter than today's computers because the brain employs a basic computational architecture that is more suited to deal with a central aspect of the natural information processing tasks that people are so good at. . . . [T]hese tasks generally require the simultaneous consideration of many pieces of information or constraints. Each constraint may be imperfectly specified and ambiguous, yet each can play a potentially decisive role in determining the outcome of processing. (McClelland, Rumelhart & Hinton, 1986, pp. 3–4)

CONCEPTS

Concepts Promote Cognitive Economy

From a psychological perspective, concepts are mental representations of classes (e.g., one's beliefs about the class of dogs or tables), and their most salient function is to promote *cognitive economy*. . . . By partitioning the world into classes, we decrease the amount of information we must perceive, learn, remember, communicate, and reason about. Thus, if we had no concepts, we would have to refer to each individual entity by its own name; every different table, for example, would be denoted by a different word. The mental lexicon required would be so enormous that communication as we know it might be impossible. Other mental functions might collapse under the sheer number of entities we would have to keep track of.

Another important function of concepts is that they enable us to *go beyond the information given*. . . . When we come across an object, say a wolf, we have direct knowledge only of its appearance. It is essential that we go beyond appearances and bring to bear other knowledge that we have, such as our belief that wolves can bite and inflict severe injury. Concepts are our means of linking perceptual and nonperceptual information. We use a perceptual description of the creature in front of us to access the concept *wolf* and then use our nonperceptual beliefs to direct our behavior, that is, run. Concepts, then, are recognition devices; they serve as entry points into our knowledge stores and provide us with expectations that we can use to guide our actions.

A third important function of concepts is that they can be *combined to form complex concepts and thoughts. Stoves* and *burn* are two simple concepts; *Stoves can burn* is a full-fledged thought. Presumably our understanding of this thought, and of complex concepts in general, is based on our understanding of the constituent concepts. (Smith, 1988, pp. 19–20)

CONCEPTS

The Nature of Concepts

The concept may be a butterfly. It may be a person he has known. It may be an animal, a city, a type of action, or a quality. Each concept calls for a name. These names are wanted for what may be a noun or a verb, an adjective or an adverb. Concepts of this type have been formed gradually over the years from childhood on. Each time a thing is seen or heard or experienced, the individual has a *perception* of it. A part of that perception comes from his own concomitant interpretation. Each successive perception forms and probably alters the permanent concept. And words are acquired gradually, also, and deposited somehow in the treasure-house of word memory. . . . Words are often acquired simultaneously with the concepts. . . . A little boy may first see a butterfly fluttering from flower to flower in a meadow. Later he sees them on the wing or in pictures, many times. On each occasion he adds to his conception of butterfly.

It becomes a generalization from many particulars. He builds up a concept of a butterfly which he can remember and summon at will, although when he comes to manhood, perhaps, he can recollect none of the particular butterflies of past experience.

The same is true of the sequence of sound that makes up a melody. He remembers it after he has forgotten each of the many times he heard or perhaps sang or played it. The same is true of colours. He acquires, quite quickly, the concept of lavender, although all the objects of which he saw the colour have faded beyond the frontier of voluntary recall. The same is true of the generalization he forms of an acquaintance. Later on he can summon his concept of the individual without recalling their many meetings. (Penfield, 1959, pp. 228–229)

CONNECTIONISM

The Nature of Connectionism Architecture

While connectionism as an AI theory comes in many different forms, they all seem to share the idea that the *representation* of information is based on weights of connections between processing units in a network, and information processing consists of (i) the units transforming their input into some output, which is then (ii) modulated by the weights of connections as inputs to other units. Connectionist theories especially emphasize a form of learning in which continuous functions adjust the weights in the network. In some connectionist theories the above "pure" form is mixed with symbol manipulation processes. (Chandrasekaran, 1990, p. 21)

CONSCIOUSNESS

Consciousness and the New Mysterians

Consciousness is what makes the mind-body problem really intractable. . . . Without consciousness the mind-body problem would be much less interesting. With consciousness it seems hopeless. (T. Nagel, 1979, pp. 165–166)

CONSCIOUSNESS

Consciousness and Sensory Qualia

This approach to understanding sensory qualia is both theoretically and empirically motivated . . . [;] it suggests an effective means of expressing the allegedly inexpressible. The "ineffable" pink of one's current visual

sensation may be richly and precisely expressed as a 95Hz/80Hz/80Hz "chord" in the relevant triune cortical system. The "unconveyable" taste sensation produced by the fabled Australian health tonic Vegamite might be poignantly conveyed as a 85/80/90/15 "chord" in one's four channeled gustatory system. . . . And the "indescribably" olfactory sensation produced by a newly opened rose might be quite accurately described as a 95/35/10/80/60/55 "chord" in some six-dimensional space within one's olfactory bulb. (P. M. Churchland, 1989, p. 106)

CONSCIOUSNESS

Consciousness Appears to Be the Last Bastion of Occult Properties

One of philosophy's favorite facets of mentality has received scant attention from cognitive psychologists, and that is consciousness itself: full-blown, introspective, inner-world phenomenological consciousness. In fact if one looks in the obvious places . . . one finds not so much a lack of interest as a deliberate and adroit avoidance of the issue. I think I know why. Consciousness appears to be the last bastion of occult properties, epiphenomena, and immeasurable subjective states—in short, the one area of mind best left to the philosophers, who are welcome to it. Let them make fools of themselves trying to corral the quicksilver of "phenomenology" into a respectable theory. (Dennett, 1978b, p. 149)

CONSCIOUSNESS

Consciousness Can Be Resolved into Its Elementary Sensations

When I am thinking about anything, my consciousness consists of a number of ideas. . . . But every idea can be resolved into elements . . . and these elements are sensations. (Titchener, 1910, p. 33)

CONSCIOUSNESS

Consciousness Is an Aspect of the Darwinian Machine

A Darwin machine now provides a framework for thinking about thought, indeed one that may be a reasonable first approximation to the actual brain machinery underlying thought. An intracerebral Darwin Machine need not try out one sequence at a time against memory; it may be able to try out dozens, if not hundreds, simultaneously, shape up new generations in milliseconds, and thus initiate insightful actions without *overt* trial and error. This massively parallel selection among stochastic sequences is more analogous to the ways of darwinian biology than to the "von Neumann" serial computer. Which is why I call it a Darwin Machine instead; it shapes up thoughts in milliseconds rather than millennia, and uses innocuous remembered environments rather than noxious real-life ones. It may well create the uniquely human aspect of our consciousness. (Calvin, 1990, pp. 261–262)

CONSCIOUSNESS

Problems about Consciousness Arise from Use of the Personal Pronoun "I"

To suppose the mind to exist in two different states, in the same moment, is a manifest absurdity. To the whole series of states of the mind, then, whatever the individual, momentary successive states may be, I give the name of our *consciousness*. . . . There are not sensations, thoughts, passions, *and also consciousness*, any more than there is *quadruped* or *animal*, as a separate being to be added to the wolves, tygers, elephants, and other living creatures. . . . The fallacy of conceiving consciousness to be something different from the feeling, which is said to be its *object*, has arisen, in a great measure, from the use of the personal pronoun *I*. (T. Brown, 1970, p. 336)

CONSCIOUSNESS

The Capacity for Consciousness and Self-Consciousness Is Characteristically Human

The human capacity for speech is certainly unique. But the gulf between it and the behavior of animals no longer seems unbridgeable. . . . What does this leave us with, then, which is characteristically human?. . . . [I]t resides in the human capacity for consciousness and self-consciousness. (Rose, 1976, p. 177)

CONSCIOUSNESS

The Origin of the Problems of Consciousness

[Human consciousness] depends wholly on our seeing the outside world in such categories. And the problems of consciousness arise from putting *reconstitution* beside *internalization*, from our also being able to see ourselves as if we were objects in the outside world. That is in the very nature of language; it is impossible to have a symbolic system without it. . . . The Cartesian dualism between mind and body arises directly from this, and so do all the famous paradoxes, both in mathematics and in linguistics. . . . (Bronowski, 1978, pp. 38–39)

CONSCIOUSNESS

Views on Consciousness and Computation

It seems to me that there are at least four different viewpoints—or extremes of viewpoint—that one may reasonably hold on the matter [of computation and conscious thinking]:

A. All thinking is computation; in particular, feelings of conscious awareness are evoked merely by the carrying out of appropriate computations.
B. Awareness is a feature of the brain's physical action; and whereas any physical action can be simulated computationally, computational simulation cannot by itself evoke awareness.
C. Appropriate physical action of the brain evokes awareness, but this physical action cannot even be properly simulated computationally.
D. Awareness cannot be explained by physical, computational, or any other scientific terms. (Penrose, 1994, p. 12)

CONTEXT

The Function of Context in Human Language Use and Comprehension

All language involves context; its meaning is contextually constrained. There is always an interplay of text and context. Indeed, human consciousness is inherently responsive to context. . . . [I]n the use of verbal language, there is a continual retracing of the hermeneutic circle of sign and context, an attempt to "frame" properly the associative scenario of the sign, . . . to equilibrize the tension between its general (lexemic) and particular (sememic) meanings. (M. L. Johnson, 1988, p. 107)

CREATIVITY

All Human Complex Problem Solving Is Creativity

Put in this bald way, these aims sound utopian. How utopian they are—or rather, how imminent their realization—depends on how broadly or narrowly we interpret the term "creative." If we are willing to regard all human complex problem solving as creative, then—as we will point

out—successful programs for problem solving mechanisms that simulate human problem solvers already exist, and a number of their general characteristics are known. If we reserve the term "creative" for activities like discovery of the special theory of relativity or the composition of Beethoven's Seventh Symphony, then no example of a creative mechanism exists at the present time. (Simon, 1979, pp. 144–145)

CREATIVITY

Artificial Intelligence Models of Creative Association

Among the questions that can now be given preliminary answers in computational terms are the following: how can ideas from very different sources be spontaneously thought of together? how can two ideas be merged to produce a new structure, which shows the influence of both ancestor ideas without being a mere "cut-and-paste" combination? how can the mind be "primed," so that one will more easily notice serendipitous ideas? why may someone notice—and remember—something fairly uninteresting, if it occurs in an interesting context? how can a brief phrase conjure up an entire melody from memory? and how can we accept two ideas as similar ("love" and "prove" as rhyming, for instance) in respect of a feature not identical in both? The features of connectionist AI models that suggest answers to these questions are their powers of pattern completion, graceful degradation, sensitization, multiple constraint satisfaction, and "best-fit" equilibration. . . . Here, the important point is that the unconscious, "insightful," associative aspects of creativity can be explained—in outline, at least—by AI methods. (Boden, 1996, p. 273)

CREATIVITY

Creative Innovation and Social Independence

There thus appears to be an underlying similarity in the process involved in creative innovation and social independence, with common traits and postures required for expression of both behaviors. The difference is one of product—literary, musical, artistic, theoretical products on the one hand, opinions on the other—rather than one of process. In both instances the individual must believe that his perceptions are meaningful and valid and be willing to rely upon his own interpretations. He must trust himself sufficiently that even when persons express opinions counter to his own he can proceed on the basis of his own perceptions and convictions. (Coopersmith, 1967, p. 58)

CREATIVITY

Ego Strength and Emotional Stability among Creative Geniuses

[T]he average level of ego strength and emotional stability is noticeably higher among creative geniuses than among the general population, though it is possibly lower than among men of comparable intelligence and education who go into administrative and similar positions. High anxiety and excitability appear common (e.g. Priestley, Darwin, Kepler) but full-blown neurosis is quite rare. (Cattell & Butcher, 1970, p. 315)

CREATIVITY

Its Mundane Character

[T]he insight that is supposed to be required for such work as discovery turns out to be synonymous with the familiar process of recognition; and other terms commonly used in the discussion of creative work—such terms as "judgment," "creativity," or even "genius"—appear to be wholly dispensable or to be definable, as insight is, in terms of mundane and well-understood concepts. (Simon, 1989, p. 376)

CREATIVITY

Mozart's Musical Ideas Came to Him in Polished Form

From the sketch material still in existence, from the condition of the fragments, and from the autographs themselves we can draw definite conclusions about Mozart's creative process. To invent musical ideas he did not need any stimulation; they came to his mind "ready-made" and in polished form. In contrast to Beethoven, who made numerous attempts at shaping his musical ideas until he found the definitive formulation of a theme, Mozart's first inspiration has the stamp of finality. Any Mozart theme has completeness and unity; as a phenomenon it is a Gestalt. (Herzmann, 1964, p. 28)

CREATIVITY

Scientific Theories and Works of Art Alike Originate in Fantasy

Great artists enlarge the limits of one's perception. Looking at the world through the eyes of Rembrandt or Tolstoy makes one able to perceive

aspects of truth about the world which one could not have achieved without their aid. Freud believed that science was adaptive because it facilitated mastery of the external world; but was it not the case that many scientific theories, like works of art, also originated in phantasy? Certainly, reading accounts of scientific discovery by men of the calibre of Einstein compelled me to conclude that phantasy was not merely escapist, but a way of reaching new insights concerning the nature of reality. Scientific hypotheses require proof; works of art do not. Both are concerned with creating order, with making sense out of the world and our experience of it. (Storr, 1993, p. xii)

CREATIVITY

Self-Esteem and Creative Expression

The importance of self-esteem for creative expression appears to be almost beyond disproof. Without a high regard for himself the individual who is working in the frontiers of his field cannot trust himself to discriminate between the trivial and the significant. Without trust in his own powers the person seeking improved solutions or alternative theories has no basis for distinguishing the significant and profound innovation from the one that is merely different. . . . An essential component of the creative process, whether it be analysis, synthesis, or the development of a new perspective or more comprehensive theory, is the conviction that one's judgment in interpreting the events is to be trusted. (Coopersmith, 1967, p. 59)

CREATIVITY

Stages in Creative Problem-Solving

In the daily stream of thought these four different stages [preparation; incubation; illumination or inspiration; and verification] constantly overlap each other as we explore different problems. An economist reading

a Blue Book, a physiologist watching an experiment, or a business man going through his morning's letters, may at the same time be "incubating" on a problem which he proposed to himself a few days ago, be accumulating knowledge in "preparation" for a second problem, and be "verifying" his conclusions to a third problem. Even in exploring the same problem, the mind may be unconsciously incubating on one aspect of it, while it is consciously employed in preparing for or verifying another aspect. (Wallas, 1926, p. 81)

CREATIVITY

The Bisociative Pattern of the Creative Synthesis

[T]he basic, bisociative pattern of the creative synthesis [is] the sudden interlocking of two previously unrelated skills, or matrices of thought. (Koestler, 1964, p. 121)

CREATIVITY

The Earliest Stages in the Creative Process Involve a Commerce with Disorder

Even to the creator himself, the earliest effort may seem to involve a commerce with disorder. For the creative order, which is an extension of life, is not an elaboration of the established, but a movement beyond the established, or at least a reorganization of it and often of elements not included in it. The first need is therefore to transcend the old order. Before any new order can be defined, the absolute power of the established, the hold upon us of what we know and are, must be broken. New life comes always from outside our world, as we commonly conceive that world. This is the reason why, in order to invent, one must yield to the indeterminate within him, or, more precisely, to certain ill-

defined impulses which seem to be of the very texture of the ungoverned fullness which John Livingston Lowes calls "the surging chaos of the unexpressed." (Ghiselin, 1985, p. 4)

CREATIVITY

The Inner Life of the Creative Process

New life comes always from outside our world, as we commonly conceive our world. This is the reason why, in order to invent, one must yield to the indeterminate within him, or, more precisely, to certain ill-defined impulses which seem to be of the very texture of the ungoverned fullness which John Livingston Lowes calls "the surging chaos of the unexpressed." Chaos and disorder are perhaps the wrong terms for that indeterminate fullness and activity of the inner life. For it is organic, dynamic, full of tension and tendency. What is absent from it, except in the decisive act of creation, is determination, fixity, and commitment to one resolution or another of the whole complex of its tensions. (Ghiselin, 1952, p. 13)

CREATIVITY

The Problem of What Impels the Creative Person

[P]sychoanalysts have principally been concerned with the content of creative products, and with explaining content in terms of the artist's infantile past. They have paid less attention to examining why the artist chooses his particular activity to express, abreact or sublimate his emotions. In short, they have not made much distinction between art and neurosis; and, since the former is one of the blessings of mankind, whereas the latter is one of the curses, it seems a pity that they should not be better differentiated. . . .

Psychoanalysis, being fundamentally concerned with drive and mo-

tive, might have been expected to throw more light upon what impels the creative person that in fact it has. (Storr, 1993, pp. xvii, 3)

CREATIVITY

Theories of Creative Thinking

A number of theoretical approaches were considered. Associative theory, as developed by Mednick (1962), gained some empirical support from the apparent validity of the Remote Associates Test, which was constructed on the basis of the theory. . . . Koestler's (1964) bisociative theory allows more complexity to mental organization than Mednick's associative theory, and postulates "associative contexts" or "frames of reference." He proposed that normal, non-creative, thought proceeds *within* particular contexts or frames and that the creative act involves linking together previously unconnected frames. . . . Simonton (1988) has developed associative notions further and explored the mathematical consequences of chance permutation of ideas. . . .

Like Koestler, Gruber (1980; Gruber and Davis, 1988) has based his analysis on case studies. He has focused especially on Darwin's development of the theory of evolution. Using piagetian notions, such as assimilation and accommodation, Gruber shows how Darwin's system of ideas changed very slowly over a period of many years. "Moments of insight," in Gruber's analysis, were the culminations of slow long-term processes. . . . Finally, the information-processing approach, as represented by Simon (1966) and Langley *et al*. (1987), was considered. . . . [Simon] points out the importance of good problem representations, both to ensure search is in an appropriate problem space and to aid in developing heuristic evaluations of possible research directions. . . . The work of Langley *et al*. (1987) demonstrates how such search processes, realized in computer programs, can indeed discover many basic laws of science from tables of raw data. . . . Boden (1990a, 1994) has stressed the importance of restructuring the problem space in creative work to develop new genres and paradigms in the arts and sciences. (Gilhooly, 1996, pp. 243–244; emphasis in original)

CULTURE

Patterns of Ideas

Culture consists of patterns, explicit and implicit, of and for behavior acquired and transmitted by symbols, constituting the distinctive achievement of human groups, including their embodiments in artifacts; the essential core of culture consists of traditional (i.e., historically derived and selected) ideas and especially their latest values; culture systems may, on the one hand, be considered as products of action, on the other as conditioning elements of further action. (Kroeber & Kluckhohn, 1952, quoted in Brislin, Lonner & Thorndike, 1973, pp. 4–5)

CYBERNETICS

The Parallel Nature of Feedback in Living Individuals and Communication Machines

It is my thesis that the physical functioning of the living individual and the operation of some of the newer communication machines are precisely parallel in their analogous attempts to control entropy through feedback. Both of them have sensory receptors as one stage of their cycle of operation: that is, in both of them there exists a special apparatus for collecting information from the outer world at low energy levels, and for making it available in the operation of the individual or of the machine. In both cases these external messages are not taken *neat*, but through the internal transforming powers of the apparatus, whether it be alive or dead. The information is then turned into a new form available for the further stages of performance. In both the animal and the machine this performance is made to be effective on the outer world. In both of them, their *performed* action on the outer world, and not merely their *intended* action, is reported back to the central regulatory apparatus. (Wiener, 1954, pp. 26–27)

CYBERNETICS

The Study of Information Transfer

[The job of the cyberneticist] is the study of *information transfer*: the converting of information from one form to another—the human voice into radio waves and back into sound once more, or a complex mathematical equation into a set of punched holes on a tape, to be fed into a computer and then into a set of traces on reels of magnetic tape in the computer's "memory store." . . . To him, protein synthesis is just such another case. The mechanism for ensuring the exact replication of a protein chain by a new cell is that of transferring the *information* about the protein structure from the parent to the daughter cell. (Rose, 1970, p. 162)

CYBERNETICS

Why Computational Devices Are Likely to Be Literal Minded

The theme of all these tales [("Fisherman and the Jinni" in the *Thousand Nights and a Night*; *The Sorcerer's Apprentice*; and "The Monkey's Paw" by W. W. Jacobs)] is the danger of magic. This seems to lie in the fact that the operation of magic is singularly literal-minded, and that if it grants you anything at all it grants what you ask for, not what you should have asked for or what you intend. . . .

The magic of automation, and in particular the magic of an automatization in which the devices learn, may be expected to be similarly literal-minded. If you are playing a game according to certain rules and set the playing-machine to play for victory, you will get victory if you get anything at all, and the machine will not pay the slightest attention to any consideration except victory according to the rules. If you are playing a war game with a certain conventional interpretation of victory, victory will be the goal at any cost, even that of the extermination of your own side, unless this condition of survival is explicitly contained in the definition of victory according to which you program the machine. (Wiener, 1964, pp. 59–60)

D

DEFINITIONS

Definitions Are Circular

There is no self-contained set of "primitives" from which everything else can be defined. Definitions are circular, with the meaning of each concept depending on the other concepts. (Winograd, 1972, p. 26)

DETECTION

Detection Ought to Be an Exact Science

Detection is, or ought to be, an exact science and should be treated in the same cold and unemotional manner. You have attempted to tinge it with romanticism, which produces much the same effect as if you worked a love-story or an elopement into the fifth proposition of Euclid. (Doyle, 1986, Vol. 1)

DIALECTIC

The Dialectic as Used by Philosophers

Dialectic As in dialogue (Socrates) or debate over opposites (Hegel) and clash of material forces (Marx) producing dynamic change.

Or, a process of reasoning based upon the analysis of opposing propositions. Socrates used the dialectic method of teaching by distinguishing between opinion and knowledge. Hegel and Marx developed dialectic conceptions of history in which for Hegel, opposing ideas were the key, while for Marx history was explained as the conflict of material forces. (Stumpf, 1994, p. 936)

DISCOVERY

In Great Discoveries, a Certain Question Is Found

[The] function of thinking is not just solving an actual problem but discovering, envisaging, going into deeper questions. Often, in great discovery the most important thing is that a certain question is found. (Wertheimer, 1945, p. 123)

DISCOVERY

The Discovery of Novel Methods of Representation in Science

The heart of all major discoveries in the physical sciences is the discovery of novel methods of representation and so of fresh techniques by which inferences can be drawn—and drawn in ways which fit the phenomena under investigation. (Toulmin, 1957, p. 34)

DOUBT

Doubt Delivers Us from All Sorts of Prejudices

[Doubt] delivers us from all sorts of prejudices and makes available to us an easy method of accustoming our minds to become independent of the senses. (Descartes, 1950, p. 21)

E

EDUCATIONAL PSYCHOLOGY

The Importance of Aptitude-Treatment Interaction

No aptitude-treatment interactions [ATIs] are so well confirmed that they can be used directly as guides to instruction. . . . Aptitude-treatment interactions exist. To assert the opposite is to assert that whichever educational procedure is best for Johnny is best for everyone else in Johnny's school. Even the most commonplace adaptation of instruction, such as choosing different books for more and less capable readers of a given age, rests on an assumption of ATI that it seems foolish to challenge. It becomes clear that the problem of characterizing, understanding, and using . . . interactions poses the major challenge to educational and psychological science today. (Cronbach & Snow, 1977, pp. vii, 492)

EIDETIC MEMORY

Why Eidetic Memory May Not Be So Beneficial a Gift

[A]lthough eidetic [("photographic")] memory is rare in adults, it seems to be much more frequent in young children. Think back to your own

early memories, and it is probable that you will recollect them as a series of snapshots, fixed or frozen in time. . . . In a typical study, [Ralph] Haber would show children a coloured picture of Alice and the Cheshire cat from an illustrated *Alice in Wonderland*. In the drawing, the cat sat on a tree, striped tail curled behind it. Children having been briefly shown the picture could later answer questions in detail about it—for instance, when asked how many stripes were visible on the cat's tail, they would behave as if they were counting them off from some sort of mental image. Similarly, children shown a picture with writing on it in a foreign language could subsequently spell out the words as if reading them from an open book.

Many, if not all young children apparently do normally see and remember eidetically, but this capacity is lost to most as they grow up. What is in young children an apparently general capacity has become a remarkable rarity in adults. . . .

The rarity of eidetic memory, coupled with the fact that to possess such a capacity does not seem to make for much success in life, suggests that it may not be so beneficial a gift. To be able to synthesize and generalize from past events, to abstract from them, indeed to *forget* them, may thus be as essential for survival and effective action in the world as is the capacity to remember them in the first case. (Rose, 1993, pp. 103–104, 102–103)

EMOTION

The Absence of Emotion and Feeling May Damage Our Human Rationality

I . . . propose that reason may not be as pure as most of us think it is or wish it were, that emotions and feelings may not be intruders in the bastion of reason at all: they may be enmeshed in its networks, for worse *and* for better.

The strategies of human reason probably did not develop, in either evolution or any single individual, without the guiding force of the mechanisms of biological regulation, of which emotion and feeling are notable expressions. Moreover, even after reasoning strategies become

established in the formative years, their effective deployment probably depends, to a considerable extent, on a continued ability to experience feelings.

This is not to deny that emotions and feelings can cause havoc in the processes of reasoning under certain circumstances. Traditional wisdom has told us that they can, and recent investigations of the normal reasoning process also reveal the potentially harmful influence of emotional biases. It is thus even more surprising and novel that the *absence* of emotion and feeling is no less damaging, no less capable of compromising the rationality that makes us distinctly human and allows us to decide in consonance with a sense of personal future, social convention, and moral principle. (Damasio, 1994, p. xii)

EPISTEMOLOGY

Beyond Psychophysiology and Sociology and History of Science There Is Nothing for Epistemology to Do

If we have psychophysiology to cover causal mechanisms, and the sociology and history of science to note the occasions on which observation sentences are invoked or dodged in constructing and dismantling theories, then epistemology has nothing to do. (Rorty, 1979, p. 225)

EPISTEMOLOGY

Epistemology Is a Chapter in Psychology or Natural Science

But I think that at this point it may be more useful to say rather that epistemology still goes on, though in a new setting and a clarified status. Epistemology, or something like it, simply falls into place as a chapter of psychology and hence of natural science. It studies a natural phenom-

enon, viz, a physical human subject. This human subject is accorded a certain experimentally controlled input—certain patterns of irradiation in assorted frequencies, for instance—and in the fullness of time the subject delivers as output a description of the three-dimensional external world and its history. The relation between the meager input and the torrential output is a relation that we are prompted to study for somewhat the same reasons that always prompted epistemology; namely, in order to see how evidence relates to theory, and in what ways one's theory of nature transcends any available evidence. (Quine, quoted in Royce & Rozeboom, 1972, p. 18)

EPISTEMOLOGY

The Assumption That Cognitive Psychology Has Epistemological Import Can Be Challenged

Only the assumption, that one day the various taxonomies put together by, for example, Chomsky, Piaget, Lévi-Strauss, Marx, and Freud will all flow together and spell out one great Universal Language of Nature . . . would suggest that cognitive psychology had epistemological import. But that suggestion would still be as misguided as the suggestion that, since we may predict everything by knowing enough about matter in motion, a completed neurophysiology will help us demonstrate Galileo's superiority to his contemporaries. The gap between explaining ourselves and justifying ourselves is just as great whether a programming language or a hardware language is used in the explanations. (Rorty, 1979, p. 249)

EQUILIBRATION

The Integration of Knowledge

Little by little there has to be a constant equilibrium established between the parts of the subject's knowledge and the totality of his knowledge at any given moment. There is a constant differentiation of the totality of knowledge into the parts and an integration of the parts back into the whole. (Piaget, 1977, p. 839)

EVALUATION

Focused Evaluation Paves the Way to Later Simple Noticing

Focused evaluation can sensitize a person to considerations that will become simply noticed later. (Perkins, 1981, p. 114)

EXISTENTIALISM

Existence Precedes Essence

Existentialism As defined by Sartre, *existence* precedes essence, i.e., people have no given identity until they have made specific decisions and have chosen their work and have thereby defined themselves.

A mode of philosophy which focuses on the existing individual person; instead of searching for truth in distant universal concepts, existentialism is concerned with the authentic concerns of concrete existing individuals as they face choices and decisions in daily life. (Stumpf, 1994, p. 936)

EXISTENTIALISM

To Live According to Nature Is to Live Dominated by Indifference

"According to nature," you want to *live*? O you noble Stoics, what deceptive words these are! Imagine a being like nature, wasteful beyond

measure, indifferent beyond measure, without purposes and consideration, without mercy and justice, fertile and desolate and uncertain at the same time; imagine indifference itself as a power—how *could* you live according to this indifference! (Nietzsche, 1966, p. 15)

EXPERIENCE
Subjective and Objective Knowledge

Any kind of experience—accidental impressions, observations, and even "inner experience" not induced by stimuli received from the environment—may initiate cognitive processes leading to changes in a person's knowledge. Thus, new knowledge can be acquired without new information being received. (That this statement refers to subjective knowledge goes without saying; but there is no such thing as objective knowledge that was not previously somebody's subjective knowledge. (Machlup & Mansfield, 1983, p. 644)

EXPERIENCE
We Have an Untenable Concept of the Nature of Experience

Our faith in experience is far from well grounded, because we have an untenable concept of the nature of experience, one that assumes truth is manifest, and does not have to be inferred. (Brehmer, 1986, p. 715)

EXPERIENCE
Without Experience, Nothing Can Be Sufficiently Known

I now wish to unfold the principles of experimental science, since without experience nothing can be sufficiently known. For there are two

modes of acquiring knowledge, namely by reasoning and experience. Reasoning draws a conclusion and makes us grant the conclusion, but does not make the conclusion certain, nor does it remove doubt so that the mind may rest on the intuition of truth, unless the mind discovers it by the path of experience. . . . Aristotle's statement then that proof is reasoning that causes us to know is to be understood with the proviso that the proof is accompanied by its appropriate experience, and is not to be understood of the bare proof. . . . He therefore who wishes to rejoice without doubt in regard to the truths underlying phenomena must know how to devote himself to experiment. (Bacon, 1928, Pt. VI, Chap. 1)

EXPERTISE

Abstract Representations Give Power to Expert Performance

[It is] predominantly the experts who construct an elaborate representation and . . . this representation need not correspond directly to a physical representation, but may be more abstract. (Chi, Glaser & Rees, 1982, p. 18)

EXPERTISE

Expert Writers Produce Texts Much Reduced from Their Stock of Mental Information

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When . . . [expert writers] produce texts, they bring to mind a great deal of information that they later toss out. (Scardmalia & Bereiter, 1992, p. 172)

EXPERTISE

Expertise Is the Overcoming of Ordinary Human Processing Limitations

A common characteristic of expertise in virtually every domain is that high levels of performance are accomplished by overcoming limitations that serve to restrain the performance of most people. (Salthouse, 1992, pp. 291–292)

F

FANTASY

A Happy Person Never Fantasizes

We may lay it down that a happy person never phantasies, only an unsatisfied one. The motive forces of phantasies are unsatisfied wishes, and every single phantasy is the fulfillment of a wish, a correction of unsatisfying reality. These motivating wishes vary according to the sex, character and circumstances of the person who is having the phantasy; but they fall naturally into two main groups. They are either ambitious wishes, which serve to elevate the subject's personality; or they are erotic ones. (Freud, 1959, Vol. 9, p. 144)

FORMAL SYSTEM

The Problem of Formal Systems in Linguistics

Common to both logical positivism and transformational linguistics is their view of language-as-mathematics. Both focus on language as a system of primitive or elementary units which can be combined according to fixed rules. However useful this analogy may be in certain limited

ways, it creates problems in understanding how the purely formal system of elements and rules relates to something other than itself. Both create dualistic systems which oppose formal linguistic competence to empirical components. (Tyler, 1978, pp. 13–14)

FORMAL SYSTEMS

The Intellectual Poverty of Formalism

No less than the death of meaning should we have forecast from a manner of thought that emptied thought of all content, and what else could we expect from a method of analysis that presumed to show that meaning might mysteriously emerge from the mechanical concatenation of meaningless elements? . . . Whether in art or science nothing is clearer than the intellectual poverty of formalism. (Tyler, 1978, p. 465)

FRAMES

The Theory and Function of Frames

Here is the essence of the theory: when one encounters a new situation (or makes a substantial change in one's view of the present problem) one selects from memory a substantial structure called a frame. This is a remembered framework to be adapted to fit reality by changing details as necessary.

A *frame* is a data-structure for representing a stereotyped situation, like being in a certain kind of living room, or going to a child's birthday party. Attached to each frame are several kinds of information. Some of this information is about how to use the frame. Some is about what one can expect to happen next. Some is about what to do if these expectations are not confirmed.

We can think of a frame as a network of nodes and relations. The "top levels" of a frame are fixed, and represent things that are always true

about the supposed situation. The lower levels have many *terminals*—"slots" that must be filled by specific instances or data. . . . Collections of related frames are linked together into *frame systems*. The effects of important actions are mirrored by transformations between the frames of a system. These are used to make certain kinds of calculations economical, to represent changes of emphasis and attention, and to account for the effectiveness of "imagery."

For visual scene analysis, the different frames of a system describe the scene from different viewpoints, and the transformations between one frame and another represent the effects of moving from place to place. For nonvisual kinds of frames, the differences between the frames of a system can represent actions, cause-effect relations, or changes in metaphorical viewpoint. Different frames of a system share the same terminals; this is the critical point that makes it possible to coordinate information gathered from different viewpoints. (Minsky, 1975, pp. 211, 212)

G

GENIUS

A High Rate of Original Thinking Characterizes the Life of the Inventive Genius

The biography of the inventive genius commonly records a lifetime of original thinking, though only a few ideas survive and are remembered to fame. Voluminous productivity is the rule and not the exception among the individuals who have made some noteworthy contribution. (Barron, 1963, p. 139)

GENIUS

The Idea of the Genius and Its Origins

The genius was, I suggest, in origin the Roman analogue to the *psyche* as here explained, the life-spirit active in procreation, dissociated from and external to the conscious self that is central in the chest. This will explain many facts not hitherto accounted for. The genius was believed to assume the form of a snake, as was the *psyche*. The *psyche* was believed to be in the head. . . .

Not only was his genius thus apparently liable to intervene or take possession of a man but we shall also see reason to believe that it was, in the time of Platus, thought to enjoy knowledge beyond what was enjoyed by the conscious self and to give the latter warning of impending events. . . . The idea of the genius seems to have served in great part as does the twentieth-century concept of an "unconscious mind," influencing a man's life and actions apart from or even despite his conscious mind. It is now possible to trace the origin of our idiom that a man "has" or "has not" genius, meaning that he possesses or does not possess a native source of inspiration beyond ordinary intelligence. (Onians, 1954, p. 129)

GESTALT PSYCHOLOGY

The Gestaltists Demonstrate How Symbolic Reasoning Follows Their Principles of Perception

The Gestaltists look for simple and fundamental principles about how perception is organized, and then attempt to show how symbolic reasoning can be seen as following the same principles, while we construct a complex theory of how knowledge is applied to solve intellectual problems and then attempt to show how the symbolic description that is what one "sees" is constructed according to similar processes. (Minsky & Papert, 1973, p. 34)

GRAMMAR

Grammar as Analogous to a Scientific Theory

I think that the failure to offer a precise account of the notion "grammar" is not just a superficial defect in linguistic theory that can be remedied

by adding one more definition. It seems to me that until this notion is clarified, no part of linguistic theory can achieve anything like a satisfactory development. . . . I have been discussing a grammar of a particular language here as analogous to a particular scientific theory, dealing with its subject matter (the set of sentences of this language) much as embryology or physics deals with its subject matter. (Chomsky, 1964, p. 213)

GRAMMAR

Native Speakers and Their Grammar

Obviously, every speaker of a language has mastered and internalized a generative grammar that expresses his knowledge of his language. This is not to say that he is aware of the rules of grammar or even that he can become aware of them, or that his statements about his intuitive knowledge of his language are necessarily accurate. (Chomsky, 1965, p. 8)

GRAMMAR

The Reduction of Transformation Rules In a Science of Grammar

Much effort has been devoted to showing that the class of possible transformations can be substantially reduced without loss of descriptive power through the discovery of quite general conditions that all such rules and the representations they operate on and form must meet. . . . [The] transformational rules, at least for a substantial core grammar, can be reduced to the single rule, "Move alpha" (that is, "move any category anywhere"). (Mehler, Walker & Garrett, 1982, p. 21)

GRAMMAR

The Relationship of Transformational Grammar to Semantics and to Human Performance

[T]he implications of assuming a semantic memory for what we might call "generative psycholinguistics" are: that dichotomous judgments of semantic well-formedness versus anomaly are not essential or inherent to language performance; that the transformational component of a grammar is the part most relevant to performance models; that a generative grammar's role should be viewed as restricted to language production, whereas sentence understanding should be treated as a problem of extracting a cognitive representation of a text's message; that until *some* theoretical notion of cognitive representation is incorporated into linguistic conceptions, they are unlikely to provide either powerful language-processing programs or psychologically relevant theories.

Although these implications conflict with the way others have viewed the relationship of transformational grammars to semantics and to human performance, they do not eliminate the importance of such grammars to psychologists, an importance stressed in, and indeed largely created by, the work of Chomsky. It is precisely because of a growing interdependence between such linguistic theory and psychological performance models that their relationship needs to be clarified. (Quillian, 1968, p. 260)

GRAMMAR

The Terminologies of Formal Grammar

[T]here are some terminological distinctions that are crucial to explain, or else confusions can easily arise. In the formal study of grammar, a *language* is defined as a set of sentences, possibly infinite, where each sentence is a string of symbols or words. One can think of each sentence

as having several representations linked together: one for its sound pattern, one for its meaning, one for the string of words constituting it, possibly others for other data structures such as the "surface structure" and "deep structure" that are held to mediate the mapping between sound and meaning. Because no finite system can store an infinite number of sentences, and because humans in particular are clearly not pull-string dolls that emit sentences from a finite stored list, one must explain human language abilities by imputing to them a *grammar*, which in the technical sense is a finite rule system, or programme, or circuit design, capable of generating and recognizing the sentences of a particular language. This "mental grammar" or "psychogrammar" is the neural system that allows us to speak and understand the possible word sequences of our native tongue. A grammar for a specific language is obviously acquired by a human during childhood, but there must be neural circuitry that actually carries out the acquisition process in the child, and this circuitry may be called the *language faculty* or *language acquisition device*. An important part of the language faculty is *universal grammar*, an implementation of a set of principles or constraints that govern the possible form of any human grammar. (Pinker, 1996, p. 263)

GRAMMAR

The Theory of Grammar

A grammar of language L is essentially a theory of L. Any scientific theory is based on a finite number of observations, and it seeks to relate the observed phenomena and to predict new phenomena by constructing general laws in terms of hypothetical constructs. . . . Similarly a grammar of English is based on a finite corpus of utterances (observations), and it will contain certain grammatical rules (laws) stated in terms of the particular phonemes, phrases, etc., of English (hypothetical constructs). These rules express structural relations among the sentences of the corpus and the infinite number of sentences generated by the grammar beyond the corpus (predictions). (Chomsky, 1957, p. 49)

H

HERMENEUTICS

Explanation Is Contextual

Explanation is contextual, is "horizontal." It must be made within a horizon of already granted meanings and intentions. In hermeneutics, this area of assumed understanding is called pre-understanding. . . . It might be asked what horizon of interpretation a great literary text inhabits, and then how the horizon of an individual's own world of intentions, hopes, and preinterpretations is related to it. (Palmer, 1969, p. 24)

HEURISTICS

The Centrality of Heuristics in the Mathematical Discoveries of AM (Automatic Mathematician)

[A]t one point AM [Automatic Mathematician] had some notions of sets, set-operations, numbers, and simple arithmetic. One heuristic rule it knew said "*If F is an interesting relation, then look at its inverse*". This rule fired after AM had studied "multiplication" for a while. The r.h.s. of the rule then directed AM to define and study the relation "divisors-of" (e.g.

divisors-of (12) = {1,2,3,4,6,12}. Another heuristic rule that later fired said "*If f is a relation from A into B, then it's worth examining those members of A which map into extremal members of B*." In this case, *f* was matched to "divisors-of", *A* was "numbers", *B* was "sets of numbers", and an extremal member of *B* might be, e.g., a very *small* set of numbers. Thus this heuristic rule caused AM to define the set of numbers with no divisors, the set of numbers with only 1 divisor, with only 2 divisors, etc. One of these sets (the last [*sic*] mentioned) turned out subsequently to be quite important; these numbers are of course the primes. (Lenat & Harris, 1978, p. 30)

HEURISTICS

The Power of Heuristics in Problem Solving

Extraordinarily rapid progress during the early stages of an attack on a new problem area is a rather common occurrence in AI research; it merely signifies that the test cases with which the system has been challenged are below the level of difficulty where combinatorial explosion of the number of pathways in the problem space sets in. . . . It is the goal of AI research to move that threshold higher and higher on the scale of problem complexity through the introduction of heuristics—heuristics to reduce the rate of growth of the solution tree, heuristics to guide the development of the tree so that it will be rich in pathways leading to satisfactory problem solutions, and heuristics to direct the search to the "best" of these pathways. (Gelernter, quoted in Barr & Feigenbaum, 1982, pp. 139–140)

HISTORY

The Great Man Theory of History

For, as I take it, Universal History, the history of what man has accomplished in this world, is at bottom the History of the great Men who have worked here. They were the leaders of men, these great ones; the

modellers, patterns, and in a wide sense creators, of whatsoever the general mass of men contrived to do or attain; all things that we see standing accomplished in the world are properly the outer material result, the practical realisation and embodiment, of Thoughts that dwelt in the great Men sent into the world: the soul of the world's history, it may justly be considered, were the history of these. (Carlyle, 1966, p. 1)

HISTORY
The Value of History

It is generally thought to be of importance to a man that he should know himself: where knowing himself means knowing not his merely personal peculiarities, the things that distinguish him from other men, but his nature as a man. . . . Knowing yourself means knowing what you can do; and since nobody knows what he can do until he tries, the only clue to what man can do is what man has done. The value of history, then, is that it teaches us what man has done and thus what man is. (Collingwood, 1972, p. 10)

HISTORY
The Relation of Psychology to History

To regard [psychology] as rising above the sphere of history, and establishing the permanent and unchanging laws of human nature, is therefore possible only to a person who mistakes the transient conditions of a certain historical age for the permanent conditions of human life. (Collingwood, 1972, p. 224)

I

IDEAS

The Problem of Innate Ideas

I never wrote or concluded that the mind required innate ideas which were in some sort different from its faculty of thinking; but when I observed the existence in me of certain thoughts which proceeded, not from extraneous objects nor from the determination of my will, but solely from the faculty of thinking which is within me, then . . . I termed [these] "innate." (Descartes, 1955, p. 442)

IDEAS

The Source of the Mind's Complex Ideas

[S]imple ideas are not fictions of our fancies, but the natural and regular productions of things without us really operating upon us. . . . Thus, the idea of whiteness or bitterness, as it is in the mind, exactly answering that power which is in any body to produce it there, has all the real conformity it can or ought to have with things without us. . . . [However], all our complex ideas except those of substances being archetypes of the mind's own making, not intended to be the copies of anything, as to

their originals, cannot want any conformity necessary to real knowledge. For that which is not designed to represent anything but itself, can never be capable of a wrong representation, nor mislead us from the true apprehension of anything by its dislikeness to it; and such, excepting those of substances, are all our complex ideas: which . . . are combinations of ideas which the mind by its free choice puts together without considering any connection they have in nature. (Locke, 1956, B. IV, Chap. 4, Sec. 5)

IDEAS

Our Moral Ideas

[O]ur moral ideas as well as mathematical, being archetypes themselves, and so adequate and complete ideas, all the agreement or disagreement which we shall find in them will produce real knowledge, as well as in mathematical figures. (Locke, 1956, B. IV, Chap. 4, Sec. 7)

IDEAS

An Idea Can Be like Nothing But an Idea

Ideas . . . are real things, or do really exist; this we do not deny, but we deny they can subsist without the minds which perceive them, or that they are resemblances of any archetypes existing without the mind; since the very being of a sensation or idea consists in being perceived, and an idea can be like nothing but an idea. (Berkeley, 1996, Pt. I, No. 90, pp. 63–64)

IDEAS

Ideas Create Information, Not the Other Way Around

The empiricists were right to believe that facts and ideas are significantly connected, but they inverted the relationship. *Ideas create information*, not the other way around. Every fact grows from an idea; it is the answer to a question we could not ask in the first place if an idea had not been invented which isolated some portion of the world, made it important, focused our attention, and stimulated inquiry. (Roszak, 1994, p. 105)

IGNORANCE

Knowledge Is Finite, Ignorance Infinite

The more we learn about the world, and the deeper our learning, the more conscious, specific, and articulate will be our knowledge of what we do not know, our knowledge of our ignorance. For this, indeed, is the main source of our ignorance—the fact that our knowledge can be only finite, while our ignorance must necessarily be infinite. (Popper, 1968, p. 28)

IGNORANCE

The Value of Ignorance in Science

The most sincere account that we can give of the attempt to build a science of human behavior . . . emphasizes ignorance rather than reliable knowledge. More specifically, however, to make a rational assessment of our ignorance on a particular topic—to identify enigmas and formulate consensible questions—is itself an important scientific activity. (Ziman, 1978, p. 148)

ILLUMINATION

Illumination as a Stage in Problem-Solving

This appearance of sudden illumination [is] a manifest sign of long, unconscious prior work. . . . [This unconscious work] is possible, and of a certainty it is only fruitful, if it is on the one hand preceded and on the other hand followed by a period of conscious work. (Poincaré, 1913, p. 389)

IMAGERY

The General Conditions for Mental Imagery

A subject is imaging whenever he employs some of the same cognitive processes that he would use in perceiving, but when the stimulus input that would normally give rise to such perception is absent. (Neisser, 1972, p. 245)

IMAGINING

The Relation of Imagining to Perception

Imagining is not perceiving, but images are indeed derivatives of perceptual activity. In particular, they are the *anticipatory phases* of that activity, schemata that the perceiver has detached from the perceptual cycle for other purposes. . . . The experience of having an image is just the inner aspect of a readiness to perceive the imagined object. (Neisser, 1976, pp. 130–131)

INDUCTION

The Uncertainties of Induction

If an induction is worth making, it may be wrong. (Russell, 1927, p. 83)

INFORMATION

Information and the Human Brain

Information is carried by physical entities, such as books or sound waves or brains, but it is not itself material. Information in a living system is a feature of the order and arrangement of its parts, which arrangement provides the signs that constitute a "code" or "language." . . . The organization of the brain can be considered as the written script of the programs of our lives. So the important feature of brains is not the material that they are made of but the information that they carry.

What neuroscience can do is to translate the language in which the brain programs are written into ordinary language. Since these are the programs that produce the phenomena of human language we are not really escaping it. We are using the analogies of language and of writing to understand the entities that produce them. As so often in the past, man, having invented an artifact (in this case writing) to help him with his life (by carrying information), is now trying to describe himself in terms of his artifact. (Young, 1978, p. 2)

INFORMATION PROCESSES

Basic Kinds of Elementary Information Processes

[Three basic kinds of elementary information processes are] metacomponents, which are high order control processes that are used in

executive planning and decision making in problem solving; performance components, which are lower order processes used in executing a problem-solving strategy; and knowledge-acquisition components, which are lower order processes used in acquiring, retaining and transferring new information. (Sternberg & Davidson, 1985, p. 51)

INFORMATION PROCESSING

Origin of the Term "Information Processing"

The term "information processing" originated in the late fifties in the computer field as a general descriptive term that seemed somewhat less contingent and parochial than "computer science," which also came into use during the same period. Thus, it was the name of choice for two of the encompassing professional organizations formed at the time: the *International Federation of Information Processing Societies* and the *American Federation of Information Processing Societies*. Although the transfer of the phrase from activities of computers to parallel activities of human beings undoubtedly occurred independently in a number of heads, the term was originally identified pretty closely with computer simulation of cognitive processes . . . ; that is, with the kind of effort from which arose the theory in this book. (Newell & Simon, 1972, p. 888)

INFORMATION PROCESSING

Assumptions of Information Processing Psychology

It was because the activities of the computer itself seemed in some ways akin to cognitive processes. Computers accept information, manipulate symbols, store items in "memory" and retrieve them again, classify in-

puts, recognize patterns and so on. . . . Indeed the assumptions that underlie most contemporary work on information processing are surprisingly like those of nineteenth century introspective psychology, though without introspection itself. (Neisser, 1976, pp. 5, 7)

INFORMATION PROCESSING

The Processor and the Logical Nature of Problem-Solving Strategies

The processor was assumed to be rational, and attention was directed to the logical nature of problem solving strategies. The "mature western mind" was presumed to be one that, in abstracting knowledge from the idosyncracies of particular everyday experience, employed Aristotelian laws of logic. When applied to categories, this meant that to know a category was to have an abstracted clear-cut, necessary, and sufficient criteria for category membership. If other thought processes, such as imagery, ostensive definition, reasoning by analogy to particular instances, or the use of metaphors were considered at all, they were usually relegated to lesser beings such as women, children, primitive people, or even to nonhumans. (Rosch & Lloyd, 1978, p. 2)

INQUIRY

The Importance of Seeking to Know What We Do Not Know

SOCRATES: And I, Meno, like what I am saying. Some things I have said of which I am not altogether confident. But that we shall be better and braver and less helpless if we think that we ought to enquire, than

we should have been if we indulged in the idle fantasy that there was no knowing and no use in seeking to know what we do not know;—that is a theme upon which I am ready to fight, in word and deed, to the utmost of my power. (Plato, 1892, Vol. 2, p. 47)

INSANITY

Insanity and Civilization

That insanity is a form of freedom became the basic assumption of Foucault's most widely read work, *Madness and Civilization* (1961). The dichotomy is significant; in the precapitalist West of the Middle Ages and Renaissance, Foucault claimed, insanity was understood to be part of the human condition, even an ironic comment on man's pretensions to autonomy and power. Then the classical age defined madness as the enemy of reason and hence the enemy of humanity, requiring rigid and brutal segregation of the insane and other "deviants" in asylums and hospitals. That process of "confinement," the categorizing, segregation, and exclusion of what seems foreign and hence threatening to the rationalizing self, defined for Foucault the Enlightenment mind and all of modern civilization. All of modern society is, for Foucault, a prison with modern man its inmate. (Herman, 1997, p. 353)

INSIGHT

The Catalyst to Darwin's Discovery of the Principle of Natural Selection

In October 1838 that is, fifteen months after I had begun my systematic enquiry, I happened to read for amusement "Malthus on Population," and being well prepared to appreciate the struggle for existence which

everywhere goes on from long-continued observation of the habits of animals and plants, it at once struck me that under these circumstances favorable variations would tend to be preserved, and unfavorable ones to be destroyed. (Darwin, 1911, p. 68)

INSIGHT
Insight in the Chimpanzee

The insight of the chimpanzee shows itself to be principally determined by his optical apprehension of the situation. (Köhler, 1925, p. 267)

INSIGHT
Brevity, Suddenness and Immediate Certainty

Then I turned my attention to the study of some arithmetical questions apparently without much success and without a suspicion of any connection with my preceding researches. Disgusted with my failure, I went to spend a few days at the seaside, and thought of something else. One morning, walking on the bluff, the idea came to me, with just the same characteristics of brevity, suddenness and immediate certainty, that the arithmetic transformations of indeterminate ternary quadratic forms were identical with those of non-Euclidean geometry. (Poincaré, 1929, p. 388)

INSIGHT
Insight Is Not a Mysterious Mental Agent

The direct awareness of determination . . . may also be called *insight*. When I once used this expression in a description of the intelligent behavior of apes, an unfortunate misunderstanding was, it seems, not en-

tirely prevented. . . . Apparently, some readers interpreted this formulation as though it referred to a mysterious mental agent or faculty which was made responsible for the apes' behavior. Actually, nothing of this sort was intended . . . the concept is used in a strictly descriptive fashion. (Köhler, 1947, pp. 341–342)

INSIGHT

Insight in Animal Problem-Solving

The task must be neither so easy that the animal solves the problem at once, thus not allowing one to analyze the solution; nor so hard that the animal fails to solve it except by rote learning in a long series of trials. With a problem of such borderline difficulty, the solution may appear out of a blue sky. There is a period first of fruitless effort in one direction, or perhaps a series of attempted solutions. Then suddenly there is a complete change in the direction of effort, and a cleancut solution of the task. This then is the first criterion of the occurrence of *insight*. The behavior cannot be described as a gradual accretion of learning; it is evident that something has happened in the animal at the moment of solution. (What happens is another matter.) (Hebb, 1949, p. 160)

INSIGHT

An Explanation of Sudden Insight

If the subject had not spontaneously solved the problem [of how to catch hold at the same time of two strings hung from the ceiling so wide apart that he or she could only get hold of one at a time, when the only available tool was a pair of pliers, by tying the pliers to one string and setting it into pendular motion] within ten minutes, Maier supplied him with a hint; he would "accidentally" brush against one of the strings, causing it to swing gently. Of those who solved the problem after this hint, the

average interval between hint and solution was only forty-two seconds. . . . Most of those subjects who solved the problem immediately after the hint did so without any realization that they had been given one. The "idea" of making a pendulum with pliers seemed to arise spontaneously. (Osgood, 1960, p. 633)

INSIGHT

Flashes of Insight Do Not Explain Problem-Solving

There seems to be very little reason to believe that solutions to novel problems come about in flashes of insight, independently of past experience. . . . People create solutions to new problems by starting with what they know and later modifying it to meet the specific problem at hand. (Weisberg, 1986, p. 50)

INTELLECTUALS

Intellectuals Classified as Hedgehogs or Foxes

There is a line among the fragments of the Greek poet Archilochus which says: "The fox knows many things, but the hedgehog knows one big thing." Scholars have differed about the correct interpretation of these dark words, which may mean no more than that the fox, for all his cunning, is defeated by the hedgehog's one defence. But, taken figuratively, the words can be made to yield a sense in which they mark one of the deepest differences which divide writers and thinkers, and, it may be, human beings in general. For there exists a great chasm between those, on one side, who relate everything to a single central vision, one system, less or more coherent or articulate, in terms of which they understand, think and feel—a single, universal, organising principle in

terms of which alone all that they are and say has significance—and, on the other side, those who pursue many ends, often unrelated and even contradictory, connected, if at all, only in some *de facto* way, for some psychological or physiological cause, related by no moral or aesthetic principle. . . . The first kind of intellectual and artistic personality belongs to the hedgehogs, the second to the foxes; and without insisting on a rigid classification, we may, without too much fear of contradiction, say that, in this sense, Dante belongs to the first category, Shakespeare to the second; Plato, Lucretius, Pascal, Hegel, Dostoevsky, Nietsche, Ibsen, [and] Proust are, in varying degrees hedgehogs; Herodotus, Aristotle, Montaigne, Erasmus, Molière, Goethe, Pushkin, Balzac, [and] Joyce are foxes. (Berlin, 1953, pp. 1–2; Archilochus, 1971, frag. 201)

INTELLIGENCE

Child Development and the Intellectual Life

There is no mystery about it: the child who is familiar with books, ideas, conversation—the ways and means of the intellectual life—before he begins school, indeed, before he begins consciously to think, has a marked advantage. He is at home in the House of intellect just as the stableboy is at home among horses, or the child of actors on the stage. (Barzun, 1959, p. 142)

INTELLIGENCE

Comparison of Sensory-Motor Intelligence and Conceptual Thought

It is . . . no exaggeration to say that sensory-motor intelligence is limited to desiring success or practical adaptation, whereas the function of verbal or conceptual thought is to know and state truth. (Piaget, 1954, p. 359)

INTELLIGENCE

The Epistemological and Heuristic Parts of Intelligence

[I]ntelligence has two parts, which we shall call the epistemological and the heuristic. The epistemological part is the representation of the world in such a form that the solution of problems follows from the facts expressed in the representation. The heuristic part is the mechanism that on the basis of the information solves the problem and decides what to do. (McCarthy & Hayes, 1969, p. 466)

INTELLIGENCE

Comparison of Intelligence in Human and Nonhuman Primates

Many scientists implicitly assume that, among all animals, the behavior and intelligence of nonhuman primates are most like our own. Nonhuman primates have relatively larger brains and proportionally more neocortex than other species . . . and it now seems likely that humans, chimpanzees, and gorillas shared a common ancestor as recently as 5 to 7 million years ago. . . . This assumption about the unique status of primate intelligence is, however, just that: an assumption. The relations between intelligence and measures of brain size is poorly understood, and evolutionary affinity does not always ensure behavioral similarity. Moreover, the view that nonhuman primates are the animals most like ourselves coexists uneasily in our minds with the equally pervasive view that primates differ fundamentally from us because they lack language; lacking language, they also lack many of the capacities necessary for reasoning and abstract thought. (Cheney & Seyfarth, 1990, p. 4)

INTELLIGENCE

Four Approaches to the Study of Intelligence

Few constructs are asked to serve as many functions in psychology as is the construct of human intelligence. . . . Consider four of the main functions addressed in theory and research on intelligence, and how they differ from one another.

1. Biological. This type of account looks at biological processes. To qualify as a useful biological construct, intelligence should be a biochemical or biophysical process or at least somehow a resultant of biochemical or biophysical processes.

2. Cognitive approaches. This type of account looks at molar cognitive representations and processes. To qualify as a useful mental construct, intelligence should be specifiable as a set of mental representations and processes that are identifiable through experimental, mathematical, or computational means.

3. Contextual approaches. To qualify as a useful contextual construct, intelligence should be a source of individual differences in accomplishments in "real-world" performances. It is not enough just to account for performance in the laboratory. On [*sic*] the contextual view, what a person does in the lab may not even remotely resemble what the person would do outside it. Moreover, different cultures may have different conceptions of intelligence, which affect what would count as intelligent in one cultural context versus another.

4. Systems approaches. Systems approaches attempt to understand intelligence through the interaction of cognition with context. They attempt to establish a link between the two levels of analysis, and to analyze what forms this link takes. (Sternberg, 1994, pp. 263–264)

INTELLIGENCE

High Intelligence Combined with the Greatest Degrees of Persistence

High but not the highest intelligence, combined with the greatest degrees of persistence, will achieve greater eminence than the highest degree of intelligence with somewhat less persistence. (Cox, 1926, p. 187)

INTELLIGENCE

Intelligence Is Not Marked by Definitive Criteria

There are no definitive criteria of intelligence, just as there are none for chairness; it is a fuzzy-edged concept to which many features are relevant. Two people may both be quite intelligent and yet have very few traits in common—they resemble the prototype along different dimensions. . . . [Intelligence] is a resemblance between two individuals, one real and the other prototypical. (Neisser, 1979, p. 185)

INTELLIGENCE

Synthesis of Differential and Information-Processing Approaches to the Study of Intelligence

Given the complementary strengths and weaknesses of the differential and information-processing approaches, it should be possible, at least in

theory, to synthesise an approach that would capitalise upon the strength of each approach, and thereby share the weakness of neither. (Sternberg, 1977, p. 65)

INTENTION

All Acts Have the Character of Being Intended

All acts have in common the character of being intended or willed. But one act is distinguishable from another by the content of it, the expected result of it, which is here spoken of as its intent. There is no obvious way in which we can say what act it is which is thought of or is done except by specifying this intent of it. (Lewis, 1946, p. 367)

INTENTION

Intentions Are Rapid Premonitory Perspective Views of Schemes of Thought

And has the reader never asked himself what kind of a mental fact is his *intention of saying a thing* before he has said it? It is an entirely definite intention, distinct from all other intentions, an absolutely distinct state of consciousness, therefore; and yet how much of it consists of definite sensorial images, either of words or of things? Hardly anything! Linger, and the words and things come into the mind; the anticipatory intention, the divination is there no more. But as the words that replace it arrive, it welcomes them successively and calls them right if they agree with it, it rejects them and calls them wrong if they do not. It has therefore a nature of its own of the most positive sort, and yet what can we say about it without using words that belong to the later mental facts that

replace it? The intention *to-say-so-and-so* is the only name it can receive. One may admit that a good third of our psychic life consists in these rapid premonitory perspective views of schemes of thought not yet articulate. (James, 1890, p. 253)

INTENTIONALITY

The Problem of the Causal Efficacy of Intentionality

Mental states are both *caused* by the operations of the brain and *realized* in the structure of the brain (and the rest of the central nervous system). Once the possibility of mental and physical phenomena standing in both these relations is understood we have removed at least one major obstacle to seeing how mental states which are caused by brain states can also cause further brain states and mental states.

But this model of "caused by" and "realized in" only raises the next question, how can Intentionality function causally? Granted that Intentional states can themselves be caused by and realized in the structure of the brain, how can Intentionality itself have any causal efficacy? When I raise my arm my intention in action causes my arm to go up. This is a case of a mental event causing a physical event. But, one might ask, how could such a thing occur? My arm going up is caused entirely by a series of neuron firings. We do not know where in the brain these firings originate, but they go at some point through the motor cortex and control a series of arm muscles which contract when the appropriate neurons fire. Now what has any mental event got to do with all of this? As with our previous questions, I want to answer this one by appealing to different levels of description of a substance, where the phenomena at each of the different levels function causally. (Searle, 1983, pp. 265, 268)

INTERPRETATION

Existing Itself May Be Said to Be a Constant Process of Interpretation

From the time you wake in the morning until you sink into sleep, you are "interpreting." On waking you glance at the bedside clock and interpret its meaning: you recall what day it is, and in grasping the meaning of the day you are already primordially recalling to yourself the way you are placed in the world and your plans for the future; you rise and must interpret the words and gestures of those you meet on the daily round. . . . Existing itself may be said to be a constant process of interpretation. (Palmer, 1969, p. 8)

INTROSPECTION

Experimental Introspection Is the One Reliable Method of Knowing Ourselves

When we are trying to understand the mental processes of a child or a dog or an insect as shown by conduct and action, the outward signs of mental processes, . . . we must always fall back upon experimental introspection . . . [;] we cannot imagine processes in another mind that we do not find in our own. Experimental introspection is thus our one reliable method of knowing ourselves; it is the sole gateway to psychology. (Titchener, 1914, p. 32)

INTROSPECTION

The Limitation of Introspection

There is a somewhat misleading point of view that one's own experience provides a sufficient understanding of mental life for scientific purposes. Indeed, early in the history of experimental psychology, the main

method for studying cognition was *introspection*. By observing one's own mind, the argument went, one could say how one carried out cognitive activities. . . .

Yet introspection failed to be a good technique for the elucidation of mental processes in general. There are two simple reasons for this. First, so many things which we can do seem to be quite unrelated to conscious experience. Someone asks you your name. You do not know how you retrieve it, yet obviously there is some *process* by which the retrieval occurs. In the same way, when someone speaks to you, you understand what they say, but you do not know how you came to understand. Yet somehow processes take place in which words are picked out from the jumble of sound waves which reach your ears, in-built knowledge of syntax and semantics gives it meaning, and the significance of the message comes to be appreciated. Clearly, introspection is not of much use here, but it is undeniable that understanding language is as much a part of mental life as is thinking.

As if these arguments were not enough, it is also the case that introspective data are notoriously difficult to evaluate. Because it is private to the experiencer, and experience may be difficult to convey in words to somebody else. Many early introspective protocols were very confusing to read and, even worse, the kinds of introspection reported tended to conform to the theoretical categories used in different laboratories. Clearly, what was needed was both a change in experimental method and a different (non-subjective) theoretical framework to describe mental life. (Sanford, 1987, pp. 2–3)

INTUITION

Direct and Immediate Knowledge

Intuition Direct and immediate knowledge, or the immediate apprehension by the self of itself, of the truth of certain propositions, of the external world, and of values, without the prior need for the ability to define a term, to justify a conclusion, or to build upon inferences. (Stumpf, 1994, p. 937)

INVENTION

The Variety of Human Invention and the Variety of Life Forms

Although we have taken no voyage comparable to Darwin's it seems to us that the variety of human inventions seems in its own way as overwhelming and inexplicable as the infinite variety of life forms that Darwin saw. (Feldman, 1980, p. 36)

INVENTION

Invention in Piagetan Theory

[T]he sudden inventions characteristic of the sixth stage [of infant development] are in reality the product of a long evolution of schemata and not only of an internal maturation of perceptive structures. . . . This is revealed by the existence of a fifth stage, characterized by experimental groping. . . . What does this mean if not that the practice of actual experience is necessary in order to acquire the practice of mental experience and that invention does not arise entirely preformed despite appearances? (Piaget, 1952, p. 348)

ISOMORPHISM

The Significance of Isomorphisms

[An *isomorphism* is] an information-preserving transformation [that] applies when two complex structures can be mapped onto each other, in such a way that to each part of one structure there is a corresponding part in the other structure, where "corresponding" means that the two

parts play similar roles in their respective structures. . . . The perception of an isomorphism between two known structures is a significant advance in knowledge. . . . [I]t is such perceptions of isomorphism which create *meanings* in the minds of people. (Hofstadter, 1979, pp. 49–50)

J

JUDGMENT

Good Judgment Is Sufficient to Guarantee Good Behavior

Since our will neither seeks nor avoids anything except as it is judged good or bad by our reason, good judgment is sufficient to guarantee good behavior. (Descartes, 1950, p. 18)

K

KNOWING

The Relation of Knowing to Rules Abstracted from Exemplars

I have in mind a manner of knowing which is misconstrued if reconstructed in terms of rules that are first abstracted from exemplars and thereafter function in their stead. (Kuhn, 1970, p. 192)

KNOWLEDGE

To Exist Is to Be Perceived

It is indeed an opinion strangely prevailing amongst men, that houses, mountains, rivers, and, in a word, all sensible objects, have an existence, natural or real, distinct from their being perceived by the understanding. But, with how great an assurance and acquiescence soever this principle may be entertained in the world, yet whoever shall find in his heart to call it into question may, if I mistake not, perceive it to involve a manifest contradiction. For, what are the forementioned objects but things we per-

ceive by sense? and what do we perceive besides our own ideas or sensations? and is it not plainly repugnant that any one of these, or any combination of them, should exist unperceived? (Berkeley, 1996, Pt. I, No. 4, p. 25)

KNOWLEDGE

Abstract Science or Demonstration Is a More Perfect Species of Knowledge

It seems to me that the only objects of the abstract sciences or of demonstration are quantity and number, and that all attempts to extend this more perfect species of knowledge beyond these bounds are mere sophistry and illusion. As the component parts of quantity and number are entirely similar, their relations become intricate and involved; and nothing can be more curious, as well as useful, than to trace, by a variety of mediums, their equality or inequality, through their different appearances.

But as all other ideas are clearly distinct and different from each other, we can never advance farther, by our utmost scrutiny, than to observe this diversity, and, by an obvious reflection, pronounce one thing not to be another. Or if there be any difficulty in these decisions, it proceeds entirely from the undeterminate meaning of words, which is corrected by juster definitions. That *the square of the hypotenuse is equal to the squares of the other two sides* cannot be known, let the terms be ever so exactly defined, without a train of reasoning and enquiry. But to convince us of this proposition, *that where there is no property, there can be no injustice*, it is only necessary to define the terms, and explain injustice to be a violation of property. This proposition is, indeed, nothing but a more imperfect definition. It is the same case with all those pretended syllogistical reasonings, which may be found in every other branch of learning, except the sciences of quantity and number; and these may safely, I think, be pronounced the only proper objects of knowledge and demonstration. (Hume, 1975, Sec. 12, Pt. 3, pp. 163–165)

KNOWLEDGE

Knowledge Derives from Two Fundamental Sources of the Mind

Our knowledge springs from two fundamental sources of the mind; the first is the capacity of receiving representations (the ability to receive impressions), the second is the power to know an object through these representations (spontaneity in the production of concepts).

Through the first, an object is *given* to us; through the second, the object is *thought* in relation to that representation. . . . Intuition and concepts constitute, therefore, the elements of all our knowledge, so that neither concepts without intuition in some way corresponding to them, nor intuition without concepts, can yield knowledge. Both may be either pure or empirical. . . . Pure intuitions or pure concepts are possible only *a priori*; empirical intuitions and empirical concepts only *a posteriori*.

If the *receptivity* of our mind, its power of receiving representations in so far as it is in any way affected, is to be called "sensibility," then the mind's power of producing representations from itself, the *spontaneity* of knowledge, should be called "understanding." Our nature is so constituted that our intuitions can never be other than sensible; that is, it contains only the mode in which we are affected by objects. The faculty, on the other hand, which enables us to *think* the object of sensible intuition is the understanding. . . . Without sensibility, no object would be given to us; without understanding, no object would be thought. Thoughts without content are empty; intuitions without concepts are blind. It is therefore just as necessary to make our concepts sensible, that is, to add the object to them in intuition, as to make our intuitions intelligible, that is to bring them under concepts. These two powers or capacities cannot exchange their functions. The understanding can intuit nothing, the senses can think nothing. Only through their union can knowledge arise. (Kant, 1933, Sec. 1, Pt. 2, B74–75 [p. 92])

KNOWLEDGE

The Means by Which Metaphysics Can Be Perfected as a Science

Metaphysics, as a natural disposition of Reason is real, but it is also, in itself, dialectical and deceptive. . . . Hence to attempt to draw our principles from it, and in their employment to follow this natural but none the less fallacious illusion can never produce science, but only an empty dialectical art, in which one school may indeed outdo the other, but none can ever attain a justifiable and lasting success. In order that, as a science, it may lay claim not merely to deceptive persuasion, but to insight and conviction, a Critique of Reason must exhibit in a complete system the whole stock of conceptions *a priori*, arranged according to their different sources—the Sensibility, the understanding, and the Reason; it must present a complete table of these conceptions, together with their analysis and all that can be deduced from them, but more especially the possibility of synthetic knowledge *a priori* by means of their deduction, the principles of its use, and finally, its boundaries. . . .

This much is certain: he who has once tried criticism will be sickened for ever of all the dogmatic trash he was compelled to content himself with before, because his Reason, requiring something, could find nothing better for its occupation. Criticism stands to the ordinary school metaphysics exactly in the same relation as *chemistry* to *alchemy*, or as *astronomy* to fortune-telling *astrology*. I guarantee that no one who has comprehended and thought out the conclusions of criticism, even in these Prolegomena, will ever return to the old sophistical pseudo-science. He will rather look forward with a kind of pleasure to a metaphysics, certainly now within his power, which requires no more preparatory discoveries, and which alone can procure for reason permanent satisfaction. (Kant, 1891, pp. 115–116)

KNOWLEDGE

Knowledge Is Only Real in the Form of System

Knowledge is only real and can only be set forth fully in the form of science, in the form of system. Further, a so-called fundamental proposition or first principle of philosophy, even if it is true, it is yet none the less false, just because and in so far as it is merely a fundamental proposition, merely a first principle. It is for that reason easily refuted. The refutation consists in bringing out its defective character; and it *is* defective because it is merely the universal, merely a principle, the beginning. If the refutation is complete and thorough, it is derived and developed from the nature of the principle itself, and not accomplished by bringing in from elsewhere other counter-assurances and chance fancies. It would be strictly the development of the principle, and thus the completion of its deficiency, were it not that it misunderstands its own purport by taking account solely of the negative aspect of what it seeks to do, and is not conscious of the positive character of its process and result. The really positive working out of the beginning is at the same time just as much the very reverse: it is a negative attitude towards the principle we start from. Negative, that is to say, in its one-sided form, which consists in being primarily immediate, a mere purpose. It may therefore be regarded as a refutation of what constitutes the basis of the system; but more correctly it should be looked at as a demonstration that the *basis* or principle of the system is in point of fact merely its *beginning*. (Hegel, 1910, pp. 21–22)

KNOWLEDGE

Knowledge, Action, and Evaluation Are Interconnected

Knowledge, action, and evaluation are essentially connected. The primary and pervasive significance of knowledge lies in its guidance of

action: knowing is for the sake of doing. And action, obviously, is rooted in evaluation. For a being which did not assign comparative values, deliberate action would be pointless; and for one which did not know, it would be impossible. Conversely, only an active being could have knowledge, and only such a being could assign values to anything beyond his own feelings. A creature which did not enter into the process of reality to alter in some part the future content of it, could apprehend a world only in the sense of intuitive or esthetic contemplation; and such contemplation would not possess the significance of knowledge but only that of enjoying and suffering. (Lewis, 1946, p. 1)

KNOWLEDGE

The Evolution of Knowledge

"Evolutionary epistemology" is a branch of scholarship that applies the evolutionary perspective to an understanding of how knowledge develops. Knowledge always involves getting information. The most primitive way of acquiring it is through the sense of touch: amoebas and other simple organisms know what happens around them only if they can feel it with their "skins." The knowledge such an organism can have is strictly about what is in its immediate vicinity. After a huge jump in evolution, organisms learned to find out what was going on at a distance from them, without having to actually feel the environment. This jump involved the development of sense organs for processing information that was farther away. For a long time, the most important sources of knowledge were the nose, the eyes, and the ears. The next big advance occurred when organisms developed memory. Now information no longer needed to be present at all, and the animal could recall events and outcomes that happened in the past. Each one of these steps in the evolution of knowledge added important survival advantages to the species that was equipped to use it.

Then, with the appearance in evolution of humans, an entirely new way of acquiring information developed. Up to this point, the processing of information was entirely *intrasomatic*. . . . But when speech appeared (and even more powerfully with the invention of writing), information

processing became *extrasomatic*. After that point knowledge did not have to be stored in the genes, or in the memory traces of the brain; it could be passed on from one person to another through words, or it could be written down and stored on a permanent substance like stone, paper, or silicon chips—in any case, outside the fragile and impermanent nervous system. (Csikszentmihalyi, 1993, pp. 56–57)

L

LANGUAGE

The Book of Nature Is Written in the Language of Mathematics

Philosophy is written in that great book, the universe, which is always open, right before our eyes. But one cannot understand this book without first learning to understand the language and to know the characters in which it is written. It is written in the language of mathematics, and the characters are triangles, circles, and other figures. Without these, one cannot understand a single word of it, and just wanders in a dark labyrinth. (Galileo, 1990, p. 232)

LANGUAGE

Arranging Speech so as to Reply Appropriately

It never happens that it [a nonhuman animal] arranges its speech in various ways in order to reply appropriately to everything that may be said in its presence, as even the lowest type of man can do. (Descartes, 1970a, p. 116)

LANGUAGE

No Other Animal Has the Language Capacity of the Human

It is a very remarkable fact that there are none so depraved and stupid, without even excepting idiots, that they cannot arrange different words together, forming of them a statement by which they make known their thoughts; while, on the other hand, there is no other animal, however perfect and fortunately circumstanced it may be, which can do the same. (Descartes, 1967, p. 116)

LANGUAGE

Human Beings Do Not Live Only in the World of Objects

Human beings do not live in the object world alone, nor alone in the world of social activity as ordinarily understood, but are very much at the mercy of the particular language which has become the medium of expression for their society. It is quite an illusion to imagine that one adjusts to reality essentially without the use of language and that language is merely an incidental means of solving specific problems of communication or reflection. The fact of the matter is that the "real world" is to a large extent unconsciously built on the language habits of the group. . . . We see and hear and otherwise experience very largely as we do because the language habits of our community predispose certain choices of interpretation. (Sapir, 1921, p. 75)

LANGUAGE

Language Powerfully Conditions All Our Thinking

It powerfully conditions all our thinking about social problems and processes. . . . No two languages are ever sufficiently similar to be considered as representing the same social reality. The worlds in which different societies live are distinct worlds, not merely the same worlds with different labels attached. (Sapir, 1985, p. 162)

LANGUAGE

A List of Language Games

[A list of language games, not meant to be exhaustive:]

Giving orders, and obeying them—

Describing the appearance of an object, or giving its measurements—

Constructing an object from a description (a drawing)—

Reporting an event—

Speculating about an event—

Forming and testing a hypothesis—

Presenting the results of an experiment in tables and diagrams—

Making up a story; and reading it—

Play acting—

Singing catches—

Guessing riddles—

Making a joke; and telling it—

Solving a problem in practical arithmetic—

Translating from one language into another—

Asking, thanking, cursing, greeting, and praying—. (Wittgenstein, 1953, Pt. I, No. 23, pp. 11^{e}–12^{e})

LANGUAGE

Language Constrains Certain Modes of Interpretation

We dissect nature along lines laid down by our native languages. . . . The world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds—and this means largely by the linguistic systems in our minds. . . . No individual is free to describe nature with absolute impartiality but is constrained to certain modes of interpretation even while he thinks himself most free. (Whorf, 1956, pp. 153, 213–214)

LANGUAGE

We Dissect Nature in Accordance with Our Native Languages

We dissect nature along the lines laid down by our native languages. The categories and types that we isolate from the world of phenomena we do not find there because they stare every observer in the face; on the contrary, the world is presented in a kaleidoscopic flux of impressions which has to be organized by our minds—and this means largely by the linguistic systems in our minds. . . . We are thus introduced to a new principle of relativity, which holds that all observers are not led by the same physical evidence to the same picture of the universe, unless their linguistic backgrounds are similar or can in some way be calibrated. (Whorf, 1956, pp. 213–214)

LANGUAGE

The Forms of a Person's Thoughts Are Controlled by Unperceived Patterns of His Own Language

The forms of a person's thoughts are controlled by inexorable laws of pattern of which he is unconscious. These patterns are the unperceived intricate systematizations of his own language—shown readily enough by a candid comparison and contrast with other languages, especially those of a different linguistic family. (Whorf, 1956, p. 252)

LANGUAGE

The Analysis of Certain Types of Utterances

It has come to be commonly held that many utterances which look like statements are either not intended at all, or only intended in part, to record or impart straightforward information about the facts. . . . Many traditional philosophical perplexities have arisen through a mistake—the mistake of taking as straightforward statements of fact utterances which are *either* (in interesting non-grammatical ways) nonsensical *or else* intended as something quite different. (Austin, 1962, pp. 2–3)

LANGUAGE

The Dictionary of a Language Is a System of Concepts

In general, one might define a complex of semantic components connected by logical constants as a concept. The dictionary of a language is

then a system of concepts in which a phonological form and certain syntactic and morphological characteristics are assigned to each concept. This system of concepts is structured by several types of relations. It is supplemented, furthermore, by redundancy or implicational rules . . . , representing general properties of the whole system of concepts. . . . At least a relevant part of these general rules is not bound to particular languages, but represents presumably universal structures of natural languages. They are not learned, but are rather a part of the human ability to acquire an arbitrary natural language. (Bierwisch, 1970, pp. 171–172)

LANGUAGE

Talk about the Evolution of the Language Capacity is Beside the Point

In studying the evolution of mind, we cannot guess to what extent there are physically possible alternatives to, say, transformational generative grammar, for an organism meeting certain other physical conditions characteristic of humans. Conceivably, there are none—or very few—in which case talk about evolution of the language capacity is beside the point. (Chomsky, 1972, p. 98)

LANGUAGE

The Development of Language

[It is] truth value rather than syntactic well-formedness that chiefly governs explicit verbal reinforcement by parents—which renders mildly paradoxical the fact that the usual product of such a training schedule is an adult whose speech is highly grammatical but not notably truthful. (R. O. Brown, 1973, p. 330)

LANGUAGE

Sentential and Conceptual Levels in Language

[T]he conceptual base is responsible for formally representing the concepts underlying an utterance. . . . A given word in a language may or may not have one or more concepts underlying it. . . . On the *sentential level*, the utterances of a given language are encoded within a syntactic structure of that language. The basic construction of the sentential level is the sentence.

The next highest level . . . is the *conceptual level*. We call the basic construction of this level the *conceptualization*. A conceptualization consists of *concepts* and certain relations among those concepts. We can consider that both levels exist at the same point in time and that for any unit on one level, some corresponding realizate exists on the other level. This realizate may be null or extremely complex. . . . Conceptualizations may relate to other conceptualizations by nesting or other specified relationships. (Schank, 1973, pp. 191–192)

LANGUAGE

Linguistic Realities Have Not Yet Been Captured by Theoretical Models

The mathematics of multi-dimensional interactive spaces and lattices, the projection of "computer behavior" on to possible models of cerebral functions, the theoretical and mechanical investigation of artificial intelligence, are producing a stream of sophisticated, often suggestive ideas.

But it is, I believe, fair to say that nothing put forward until now in either theoretic design or mechanical mimicry comes even remotely in reach of the most rudimentary linguistic realities. (Steiner, 1975, p. 284)

LANGUAGE
The Final Steps to Human Language

The step from the simple tool to the master tool, a tool to make tools (what we would now call a machine tool), seems to me indeed to parallel the final step to human language, which I call reconstitution. It expresses in a practical and social context the same understanding of hierarchy, and shows the same analysis by function as a basis for synthesis. (Bronowski, 1977, pp. 127–128)

LANGUAGE
The Inadequacy of Formal Linguistic Models for Ordinary Language Usage

[I]t is the *language donné* in which we conduct our lives. . . . We have no other. And the danger is that formal linguistic models, in their loosely argued analogy with the axiomatic structure of the mathematical sciences, may block perception. . . . It is quite conceivable that, in language, continuous induction from simple, elemental units to more complex, realistic forms is not justified. The extent and formal "undecidability" of context—and every linguistic particle above the level of the phoneme is context-bound—may make it impossible, except in the most abstract, meta-linguistic sense, to pass from "pro-verbs," "kernals," or "deep deep structures" to actual speech. (Steiner, 1975, pp. 111–113)

LANGUAGE
When a Language Is an Abstract Machine

A higher-level formal language is an abstract machine. (Weizenbaum, 1976, p. 113)

LANGUAGE

Metaphor and Metonymy Underpin the Formation of Linguistic Signs

Jakobson sees metaphor and metonymy as the characteristic modes of binarily opposed polarities which between them underpin the two-fold process of *selection* and *combination* by which linguistic signs are formed. . . . Thus messages are constructed, as Saussure said, by a combination of a "horizontal" movement, which combines words together, and a "vertical" movement, which selects the particular words from the available inventory or "inner storehouse" of the language. The combinative (or syntagmatic) process manifests itself in contiguity (one word being placed next to another) and its mode is *metonymic*. The selective (or associative) process manifests itself in similarity (one word or concept being "like" another) and its mode is *metaphoric*. The "opposition" of metaphor and metonymy therefore may be said to represent in effect the essence of the total opposition between the *synchronic* mode of language (its immediate, coexistent, "vertical" relationships) and its *diachronic* mode (its sequential, successive, lineal progressive relationships). (Hawkes, 1977, pp. 77–78)

LANGUAGE

Language and the Analysis of Nature

It is striking that the layered structure that man has given to language constantly reappears in his analyses of nature. (Bronowski, 1977, p. 121)

LANGUAGE

Correspondence Rules for Mapping Old Theory into Subsets of New Theory

First, [an ideal intertheoretic reduction] provides us with a set of rules—"correspondence rules" or "bridge laws," as the standard vernacular has it—which effect a mapping of the terms of the old theory (T_o) onto a subset of the expressions of the new or reducing theory (T_n). These rules guide the application of those selected expressions of T_n in the following way: we are free to make singular applications of their correspondence-rule doppelgangers in T_o. . . .

Second, and equally important, a successful reduction ideally has the outcome that, under the term mapping effected by the correspondence rules, the central principles of T_o (those of semantic and systematic importance) are mapped onto general sentences of T_n that are *theorems* of T_n. (P. Churchland, 1979, p. 81)

LANGUAGE

The Inclusion of Non-linguistic Factors in a Theory of Grammar

If non-linguistic factors must be included in grammar: beliefs, attitudes, etc. [this would] amount to a rejection of the initial idealization of language as an object of study. *A priori* such a move cannot be ruled out, but it must be empirically motivated. If it proves to be correct, I would conclude that language is a chaos that is not worth studying. . . . Note that the question is not whether beliefs or attitudes, and so on, play a role in linguistic behavior and linguistic judgments . . . [but rather] whether distinct cognitive structures can be identified, which interact in the real use of language and linguistic judgments, the grammatical system being one of these. (Chomsky, 1979, pp. 140, 152–153)

LANGUAGE
Language Is Inevitably Influenced by Specific Contexts of Human Interaction

Language cannot be studied in isolation from the investigation of "rationality." It cannot afford to neglect our everyday assumptions concerning the total behavior of a reasonable person. . . . An integrational linguistics must recognize that human beings inhabit a communicational space which is not neatly compartmentalized into language and non-language. . . . It renounces in advance the possibility of setting up systems of forms and meanings which will "account for" a central core of linguistic behavior irrespective of the situation and communicational purposes involved. (Harris, 1981, p. 165)

LANGUAGE
The Genetic Blueprints of Language

By innate [linguistic knowledge], Chomsky simply means "genetically programmed." He does not literally think that children are born with language in their heads ready to be spoken. He merely claims that a "blueprint is there, which is brought into use when the child reaches a certain point in her general development. With the help of this blueprint, she analyzes the language she hears around her more readily than she would if she were totally unprepared for the strange gabbling sounds which emerge from human mouths. (Aitchison, 1987, p. 31)

LANGUAGE
Languages Are Machines

Looking at ourselves from the computer viewpoint, we cannot avoid seeing that natural language is our most important "programming language." This means that a vast portion of our knowledge and activity

is, for us, best communicated and understood in our natural language. . . . One could say that natural language was our first great original artifact and, since, as we increasingly realize, languages are machines, so natural language, with our brains to run it, was our primal invention of the universal computer. One could say this except for the sneaking suspicion that language isn't something we invented but something we became, not something we constructed but something in which we created, and recreated, ourselves. (Leiber, 1991, p. 8)

LEADING QUESTION

The Attributes of a Leading Question in Law

["Leading questions" are those] which suggest to the witness the answer desired, or which embody a material fact, and may be answered by a mere negative or affirmative, or which involve an answer bearing immediately upon the merits of the case, and indicating to the witness a representation which will best accord with the interests of the party propounding them. (Black, 1951, p. 1034)

LEARNING

Identical Elements

One mental function or activity improves others in so far as and because they are in part identical with it, because it contains elements common to them. Addition improves multiplication because multiplication is largely addition; knowledge of Latin gives increased ability to learn French because many of the facts learned in the one case are needed in the other. (Thorndike, 1906, p. 243)

LEARNING

The Law of Effect and the Law of Exercise

The Law of Effect is that: Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened, so that, when it recurs, they will be less likely to recur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond.

The Law of Exercise is that: Any response to a situation will, other things being equal, be more strongly connected with the situation in proportion to the number of times it has been connected with that situation and to the average vigor and duration of the connections. (E. L. Thorndike, 1970, p. 244)

LEARNING

Associationism Is Not the Only Kind of Learning

The main objection to the prevailing [associationist] theory, which makes one kind of connection the basis of all learning, is not that it may be incorrect but that in the course of psychological research it has prevented an unbiased study of other kinds of learning. (Katona, 1940, pp. 4–5)

LEARNING

The Classical Boundaries between the Various Kinds of Learning Will Disappear

I believe that learning by examples, learning by being told, learning by imitation, learning by reinforcement and other forms are much like one another. In the literature on learning there is frequently an unstated assumption that these various forms are fundamentally different. But I think the classical boundaries between the various kinds of learning will disappear once superficially different kinds of learning are understood in terms of processes that construct and manipulate descriptions. (Winston, 1975, p. 185)

LIST

The List Is a Very Simple But a Very Useful Structure

The list relies on discontinuity rather than continuity; it depends on physical placement, on location; it can be read in different directions, both sideways and downwards, up and down, as well as left and right; it has a clear-cut beginning and a precise end, that is, a boundary, an edge, like a piece of cloth. Most importantly it encourages the ordering of the items, by number, by initial sound, by category, etc. And the existence of boundaries, external and internal, brings greater visibility to categories, at the same time as making them more abstract. (Goody, 1977, p. 81)

LOGIC

The Science of Logic Finds Ordinary Language to Be an Obstacle

My initial step . . . was to attempt to reduce the concept of ordering in a sequence to that of logical consequence, so as to proceed from there to the concept of number. To prevent anything intuitive from penetrating here unnoticed, I had to bend every effort to keep the chain of inference free of gaps. In attempting to comply with this requirement in the strictest possible way, I found the inadequacy of language to be an obstacle. (Frege, 1972, p. 104)

LOGIC

Logic Is a Microscope

I believe I can make the relation of my 'conceptual notation' to ordinary language clearest if I compare it to the relation of the microscope to the eye. The latter, because of the range of its applicability and because of the ease with which it can adapt itself to the most varied circumstances, has a great superiority over the microscope. Of course, viewed as an optical instrument it reveals many imperfections, which usually remain unnoticed only because of its intimate connection with mental life. But as soon as scientific purposes place strong requirements upon sharpness of resolution, the eye proves to be inadequate. . . . Similarly, this 'conceptual notation' is devised for particular scientific purposes; and therefore one may not condemn it because it is useless for other purposes. (Frege, 1972, pp. 104–105)

LOGIC

Logic Carries on an Unceasing Struggle with Psychology

To sum up briefly, it is the business of the logician to conduct an unceasing struggle against psychology and those parts of language and grammar which fail to give untrammeled expression to what is logical. He does not have to answer the question: How does thinking normally take place in human beings? What course does it naturally follow in the human mind? What is natural to one person may well be unnatural to another. (Frege, 1979, pp. 6–7)

LOGIC

Logic Should Replace the Ordinary Language of Everyday Discourse

We are very dependent on external aids in our thinking, and there is no doubt that the language of everyday life—so far, at least, as a certain area of discourse is concerned—had first to be replaced by a more sophisticated instrument, before certain distinctions could be noticed. But so far the academic world has, for the most part, disdained to master this instrument. (Frege, 1979, pp. 6–7)

LOGIC

Logic Is Unnatural

There is no reproach the logician need fear less than the reproach that his way of formulating things is unnatural. . . . If we were to heed those

who object that logic is unnatural, we would run the risk of becoming embroiled in interminable disputes about what is natural, disputes which are quite incapable of being resolved within the province of logic. (Frege, 1979, p. 128)

LOGIC

The Significance of "Baby Logic" for Linguistics

[L]inguists will be forced, internally as it were, to come to grips with the results of modern logic. Indeed, this is apparently already happening to some extent. By "logic" is not meant here recursive function–theory, California model–theory, constructive proof–theory, or even axiomatic set–theory. Such areas may or may not be useful for linguistics. Rather under "logic" are included our good old friends, the homely locutions "and," "or," "if-then," "if and only if," "not," "for all x," "for some x," and "is identical with," plus the calculus of individuals, event-logic, syntax, denotational semantics, and . . . various parts of pragmatics. . . . It is to these that the linguist can most profitably turn for help. These are his tools. And they are "clean tools," to borrow a phrase of the late J. L. Austin in another context, in fact, the only really clean ones we have, so that we might as well use them as much as we can. But they constitute only what may be called "baby logic." Baby logic is to the linguist what "baby mathematics" (in the phrase of Murray Gell-Mann) is to the theoretical physicist—very elementary but indispensable domains of theory in both cases. (Martin, 1969, pp. 261–262)

LOGIC

The Existence of a Mental Logic Denied

There appears to be no branch of deductive inference that requires us to assume the existence of a mental logic in order to do justice to the psychological phenomena. To be logical, an individual requires, not formal

rules of inference, but a tacit knowledge of the fundamental semantic principle governing any inference; a deduction is valid provided that there is no way of interpreting the premises correctly that is inconsistent with the conclusion. Logic provides a systematic method for searching for such counter-examples. The empirical evidence suggests that ordinary individuals possess no such methods. (Johnson-Laird, quoted in Mehler, Walker & Garrett, 1982, p. 130)

LOGIC

The Fundamental Paradox of Logic

The fundamental paradox of logic [that "there is no class (as a totality) of those classes which, each taken as a totality, do not belong to themselves" (Russell to Frege, 16 June 1902, in van Heijenoort, 1967, p. 125)] is with us still, bequeathed by Russell—by way of philosophy, mathematics, and even computer science—to the whole of twentieth-century thought. Twentieth-century philosophy would begin not with a foundation for logic, as Russell had hoped in 1900, but with the discovery in 1901 that no such foundation can be laid. (Everdell, 1997, p. 184)

LOGICAL CONSISTENCY

The Relevance of Logical Consistency to Actuality

Indeed, the more rigidly rigorous the pursuit of logical consistency, the more obscure becomes its relevance to actuality. For a high degree of consistency is obtainable only in those areas of knowledge which, like mathematics, approach a high degree of abstraction. But here pure logical consistency is what Whitehead calls "an easy intellectual consistency," i.e. questions about the relevance to actuality, which is where the real difficulties lie, are simply ignored. (Code, 1985)

LOGICAL EMPIRICISM

The Value of Modern Analytical Empiricism

Modern analytical empiricism . . . differs from that of Locke, Berkeley, and Hume by its incorporation of mathematics and its development of a powerful logical technique. It is thus able, in regard to certain problems, to achieve definite answers, which have the quality of science rather than of philosophy. It has the advantage, as compared with the philosophies of the system-builders, of being able to tackle its problems one at a time, instead of having to invent at one stroke a block theory of the whole universe. Its methods, in this respect, resemble those of science. I have no doubt that, in so far as philosophical knowledge is possible, it is by such methods that it must be sought: I also have no doubt that, by these methods, many ancient problems are completely soluble. . . . Take such questions as: What is number? What are space and time? What is mind, and what is matter? I do not say that we can here and now give definitive answers to all these ancient questions, but I do say that a method has been discovered by which, as in science, we can make successive approximations to the truth, in which each new stage results from an improvement, not a rejection, of what has gone before. (Russell, 1961, pp. 788–789)

LOGICAL EMPIRICISM

The Grand Theses of Logical Empiricism Have Not Turned out to Be Correct

Not a single one of the great theses of Logical Empiricism (that Meaning is Method of Verification; that metaphysical propositions are literally without sense; that Mathematics is True by Convention) has turned out to be correct. It detracts from the excitement of the fact that, by turning

philosophical theses into linguistic ones [as Carnap had tried to do] . . . one can make philosophy more scientific and settle the truth value of philosophical propositions by hard scientific research, if the results one obtains are uniformly *negative*. (Putnam, 1975, p. 20)

LOGICAL POSITIVISM

The Question of the Validity and Justification of Metaphysics

There have been many *opponents of metaphysics* from the Greek sceptics to the empiricists of the nineteenth century. Criticisms of very diverse kinds have been set forth. Many have declared that the doctrine of metaphysics is *false*, since it contradicts our empirical knowledge. Others have believed it to be *uncertain*, on the ground that its problems transcend the limits of human knowledge. Many anti-metaphysicians have declared that occupation with metaphysical questions is *sterile*. Whether or not these questions can be answered, it is at any rate unnecessary to worry about them; let us devote ourselves entirely to the practical tasks which confront active men every day of their lives!

The development of *modern logic* has made it possible to give a new and sharper answer to the question of the validity and justification of metaphysics. The researchers of applied logic or the theory of knowledge, which aim at clarifying the cognitive content of scientific statements and thereby the meanings of the terms that occur in the statements, by means of logical analysis, lead to a positive and to a negative result. The positive result is worked out in the domain of empirical science; the various concepts of the various branches of science are clarified; their formal, logical and epistemological connections are made explicit.

In the domain of *metaphysics*, including all philosophy of value and normative theory, logical analysis yields the negative result *that the alleged statements in this domain are entirely meaningless*. Therewith a radical elimination of metaphysics is attained, which was not yet possible from the earlier anti-metaphysical standpoints. (Carnap, 1959, p. 60)

M

MACHINE

An Infallible Machine Cannot Also Be Intelligent

In other words then, if a machine is expected to be infallible, it cannot also be intelligent. There are several theorems which say almost exactly that. But these theorems say nothing about how much intelligence may be displayed if a machine makes no pretence at infallibility. (Turing, 1946, p. 124)

MACHINES

The Desire for the Creation of Machines

[T]he human desire to escape the flesh, which took one form in asceticism, might take another form in the creation of machines. Thus, the wish to rise above the bestial body manifested itself not only in angels but in mechanical creatures. (Mazlish, 1993, p. 218)

MATHEMATICAL DISCOVERY

Mathematical Discovery Consists of the Discernment and Selection of Useful Combinations

What, in fact, is mathematical discovery? It does not consist in making new combinations with mathematical entities that are already known. That can be done by anyone, and the combinations that could be so formed would be infinite in number, and the greater part of them would be absolutely devoid of interest. Discovery consists precisely in not constructing useless combinations, but in constructing those that are useful, which are an infinitely small minority. Discovery is discernment, selection. (Poincaré, 1952, pp. 50–51)

MATHEMATICS

The World of Mathematics Is Really a Beautiful World

The world of mathematics, which you contemn, is really a beautiful world; it has nothing to do with life and death and human sordidness, but is eternal, cold and passionless. To me pure mathematics is one of the highest forms of art; it has a sublimity quite special to itself, and an immense dignity derived from the fact that its world is exempt from change and time. I am quite serious in this. . . . [M]athematics is the only thing we know of that is capable of perfection; in thinking about it we become Gods. (Russell [to Helen Thomas, 30 December 1901], 1992, Letter No. 98, p. 224)

MATHEMATICS

Why Mathematics Works

One of the deepest problems of nature is the success of mathematics as a language for describing and discovering features of physical reality. In short, why does mathematics work? . . .

We humans have stripped back the clouds that cloak our understanding of our cosmic beginning and our current persistence to the stage that exposes the mathematical structure of the world more clearly than it has ever been observed before. . . . Furthermore, the attention of seriously equipped thinkers, those thinkers we call scientists, is at last beginning to turn to that other great conundrum of being: consciousness. . . . If we can understand why that supreme construct of the human intellect, that archdisembodiment of intellect, mathematics, works as a description of the world, then maybe we shall have an insight into cognition. . . .

The name *deep structuralism* is intended to convey the idea that the physical world has the same logical structure as mathematics. By implication, the reason why mathematics works as a description of physical reality is that they share the same logical structure.

. . . By *weak deep structuralism* I shall mean that mathematics and physical reality merely share the same logical structure and mathematics is a mirror that can be held up to nature. By *strong deep structuralism* I shall mean that mathematics and physical reality do not merely share the same logical structure but are actually the same. In other words, according to the hypothesis of strong deep structuralism, physical reality is mathematics and mathematics is physical reality. . . . The reason why we may be conscious of the world, including the inner, introspective world of emotion and intellect, may be that our brains are material portrayals of the same deep structure. That may also be the reason why brains can generate the mathematics that we need to comprehend the world. (Atkins, 1992, pp. 99–101, 109–111)

MEMORY

A Unitary Search Process for All the Phenomena of Memory

To what extent can we lump together what goes on when you try to recall: (1) your name; (2) how you kick a football; and (3) the present location of your car keys? If we use introspective evidence as a guide, the first seems an immediate automatic response. The second may require constructive internal replay prior to our being able to produce a verbal description. The third . . . quite likely involves complex operational responses under the control of some general strategy system. Is any unitary search process, with a single set of characteristics and input-output relations, likely to cover all these cases? (Reitman, 1970, p. 485)

MEMORY

Semantic Memory Is a Mental Thesaurus

[Semantic memory] Is a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meanings and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations. Semantic memory does not register perceptible properties of inputs, but rather cognitive referents of input signals. (Tulving, 1972, p. 386)

MEMORY

The Development of Mnemonic Codes

The mnemonic code, far from being fixed and unchangeable, is structured and restructured along with general development. Such a restructuring of the code takes place in close dependence on the schemes of

intelligence. The clearest indication of this is the observation of different types of memory organisation in accordance with the age level of a child so that a longer interval of retention without any new presentation, far from causing a deterioration of memory, may actually improve it. (Piaget & Inhelder, 1973, p. 36)

MEMORY

The Logic of Some Memory Theorization Is of Dubious Worth in the History of Psychology

If a cue was effective in memory retrieval, then one could infer it was encoded; if a cue was not effective, then it was not encoded. The logic of this theorization is "heads I win, tails you lose" and is of dubious worth in the history of psychology. We might ask how long scientists will puzzle over questions with no answers. (Solso, 1974, p. 28)

MEMORY

The Constituent Elements of Memory Theory

We have iconic, echoic, active, working, acoustic, articulatory, primary, secondary, episodic, semantic, short-term, intermediate-term, and long-term memories, and these memories contain tags, traces, images, attributes, markers, concepts, cognitive maps, natural-language mediators, kernel sentences, relational rules, nodes, associations, propositions, higher-order memory units, and features. (Eysenck, 1977, p. 4)

MEMORY
The Problem with the Memory Metaphor

The problem with the memory metaphor is that storage and retrieval of traces only deals [*sic*] with old, previously articulated information. Memory traces can perhaps provide a basis for dealing with the "sameness" of the present experience with previous experiences, but the memory metaphor has no mechanisms for dealing with novel information. (Bransford, McCarrell, Franks & Nitsch, 1977, p. 434)

MEMORY
The Results of a Hundred Years of the Psychological Study of Memory Are Somewhat Discouraging

The results of a hundred years of the psychological study of memory are somewhat discouraging. We have established firm empirical generalisations, but most of them are so obvious that every ten-year-old knows them anyway. We have made discoveries, but they are only marginally about memory; in many cases we don't know what to do with them, and wear them out with endless experimental variations. We have an intellectually impressive group of theories, but history offers little confidence that they will provide any meaningful insight into natural behavior. (Neisser, 1978, pp. 12–13)

MEMORY
The Structure and Function of a Schema in Memory

A schema, then is a data structure for representing the generic concepts stored in memory. There are schemata representing our knowledge

about all concepts; those underlying objects, situations, events, sequences of events, actions and sequences of actions. A schema contains, as part of its specification, the network of interrelations that is believed to normally hold among the constituents of the concept in question. A schema theory embodies a *prototype* theory of meaning. That is, inasmuch as a schema underlying a concept stored in memory corresponds to the *meaning* of that concept, meanings are encoded in terms of the typical or normal situations or events that instantiate that concept. (Rumelhart, 1980, p. 34)

MEMORY

Competence and Performance in Theories of Memory

Memory appears to be constrained by a structure, a "syntax," perhaps at quite a low level, but it is free to be variable, deviant, even erratic at a higher level. . . .

Like the information system of language, memory can be explained in part by the abstract rules which underlie it, but only in part. The rules provide a basic competence, but they do not fully determine performance. (Campbell, 1982, pp. 228, 229)

MEMORY

Metaphors of Memory

When people think about the mind, they often liken it to a physical space, with memories and ideas as objects contained within that space. Thus, we speak of ideas being in the dark corners or dim recesses of our minds, and of holding ideas in mind. Ideas may be in the front or back of our minds, or they may be difficult to grasp. With respect to the processes involved in memory, we talk about storing memories, of

searching or looking for lost memories, and sometimes of finding them. An examination of common parlance, therefore, suggests that there is general adherence to what might be called the spatial metaphor. The basic assumptions of this metaphor are that memories are treated as objects stored in specific locations within the mind, and the retrieval process involves a search through the mind in order to find specific memories. . . .

However, while the spatial metaphor has shown extraordinary longevity, there have been some interesting changes over time in the precise form of analogy used. In particular, technological advances have influenced theoretical conceptualisations. . . . The original Greek analogies were based on wax tablets and aviaries; these were superseded by analogies involving switchboards, gramophones, tape recorders, libraries, conveyor belts, and underground maps. Most recently, the workings of human memory have been compared to computer functioning . . . and it has been suggested that the various memory stores found in computers have their counterparts in the human memory system. (Eysenck, 1984, pp. 79–80)

MEMORY

Comparison of Primary Memory and Secondary Memory

Primary memory [as proposed by William James] relates to information that remains in consciousness after it has been perceived, and thus forms part of the psychological present, whereas secondary memory contains information about events that have left consciousness, and are therefore part of the psychological past. (Eysenck, 1984, p. 86)

MEMORY

Semantic Memory and Episodic Memory

Once psychologists began to study long-term memory per se, they realized it may be divided into two main categories. . . . Semantic memories have to do with our general knowledge about the working of the

world. We know what cars do, what stoves do, what the laws of gravity are, and so on. Episodic memories are largely events that took place at a time and place in our personal history. Remembering specific events about our own actions, about our family, and about our individual past falls into this category. With amnesia or in aging, what dims . . . is our personal episodic memories, save for those that are especially dear or painful to us. Our knowledge of how the world works remains pretty much intact. (Gazzaniga, 1988, p. 42)

MEMORY

The Relation of Memory to Thinking

The nature of *memory* . . . provides a natural starting point for an analysis of thinking. Memory is the repository of many of the beliefs and representations that enter into thinking, and the retrievability of these representations can limit the quality of our thought. (Smith, 1990, p. 1)

MENTAL MODELS

Mental Models Can Take Many Forms and Serve Many Purposes

Since mental models can take many forms and serve many purposes, their contents are very varied. They can contain nothing but tokens that represent individuals and identities between them, as in the sorts of models that are required for syllogistic reasoning. They can represent spatial relations between entities, and the temporal or causal relations between events. A rich imaginary model of the world can be used to compute the projective relations required for an image. Models have a content and form that fits them to their purpose, whether it be to explain, to predict, or to control. (Johnson-Laird, 1983, p. 410)

MIND
To Know the Different Operations of the Mind

It becomes, therefore, no inconsiderable part of science . . . to know the different operations of the mind, to separate them from each other, to class them under their proper heads, and to correct all that seeming disorder in which they lie involved when made the object of reflection and inquiry. . . . It cannot be doubted that the mind is endowed with several powers and faculties, that these powers are distinct from one another, and that what is really distinct to the immediate perception may be distinguished by reflection and, consequently, that there is a truth and falsehood which lie not beyond the compass of human understanding. (Hume, 1955, p. 22)

MIND
The Mind Is Furnished by Experience

Let us then suppose the mind to be, as we say, white Paper, void of all Characters, without any *Ideas*: How comes it to be furnished? Whence comes it by that vast store, which the busy and boundless Fancy of Man has painted on it, with an almost endless variety? Whence has it all the materials of Reason and Knowledge? To this I answer, in one word, from *Experience*. (Locke, quoted in Herrnstein & Boring, 1965, p. 584)

MIND
Mythical Thought Is as Rigorous as That of Modern Science

The kind of logic in mythical thought is as rigorous as that of modern science, and . . . the difference lies, not in the quality of the intellectual

process, but in the nature of things to which it is applied. . . . Man has always been thinking equally well; the improvement lies, not in an alleged progress of man's mind, but in the discovery of new areas to which it may apply its unchanged and unchanging powers. (Lévi-Strauss, 1963, p. 230)

MIND

The Mind Has Nothing But Itself to Know Itself

MIND. A mysterious form of matter secreted by the brain. Its chief activity consists in the endeavor to ascertain its own nature, the futility of the attempt being due to the fact that it has nothing but itself to know itself with. (Bierce, quoted in Minsky, 1986, p. 55)

MIND

To Know Is to Represent Accurately

[Philosophy] understands the foundations of knowledge and it finds these foundations in a study of man-as-knower, of the "mental processes" or the "activity of representation" which make knowledge possible. To know is to represent accurately what is outside the mind, so to understand the possibility and nature of knowledge is to understand the way in which the mind is able to construct such representation. . . . We owe the notion of a "theory of knowledge" based on an understanding of "mental processes" to the seventeenth century, and especially to Locke. We owe the notion of "the mind" as a separate entity in which "processes" occur to the same period, and especially to Descartes. We owe the notion of philosophy as a tribunal of pure reason, upholding or

denying the claims of the rest of culture, to the eighteenth century and especially to Kant, but this Kantian notion presupposed general assent to Lockean notions of mental processes and Cartesian notions of mental substance. (Rorty, 1979, pp. 3–4)

MIND

The Question of Mind in Relation to Machine

Under pressure from the computer, the question of mind in relation to machine is becoming a central cultural preoccupation. It is becoming for us what sex was to Victorians—threat, obsession, taboo, and fascination. (Turkle, 1984, p. 313)

MIND

Understanding the Mind Remains as Resistant to Neurological as to Cognitive Analyses

Recent years have been exciting for researchers in the brain and cognitive sciences. Both fields have flourished, each spurred on by methodological and conceptual developments, and although understanding the mechanisms of mind is an objective shared by many workers in these areas, their theories and approaches to the problem are vastly different. . . .

Early experimental psychologists, such as Wundt and James, were as interested in and knowledgeable about the anatomy and physiology of the nervous system as about the young science of the mind. However, the experimental study of mental processes was short-lived, being eclipsed by the rise of behaviorism early in this century. It was not until the late 1950s that the signs of a new mentalism first appeared in scat-

tered writings of linguists, philosophers, computer enthusiasts, and psychologists.

In this new incarnation, the science of mind had a specific mission: to challenge and replace behaviorism. In the meantime, brain science had in many ways become allied with a behaviorist approach. . . . While behaviorism sought to reduce the mind to statements about bodily action, brain science seeks to explain the mind in terms of physiochemical events occurring in the nervous system. These approaches contrast with contemporary cognitive science, which tries to understand the mind as it is, without any reduction, a view sometimes described as functionalism.

The cognitive revolution is now in place. Cognition is *the* subject of contemporary psychology. This was achieved with little or no talk of neurons, action potentials, and neurotransmitters. Similarly, neuroscience has risen to an esteemed position among the biological sciences without much talk of cognitive processes. Do the fields need each other? . . . [Y]es because the problem of understanding the mind, unlike the would-be problem solvers, respects no disciplinary boundaries. It remains as resistant to neurological as to cognitive analyses. (LeDoux & Hirst, 1986, pp. 1–2)

MIND

Approaches to the Study of the Mind

Since the Second World War scientists from different disciplines have turned to the study of the human mind. Computer scientists have tried to emulate its capacity for visual perception. Linguists have struggled with the puzzle of how children acquire language. Ethologists have sought the innate roots of social behaviour. Neurophysiologists have begun to relate the function of nerve cells to complex perceptual and motor processes. Neurologists and neuropsychologists have used the pattern of competence and incompetence of their brain-damaged patients to elucidate the normal workings of the brain. Anthropologists have examined the conceptual structure of cultural practices to advance hypotheses about the basic principles of the mind. These days one meets engineers who work on speech perception, biologists who investigate the mental

representation of spatial relations, and physicists who want to understand consciousness. And, of course, psychologists continue to study perception, memory, thought and action.

. . . [W]orkers in many disciplines have converged on a number of central problems and explanatory ideas. They have realized that no single approach is likely to unravel the workings of the mind: it will not give up its secrets to psychology alone; nor is any other isolated discipline—artificial intelligence, linguistics, anthropology, neurophysiology, philosophy—going to have any greater success. (Johnson-Laird, 1988, p. 7)

MIND-BODY PROBLEM

The Mind Is Entirely Distinct from Body

From this I knew that I was a substance the whole essence or nature of which is to think, and that for its existence there is no need of any place, nor does it depend on any material thing; so that this "me," that is to say, the soul by which I am what I am, is entirely distinct from body, and is even more easy to know than is the latter; and even if body were not, the soul would not cease to be what it is. (Descartes, 1970a, p. 101)

MIND-BODY PROBLEM

Critique of the Cartesian View

[It] still remains to be explained how that union and apparent intermingling [of mind and body] . . . can be found in you, if you are incorporeal, unextended and indivisible. . . . How, at least, can you be united with the brain, or some minute part in it, which (as has been said) must yet have

some magnitude or extension, however small it be? If you are wholly without parts how can you mix or appear to mix with its minute subdivisions? For there is no mixture unless each of the things to be mixed has parts that can mix with one another. (Gassendi, 1970, p. 201)

MIND-BODY PROBLEM

The Union That Exists between the Body and the Mind

[T]here are . . . certain things which we experience in ourselves and which should be attributed neither to the mind nor body alone, but to the close and intimate union that exists between the body and the mind. . . . Such are the appetites of hunger, thirst, etc., and also the emotions or passions of the mind which do not subsist in mind or thought alone . . . and finally all the sensations. (Descartes, 1970b, p. 238)

MIND-BODY PROBLEM

Psychology Is Not the Study of Disembodied Minds

With any other sort of mind, absolute Intelligence, Mind unattached to a particular body, or Mind not subject to the course of time, the psychologist as such has nothing to do. (James, 1890, p. 183)

MIND-BODY PROBLEM

Each Mental Event Can Be Reduced to a Neural Event

[The] intention is to furnish a psychology that shall be a natural science: that is to represent psychical processes as quantitatively determinate states of specifiable material particles, thus making these processes perspicuous and free from contradiction. (Freud, 1966, p. 295)

MIND-BODY PROBLEM

The Thesis Is That the Mental Is Nomologically Irreducible

The thesis is that the mental is nomologically irreducible: there may be true general statements relating the mental and the physical, statements that have the logical form of a law; but they are not *lawlike* (in a strong sense to be described). If by absurdly remote chance we were to stumble on a non-stochastic true psychophysical generalization, we would have no reason to believe it more than roughly true. (Davidson, 1970, p. 90)

MIND-BODY PROBLEM

The Doctrine That Men Are Machines

We can divide those who uphold the doctrine that men are machines, or a similar doctrine, into two categories: those who deny the existence of mental events, or personal experiences, or of consciousness; . . . and those who admit the existence of mental events, but assert that they are "epiphenomena"—that everything can be explained without them, since the material world is causally closed. (Popper & Eccles, 1977, p. 5)

MIND-BODY PROBLEM

Brain-Mind Interaction

Mind affects brain and brain affects mind. That is the message, and by accepting it you commit yourself to a special view of the world. It is a view that shows the limits of the genetic imperative on what we turn out to be, both intellectually and emotionally. It decrees that, while the secrets of our genes express themselves with force throughout our lives, the effect of that information on our bodies can be influenced by our psychological history and beliefs about the world. And, just as important, the other side of the same coin argues that what we construct in our minds as objective reality may simply be our interpretations of certain bodily states dictated by our genes and expressed through our physical brains and body. Put differently, various attributes of mind that seem to have a purely psychological origin are frequently a product of the brain's interpreter rationalizing genetically driven body states. Make no mistake about it: this two-sided view of mind-brain interactions, if adopted, has implications for the management of one's personal life. (Gazzaniga, 1988, p. 229)

MINDFULNESS

The Qualities of a Mindful State of Being

[T]he key qualities of a mindful state of being [are]: (1) creation of new categories; (2) openness to new information; and (3) awareness of more than one perspective. (E. J. Langer, 1989, p. 62)

MINDFULNESS

Most Situations Can Become Subject to Control If Viewed Mindfully

Even the most apparently fixed and certain situations can become subject to control if viewed mindfully. The Birdman of Alcatraz was sentenced to life in prison with no hope of reprieve. All the world was cut off from him; one empty, grim day followed the next, as he stared at the flocks of birds flying outside his window. One morning, a crippled sparrow happened into his cell, and he nursed it back to health. The bird was no longer just a bird; for him it was a particular sparrow. Other prisoners, guards, visitors started giving him birds and he learned more and more about them. Soon he had a veritable aviary in his cell. He became a distinguished authority on bird diseases, noticing more and more about these creatures and developing more and more expertise. Everything he did was self-taught and original.

Instead of living a dull, stale existence in a cell for forty-odd years, the Birdman of Alcatraz found that boredom can be just another construct of the mind, no more certain than freedom. There is always something new to notice. And he turned what might have been an absolute hell into, at the least, a fascinating, mindful purgatory. (E. J. Langer, 1989, p. 74)

MODELING OF THEORY

Mathematical Modeling Can Result in the Neglect of Basic Clinical Problems

Iatromathematical enthusiasts could make substantial contributions to clinical medicine if the efforts now being expended on Bayesian and decision-analytic fantasies were directed to the major challenges of algorithmically dissecting clinical judgement, based on the way the judgements are actually performed. Instead, however, the enthusiasts

usually become infatuated with the mathematical processes and with the associated potential for computer manipulations, so that the basic clinical challenges become neglected or evaded. (Feinstein, quoted in Hand, 1985, p. 213)

MODERNISM

Modernism Begins with the Theory of Numbers

Gottlob Frege, Georg Cantor, and Richard Dedekind were pure mathematicians who built no machines; but they did provide a means, laying the foundations of a new way of thinking in the West. If there is any utility to Modernism, Dedekind did something profoundly useful. The great event . . . came in the year he wrote his first letter to a fellow mathematician named Georg Cantor, and soon after published a mathematical definition of irrational numbers now known as the "Dedekind Cut." Separating forever the digital from the continuous, at least in arithmetic, Dedekind became the West's first Modernist in 1872. Everyone who has heard of Modernism has heard of Picasso. Most have heard of Joyce. But who has heard of Dedekind? Only mathematicians, the least likely-looking of those who aspire to change the world by using their minds. The public doesn't know what mathematicians are doing, and mathematicians are just as happy it doesn't, for they are as genuinely unworldly as artists claim to be. . . . Mathematicians did not invent. Instead, they insisted, they discovered things as Plato had—searching in a complicated alternate universe for elegant and beautiful relationships among objects that could not be said to exist outside the mind.

Without their knowledge, however, the mathematicians of 1870s Germany were about to change the world. As a clutch of Victorian professors, avuncular, ascetic, . . . they were gathering unawares around the cradle of an infant Briar Rose that would one day be christened Modernism. (Everdell, 1997, pp. 30–31)

MUSIC

The Compulsion to Renewed Creativity in the Serious Musical Composer

The serious composer who thinks about his art will sooner or later have occasion to ask himself: why is it so important to my own psyche that I compose music? What makes it seem so absolutely necessary, so that every other daily activity, by comparison, is of lesser significance? And why is the creative impulse never satisfied; why must one always begin anew? To the first question—the need to create—the answer is always the same—self-expression; the basic need to make evident one's deepest feelings about life. But why is the job never done? Why must one always begin again? The reason for the compulsion to renewed creativity, it seems to me, is that each added work brings with it an element of self-discovery. I must create in order to know myself, and since self-knowledge is a never-ending search, each new work is only a part-answer to the question "Who am I?" and brings with it the need to go on to other and different part-answers. (Copland, 1952, pp. 40–41)

MUSIC

The Relation of Music to Conscious and Unconscious Thought

When collaboration occurs, when, for a while, the lines of conscious and unconscious thought run along the same track, we achieve the feeling of wholeness and satisfaction which is characteristic of our response to great art and other transcendent states of mind. The patterns of music, translated, analyzed, shorn of detail, are able to stimulate the patterns of emotions on many levels simultaneously, thus bringing various hierarchical states of consciousness and unconsciousness into harmony with

one another during the existence of the music for us, whether this is in a performance or purely in the memory. As this happens we experience the sense of unity which arises from the cessation of conflict between conscious and unconscious. (McLaughlin, 1970, pp. 104–105)

MYTH

The Contrast between Myth and Reality

The contrast between myth and reality has been a major philosophical concern since the time of the Pre-Socratics. Myth is a many-faceted personal and cultural phenomenon created to provide a reality and a unity to what is transitory and fragmented in the world that we experience. . . . Myth provides us with absolutes in the place of ephemeral values and a comforting perception of the world that is necessary to make the insecurity and terror of existence bearable.

It is disturbing to realize that our faith in absolutes and actual truth can be easily shattered. "Facts" change in all the sciences; textbooks in chemistry, physics, and medicine are sadly (or happily, for progress) soon out of date. It is embarrassingly banal but fundamentally important to reiterate the platitude that myth, like art, is truth on a quite different plane from that of prosaic and transitory factual knowledge. Yet myth and factual truth need not be mutually exclusive, as some so emphatically insist. A story embodying eternal values may contain what was imagined, at any one period, to be scientifically correct in every factual detail; and the accuracy of that information may be a vital component of its mythical raison d'être. Indeed one can create a myth out of a factual story, as a great historian must do: any interpretation of the facts, no matter how credible, will inevitably be a mythic invention. On the other hand, a different kind of artist may create a nonhistorical myth for the ages, and whether it is factually accurate or not may be quite beside the point.

Myth in a sense is the highest reality; and the thoughtless dismissal of myth as untruth, fiction, or a lie is the most barren and misleading definition of all. (Morford & Lenardon, 1995, p. 4)

MYTHICAL THINKING

Mythical Thinking Is Not Rational Analysis but Rather the Captivating of Consciousness

Mythical thinking . . . does not dispose freely over the data of intuition, in order to relate and compare them to each other, but is captivated and enthralled by the intuition which suddenly confronts it. It comes to rest in the immediate experience; the sensible present is so great that everything else dwindles before it. For a person whose apprehension is under the spell of this . . . attitude, it is as though the whole world were simply annihilated; the immediate content, whatever it be, commands his . . . interest so completely that nothing else can exist beside and apart from it. The ego is spending all its energy in this single object, lives in it, loses itself in it. (Cassirer, 1946, pp. 32–33)

N

NATURE

Modern Science Focuses Not on Nature Itself, But on Abstract Representations of Nature

To Newtonians, each question had its singular answer, one that would remain the same no matter who asked it, or why. But now, the uncertainty that undercuts every measurement of some fact in the real world compels the observer to choose which question to ask, which aspect of a phenomenon to study.

The necessity of choice became overwhelmingly apparent when Heisenberg elevated uncertainty to a principle in quantum mechanics in 1927, having recognized that on the subatomic level the observer had to emphasize only one of a pair of properties to study at any one time. In one of the prominent interpretations of quantum mechanics, the idea took on a larger meaning: that in choosing what to study, the scientist in effect creates the object of his inquiry. . . . The impossibility of constructing a complete, accurate quantitative description of a complex system forces observers to pick which aspects of the system they most wish to understand. . . .

What one studies from among this wealth of choice depends on what one wants to know; the questions create—or at least determine—the range of possible answers. No such answer can be completely "true": instead of saying "This is what nature is like," they can claim only, "This

is what nature seems like from here"—a vastly diminished claim from that of Newton. The critical issue raised by such subjectivity is how to decide what value each partial answer has, what connection it actually makes between the real world and our understanding of it. The object of study, the focus of much of modern science, has therefore shifted inward, to examine not nature itself but rather to study the abstract representations of nature, the choices made of what to leave in and what to drop out of any given study. (Levenson, 1995, pp. 228–229)

NEURAL NETWORK

The Characteristics of Neural Networks That Make Them So Useful

1. A neural network is composed of a number of very simple processing elements [("neurodes")] that communicate through a rich set of interconnections with variable weights or strengths.

2. Memories are stored or represented in a neural network in the pattern of variable interconnection weights among the neurodes. Information is processed by a spreading, constantly changing pattern of activity distributed across many neurodes.

3. A neural network is taught or trained rather than programmed. It is even possible to construct systems capable of independent or autonomous learning. . . .

4. Instead of having a separate memory and controller, plus a stored external program that dictates the operation of the system as in a digital computer, the operation of a neural network is implicitly controlled by three properties: the transfer function of the neurodes, the details of the structure of the connections among the neurodes, and the learning law the system follows.

5. A neural network naturally acts as an associative memory. That is, it inherently associated items it is taught, physically grouping similar items together in its structure. A neural network operated as a memory is content addressable; it can retrieve stored information from incomplete, noisy, or partially incorrect input cues.

6. A neural network is able to generalize; it can learn the character-

istics of a general category of objects based on a series of specific examples from that category.

7. A neural network keeps working even after a significant fraction of its neurodes and interconnections have become defective.

8. A neural network innately acts as a processor for time-dependent spatial patterns, or spatiotemporal patterns. (Caudill & Butler, 1990, pp. 7–8)

P

PERCEPTION

The Nature of Perception

Perception is the immediate discriminatory response of the organism to energy-activating sense organs. . . . To discriminate is to make a choice reaction in which contextual conditions play a deciding role. (Bartley, 1969, pp. 11–12)

PERCEPTION

The Problem of Recoding Perceptions to Achieve Understanding

[I]t seems (to many) that we cannot account for perception unless we suppose it provides us with an internal image (or model or map) of the external world, and yet what good would that image do us unless we have an inner eye to perceive it, and how are we to explain *its* capacity for perception? It also seems (to many) that understanding a heard sentence must be somehow *translating* it into some internal message, but

how will this message be understood: by translating it into something else? The problem is an old one, and let's call it *Hume's Problem*, for while he did not state it explicitly, he appreciated its force and strove mightily to escape its clutches. (Dennett, 1978a, p. 122)

PERCEPTION

We Sense the Presence of a Stimulus, But We Perceive What It Is

Perception refers to the way in which we interpret the information gathered (and processed) by the senses. In a word, we sense the presence of a stimulus, but we perceive what it is. (Levine & Schefner, 1981, p. 1)

PERCEPTION

Locating the Source of a Perception or an Idea

[W]henever we do try and find the source of . . . a perception or an idea, we find ourselves in an ever-receding fractal, and wherever we choose to delve we find it equally full of details and interdependencies. It is always the perception of a perception of a perception. (Varela, 1984, p. 320)

PERSONAL ESSAY

Modern Existentialism Is Captured in the Personal Essay

The hallmark of the personal essay is its intimacy. The writer seems to be speaking directly into your ear, confiding everything from gossip to

wisdom. Through sharing thoughts, memories, desires, complaints, and whimsies, the personal essayist sets up a relationship with the reader, a dialogue—a friendship, if you will, based on identification, understanding, testiness, and companionship.

At the core of the personal essay is the supposition that there is a certain unity to human experience. As Michel de Montaigne, the great innovator and patron saint of personal essayists, put it, "Every man has within himself the entire human condition." . . .

In the final analysis, the personal essay represents a mode of being. It points a way for the self to function with relative freedom in an uncertain world. Skeptical yet gyroscopically poised, undeceived but finally tolerant of flaws and inconsistencies, this mode of being suits the modern existential situation, which Montaigne first diagnosed. His recognition that human beings were surrounded by darkness, with nothing particularly solid to cling to, led to a philosophical acceptance that one had to make oneself up from moment to moment. (Lopate, 1994, pp. xxiii, xliv)

PHILOSOPHY

There Are Ideas That Have Their Own True and Immutable Nature

And what I believe to be more important here is that I find in myself an infinity of ideas of certain things which cannot be assumed to be pure nothingness, even though they may have perhaps no existence outside of my thought. These things are not figments of my imagination, even though it is within my power to think of them or not to think of them; on the contrary, they have their own true and immutable natures. Thus, for example, when I imagine a triangle, even though there may perhaps be no such figure anywhere in the world outside of my thought, nor ever have been, nevertheless the figure cannot help having a certain determinate nature . . . or essence, which is immutable and eternal, which I have not invented and which does not in any way depend upon my mind. (Descartes, 1951, p. 61)

PHILOSOPHY

Examine What Is within Our Reach

Let us console ourselves for not knowing the possible connections between a spider and the rings of Saturn, and continue to examine what is within our reach. (Voltaire, 1961, p. 144)

PHILOSOPHY

Modern Philosophy Starts with the Cartesian Catastrophe

As modern physics started with the Newtonian revolution, so modern philosophy starts with what one might call the Cartesian Catastrophe. The catastrophe consisted in the splitting up of the world into the realms of matter and mind, *and* the identification of "mind" with conscious thinking. The result of this identification was the shallow rationalism of *l'esprit Cartesien*, and an impoverishment of psychology which it took three centuries to remedy even in part. (Koestler, 1964, p. 148)

PHILOSOPHY

The Rightful Claims of Philosophy

It has been made of late a reproach against natural philosophy that it has struck out on a path of its own, and has separated itself more and more widely from the other sciences which are united by common philological and historical studies. The opposition has, in fact, been long apparent, and seems to me to have grown up mainly under the influence of the Hegelian philosophy, or, at any rate, to have been brought out

into more distinct relief by that philosophy. . . . The sole object of Kant's "Critical Philosophy" was to test the sources and the authority of our knowledge, and to fix a definite scope and standard for the researches of philosophy, as compared with other sciences. . . . [But Hegel's] "Philosophy of Identity" was bolder. It started with the hypothesis that not only spiritual phenomena, but even the actual world—nature, that is, and man—were the result of an act of thought on the part of a creative mind, similar, it was supposed, in kind to the human mind. . . . The philosophers accused the scientific men of narrowness; the scientific men retorted that the philosophers were crazy. And so it came about that men of science began to lay some stress on the banishment of all philosophic influences from their work; while some of them, including men of the greatest acuteness, went so far as to condemn philosophy altogether, not merely as useless, but as mischievous dreaming. Thus, it must be confessed, not only were the illegitimate pretensions of the Hegelian system to subordinate to itself all other studies rejected, but no regard was paid to the rightful claims of philosophy, that is, the criticism of the sources of cognition, and the definition of the functions of the intellect. (Helmholz, quoted in Dampier, 1966, pp. 291–292)

PHILOSOPHY

The Philosophy of Philosophy

Philosophy remains true to its classical tradition by renouncing it. (Habermas, 1972, p. 317)

PHILOSOPHY

Philosophy Is a Field Which Has Certain Central Questions

I have not attempted . . . to put forward any grand view of the nature of philosophy; nor do I have any such grand view to put forth if I would.

It will be obvious that I do not agree with those who see philosophy as the history of "howlers" and progress in philosophy as the debunking of howlers. It will also be obvious that I do not agree with those who see philosophy as the enterprise of putting forward *a priori* truths about the world. . . . I see philosophy as a field which has certain central questions, for example, the relation between thought and reality. . . . It seems obvious that in dealing with these questions philosophers have formulated rival research programs, that they have put forward general hypotheses, and that philosophers within each major research program have modified their hypotheses by trial and error, even if they sometimes refuse to admit that that is what they are doing. To that extent philosophy is a "science." To argue about whether philosophy is a science in any more serious sense seems to me to be hardly a useful occupation. . . . It does not seem to me important to decide whether science is philosophy or philosophy is science as long as one has a conception of both that makes both essential to a responsible view of the world and of man's place in it. (Putnam, 1975, p. xvii)

PHILOSOPHY

The Central Task of Philosophy

What can philosophy contribute to solving the problem of the relation [of] mind to body? Twenty years ago, many English-speaking philosophers would have answered: "Nothing beyond an analysis of the various mental *concepts*." If we seek knowledge of things, they thought, it is to science that we must turn. Philosophy can only cast light upon our concepts of those things.

This retreat from things to concepts was not undertaken lightly. Ever since the seventeenth century, the great intellectual fact of our culture has been the incredible expansion of knowledge both in the natural and in the rational sciences (mathematics, logic).

The success of science created a crisis in philosophy. What was there for philosophy to do? Hume had already perceived the problem in some degree, and so surely did Kant, but it was not until the twentieth century, with the Vienna Circle and with Wittgenstein, that the difficulty began

to weigh heavily. Wittgenstein took the view that philosophy could do no more than strive to undo the intellectual knots it itself had tied, so achieving intellectual release, and even a certain illumination, but no knowledge. A little later, and more optimistically, Ryle saw a positive, if reduced role, for philosophy in mapping the "logical geography" of our concepts: how they stood to each other and how they were to be analyzed. . . .

Since that time, however, philosophers in the "analytic" tradition have swung back from Wittgensteinian and even Rylean pessimism to a more traditional conception of the proper role and tasks of philosophy. Many analytic philosophers now would accept the view that the central task of philosophy is to give an account, or at least play a part in giving an account, of the most general nature of things and of man. (Armstrong, 1990, pp. 37–38)

PHILOSOPHY

Philosophy's Evolving Engagement with Artificial Intelligence and Cognitive Science

In the beginning, the nature of philosophy's engagement with artificial intelligence and cognitive science was clear enough. The new sciences of the mind were to provide the long-awaited vindication of the most potent dreams of naturalism and materialism. Mind would at last be located firmly within the natural order. We would see in detail how the most perplexing features of the mental realm could be supported by the operations of solely physical laws upon solely physical stuff. Mental causation (the power of, e.g., a belief to cause an action) would emerge as just another species of physical causation. Reasoning would be understood as a kind of automated theorem proving. And the key to both was to be the depiction of the brain as the implementation of multiple higher level programs whose task was to manipulate and transform symbols or representations: inner items with one foot in the physical (they were realized as brain states) and one in the mental (they were bearers of contents, and their physical gymnastics were cleverly designed to respect semantic relationships such as truth preservation). (A. Clark, 1996, p. 1)

PHILOSOPHY

The Enduring Value of Philosophy

Socrates of Athens famously declared that "the unexamined life is not worth living," and his motto aptly explains the impulse to philosophize. Taking nothing for granted, philosophy probes and questions the fundamental presuppositions of every area of human inquiry. . . . [P]art of the job of the philosopher is to keep at a certain critical distance from current doctrines, whether in the sciences or the arts, and to examine instead how the various elements in our world-view clash, or fit together. Some philosophers have tried to incorporate the results of these inquiries into a grand synoptic view of the nature of reality and our human relationship to it. Others have mistrusted system-building, and seen their primary role as one of clarifications, or the removal of obstacles along the road to truth. But all have shared the Socratic vision of using the human intellect to challenge comfortable preconceptions, insisting that every aspect of human theory and practice be subjected to continuing critical scrutiny. . . .

Philosophy is, of course, part of a continuing tradition, and there is much to be gained from seeing how that tradition originated and developed. But the principal object of studying the materials in this book is not to pay homage to past genius, but to enrich one's understanding of central problems that are as pressing today as they have always been—problems about knowledge, truth and reality, the nature of the mind, the basis of right action, and the best way to live. These questions help to mark out the territory of philosophy as an academic discipline, but in a wider sense they define the human predicament itself; they will surely continue to be with us for as long as humanity endures. (Cottingham, 1996, pp. xxi–xxii)

PHILOSOPHY

The Distinction between Dionysian Man and Apollonian Man, between Art and Creativity and Reason and Self-Control

In his study of ancient Greek culture, *The Birth of Tragedy*, Nietzsche drew what would become a famous distinction, between the Dionysian spirit, the untamed spirit of art and creativity, and the Apollonian, that of reason and self-control. The story of Greek civilization, and all civilizations, Nietzsche implied, was the gradual victory of Apollonian man, with his desire for control over nature and himself, over Dionysian man, who survives only in myth, poetry, music, and drama. Socrates and Plato had attacked the illusions of art as *unreal*, and had overturned the delicate cultural balance by valuing only man's critical, rational, and controlling consciousness while denigrating his vital life instincts as irrational and base. The result of this division is "Alexandrian man," the civilized and accomplished Greek citizen of the later ancient world, who is "equipped with the greatest forces of knowledge" but in whom the wellsprings of creativity have dried up. (Herman, 1997, pp. 95–96)

PLAN

Planning and Problem Solving

We have a plan when we know, or at least know in outline, which calculations, computations, or constructions we have to perform in order to obtain the unknown. The way from understanding the problem to conceiving a plan may be long and tortuous. In fact, the main achievement in the solution of a problem is to conceive the idea of a plan. This idea may emerge gradually. Or, after apparently unsuccessful trials and a period of hesitation, it may occur suddenly, in a flash, as a "bright idea." (Polya, 1945, p. 8)

PRAGMATISM

The Nature of the Pragmatic Method

Pragmatism According to William James, pragmatism is a method of solving various types of problems, such as "Does God exist?" or "Is man's will free?" by looking at the practical consequences of accepting this or that answer. James says, "The pragmatic method tries to interpret each notion (or theory) by tracing its respective practical consequences. . . . If no practical differences whatever can be traced . . . they mean practically the same thing," and ends the argument. As a theory of truth, James says that an idea is true if it works in daily life. (Stumpf, 1994, p. 938)

PRECONSCIOUS PROCESSING

The Brain Responds to External Stimuli That Are Not Consciously Perceived

The brain respond[s] to external stimuli which, for one reason or another, are not consciously perceived. The effect of such stimuli may be almost as varied as those of sensory inflow which *does* enter consciousness. They include the evoking and determination of cortical potentials, changes in the EEG, the production of electrodermal responses, and changes in sensory threshold. They also include effects on memory, the influencing of lexical decisions, and such subjective manifestations as changes in conscious perceptual experience, dreams, and the evoking of appropriate effects. (Dixon, 1981, p. 262)

PROCESSING SYSTEMS

Determining the Hierarchical Position of a Processing System Involved in a Performance Task

The position of any processing system within the hierarchy is determined by two major criteria: (1) the generality-specificity of the processing system and (2) the degree of automaticity of the processing system. Relatively general and non-automatic processes appear towards the top of the hierarchy, and specific, automatic processes occur at the bottom. As a rule of thumb, the location in the hierarchy of the processes involved in the performance of a task can be assessed by a series of experiments in which the task is paired with several others: higher-level processes will more consistently produce interference than will low-level processes. (Eysenck, 1982, p. 45)

PRODUCTION SYSTEMS

The Production System Methodology Is Clearly Powerful

[T]he interest in production systems on the part of those building high performance knowledge-based systems is more than a coincidence. It is suggested that this is a result of current research (re)discovering what has been learned by naturally intelligent systems through evolution—that structuring knowledge in a production system format is an effective approach to the organisation, retrieval and use of very large amounts of knowledge.

The success of some production rule-based AI systems does give weight to this argument, and the production system methodology is

clearly powerful. But whether this is a result of its equivalence to human cognitive processes, and whether this implies artificially intelligent systems ought to be similarly structured, are, we feel, still open questions. (Davis & King, 1977, p. 307)

PROGRAMMING LANGUAGE

Theories of Human Mental Processes Can Be Expressed in Programming Languages

It [the information-processing revolution] has introduced computer programming languages as formal ["mathematical"] languages for expressing theories of human mental processes; and it has introduced the computers themselves as a device to simulate these processes and thereby make behavioral predictions for testing of the theories. (Simon, 1979, p. ix)

PROGRAMMING LANGUAGE

The Advantages of LISP

LISP is now the second oldest programming language in present widespread use (after FORTRAN). . . . Its core occupies some kind of local optimum in the space of programming languages given that static friction discourages purely notational changes. Recursive use of conditional expressions, representation of symbolic information externally by lists and internally by list structure, and representation of program in the same way will probably have a very long life. (McCarthy, quoted in Barr & Feigenbaum, 1982, p. 5)

PROGRAMMING LANGUAGE

When a Machine Might Begin to Have a Mind of Its Own

Although it sounds implausible, it might turn out that above a certain level of complexity, a machine ceased to be predictable, even in principle, and started doing things on its own account, or, to use a very revealing phrase, it might begin to have a mind of its own. (Lucas, quoted in Hand, 1985, p. 4)

PROPOSITIONAL LOGIC

Formal Operations Are Combinatorial

The specificity of propositional logic is not that it is a verbal logic, but rather a logic of all possible thought combinations. (Inhelder & Piaget, 1958, p. 222)

PSYCHOANALYSIS

The Ego Is Not Even Master in Its Own House

[Psychoanalysis] seeks to prove to the ego that it is not even master in its own house, but must content itself with scanty information of what is going on unconsciously in the mind. (Freud, 1953–1974, Vol. 16, pp. 284–285)

PSYCHOANALYSIS

Methodological Problems of Psychoanalysis

Although in the interview the analyst is supposedly a "passive" auditor of the "free association" narration by the subject, in point of fact the analyst does direct the course of the narrative. This by itself does not necessarily impair the evidential worth of the outcome, for even in the most meticulously conducted laboratory experiment the experimenter intervenes to obtain the data he is after. There is nevertheless the difficulty that in the nature of the case the full extent of the analyst's intervention is not a matter that is open to public scrutiny, so that by and large one has only his own testimony as to what transpires in the consulting room. It is perhaps unnecessary to say that this is not a question about the personal integrity of psychoanalytic practitioners. The point is the fundamental one that no matter how firmly we may resolve to make explicit our biases, no human being is aware of all of them, and that objectivity in science is achieved through the criticism of publicly accessible material by a community of independent inquirers. . . . Moreover, unless data are obtained under carefully standardized circumstances, or under different circumstances whose dependence on known variables is nevertheless established, even an extensive collection of data is an unreliable basis for inference. To be sure, analysts apparently do attempt to institute standard conditions for the conduct of interviews. But there is not much information available on the extent to which the standardization is actually enforced, or whether it relates to more than what may be superficial matters. (E. Nagel, 1959, pp. 49–50)

PSYCHOANALYSIS

No Necessary Incompatibility between Psychoanalysis and Certain Religious Formulations

[T]here would seem to be no necessary incompatibility between psychoanalysis and those religious formulations which locate God within the

self. One could, indeed, argue that Freud's Id (and even more Groddeck's It), the impersonal force within which is both the core of oneself and yet not oneself, and from which in illness one become[s] alienated, is a secular formation of the insight which makes religious people believe in an immanent God. (Ryecroft, 1966, p. 22)

PSYCHOANALYSIS

The Problem of Verifying Psychoanalytic Theory

Freudian analysts emphasized that their theories were constantly verified by their "clinical observations." . . . It was precisely this fact—that they always fitted, that they were always confirmed—which in the eyes of their admirers constituted the strongest argument in favour of these theories. It began to dawn on me that this apparent strength was in fact their weakness. . . . It is easy to obtain confirmations or verifications, for nearly every theory—if we look for confirmation. (Popper, 1968, pp. 34–35)

PSYCHOANALYSIS

Psychoanalysis Is Not a Science But Rather the Interpretation of a Narrated History

Psychoanalysis does not satisfy the standards of the sciences of observation, and the "facts" it deals with are not verifiable by multiple, independent observers. . . . There are no "facts" nor any observation of "facts" in psychoanalysis but rather the interpretation of a narrated history. (Ricoeur, 1974, p. 186)

PSYCHOANALYSIS

Some of the Qualities of a Scientific Approach Are Possessed by Psychoanalysis

In sum: psychoanalysis is *not* a science, but it shares some of the qualities associated with a scientific approach—the search for truth, understanding, honesty, openness to the import of the observation and evidence, and a skeptical stance toward authority. (Breger, 1981, p. 50)

PSYCHOANALYSIS

Major Attributes of Psychoanalysis

[Attributes of Psychoanalysis:]

1. Psychic Determinism. No item in mental life and in conduct and behavior is "accidental"; it is the outcome of antecedent conditions.
2. Much mental activity and behavior is purposive or goal-directed in character.
3. Much of mental activity and behavior, and its determinants, is unconscious in character.
4. The early experience of the individual, as a child, is very potent, and tends to be pre-potent over later experience. (Farrell, 1981, p. 25)

PSYCHOANALYSIS

The Scientific and Rational Are Not Co-extensive

Our sceptic may be unwise enough . . . to maintain that, because analytic theory is unscientific on his criterion, it is not worth discussing. This step

is unwise, because it presupposes that, if a study is not scientific on his criterion, it is not a rational enterprise . . . an elementary and egregious mistake. The scientific and the rational are not co-extensive. Scientific work is only *one* form that rational inquiry can take: there are many others. (Farrell, 1981, p. 46)

PSYCHOANALYSIS

The Validity of Psychoanalytic Therapy

Psychoanalysts have tended to write as though the term *analysis* spoke for itself, as if the statement "analysis revealed" or "it was analyzed as" preceding a clinical assertion was sufficient to establish the validity of what was being reported. An outsider might easily get the impression from reading the psychoanalytic literature that some standardized, generally accepted procedure existed for both inference and evidence. Instead, exactly the opposite has been true. Clinical material in the hands of one analyst can lead to totally different "findings" in the hands of another. (Peterfreund, 1986, p. 128)

PSYCHOANALYSIS

The Issues of Inference and Evidence in Psychoanalysis

The analytic process—the means by which we arrive at psychoanalytic understanding—has been largely neglected and is poorly understood, and there has been comparatively little interest in the issues of inference and evidence. Indeed, psychoanalysts as a group have not recognized the importance of being bound by scientific constraints. They do not seem to understand that a possibility is only that—a possibility—and that innumerable ways may exist to explain the same data. Psychoanalysts all too often do not seem to distinguish hypotheses from facts, nor

do they seem to understand that hypotheses must be tested in some way, that criteria for evidence must exist, and that any given test for any hypothesis must allow for the full range of substantiation/refutation. (Peterfreund, 1986, p. 129)

PSYCHOLOGICAL TESTING

Clinical Testing and Its Complex Psychological Structure

The clinical testing situation has a complex psychological structure. It is not an impersonal getting-together of two people in order that one, with the help of a little "rapport," may obtain some "objective" test responses from the other. The [disturbed] . . . patient is in some acute or chronic life crisis. He cannot but bring many hopes, fears, assumptions, demands and expectations into the test situation. He cannot but respond intensely to certain real as well as fantasied attributes of that situation. Being human and having to make a living—facts often ignored—the tester too brings hopes, fears, assumptions, demands and expectations into the test situation. She too responds personally and often intensely to what goes on—in reality and in fantasy—in that situation, however well she may conceal her personal response from the patient, from herself, and from her colleagues. (Schafer, 1954, p. 6)

PSYCHOLOGY

The Knowledge of Ourselves

We come therefore now to that knowledge whereunto the ancient oracle directeth us, which is *the knowledge of ourselves*; which deserveth the more accurate handling, by how much it toucheth us more nearly. This knowledge, as it is the end and term of natural philosophy in the intention of man, so notwithstanding it is but a portion of natural philosophy in the

continent of nature. . . . [W]e proceed to human philosophy or Humanity, which hath two parts: the one considereth man segregate, or distributively; the other congregate, or in society. So as Human philosophy is either Simple and Particular, or Conjugate and Civil. Humanity Particular consisteth of the same parts whereof man consisteth; that is, of knowledges which respect the Body, and of knowledges that respect the Mind . . . *how the one discloseth the other* and *how the one worketh upon the other* . . . [:] the one is honored with the inquiry of Aristotle, and the other of Hippocrates. (Bacon, 1878, pp. 236–237)

PSYCHOLOGY

As a Science, Psychology Is Distinct

The claims of Psychology to rank as a distinct science are . . . not smaller but greater than those of any other science. If its phenomena are contemplated objectively, merely as nervo-muscular adjustments by which the higher organisms from moment to moment adapt their actions to environing co-existences and sequences, its degree of specialty, even then, entitles it to a separate place. The moment the element of feeling, or consciousness, is used to interpret nervo-muscular adjustments as thus exhibited in the living beings around, objective Psychology acquires an additional, and quite exceptional, distinction. (Spencer, 1896, p. 141)

PSYCHOLOGY

Psychology Can Never Be an Exact Natural Science

Kant once declared that psychology was incapable of ever raising itself to the rank of an exact natural science. The reasons that he gives . . . have often been repeated in later times. In the first place, Kant says, psychology cannot become an exact science because mathematics is inapplicable

to the phenomena of the internal sense; the pure internal perception, in which mental phenomena must be constructed,—time,—has but one dimension. In the second place, however, it cannot even become an experimental science, because in it the manifold of internal observation cannot be arbitrarily varied,—still less, another thinking subject be submitted to one's experiments, comformably to the end in view; moreover, the very fact of observation means alteration of the observed object. (Wundt, 1904, p. 6)

PSYCHOLOGY

How a "Mathematical" Psychology May Be Realized in Practice

It is [Gustav] Fechner's service to have found and followed the true way; to have shown us how a "mathematical psychology" may, within certain limits, be realized in practice. . . . He was the first to show how Herbart's idea of an "exact psychology" might be turned to practical account. (Wundt, 1904, pp. 6–7)

PSYCHOLOGY

The Rights of Psychology as Science

"Mind," "intellect," "reason," "understanding," etc. are concepts . . . that existed before the advent of any scientific psychology. The fact that the naive consciousness always and everywhere points to internal experience as a special source of knowledge, may, therefore, be accepted for the moment as sufficient testimony to the rights of psychology as science. . . . "Mind," will accordingly be the subject, to which we attribute all the separate facts of internal observation as predicates. The subject itself is determined wholly and exclusively by its predicates. (Wundt, 1904, p. 17)

PSYCHOLOGY
The Study of Animal Psychology

The study of animal psychology may be approached from two different points of view. We may set out from the notion of a kind of comparative physiology of mind, a universal history of the development of mental life in the organic world. Or we may make human psychology the principal object of investigation. Then, the expressions of mental life in animals will be taken into account only so far as they throw light upon the evolution of consciousness in man. . . . Human psychology . . . may confine itself altogether to man, and generally has done so to far too great an extent. There are plenty of psychological text-books from which you would hardly gather that there was any other conscious life than the human. (Wundt, 1907, pp. 340–341)

PSYCHOLOGY
The Behaviorist's Formulation

The Behaviorist began his own formulation of the problem of psychology by sweeping aside all medieval conceptions. He dropped from his scientific vocabulary all subjective terms such as sensation, perception, image, desire, purpose, and even thinking and emotion as they were subjectively defined. (Watson, 1930, pp. 5–6)

PSYCHOLOGY
Man Is a Microcosm

According to the medieval classification of the sciences, psychology is merely a chapter of special physics, although the most important chapter; for man is a *microcosm*; he is the central figure of the universe. (deWulf, 1956, p. 125)

PSYCHOLOGY

Brief Overview of Psychology's History

At the beginning of this century the prevailing thesis in psychology was Associationism. . . . Behavior proceeded by the stream of associations: each association produced its successors, and acquired new attachments with the sensations arriving from the environment.

In the first decade of the century a reaction developed to this doctrine through the work of the Wurzburg school. Rejecting the notion of a completely self-determining stream of associations, it introduced the task (*Aufgabe*) as a necessary factor in describing the process of thinking. The task gave direction to thought. A noteworthy innovation of the Wurzburg school was the use of systematic introspection to shed light on the thinking process and the contents of consciousness. The result was a blend of mechanics and phenomenalism, which gave rise in turn to two divergent antitheses, Behaviorism and the Gestalt movement.

The behavioristic reaction insisted that introspection was a highly unstable, subjective procedure. . . . Behaviorism reformulated the task of psychology as one of explaining the response of organisms as a function of the stimuli impinging upon them and measuring both objectively. However, Behaviorism accepted, and indeed reinforced, the mechanistic assumption that the connections between stimulus and response were formed and maintained as simple, determinate functions of the environment.

The Gestalt reaction took an opposite turn. It rejected the mechanistic nature of the associationist doctrine but maintained the value of phenomenal observation. In many ways it continued the Wurzburg school's insistence that thinking was more than association—thinking has direction given to it by the task or by the set of the subject. Gestalt psychology elaborated this doctrine in genuinely new ways in terms of holistic principles of organization.

Today psychology lives in a state of relatively stable tension between the poles of Behaviorism and Gestalt psychology. . . . (Newell & Simon, 1963, pp. 279–280)

PSYCHOLOGY

Psychological Research Is Not Building toward Systematic Clarity

As I examine the fate of our oppositions, looking at those already in existence as guide to how they fare and shape the course of science, it seems to me that clarity is never achieved. Matters simply become muddier and muddier as we go down through time. Thus, far from providing the rungs of a ladder by which psychology gradually climbs to clarity, this form of conceptual structure leads rather to an ever increasing pile of issues, which we weary of or become diverted from, but never really settle. (Newell, 1973b, pp. 288–289)

PSYCHOLOGY

Psychology as a Scientific Discipline

The subject matter of psychology is as old as reflection. Its broad practical aims are as dated as human societies. Human beings, in any period, have not been indifferent to the validity of their knowledge, unconcerned with the causes of their behavior or that of their prey and predators. Our distant ancestors, no less than we, wrestled with the problems of social organization, child rearing, competition, authority, individual differences, personal safety. Solving these problems required insights—no matter how untutored—into the *psychological* dimensions of life. Thus, if we are to follow the convention of treating psychology as a young discipline, we must have in mind something other than its subject matter. We must mean that it is young in the sense that physics was young at the time of Archimedes or in the sense that geometry was "founded" by Euclid and "fathered" by Thales. Sailing vessels were launched long before Archimedes discovered the laws of bouyancy [*sic*], and pillars of identical circumference were constructed before anyone knew that C =

IID. We do not consider the ship builders and stone cutters of antiquity physicists and geometers. Nor were the ancient cave dwellers psychologists merely because they rewarded the good conduct of their children. The archives of folk wisdom contain a remarkable collection of achievements, but *craft*—no matter how perfected—is not *science*, nor is a litany of successful accidents a discipline. If psychology is young, it is young as a *scientific discipline* but it is far from clear that psychology has attained this status. (Robinson, 1986, p. 12)

R

READING

The Discovery of Truth Depends on the Thoughtful Reading of Authoritative Texts

For the Middle Ages, all discovery of truth was first reception of traditional authorities, then later—in the thirteenth century—rational reconciliation of authoritative texts. A comprehension of the world was not regarded as a creative function but as an assimilation and retracing of given facts; the symbolic expression of this being reading. The goal and the accomplishment of the thinker is to connect all these facts together in the form of the "summa." Dante's cosmic poem is such a summa too. (Curtius, 1973, p. 326)

READING

The Many Functions of Reading

The readers of books . . . extend or concentrate a function common to us all. Reading letters on a page is only one of its many guises. The astronomer reading a map of stars that no longer exist; the Japanese architect reading the land on which a house is to be built so as to guard it from

evil forces; the zoologist reading the spoor of animals in the forest; the card-player reading her partner's gestures before playing the winning card; the dancer reading the choreographer's notations, and the public reading the dancer's movements on the stage; the weaver reading the intricate design of a carpet being woven; the organ-player reading various simultaneous strands of music orchestrated on the page; the parent reading the baby's face for signs of joy or fright, or wonder; the Chinese fortune-teller reading the ancient marks on the shell of a tortoise; the lover blindly reading the loved one's body at night, under the sheets; the psychiatrist helping patients read their own bewildering dreams; the Hawaiian fisherman reading the ocean currents by plunging a hand into the water; the farmer reading the weather in the sky—all these share with book-readers the craft of deciphering and translating signs. . . .

We all read ourselves and the world around us in order to glimpse what and where we are. We read to understand, or to begin to understand. We cannot do but read. Reading, almost as much as breathing, is our essential function. (Manguel, 1996, pp. 6–7)

READING

Theories of Language Processing during Reading

There is a pitched battle between those theorists and modellers who embrace the primacy of syntax and those who embrace the primacy of semantics in language processing. At times both schools have committed various excesses. For example, some of the former have relied foolishly on context-free mathematical-combinatory models, while some of the latter have flirted with versions of the "direct-access hypothesis," the idea that skilled readers process printed language directly into meaning without phonological or even syntactic processing. The problems with the first excess are patent. Those with the second are more complex and demand more research. Unskilled readers apparently do rely more on phonological processing than do skilled ones; hence their spoken dialects may interfere with their reading—and writing—habits. But the extent to which phonological processing is absent in the skilled reader has not

been established, and the contention that syntactic processing is suspended in the skilled reader is surely wrong and not supported by empirical evidence—though blood-flow patterns in the brain are curiously different during speaking, oral reading, and silent reading. (M. L. Johnson, 1988, pp. 101–102)

REALITY

The Subject-Object Split Does Not Exist

[Constructivism] does not create or explain any reality "out there"; it shows that there is no inside and no outside, no objective world facing the subjective, rather, it shows that the subject-object split, that source of myriads of "realities," does not exist, that the apparent separation of the world into pairs of opposites is constructed by the subject. (Watzlawick, 1984, p. 330)

REASON

Thinking May Include Processes Other than Reason

Reason is only one out of a thousand possibilities in the thinking of each of us. (James, 1890, p. 552)

REASONING

No Purely Formal Calculus Can Model People's Inferences

For some considerable time we cherished the illusion that [using formal logic to construct psychological models of reasoning] was the way to

proceed and that only the structural characteristics of the problem mattered. Only gradually did we realise first that there was no existing formal calculus which correctly modelled our subject's inferences, and second that no purely formal calculus would succeed. (Wason & Johnson-Laird, 1972, p. 244)

REDUCTIONISM

The Rejection of Reductionism

Reductionism is a dirty word, and a kind of "holistier than thou" self-righteousness has become fashionable. (Dawkins, 1982, p. 113)

REPRESENTATION

A Representation Is Valuable for Its Usefulness

When I observed what was good or bad about a representation, I found it was not its form or notation that was important . . . rather, the important issue was what could or could not be done easily with a representation. (Anderson, 1983, p. 45)

RESTRUCTURING

Restructuring Is the Decisive Step in Problem Solving

[In problem solving,] the decisive step is what we may call a *restructuring* of the given material. (Köhler, 1969, p. 146)

ROBOT

The Temptation to Introduce an Entelechy into a Robot

Regard . . . the behaving organism as a completely self-maintaining robot, constructed of materials as unlike ourselves as may be. In doing this it is not necessary to attempt the solution of the detailed engineering problems connected with the design of such a creature. It is a wholesome and revealing exercise, however, to consider the various general problems in behavior dynamics which must be solved in the design of a truly self-maintaining robot. . . . The temptation to introduce an entelechy, soul, spirit, or daemon into a robot is slight; it is relatively easy to realize that *the introduction of an entelechy would not really solve the problem of designing the entelechy itself, which is the core of the original problem all over again*. The robot approach thus aids us in avoiding the very natural but childish tendency to choose easy though false solutions to our problems, by removing all excuses for not facing them squarely and without evasion. (Hull, 1943, pp. 27–28)

ROBOTS

The Frame Problem in Robots

So far as I can tell, the usual assumption about the frame problem in AI is that it is somehow to be solved "heuristically." . . . Perhaps a bundle of such heuristics, properly coordinated and rapidly deployed, would suffice to make the central processes of a robot as [holistic] as yours, or mine, or the practicing scientist's ever actually succeed in being. Since there are, at present, no serious proposals about what heuristics might belong to such a bundle, it seems hardly worth arguing the point. (Fodor, 1983, pp. 115–116)

RULES

The Explanation of Behavior

Suppose that our most successful mode of explanation and description attributes to Jones an initial and attained state including certain rules (principles with parameters fixed or rules of other sorts) and explains Jones's behavior in these terms; that is, the rules form a central part of the best account of his use and understanding of language and are directly and crucially invoked in explaining it in the best theory we can devise. . . . I cannot see that anything is involved in attributing causal efficacy to rules beyond the claim that these rules are constituent elements of the states postulated in an explanatory theory of behavior and enter into our best account of this behavior. (Chomsky, 1986, pp. 252–253)

S

SCHEMA

Schema Denotes the Active Organization of Past Reactions or Experiences

"Schema" refers to an active organisation of past reactions, or of past experiences, which must always be supposed to be operating in any well-adapted organic response. That is, whenever there is any order or regularity of behavior, a particular response is possible only because it is related to other similar responses which have been serially organised, yet which operate, not simply as individual members coming one after another, but as a unitary mass. Determination by schemata is the most fundamental of all the ways in which we can be influenced by reactions and experiences which occurred some time in the past. All incoming impulses of a certain kind, or mode, go together to build up an active, organised setting: visual, auditory, various types of cutaneous impulses and the like, at a relatively low level; all the experiences connected by a common interest: in sport, in literature, history, art, science, philosophy, and so on, on a higher level. (Bartlett, 1932, p. 201)

SCHEMATA

Once Established, Schemata Can Control Later Observations

Once we have accepted a configuration of schemata, the schemata themselves provide a richness that goes far beyond our observations. . . . In fact, once we have determined that a particular schema accounts for some event, we may not be able to determine which aspects of our beliefs are based on direct sensory information and which are merely consequences of our interpretation. (Rumelhart, 1980, p. 38)

SCHEMATA

The Nature of Schemata

Through most of its history, the notion of the schema has been rejected by mainstream experimental psychologists as being too vague. As a result, the concept of the schema was largely shunned until the mid-1970s. The concept was then revived by an attempt to offer more clearly specified interpretation of the schema in terms of explicitly specified computer implementations or, similarly, formally specified implementations of the concept. Thus, Minsky (1975) postulated the concept of the frame, Schank and Abelson (1977) focused on the concept of the script, and Bobrow and Norman (1975) and Rumelhart (1975) developed an explicit notion of the schema. Although the details differed in each case, the idea was essentially the same. . . . Minsky and the others argued that some higher-level "suprasentential" or, more simply, conceptual structure is needed to represent the complex relations implicit in our knowledge base. The basic idea is that schemata are data structures for representing the generic concepts stored in memory. There are schemata for generalized concepts underlying objects, situations, events, sequences of events, actions, and sequences of actions. Roughly, schemata are like models of the outside world. To process information with the use of a

schema is to determine which model best fits the incoming information. Ultimately, consistent configurations of schemata are discovered which, in concert, offer the best account for the input. This configuration of schemata together constitutes the *interpretation* of the input. (Rumelhart, Smolensky, McClelland & Hinton, 1986, pp. 17–18)

SCIENCE

Thoughts, Feelings, and Actions of Sentient Beings Are Not a Subject of Science

It is a common notion, or at least it is implied in many common modes of speech, that the thoughts, feelings, and actions of sentient beings are not a subject of science. . . . This notion seems to involve some confusion of ideas, which it is necessary to begin by clearing up. Any facts are fitted, in themselves, to be a subject of science, which follow one another according to constant laws; although those laws may not have been discovered, nor even to be discoverable by our existing resources. (Mill, 1900, B. VI, Chap. 3, Sec. 1)

SCIENCE

Two Contending But Complementary Philosophies of Science

One class of natural philosophers has always a tendency to combine the phenomena and to discover their analogies; another class, on the contrary, employs all its efforts in showing the disparities of things. Both tendencies are necessary for the perfection of science, the one for its progress, the other for its correctness. The philosophers of the first of these classes are guided by the sense of unity throughout nature; the philosophers of the second have their minds more directed towards the certainty of our knowledge. The one are absorbed in search of principles,

and neglect often the peculiarities, and not seldom the strictness of demonstration; the other consider the science only as the investigation of facts, but in their laudable zeal they often lose sight of the harmony of the whole, which is the character of truth. Those who look for the stamp of divinity on every thing around them, consider the opposite pursuits as ignoble and even as irreligious; while those who are engaged in the search after truth, look upon the other as unphilosophical enthusiasts, and perhaps as phantastical contemners of truth. . . . This conflict of opinions keeps science alive, and promotes it by an oscillatory progress. (Oersted, 1920, p. 352)

SCIENCE

The Fundamental Ideas of Science Are Essentially Simple

Most of the fundamental ideas of science are essentially simple, and may, as a rule, be expressed in a language comprehensible to everyone. (Einstein & Infeld, 1938, p. 27)

SCIENCE

A New Scientific Truth Triumphs Because Its Opponents Eventually Die

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it. (Planck, 1949, pp. 33–34)
[Original quotation: "Eine neue wissenschaftliche Wahrheit pflegt sich nicht in der Weise durchzusetzen, dass ihre Gegner ueberzeugt werden

und sich as belehrt erklaeren, sondern vielmehr dadurch, dass die Gegner allmaehlich aussterben und dass die heranwachsende Generation von vornherein mit der Wahrheit vertraut gemacht ist." (Planck, 1990, p. 15)]

SCIENCE

The Search for the Absolute

I had always looked upon the search for the absolute as the noblest and most worth while task of science. (Planck, 1949, p. 46)

SCIENCE

When Your Scientific Doing Is Worthless

If you cannot—in the long run—tell everyone what you have been doing, your doing has been worthless. (Schrödinger, 1951, pp. 7–8)

SCIENCE

Description in Plain Language Is a Criterion of Understanding

Even for the physicist the description in plain language will be a criterion of the degree of understanding that has been reached. (Heisenberg, 1958, p. 168)

SCIENCE

The Tentativeness of Scientific Statements

The old scientific ideal of *epistémé*—of absolutely certain, demonstrable knowledge—has proved to be an idol. The demand for scientific objectivity makes it inevitable that every scientific statement must remain *tentative forever*. It may indeed be corroborated, but every corroboration is relative to other statements which, again, are tentative. Only in our subjective experiences of conviction, in our subjective faith, can we be "absolutely certain." (Popper, 1959, p. 280)

SCIENCE

Scientists Often Close Their Minds to New Scientific Evidence

The layman, taught to revere scientists for their absolute respect for the observed facts, and for the judiciously detached and purely provisional manner in which they hold scientific theories (always ready to abandon a theory at the sight of any contradictory evidence) might well have thought that, at Miller's announcement of this overwhelming evidence of a "positive effect" [indicating that the speed of light is *not* independent from the motion of the observer, as Einstein's theory of relativity demands] in his presidential address to the American Physical Society on December 29th, 1925, his audience would have instantly abandoned the theory of relativity. Or, at the very least, that scientists—wont to look down from the pinnacle of their intellectual humility upon the rest of dogmatic mankind—might suspend judgment in this matter until Miller's results could be accounted for without impairing the theory of relativity. But no: by that time they had so well closed their minds to any suggestion which threatened the new rationality achieved by Einstein's

world-picture, that it was almost impossible for them to think again in different terms. Little attention was paid to the experiments, the evidence being set aside in the hope that it would one day turn out to be wrong. (Polanyi, 1958, pp. 12–13)

SCIENCE
The Practice of Normal Science

The practice of normal science depends on the ability, acquired from examplars, to group objects and situations into similarity sets which are primitive in the sense that the grouping is done without an answer to the question, "Similar with respect to what?" (Kuhn, 1970, p. 200)

SCIENCE
Of What Science Consists

Science in general . . . does not consist in collecting what we already know and arranging it in this or that kind of pattern. It consists in fastening upon something we do not know, and trying to discover it. (Collingwood, 1972, p. 9)

SCIENCE
The Emergence of Scientific Fields

Scientific fields emerge as the concerns of scientists congeal around various phenomena. Sciences are not defined, they are recognized. (Newell, 1973a, p. 1)

SCIENCE

We Do Not Take Our Theories Seriously Enough

This is often the way it is in physics—our mistake is not that we take our theories too seriously, but that we do not take them seriously enough. I do not think it is possible really to understand the successes of science without understanding how *hard* it is—how easy it is to be led astray, how difficult it is to know at any time what is the next thing to be done. (Weinberg, 1977, p. 49)

SCIENCE

Science Takes away Philosophical Foundations

Science is wonderful at destroying metaphysical answers, but incapable of providing substitute ones. Science takes away foundations without providing a replacement. Whether we want to be there or not, science has put us in a position of having to live without foundations. It was shocking when Nietzsche said this, but today it is commonplace; our historical position—and no end to it is in sight—is that of having to philosophize without "foundations." (Putnam, 1987, p. 29)

SCIENTIFIC THINKING

Change in Scientific Data Is Accommodated by Change in Representation

A different form of representation is needed to accommodate the data of change. (Nersessian, 1992, p. 11)

SCRIPTS

Scripts Can Be Predicted Because They Have Occurred in Precisely This Fashion Before

A script is a giant causal chain of conceptualisations that have been known to occur in that order many times before. . . . What a script does is to set up expectations about events that are likely to follow in a given situation. These scripts can be predicted because they have occurred in precisely this fashion before. (Schank, 1976, pp. 180–181)

SELF

The Self (Personal Identity) Is But a Bundle or Collection of Perceptions

There are some philosophers who imagine we are every moment intimately conscious of what we call our *SELF*; that we feel its existence and its continuance in existence; and are certain, beyond the evidence of a demonstration, both of its perfect identity and simplicity. . . .

For my part, when I enter most intimately into what I call *myself*, I always stumble on some particular perception or other, of heat or cold, light or shade, love or hatred, pain or pleasure. I never can catch *myself* at any time without a perception, and never can observe anything but the perception. . . .

[S]etting aside some metaphysicians . . . I may venture to affirm, of the rest of mankind, that they are nothing but a bundle or collection of different perceptions, which succeed each other with an inconceivable rapidity, and are in a perpetual flux and movement. Our eyes cannot turn in their sockets without varying our perceptions. Our thought is still more variable than our sight; and all our other senses and faculties contribute to this change; nor is there any single power of the soul, which

remains unalterably the same, perhaps for one moment. The mind is a kind of theatre, where several perceptions successively make their appearance, pass, re-pass, glide away, and mingle in an infinite variety of postures and situations. There is properly no *simplicity* in it at any one time, nor *identity* in different, whatever natural propensity we may have to imagine that simplicity and identity. The comparison of the theatre must not mislead us. [It is merely] the successive perceptions . . . that constitute the mind; nor have we the most distant notion of the place where the scenes are represented, or of the materials of which it is composed. (Hume, 1978, pp. 251–256)

SELF

To Find Wherein Personal Identity Consists

To find wherein *personal identity* consists, we must consider what *person* stands for; which, I think, is a thinking intelligent being that has reason and reflection and can consider itself as itself, the same thinking thing in different times and places; which it does only by that consciousness which is inseparable from thinking and, as it seems to me, essential for it—it being impossible for anyone to perceive without perceiving that he does perceive.

When we see, hear, smell, taste, feel, meditate, or will anything, we know that we do so. Thus it is always as to our present sensations and perceptions; and by this everyone is to himself that which he calls *self*, not being considered in this case whether the same *self* be continued in the same or different substances. For since consciousness always accompanies thinking, and it is that which makes everyone to be what he calls *self*, and thereby distinguishes himself from all other thinking things, in this alone consists *personal identity*, i.e., the sameness of a rational being. And as far as this consciousness can be extended backwards to any past action or thought, so far reaches the identity of that *person*. It is the same *self* now it was then, and it is by the same *self* as this present one that now reflects on it, that action was done. (Locke, 1975, Bk. II, Chap. 27, Sec. 9–10)

SEMANTICS

The Nature of Semantics in Philosophy and Linguistics

There are people who maintain that there is no distinction between syntax and semantics, and there are others who lump the entire inference and "thought" component of an AI system under the label "semantics." Moreover, the philosophers, linguists, and programming language theorists have notions of semantics which are distinct from each other and from many of the notions of computational linguists and psychologists. . . .

First, let me set up two caricatures which I will call the Linguist and the Philosopher, without thereby asserting that all linguists fall into the first category or philosophers in the second. Both, however, represent strong traditions in their respective fields. The Linguist has the following view of semantics in linguistics: He is interested in characterizing the fact that the same sentence can sometimes mean different things, and some sentences mean nothing at all. He would like to find some notation in which to express the different things which a sentence can mean and some procedure for determining whether a sentence is "anomalous" (i.e., has no meanings). The Philosopher on the other hand is concerned with specifying the meaning of a formal notation rather than a natural language. . . . His notation is already unambiguous. What he is concerned with is determining when an expression in the notation is a "true" proposition (in some appropriate formal sense of truth) and when it is false. . . . Meaning for the Philosopher is not defined in terms of some other notation in which to represent different possible interpretations of a sentence, but he is interested in the conditions for truth of an already formal representation. (Woods, 1975, pp. 40–41)

SENSATIONS

The Existence of Our Sensations Is Indisputable

Nothing is more indisputable than the existence of our sensations. Thus, in order to prove that they are the principle of all our knowledge, it suffices to show that they can be. . . . Why suppose that we have purely intellectual notions at the outset if all we need do in order to form them is to reflect upon our sensations? (D'Alembert, 1963, p. 7)

SENSATIONS

The Source of Belief in Sensations

[S]upposing we have got the conception of hardness, how come we by the *belief* of it? Is it self-evident, from comparing the ideas, that such a sensation could not be felt unless such a quality of bodies existed? No. Can it be proved by probability or certain arguments? No. Have we got this belief then by tradition, by education, or by experience? No. . . . Shall we then throw off this belief, as having no foundation in reason? Alas! it is not in our power; it triumphs over reason, and laughs at all the arguments of a philosopher. Even the author of the "Treatise of Human Nature," though he saw no reason for this belief . . . could hardly conquer it in his speculative and solitary moments; at other times he fairly yielded to it, and confesses that he found himself under a necessity to do so. (Reid, 1970, p. 157)

SIGN

The Mind Is a Sign Resulting from Inference

[The human mind] is a sign developing according to the laws of inference. . . . [T]he content of consciousness, the entire phenomenal manifestation of mind, is a sign resulting from inference. (Peirce, 1934, p. 188)

SIGN

Every Sign Differs from Other Signs

If Saussure writes, the most precise characteristic of every sign is that it differs from other signs, then every sign in some sense bears the traces of all the other signs; they are copresent with it as the entities which define it. This means that one should not think, as logocentrism [phonocentric metaphysics of writing] would like to, of the presence in consciousness of a single autonomous signified. What is present is a network of differences. (Culler, 1976, p. 122)

SIGN

When a Sign Has Meaning

A sign has meaning when a group of people has adopted a particular program for using it. Hence the meaning of a word is defined by the rules for its use and the circumstances under which it can be verified. (Young, 1978, p. 295)

SIMULATION

Computer Simulation of Reality Should Not Be Confused with a Duplication of Reality

No one supposes that computer simulation of a five-alarm fire will burn the neighborhood down or that computer simulation of a rainstorm will leave us all drenched. Why on earth would anyone suppose that a computer simulation of understanding actually understood anything? It is sometimes said that it would be frightfully hard to get computers to feel pain or fall in love, but love and pain are neither harder nor easier than cognition or anything else. For simulation, all you need is the right input and output and a program in the middle that transforms the former into the latter. That is all the computer has for anything it does. To confuse simulation with duplication is the same mistake, whether it is pain, love, cognition, fires or rainstorms. (Searle, 1981a, p. 302)

SITUATIONISM

We Must Be Ruled, Not by Theorizing, But by the Situation Itself

What I speak of is the real decision as we experience it; and here the movement away from theory and generality is the movement towards truth. All theorizing is flight. We must be ruled by the situation itself and this is unutterably particular. Indeed it is something to which we can never get close enough, however hard we may try as it were to crawl under the net. (Murdoch, 1954, pp. 80–81)

SPECTATOR

Interrelationships between the Spectator and the Author

In fact, every spectator, in correspondence with his individuality, in his own way and out of his own experience—out of the womb of his fantasy, out of the warp and weft of his associations, all conditioned by the premises of his character, habits and social appurtenances, creates an image in accordance with the representational guidance suggested by the author, leading him to understanding and experience of the author's theme. This is the same image that was planned and created by the author, but this image is at the same time created also by the spectator himself. (Eisenstein, 1947, p. 33)

SPEECH

The Speech Units of the Child Stand for Sentences

The speech units of the child belong to no single class of words because they are (i.e. stand for) not single words but sentences. (Lorimer, 1929, p. 94)

SPEECH

Speech Can Block Clear Thinking

Often we have to get away from speech in order to think clearly. (Woodworth, 1938, p. 809)

SPEECH

The Origin of Speech

The homoiothermal [warm-blooded] organism generates the need for communication. It is, in energy or thermal needs, analogous to what will be common speech, in terms of signals and information. I imagine that one of the first forms of behavior, like one of the first signals, may be reduced to this: "keep me warm." (Serres, 1982, p. 76)

STEREOTYPE

The Abandonment of All Stereotypes Would Impoverish Human Life

Were there no practical uniformities in the environment, there would be no economy and only error in the human habit of accepting foresight for sight. But there are uniformities sufficiently accurate, and the need of economizing attention so inevitable, that the abandonment of all stereotypes for a wholly innocent approach to experience would impoverish human life. (Lippmann, 1965, p. 60)

SYMBOL

When a Symbol Refers to a Concept

When a symbol stands for a class of objects or events with common properties, we say that it refers to a *concept*. (Hilgard, 1957, p. 315)

SYMBOL

The Discrete Formal Symbol Is the Basis of All Systems of Thought

The notion of a discrete atomic symbol is the basis of all formal understanding. Indeed, it is the basis of all systems of thought, expression or calculation for which a *notation* is available. . . . No one has succeeded in defining any other type of atom from which formal understanding can be derived. Small wonder, then, that many of us are reluctant to dispense with this foundation in cognitive psychology under frequent exhortations to accept symbols with such varied intrinsic properties as continuous or analogue properties. (Pylyshyn, 1984, p. 51)

SYNESTHESIA

Synesthesia and Related Meaning Depend on Biological Systems

[I]t is *because* such diverse sensory experiences as a *white* circle (rather than black), a *straight* line (rather than crooked), a *rising* melody (rather than a falling one), a *sweet* taste (rather than a sour one), a *caressing* touch (rather than an irritating scratch)—it is because all these diverse experiences can share a common affective meaning that one easily and lawfully translates from one sensory modality into another in synesthesia and metaphor. . . . In other words, the "common market in meaning" seems to be based firmly in the biological systems of emotional and purposive behavior that all humans share. (Osgood, 1966, pp. 309–310)

SYNTAX

The Universal Syntax Is a Way of Analyzing Experience

[I]t cannot be held that there is a specific linguistic competence which underlies the syntax of all languages. The universal syntax is a human way of analyzing experience, not of putting together sentences. (Bronowski, 1977, p. 148)

T

THEORY

The Nature of Theory-Building

Neurath has likened science to a boat which, if we are to rebuild it, we must rebuild plank by plank while staying afloat in it. The philosopher and the scientist are in the same boat. . . .

Analyze theory-building how we will, we all must start in the middle. Our conceptual firsts are middle-sized, middle-distanced objects, and our introduction to them and to everything comes midway in the cultural evolution of the race. In assimilating this cultural fare we are little more aware of a distinction between report and invention, substance and style, cues and conceptualization, than we are of a distinction between the proteins and the carbohydrates of our material intake. Retrospectively we may distinguish the components of theory-building, as we distinguish the proteins and carbohydrates while subsisting on them. (Quine, 1960, pp. 4–6)

THEORY

The Functions of Theory in Science

Theories are usually introduced when previous study of a class of phenomena has revealed a system of uniformities. . . . Theories then seek to explain those regularities and, generally, to afford a deeper and more accurate understanding of the phenomena in question. To this end, a theory construes those phenomena as manifestations of entities and processes that lie behind or beneath them, as it were. (Hempel, 1966, p. 70)

THEORY

The Nature of Construct Validity

A strong approach [to construct validation] looks on construct validation as tough-minded testing of specific hypotheses:

> [T]heoretical concepts are defined conceptually or implicitly by their role in a network of nomological or statistical "laws." The meaning is partially given by the theoretical network, however tentative and as yet impoverished that network may be. Crudely put, you know what you mean by an entity to the extent that statements about it in the theoretical language are linked to statements in the observational language. These statements are about where it's found, what it does, what it's made of. Only a few of those properties are directly tied to observables [p. 136]. In [an early] theory sketch, based upon some experience and data, everything said is conjectural. We have tentative notions about some indicators of the construct with unknown validities [p. 144]. [When we check up empirically on predictions from the model] we are testing the crude

> theory sketch, we are tightening the network psychometrically, and we are validating the indicators. All of these are done simultaneously [p. 149]. [Extracted with elisions and some paraphrase from Meehl & Golden, 1982.]

(Cronbach, 1990, p. 183)

THINKING

I Am a Thinking Thing

But what then am I? A thing which thinks. What is a thing which thinks? It is a thing which doubts, understands, [conceives], affirms, denies, wills, refuses, which also imagines and feels. (Descartes, 1951, p. 153)

THINKING

Thinking Is Not Independent of the Expression of Thought

I have been trying in all this to remove the temptation to think that there "must be" a mental process of thinking, hoping, wishing, believing, etc., independent of the process of expressing a thought, a hope, a wish, etc. . . . If we scrutinize the usages which we make of "thinking," "meaning," "wishing," etc., going through this process rids us of the temptation to look for a peculiar act of thinking, independent of the act of expressing our thoughts, and stowed away in some particular medium. (Wittgenstein, 1958, pp. 41–43)

THINKING

The Experimental Differentiation of Concrete and Propositional Operations

Analyse the proofs employed by the subject. If they do not go beyond observation of empirical correspondences, they can be fully explained in terms of concrete operations, and nothing would warrant our assuming that more complex thought mechanisms are operating. If, on the other hand, the subject interprets a given correspondence as the result of any one of several possible combinations, and this leads him to verify his hypotheses by observing their consequences, we know that propositional operations are involved. (Inhelder & Piaget, 1958, p. 279)

THINKING

In Every Age, Philosophical Thinking Exploits Some Dominant Concepts

In every age, philosophical thinking exploits some dominant concepts and makes its greatest headway in solving problems conceived in terms of them. The seventeenth- and eighteenth–century philosophers construed knowledge, knower, and known in terms of sense data and their association. Descartes' self-examination gave classical psychology *the mind and its contents* as a starting point. Locke set up sensory immediacy as the new criterion of the real . . . Hobbes provided the genetic method of building up complex ideas from simple ones . . . and, in another quarter, still true to the Hobbesian method, Pavlov built intellect out of conditioned reflexes and Loeb built life out of tropisms. (S. Langer, 1962, p. 54)

THINKING

The Experimental Differentiation of Deductive and Inductive Reasoning

Experiments on deductive reasoning show that subjects are influenced sufficiently by their experience for their reasoning to differ from that described by a purely deductive system, whilst experiments on inductive reasoning lead to the view that an understanding of the strategies used by adult subjects in attaining concepts involves reference to higher-order concepts of a logical and deductive nature. (Bolton, 1972, p. 154)

THINKING

The Power of Machine Thought

There are now machines in the world that think, that learn and create. Moreover, their ability to do these things is going to increase rapidly until—in the visible future—the range of problems they can handle will be coextensive with the range to which the human mind has been applied. (Newell & Simon, quoted in Weizenbaum, 1976, p. 138)

THINKING

Thinking Is Sometimes Accompanied by Action and Sometimes Not

But how does it happen that thinking is sometimes accompanied by action and sometimes not, sometimes by motion, and sometimes not? It looks as if almost the same thing happens as in the case of reasoning

and making inferences about unchanging objects. But in that case the end is a speculative proposition . . . whereas here the conclusion which results from the two premises is an action. . . . I need covering; a cloak is a covering. I need a cloak. What I need, I have to make; I need a cloak. I have to make a cloak. And the conclusion, the "I have to make a cloak," is an action. (Nussbaum, 1978, p. 40)

THINKING

The Growth of Philosophy

It is well to remember that when philosophy emerged in Greece in the sixth century, B.C., it did not burst suddenly out of the Mediterranean blue. The development of societies of reasoning creatures—what we call civilization—had been a process to be measured not in thousands but in millions of years. Human beings became civilized as they became reasonable, and for an animal to begin to reason and to learn how to improve its reasoning is a long, slow process. So thinking had been going on for ages before Greece—slowly improving itself, uncovering the pitfalls to be avoided by forethought, endeavoring to weigh alternative sets of consequences intellectually. What happened in the sixth century, B.C., is that thinking turned round on itself; people began to think about thinking, and the momentous event, the culmination of the long process to that point, was in fact the birth of philosophy. (Lipman, Sharp & Oscanyan, 1980, p. xi)

THINKING

Thought Is, in Great Part, a Public Activity

The way to look at thought is not to assume that there is a parallel thread of correlated affects or internal experiences that go with it in some regular way. It's not of course that people *don't* have internal experiences,

of course they *do*; but that when you ask what is the state of mind of someone, say while he or she is performing a ritual, it's hard to believe that such experiences are the same for all people involved. . . . The thinking, and indeed the feeling in an odd sort of way, is really going on in public. They are really saying what they're saying, doing what they're doing, meaning what they're meaning. Thought is, in great part anyway, a public activity. (Geertz, quoted in J. Miller, 1983, pp. 202–203)

THINKING

In Thinking, Everything Needs to Be Made as Simple as Possible

Everything should be made as simple as possible, but not simpler. (Einstein, quoted in Minsky, 1986, p. 17)

THINKING

The Conditions for the Construction of Formal Thought

What, in effect, are the conditions for the construction of formal thought? The child must not only apply operations to objects—in other words, mentally execute possible actions on them—he must also "reflect" those operations in the absence of the objects which are replaced by pure propositions. Thus, "reflection" is thought raised to the second power. Concrete thinking is the representation of a possible action, and formal thinking is the representation of a representation of possible action. . . . It is not surprising, therefore, that the system of concrete operations must be completed during the last years of childhood before it can be "reflected" by formal operations. In terms of their function, formal opera-

tions do not differ from concrete operations except that they are applied to hypotheses or propositions [whose logic is] an abstract translation of the system of "inference" that governs concrete operations. (Piaget, quoted in Minsky, 1986, p. 237)

THINKING

Language Enables the Rehearsal of Thought and, Thereby, Commitment to Long-Term Memory

[E]ven a human being today (hence, a fortiori, a remote ancestor of contemporary human beings) cannot easily or ordinarily maintain uninterrupted attention on a single problem for more than a few tens of seconds. Yet we work on problems that require vastly more time. The way we do that (as we can observe by watching ourselves) requires periods of mulling to be followed by periods of recapitulation, describing to ourselves what seems to have gone on during the mulling, leading to whatever intermediate results we have reached. This has an obvious function: namely, by rehearsing these interim results . . . we commit them to memory, for the immediate contents of the stream of consciousness are very quickly lost unless rehearsed. . . . Given language, we can describe to ourselves what seemed to occur during the mulling that led to a judgment, produce a rehearsable version of the reaching-a-judgment process, and commit that to long-term memory by in fact rehearsing it. (Margolis, 1987, p. 60)

THOUGHT

The Essential Feature of Thought Is Symbolism

My hypothesis then is that thought models, or parallels, reality—that its essential feature is not "the mind," "the self," "sense-data," nor propositions but symbolism, and that this symbolism is largely of the same kind as that which is familiar to us in mechanical devices which aid thought and calculation. (Craik, 1943, p. 57)

THOUGHT

Thought Begins with Images and Works with Symbols

Human thought begins with images, and still projects them into the symbols with which it learns to work. It is certainly true to say that human language is largely symbolic, and that animal communication is not. (Bronowski, 1977, p. 105)

TIME

The Contradiction Between Physical Time and Psychological Time

In appropriating time for themselves, and abstracting it into a stark mathematical parameter, physicists have robbed it of much of its original, human, content. The physicist will usually say, "Ours is the real time—and all that there really is. The richness of human psychological time derives entirely from subjective factors and is unrelated to the intrinsic qualities of real, physical time"—and then go about his or her work and daily life immersed in the complexities of human time like everyone else.

Should we simply shrug the human experience of time aside as a matter solely for psychologists? Does the time of an altered state of conciousness have no relevance at all to the time of Newton or Einstein? Does our impression of the flow of time, or the division of time into past, present and future, tell us nothing at all about how time *is* as opposed to how it merely appears to us muddle-headed humans?

As a physicist, I am well aware how much intuition can lead us astray. As I remarked earlier, intuition suggests that the sun moves around the earth. Yet, as a human being, I find it impossible to relinquish the sensation of a flowing time and a moving present moment. It is something

so basic to my experience of the world that I am repelled by the claim that it is only an illusion or misperception. It seems to me there is an aspect of time of great significance that we have so far overlooked in our description of the physical universe. (Davies, 1995, p. 275)

TRANSLATION

The Requirements of a Translation Machine

What such a suggestion amounts to, if taken seriously, is the requirement that a translation machine should not only be supplied with a dictionary but also with a universal encyclopedia. This is surely utterly chimerical and hardly deserves any further discussion. (Bar-Hillel, 1960, p. 160)

TRANSLATION

Language Translation and Cognitive Growth

By intervening in highly abstract realms of thought to shape their speakers' cognitive lives, languages act to insure the maintenance across generations of the most complex cognitive attainments of the human race and of the most complex cognitive attainments of its individual cultures. But, ironically, these same cognitive contributions act to separate their speakers cognitively from speakers of other languages—to create and perpetuate significant cognitive barriers to cross-linguistic communication and understanding. The barriers are certainly not impenetrable. But to penetrate them one cannot rely simply on a translation equivalent or a convenient paraphrase. Here, in highly abstract realms of thought, translation depends on, and provides the direction for, cognitive growth. (Bloom, 1981, p. 86)

TROUBLESHOOTING

The Relation of Troubleshooting to Envisioning

The task of troubleshooting is, in many ways, the inverse of envisioning. The troubleshooter needs to move from known function to unknown structure, whereas the envisioning moves from known structure to unknown function. If a fault has in some way perturbed the structure of the device, the troubleshooter, even though he may have complete access to the behavior of the faulted device, no longer has total information about its structure (because, for example, a fault that opened a diode's junction might not, of course, be directly observable). The troubleshooter asks the question, "What could have caused this (symptomatic) overall behavior?" rather than, "What behavior do all these local component behaviors produce when connected in this way?" This troubleshooting process, like that of envisioning, entails extensive problem solving in order to resolve ambiguities. For the troubleshooter, the ambiguities lie in determining which of the many possible causes for a given symptom is the actual one. (deKleer & Brown, 1983, p. 181)

TRUTH

I Am, I Exist Is Necessarily True

Archimedes used to demand just one firm and immovable point in order to shift the entire earth; so I too can hope for great things if I manage to find just one thing, however slight, that is certain and unshakeable.

I will suppose then, that everything is spurious. I will believe that my memory tells me lies, and that none of the things that it reports ever happened. I have no senses. Body, shape, extension, movement and place are chimeras. So what remains true? Perhaps just the fact that nothing is certain.

Yet apart from everything I have just listed, how do I know that there

is not something else which does not allow even the slightest occasion for doubt? Is there not a God, or whatever I may call him, who puts into me the thoughts I am now having? But why do I think this, since I myself may perhaps be the author of these thoughts? In that case am not I, at least, something? But I have just said that I have no senses and no body. This is the sticking point: what follows from this? Am I not so bound up with a body and with senses that I cannot exist without them? But I convinced myself that there is absolutely nothing in the world, no sky, no earth, no minds, no bodies. Does it now follow that I too do not exist?

No: if I convinced myself of something then I certainly existed. . . . So after considering everything very thoroughly, I must finally conclude that this proposition, *I am, I exist*, is necessarily true whenever it is put forward by me or conceived in my mind. (Descartes, 1984, pp. 16–17)

TRUTH

The Great Discoverer Does Not Seize at Once upon the Truth

It would be an error to suppose that the great discoverer seizes at once upon the truth, or has any unerring method of divining it. In all probability the errors of the great mind exceed in number those of the less vigorous one. Fertility of imagination and abundance of guesses at truth are among the first requisites of discovery; but the erroneous guesses must be many times as numerous as those that prove well founded. The weakest analogies, the most whimsical notations, the most apparently absurd theories, may pass through the teeming brain, and no record remain of more than the hundredth part. (Jevons, 1900, p. 577)

TURING MACHINE

The Claim That Man Can Be Understood as a Turing Machine

[W]hen Minsky or Turing claims that man can be understood as a Turing machine, they must mean that a digital computer can reproduce a human behavior . . . by *processing data representing facts about the world using logical operations* that can be reduced to matching, classifying and Boolean operations. (Dreyfus, 1972, p. 192)

U

UNCONSCIOUS
How the Idea and the Term "Unconscious Mind" Entered European Thought

Prior to Descartes and his sharp definition of the dualism there was no cause to contemplate the possible existence of unconscious mentality as part of a separate realm of mind. Many religious and speculative thinkers had taken for granted factors lying outside but influencing immediate awareness. . . . Until an attempt had been made (with apparent success) to choose *awareness* as the defining characteristic of mind, there was no occasion to invent the idea of *unconscious* mind. . . . It is only after Descartes that we find, first the idea and then the term "unconscious mind" entering European thought. (Whyte, 1962, p. 25)

UNCONSCIOUS
Why Awareness Cannot Be Taken as the Criterion of Mentality

If there are two realms, physical and mental, awareness cannot be taken as the criterion of mentality [because] the springs of human nature lie in the unconscious . . . as the realm which links the moments of human awareness with the background of organic processes within which they emerge. (Whyte, 1962, p. 63)

UNCONSCIOUS

The Unconscious Was Not Invented by Freud

[T]he unconscious was no more invented by Freud than evolution was invented by Darwin, and has an equally impressive pedigree, reaching back to antiquity. . . . At the dawn of Christian Europe the dominant influence were the Neoplatonists; foremost among them Plotinus, who took it for granted that "feelings can be present without awareness of them," that "the absence of a conscious perception is no proof of the absence of mental activity," and who talked confidently of a "mirror" in the mind which, when correctly aimed, reflects the processes going on inside it, when aimed in another direction, fails to do so—but the process goes on all the same. Augustine marvelled at man's immense store of unconscious memories—"a spreading, limitless room within me—who can reach its limitless depth?"

The knowledge of unconscious mentation had always been there, as can be shown by quotations from theologians like St. Thomas Aquinas, mystics like Jacob Boehme, physicians like Paracelsus, astronomers like Kepler, writers and poets as far apart as Dante, Cervantes, Shakespeare, and Montaigne. This in itself is in no way remarkable; what is remarkable is that this knowledge was lost during the scientific revolution, more particularly under the impact of its most influential philosopher, René Descartes. (Koestler, 1964, p. 148)

UNCONSCIOUS

The Constructive Nature of Automatic Cognitive Functioning Argues for the Existence of Unconscious Activity

The constructive nature of the automatic functioning argues the existence of an activity analogous to consciousness though hidden from observa-

tion, and we have therefore termed it *unconscious*. The negative prefix suggests an opposition, but it is no more than verbal, not any sort of hostility or incompatibility being implied by it, but simply the absence of consciousness. Yet a real opposition between the conscious and the unconscious activity does subsist in the limitations which the former tends to impose on the latter. (Ghiselin, 1985, p. 7)

UNCONSCIOUS THINKING

The Role of Chance in Mental Processing

[It is first] necessary to construct the very numerous possible combinations. . . . It cannot be avoided that this first operation take place, to a certain extent, at random, so that the role of chance is hardly doubtful in this first step of mental process. But we see that the intervention of chance occurs inside the unconscious: for most of these combinations—more exactly, all of those which are useless—remain unknown to us. (Hadamard, 1945, p. 28)

UNDERSTANDING

Understanding Is More than the Sum of Words in the Input Sentence

If we understand something, our interpretation is always much more than the comprehension of the sum of the words of the input sentence. (Rumelhart, 1977, p. 167)

UNDERSTANDING
The Clarity of Speaking and Thinking

Never speak more clearly than you think. (Bernstein, quoted in Minsky, 1986, p. 322)

UNDERSTANDING
The Hardest Thing to Understand

The hardest thing to understand is why we can understand anything at all. (Einstein, quoted in Minsky, 1986, p. 319)

V

VERIFICATION
The Verification Stage in Problem-Solving

I did not verify the idea; I should not have had time . . . but I felt a perfect certainty. On my return to Caen, for conscience sake, I verified the result at my leisure. (Poincaré, 1913, p. 388)

VIEWS
Freud's View of Himself

I am not really a man of science, not an observer, not an experimenter, and not a thinker. I am nothing but by temperament a *conquistador*—an adventurer, . . . with the curiosity, the boldness, and the tenacity that belong to that type of being. (Freud, quoted in E. Jones, 1961, p. 227)

VIEWS
Persons Are Agents Faced with Choices and Persons Are Physical Mechanisms

We must start by recognizing that there are two very different points of view which we can take toward human behavior, that neither of these

points of view can be rejected, and that an adequate conceptualization of human behavior must have room for both. One point of view is that of theoretical sciences like physics. Whatever else we may want to say of persons, they surely are material organizations, and as such, the laws of physics, chemistry, etc. must apply to them. . . . So actions can . . . be viewed as physical phenomena whose explanation must be found in other physical phenomena in the brain and nervous system. . . .

A very different, but equally indispensable, point of view is that of the agent who is faced with choices, deliberates, makes decisions, and tries to act accordingly. . . . [H]uman beings can have a *conception* of what it is they want and what they should do in order to get what they want, and . . . their conceptions—the meaning which situations and behaviors have for them in virtue of the way they construe them—can make a difference to their actions. . . .

We cannot eliminate the notion that we are agents because it is central to our conception of what is to be a person who can engage in practical life. But I can also look at myself from a purely external point of view, as an object in nature, and that my behavior must then be seen as caused by other events in nature is central to our conception of physical science. (Mischel, 1976, pp. 145–146)

VIEWS

Points of View Can Not Be Excluded from Any Serious Account of the World

There are things about the world and life and ourselves that cannot be adequately understood from a maximally objective standpoint, however much it may extend our understanding beyond the point from which we started. A great deal is essentially connected to a particular point of view, or type of point of view, and the attempt to give a complete account of the world in objective terms detached from these perspectives inevitably leads to false reductions or to outright denial that certain patently real phenomena exist at all. (T. Nagel, 1986, p. 7)

VIRTUAL MACHINE

The Formal Structure of the Virtual Machine

[T]wo programs can be thought of as strongly equivalent or as different realizations of the same algorithm or the same cognitive process if they can be represented by the same program in some theoretically specified virtual machine. A simple way of stating this is to say that we individuate cognitive processes in terms of their expression in the canonical language of this virtual machine. The formal structure of the virtual machine—or what I call its *functional architecture*—thus represents the theoretical definition of, for example, the right level of specificity (or level of aggregation) at which to view mental processes, the sort of functional resources the brain makes available—what operations are primitive, how memory is organized and accessed, what sequences are allowed, what limitations exist on the passing of arguments and on the capacities of various buffers, and so on. (Pylyshyn, 1984, p. 92)

VIRTUE

Knowledge of the Ideal Forms

First, virtue is ultimately one, not many, and it is always the same ideal form regardless of climate or culture.

Second, the name of this ideal form is justice.

Third, not only is the good one, but virtue is knowledge of the good. He who knows the good chooses [not] the bad.

Fourth, the kind of knowledge of the good which is virtue is philosophical knowledge or intuition of the ideal form of the good, not correct opinion or acceptance of conventional beliefs. (Socrates, quoted in Kohlberg, 1971, p. 232)

W

WILL

The Will Is, in Its Nature, Free

But the will is so free in its nature, that it can never be constrained. . . . And the whole action of the soul consists in this, that solely because it desires something, it causes a little gland to which it is closely united to move in a way requisite to produce the effect which relates to this desire. (Descartes, 1897–1910, p. 350)

WISDOM

Wisdom Depends on a Kind of Emergent Competence

The emergence of a competency factor seems to imply that wisdom must rest on a sound foundation and that the superior abilities of wise people are rooted in a necessary prerequisite level of skill. (Holliday & Chandler, 1986, p. 80)

WORDS

Words and Images

Words are but the images of matter . . . to fall in love with them is all one as to fall in love with a picture. (Bacon, 1878, p. 120)

WORDS

The First Symbols of the Child Are Word-Sentences Designating Action

Chamberlin, Tracy, Dewey, Binet and others have shown that the child's symbols are action-words, i.e., their content is action. There is also practically universal agreement on the fact that the first symbols of the child are in reality word-sentences designating action and object or subject, or all three at once. (Markey, 1928, p. 50)

WORDS

The Relation of Words to Conceptual Development

The child can very readily learn at the age of three that "right" and "left" each refers to a side of the body—but ah me, which one? . . . What is set up first is a conceptual organization. By the age of six the word "right" clearly and immediately means sidedness to the child. A considerable conceptual elaboration has already occurred, and the stimulus effectively

arouses that structure; but it arouses no prompt, specific response. . . . With such facts, it becomes nonsense to explain man's conceptual development as exclusively consisting of verbal associations. (Hebb, 1949, p. 118)

WORDS

Words Are the Means by Which We Form All Our Abstractions

The use of language is not confined to its being the medium through which we communicate ideas to one another. . . . Words are the instrument by which we form all our abstractions, by which we fashion and embody our ideas, and by which we are enabled to glide along a series of premises and conclusions with a rapidity so great as to leave in memory no trace of the successive steps of this process; and we remain unconscious of how much we owe to this. (Roget, quoted in Minsky, 1986, p. 197)

WORDS

Disengaging the Interwoven Ramifications of Categories of Words

Any attempt at a philosophical arrangement under categories of the words of our language must reveal the fact that it is impossible to separate and circumscribe the several groups by absolutely distinct boundaries. Were we to disengage their interwoven ramifications, and seek to confine every word to its main or original meaning, we should find some secondary meaning has become so firmly associated with many words and phrases, that to sever the alliance would be to deprive our language of the richness due to an infinity of natural adaptations. (Roget, quoted in Minsky, 1986, p. 206)

WRITING

The Book Writing Process, According to Bertrand Russell

Very gradually I have discovered ways of writing with a minimum of worry and anxiety. When I was young each fresh piece of serious work used to seem to me for a time—perhaps a long time—to be beyond my powers. I would fret myself into a nervous state from fear that it was never going to come right. I would make one unsatisfying attempt after another, and in the end have to discard them all. At last I found that such fumbling attempts were a waste of time. It appeared that after first contemplating a book on some subject, and after giving serious preliminary attention to it, I needed a period of subconscious incubation which could not be hurried and was if anything impeded by deliberate thinking. Sometimes I would find, after a time, that I had made a mistake, and that I could not write the book I had had in mind. But often I was more fortunate. Having, by a time of very intense concentration, planted the problem in my subconsciousness, it would germinate underground until, suddenly, the solution emerged with blinding clarity, so that it only remained to write down what had appeared as if in a revelation. (Russell, 1965, p. 195)

WRITING

Without Writing, the Literate Mind Would Not and Could Not Think as It Does

Without writing, the literate mind would not and could not think as it does, not only when engaged in writing but normally even when it is composing its thought in oral form. More than any other single invention, writing has transformed human consciousness. (Ong, 1982, p. 78)

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