CHAPTER SIX

Linguistics and Artificial Intelligence:
An armchair drama in 3 acts,
with a prologue and an epilogue

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1. Prologue

Let us imagine a meeting between a linguist and a specialist in artificial intelligence. There is a common understanding that each field may and will profit from closer contacts with the other. But so far little has been done to overcome the all too human feelings of apprehensiveness and resentment against each other’s ‘misrepresentation’ of, ‘immateriality’ to, and ‘failure’ with, the problems of the study of language. Our characters are resolved, if not to alleviate this friction, then at least to clarify the respective positions and look for mutually acceptable ways of cooperation.

The artificial intelligence researcher is primarily interested in natural language processing, unlike many of his friends who work in such fields as computer vision, game playing, theorem proving, etc. A diligent person, this researcher—let us call him AI, for convenience—once set out to read all the linguistic materials he could find that might have shed light on the ways to construct a computer system for processing natural language. Had he found ready-made answers he would have simply represented the linguistic rules and structures in LISP (or another suitable programming language) and thus would have obtained a self-contained ‘linguistic’ module to be used in any natural language-related application, such as a knowledge-based ‘expert’ system, a translating machine, etc. Rather unexpectedly, AI discovered that linguistics cannot offer certified answers, that it is a complex field of study in which a number of hypotheses about the language structure and meaning compete for recognition and priority, and that even the better ideas and theories are being refuted on a regular basis. (We can only guess what AI’s confusion would be if he were told that what he observed was but a tip of the linguistic iceberg: namely, the transformationalist theories; and that linguistics can offer more insights at the philosophical and meta-theoretical level than suggested there.) After attempting halfheartedly to follow the arguments of all the sides in the linguistic dispute and trying (with results worse than expected) to use the transformational grammars (Chomsky

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1957, 1965) directly for computer generation (cf. Petrick 1965) and analysis (e.g., Kuno and Oettinger 1963; Zwicky et al. 1965), AI then concluded that the best linguistics could offer at the moment for extensive use in artificial intelligence research was the idea of case grammars (Fillmore 1968, 1971). (There were some attempts at using dependency grammars (e.g., Hayes 1964) and systemic grammars (Halliday 1970), but they were lone, if well-known, attempts and were not pursued widely.) The case grammars were modified slightly (Simmons 1973) or significantly (Schank 1973, 1975); and used in various computer systems (cf. Samlowski 1976; Bruce 1975; Winograd 1983, for three surveys).

AI brought himself to accept the obvious incompleteness of the current versions of case grammars by convincing himself that for the purposes of intelligent computer systems nothing more was necessary. Some more ideas (notably, the notion of ‘natural logic’) were picked up in the linguistic realm, but AI effectively decided to be self-sufficient in dealing with problems of language. The prevalent position was: ‘Linguistics, as it is at the present time, cannot help us to build intelligent machines.’ Incidentally, many of AI’s best friends are linguists.

The linguist, L, has been bred on (though does not necessarily strictly adhere to) the transformationalists approach. He recognizes semantics as a vital component of linguistics and does not divorce language from its communicative function. Therefore, pragmatics, the field that studies language carriers in their relationship to the world they inhabit, as well as to each other, is one of the aspects of the study of language that interests him most. He is not sure that there is still any sense in staunchly defending the emphasis on the study of linguistic competence at the expense of performance, though he admits that the former approach has come up with more detailed formalisms. The historically ‘post-Chomskian’ or independently pursued topics of pragmatic presupposition, speech acts, conversational postulates, natural logic, language formulae, etc., have been more or less central to his studies. He was even for some time toying with the idea of borrowing the notion of frame (from artificial intelligence or directly from psychology) for use in language analysis.

He has an open mind towards computers and their application in linguistic research. As a matter of fact, he used to take part in building concordances and thesauri with the help of a computer. Of course, he has always understood the proper place of the computer: it is a tool, not unlike a pen or a pocket calculator. Artificial intelligence does not employ ‘smart’ computers; there is no such thing: computers are nothing but behemoth number-crunchers. Computer programs are being built that simulate ‘intelligent’ behavior, but these are more products of ingenious craftsmen than results of the application of scientific theories. In short, the linguist believes that artificial intelligence is an art. (We can only guess at what L’s reaction would be if he heard that there is a lively discussion in the field of computer science as to whether computer programs may be regarded as theories.) At the same time L welcomes the thought that computers may be
useful in more than the one simple way he is aware of. Needless to say, many of L’s best friends are computer scientists.

Obviously, AI and L have a great deal to discuss. The most important thing for each of them to learn is what bearing his own discipline exerts on the other and, conversely, what use the other field has for his own. Ironically, AI and L hold very restrictive and unflattering views of each other’s positions. In reality, however, neither is as narrow-minded as the other side believes.

2. Act One. Mostly Definitions

AI: If we are to discuss the relations between our fields, then the best starting point will be to clarify whether we have a common understanding of the scope and goals of these disciplines. In my understanding, linguistics is a field whose object of study is natural language, especially the rules governing the construction of correct texts in natural language. Of course, not only may sincerity frighten the boy, but also my pet amoeba believes that I am a lousy cook. In general, though, the emphasis is on syntactic studies since the bulk of the formalisms for natural language is syntactic rather than semantic, to say nothing about the connection with the models of the real world in which language is a phenomenon. Also, linguists speak exclusively about structures, with a complete blackout on processes involved in language comprehension and production.

L: I think I must first of all thank you for just considering linguistics a scientific discipline. This is a welcome change from Wilensky’s claim that “artificial intelligence is the real psychology, linguistics and philosophy” (Brachman and Smith 1980:109). Seriously, it is quite difficult to present a noncontroversial definition of a scientific field in a couple of sentences. Your definition tends to be closer to that of microlinguistics in the sense of Lyons (1981:36). First of all, people who work on comparative grammars of Semitic languages or on the intonation patterns in Burushaski are still linguists. The emphasis on language at the expense of languages is mostly a feature of just one influential stream in linguistic science that has come to be known as the Chomskian or transformationalist approach. Note that I use these names only as a rough reference, since many modern linguists would reject any association of their work with either Chomsky or the notion of transformations. Still, they share the basic attitude towards linguistic study and, at least for an outsider, constitute a group.

AI: For me this theoretical part of linguistics is the most interesting or even the only linguistics there is.

L: This is a restrictive position: pre-Chomskian linguistics is not necessarily nontheoretical. Linguistics as the study of language long predated Chomsky. Moreover, the status of the linguistic ‘field work’ is not unlike that of the numerous computer systems dealing with language. A grammar of Mohawk may
carry as much (or as little) theoretical message as a system of augmented transition network--based parsing of Hebrew.

Back to the attempt at definition. Based on the idea that humans possess an innate language ability, linguistic competence, the linguists proceed to build theories about what makes a language entity (an utterance or a text) grammatical, meaningful, and appropriate. If an entity does not possess at least one of the above properties, it is considered 'incorrect,' or, more properly, not a language entity at all. And this is the sense in which I can agree with your usage of the word 'correct.' As an illustration, (1) is ungrammatical, (2) is grammatical but meaningless, and (3) is grammatical and meaningful, but inappropriate if uttered at noon.

(1) *Done have homework he been his.
(2) *Colorless green ideas sleep furiously.
(3) This is the happiest night of my life.

One tradition is to connect grammaticality with syntax, meaningfulness with semantics, and appropriateness with pragmatics. Another understands grammaticality as the sum of all three.

AI: I have several questions to ask. The first concerns the problem of completeness: Can it be proved that still further constraints on the notion of grammaticality will not be necessary, that is, that the above triad adequately describes the notion of 'correctness' underlying much of the theoretical work in linguistics? Second, what are the criteria that permit us to judge a theory's verdict about the 'correctness' of a language element? Do these belong to the field of linguistics or is there a need to borrow them from another field, possibly psychology or philosophy? Third, where does the competence assumption fit in here, or, in other words, why should the notion of the 'innate linguistic faculty' be the foundation of the whole edifice of the linguistic theory? And, finally, a simple observation: Does the notion of grammaticality need to be concentric? Isn't it possible, say, for an utterance to be meaningful and appropriate but 'ungrammatical'; I mean, syntactically unacceptable, and, at the same time readily understandable?

L: The first and the second questions would warrant book-length answers. In a sense, this is what linguistics is all about. I hope we shall return to a discussion of the second question, because the problem you mention, justification, is a methodological cornerstone not only of linguistics but also of artificial intelligence, cognitive psychology, and, as a matter of fact, science in general. The notion of competence, or rather the distinction between competence and performance, has been a very useful methodological tool that was also an expression of a hypothesis about human cognitive processes. True, it could not
provide a basis for a universal linguistic theory, and it is for a long time now that some linguists have considered the study of performance at least as important as the study of competence.

Your fourth question, however, seems to be an expression of a certain assumption that I'd like to clarify. By questioning the 'concentricity' of the composite grammaticality notion you proclaim the primacy of semantics and pragmatics over syntax. First, the suggestion that since 'irregular' syntactic constructions are habitual in language use, syntax is largely irrelevant for the study of language, rests on false premises. Let me suggest that it may well be a fault of the theories of syntax that they became to a certain extent prescriptive: a certain class of structures was declared 'grammatical' and the discrepancy between this class and the existence of a larger set of structures judged to be proper and applicable by native speakers was explained in terms of the competence/performance dichotomy, which implied that performance may vulgarize the 'true' theory of competence understood as the structure of the well-delineated notion of an innate 'language faculty' in man.

Al: Yes, this state of affairs was, to a certain extent, inherited by the natural language analysis within the artificial intelligence paradigm. Consider, for example, the necessity of introducing weakening extensions, such as 'relaxation techniques' of Kwasny (1980) or systems for treating 'unparseable inputs' (cf. Weischedel and Black 1980) to the ATN parsers for English that were programs processing language within theoretically 'prescribed' syntax (cf. Woods 1970).

L: Arguably, ATN parsers themselves are not exactly products of a linguistically sound research, largely because they were never seriously meant to be more than frameworks for the applications of linguistic theories (cf. the claimed ability of ATNs to accommodate multiple linguistic approaches in Bates 1978; cf. also the discussion in Winograd 1983:Chapters 5 and 7).

The notion of competence, however, has played a singularly important part in making the theories of syntax within the transformational framework possible. This role resembles, for example, that of the notion of 'ideal gas' for physicists. The abstraction was necessary as an initial simplification. There may be a theory that will classify the previously rejected elements as correct.

Al: But what about the following opinion: "'The theory of linguistic competence is a proper subpart of a theory of performance, not some first approximation of one'" (Dresher and Hornstein 1977a)?

L: As you may have guessed already, this position can be defended only by somebody who desperately needs to maintain the original distinction between competence and performance. Remove this distinction, and the domino effect will immediately follow: most of the proposals within this particular approach will fall with it. At present, almost two decades after Chomsky's Aspects, it is only a minority in the linguistic community that subscribes to this idea in its original formulation. It may be erroneous to speak about language entities that satisfy pragmatic and semantic requirements but fail at the syntactic level. There
might be a better, weaker linguistic theory, in which today’s irregularities will cease to be such. It remains to be seen whether such a theory will seriously rely on semantics and pragmatics for its explanatory force, but so far nobody has produced a framework, let alone the formalism for such a theory, certain claims to the contrary notwithstanding. (The lexical-functional grammar of Kaplan and Bresnan 1982 is inspired by the all-encompassing Chomskian universal grammar, e.g., Chomsky 1975, which in its most cautious definition is weak enough; but the lexical-functional grammar itself is still a ‘strong’ claim.)

In artificial intelligence, the initial dissatisfaction with what linguistics had to offer for syntactic analysis led to the quick opinion that since semantic processing is to be done anyway in the process of language comprehension or generation (and procedural thinking prevails in artificial intelligence), then one might dispense with syntax or demote it to the status of a poor relative who does not deserve a full-fledged treatment. (Schank and Birnbaum 1980 is a very forcefully expressed statement to this effect; Raskin 1971 may well be the earliest such claim.) To be sure, this might be the description of an extreme position. But it reflects many a theoretical position and the mainstream of current knowledge-based language understanding practice. This is a reaction against the ‘autonomy of syntax’ hypothesis, which was erroneously perceived by most in artificial intelligence as a claim that semantics (and phonology, and pragmatics) should play only a supporting role to syntax.

In fact, the claim was that it is possible to study syntax in isolation from semantics, etc., and carried a methodological significance: if accepted, it brought along hope that a theory of syntax could be built in the observable future. This methodological device need not be considered relevant only to linguistics. Winograd (1983:151–3) discusses this hypothesis in terms of a “nearly decomposable system” in which the relations between different components (in our case, syntax and semantics) are in a certain sense weaker than the relations between elements and phenomena within each single component. The perception mistake made by artificial intelligence workers was confounded by the fact that, indeed, after making the methodological assumption of the above autonomy, many (if not most) linguists attacked specifically syntax—so that it appeared that this is the only thing they were interested in. This reaction notwithstanding, the artificial intelligence people should not have been drawn to the opposite extreme: after all, syntactic ambiguity is one of the most widespread and common phenomena (remember old men and women, flying planes, and scores of other famous examples).

AI: Let us go on with our agenda. It is time now to learn what you mean by ‘artificial intelligence.’

L: Artificial intelligence is a collection of computer techniques and programs that desires to make the computer carry out tasks previously done by humans. The main idea is to explore the ways in which such a powerful tool as the digital computer may become an extension of the brain. So understood, the
task of artificial intelligence products is not unlike that of the alphabet, the abacus, the book, and the pencil. This is the latest entry on the list of 'mental work implements,' just as, say, the space shuttle is one of the newest transportation means. Once man had to retain in his own memory all the information he had to process; then he invented cuneiform tablets and papyrus. Once man had to understand mass spectrograms manually; now DENDRAL does it for him.

AI: Well, isn't this a restrictive definition! I am sure you include more in the notion of artificial intelligence than you just said. You know, in an argument people tend to slide towards more extreme and irreconcilable positions than they really hold. Tell me, would you describe our field in the same way if you were talking with another linguist?

L: This is quite immaterial to our discussion.

AI: In the short history of artificial intelligence one can find descriptions of its object of study similar to the one you suggested. Thus, Newell offers three possible views of artificial intelligence: 1) as the science concerned with the answer to the question, "What mechanisms can accomplish what intellectual functions?" (1973:2); 2) "as a field devoted to the discovery and collection of a set of methods," where the methods have three components: the problem statement, the procedure, and, most notably, the justification, "the reasons for believing that if the conditions of the problem statement are satisfied, then the procedure may result in a solution" (op. cit.:9); and 3) as a field "that serves as theoretical psychology if one adopts the view of man as a processor of information, represented as a system of discrete symbols" (op. cit.:26). He then goes on to state that the first view is "closest to the historical truth in terms of the motivations and fascinations of the men who have worked and dabbled in the field of artificial intelligence" (op. cit.:2).

He also admonishes that "sciences are not defined, they are recognized." Perhaps this is a reason why the authors of major artificial intelligence textbooks often seem reluctant to present a definition of the subject, choosing instead to delve immediately into the description of specific methods or subfields (cf. Bundy 1978, Nilsson 1981, Raphael 1976, though the latter may be considered a 'popular' introduction to the discipline).

L: Come to think of it, this state of affairs is not surprising. The thoughts about defining a subject usually follow the accumulation of facts in it. In the meantime, the 'working' definitions make do. Indeed, one would imagine that a course in, say, foundations of mathematics, would be offered to students only after they have had a couple of thousand hours of elementary and advanced calculus, algebra, etc.

AI: Yes, this might be one of the reasons for those authors who did include a definition not to pursue the discussion of it any further. Here is an assorted set of definitions:

"Artificial Intelligence is concerned with the creation of computer programs capable of performing tasks normally considered to require intelligence—from
chess playing to medical diagnosis. Many such tasks involve the use of natural language and by this route Artificial Intelligence adds itself to the list of disciplines concerned with the problems of language comprehension” (Charniak 1976:1).

“The central goals of Artificial Intelligence are to make computers more useful and to understand the principles that make intelligence possible” (Winston 1977:1).

“The goal of Artificial Intelligence is commonly considered to be making machines intelligent” (Schank and Riesbeck 1981:1).

L: Notice that these definitions beg the question of what is intelligence, and that notion remains undefined.

AI: Right. More. “Artificial intelligence is the study of complex information processing problems that often have their roots in some aspect of biological information processing. The goal of the subject is to identify interesting and solvable information processing problems, and solve them” (Marr 1977:37).

Charniak’s, Winston’s, and Schank and Riesbeck’s definitions can be classified as the ‘brush-off’ type. Marr, however, attempts to put artificial intelligence in some sort of perspective by defining a subject which is (or can be) claimed by linguistics, psychology, philosophy, computer science, neurophysiology, etc. Marr also goes on to distinguish between two kinds of endeavors: the ‘what-and-why’ and the ‘how’ approaches. The former, called ‘Type 1 theories,’ are assigned the task of characterizing the underlying nature of a particular computation and its basis in the physical world. ‘Type 2 theories’ consist of particular algorithms for implementing computations.

Your definition of artificial intelligence describes just the latter approach. This position is hardly defensible on methodological grounds and is easier to attack. Marr himself has the following criticism to offer: “Most AI programs have hitherto amounted to Type 2 theories, and the danger with such theories is that they can bury crucial decisions . . . beneath the mound of small administrative decisions that are inevitable whenever a concrete program is designed” (1977:39).

In a rather uncharacteristic mood, Schank declared: “Artificial intelligence is a field that is not exactly sure what it is about” (1979:196). Is this statement strange coming from one of the foremost authorities in AI? No. It is a request for postponement of (possibly negative) judgment on AI—until the time it becomes a full-fledged scientific discipline.

Having seen some of the views of the ‘insiders,’ let’s now present a view on artificial intelligence held by a philosopher. Ringle (1979:7) divides artificial intelligence into four streams: technology, simulation, modelling, and theory. Technology constructs systems that demonstrate intelligent behavior “irrespective of whether its data structures relate in any way to human data structures.” Simulation does essentially the same, but claims an affinity between the behavior of the program and that of human beings. Models are simulations that are less
concerned with imitation of behavior and that stress the claimed similarities between the man and the machine as regards the data structures, internal states, and information processes. This is obviously the home turf of cognitive psychologists, who often feel robbed of their own subject of study by the villainous artificial intelligence people just as acutely as you feel about linguistics (cf., e.g., Longuet-Higgins 1981).

Theory is "interested in principles of knowledge and intelligence which may be used to account for concrete, physically-instantiated, time- and perspective-dependent cognition" (Ringle 1979:10). It is quite transparent that the latter part of this definition serves the purpose of preventing artificial intelligence from claiming the home turf of yet another (Ringle's own) discipline—philosophy, or, more concretely, epistemology.

L: Thank you. This has been an enlightening survey. I think it's time to discuss in great detail the attitudes linguistics and artificial intelligence have about each other.

AI: OK. One final remark. Roughly what Ringle calls artificial intelligence theory and modeling has recently acquired a new alias: cognitive science. By calling themselves cognitive scientists the new generation of researchers wanted to dissociate themselves from the technological heritage of their field. Winograd (1983:2) writes: "Much of the work in computer science has been pragmatic, based on a desire to produce computer programs that can perform useful tasks. But the design of computational systems also has a theoretical side, which is often called cognitive science. The same concepts of program and data that serve as a framework for building and understanding computer programs can be applied to the understanding of any system carrying out processes that can be understood as the rule-governed manipulation of symbols."

L: Yes, maybe the concepts of programming can be applied in manipulating any kind of symbols, but where is the proof that they should? Simply because there is a method or an approach that works in the field where it was first introduced does not necessarily mean that it will work in another field, or that this infusion will solve the problems better than the methods that had been acquired as a result of the efforts of many generations of workers in the 'recipient' field, in this case, linguistics.

3. Act Two. Mostly Grievances and Prejudices

L: I should have noted last time that, though we have finally arrived at a definition of artificial intelligence that is much more palatable than I had supposed, it by no means reflects the majority position. Philosophical problems aside, most of the people in the field are still wary of the distinction among technology, modeling, and theory. They are driven by methodological inertia. Maybe public opinion is partly to blame, what with the spectacular encroachments of computers into our everyday life. Artificial intelligence is currently in
vogue. It is this field that is currently entrusted with that elusive magician's wand which is supposed to help solve all problems of knowledge, language, and universal welfare. This may be one of the reasons why "the growth rate of the AI community seems to be faster than that of the population of some countries," to use Firdman's apt metaphor (1982:3).

AI: Why don't you mention the upsurge in linguistic research in the late fifties and early sixties—in the era of *Syntactic Structures*? Was the situation then dissimilar to what you observe in artificial intelligence now? Did you object to that instance of the same phenomenon?

L (paying no attention to AI's last words, reads from a prepared statement)
The problem with artificial intelligence may be its sheer success. The field has been quite productive in accumulating various kinds of knowledge previously unavailable. The general mood has been quite upbeat, in part because so many palpable results in the form of new programs and systems have appeared. Less emphasis has been placed upon the justification of the solutions and those clusters of working decisions that can be upgraded to the status of theories. The amount of work invested in building extensive programs seemed to justify the exalted attitude towards 'working systems,' regardless of their theoretical merit. Essentially no criticism of any work in the field was accepted from the outside on the grounds that nobody who had not built a computer system had the right to express (unfavorable or critical) opinions. "Do some real work before you speak up!" was the general advice. Real work was writing computer programs.

AI research remains at present unchallenged in the sense that there is enough room for everybody. The AI 'economy' is still extensive: there are enough fields for everybody to plow. This can be exemplified by the history of the Yale AI project. There we had a succession of emphases: first on parsing, then on memory and inference making, which spawned a number of knowledge representation applications. Now Schank (1982) claims that it's time to look at learning. We are led to believe that the former problems have been already solved and the solutions verified, proved, and sealed. Of course, even Schank himself obviously cannot think so, but the edge that the curiosity of the kind "Will it work in learning too?" holds over the tenacity in justification and modification 'chores' is disconcerting. However, this cream skimming over a variety of fields is not unfortunate in itself. A less welcome thing is the almost universal conviction that anything that works is correct theoretically. One need not go far to find numerous assertions like: "Our two goals for SOPHIE's natural language processor are efficiency and friendliness" (Brown and Burton 1975:330); "The strongest support for procedural representation comes from the fact that is works" (Winograd 1975:190); "The justification for the representation is not at all a 'vague intuition' . . . but its demonstrable ability to be used as a basis for inference" (Schank and Wilensky 1977:100); "Rules [for manipulating conceptual dependency representations] are determined by the task at hand" (ibid.); "We were not as concerned with the ultimate correctness of the [conceptual dependency]
system as we were with its usability. No other canonical form existed, and the transformational deep structure representations and predicate calculus . . . neither adequately represented meaning nor were in any sense canonical" (Schank 1980:251). One is immediately tempted to ask, What is canonical? What makes an approach canonical? Should the conceptual dependency theory become canonical, and why?

There are, however, other voices in the artificial intelligence community. Hayes (1980:242–4) has the following to offer: "All too often, serious work on representational issues in AI has been diverted or totally thwarted by premature concern for computational issues. . . . It is tempting to make . . . demonstrations [of working systems] from time to time. (They impress people; and it is satisfying to have actually made something that works, like building model railways; and one’s students can get Ph.Ds that way.) But they divert attention from the main goal. . . . It is perilously easy to say that, because one has a program that works (in some sense), its representation of its knowledge must be more or less correct (in some sense)."

I fully agree with this position. Too much of ‘theoretical’ work in the field has been the process of very intelligent and ingenious groping in the dark in hope that ‘something will click.’ "[In AI] one can try out ideas (to see if they ‘work’) at the terminal, without even having thought about them before" (Ades 1981:13). Consider the following situation: if you face, say, a cryptarithmetic puzzle, your first impulse is to try to substitute the digits for letters at random—to see whether you could stumble on the solution without even attempting a systematic search. Only after being discouraged by several consecutive failures you start to contemplate a more systematic, theoretical approach. The same with a bundle of keys to try out on an unknown lock. The same with any other everyday activity that involves search. This generalization seems, incidentally, sufficient to postulate a special try-at-random plan-box for the goal D-SOLVE (cf. Schank and Abelson 1977:88–97; my apologies for the unsolicited suggestion). Such activities, however psychologically real and observable, cannot qualify as construction of theories. Not so, say Schank and Wilensky: "... AI methodology—that is, building a program as a test of theory—has been extremely useful in pointing out deficiencies of theories, and uncovering problems that were not understood beforehand. For example, the problem of controlling the proliferation of inferences that occurred in programs like MARGIE (Schank et al. 1973) was not even recognized as a problem until we built a program that attempted to make inferences" (Schank and Abelson 1977:138).

This example does not corroborate the point—it refutes it! If MARGIE is a program that carries out inference making, then, according to the methodological statement above, there was a theory of inferences that MARGIE was supposed to test. So, what was that theory like if such an important problem as proliferation control was not addressed in it? "... It is just the fact that we don’t know what the correct theory [of language] is that makes experimentation so useful" (op.
cit.:139). Again, the impression is that experimentation is believed to be the process of building theories by 'groping' and not a means of justification and comparison. OK, you do not consider all the other theories of language or of knowledge representation and use adequate, but then the desire to implant your own hypothesis firmly in the AI—cognitive science—linguistics turf must compel you to come up with counterexamples, if not alternate theories, all by yourself, and at the very least, to emphasize the importance of the very job of 'doing justification.'

Moreover, it still needs to be shown that the empirical attitude of experimentation before theorizing is viable at all. In fact, I am sure that when faced with the question, "Is it possible for an experiment to be conducted without a certain (even not yet well-formulated) theory underlying it?" almost every AI researcher will take the Popperian anti-positivist viewpoint to answer in the negative. Why then are working programs considered to be on par with theories by so many? (For further discussion cf., e.g., Simon 1979, for a philosopher's view, and Winograd 1977:172, for that of a worker in AI.)

AI: It is quite interesting that the main topic of your critique has so far been methodological. I expected a different tune. Maybe something to the effect that we disregard the results of a generation in linguistics only to redo essentially the same research, or that our study of language does not in effect contribute anything to the study of language, or that our results are but very partial because of the insufficient generality of domains in our applications. Also, it seems strange that such criticism should come from a linguist: won't you agree with me that, to put it mildly, the concern for justification is hardly among the first items on the agenda of any linguist? Those few who address this problem specifically agree that justification, at least other than a simple and always very fuzzy reference to the notion of grammaticality, in any of the latter's meanings, is still largely a white spot on the linguistic map. Let me quote a linguist's views that corroborate this: "Very few linguists are explicitly concerned with justification, and attempts to consistently compare two alternative grammars on the basis of clearly postulated criteria are extremely rare" (Raskin 1979:154).

L: These words prove that linguists are concerned with justification. But a paraphrase of the above, I maintain, will be true for the field of artificial intelligence: "Very few AI researchers are explicitly concerned with justification and attempts to consistently compare two alternative proposals on the basis of clearly postulated theoretical criteria are practically non-existent," mostly because no such criteria have been suggested. Incidentally, Raskin suggests a number of such criteria for linguistics, which shows that it is quite erroneous to think that linguists tend to overplay the importance of grammaticality. "There are at least five more [in addition to grammaticality-awareness] manifestations of competence which the native speaker can be demonstrated to display in a no more unreliable way: . . . truth-value awareness, presupposition awareness, context awareness and appropriateness awareness" (op. cit.:156). Elsewhere (Raskin
1978), coherency awareness is also suggested. I disagree with Raskin that these are necessarily manifestations of competence, since the latter has come to be identified with the notion of grammar, which, in its turn, has never incorporated more than an (interpretivist) semantic level of description. I do not see why, for instance, context and appropriateness are not facets of the theory of linguistic performance, and I doubt that it is possible in principle to construct a ‘pragmatic’ grammar along the methodological lines familiar to all generative linguists. Raskin, however, shows that the methodological importance of the old competence/performance distinction is more or less obsolete in modern linguistics. So, we can substitute ‘linguistic theories’ instead of grammars. And we can use the above tools in consistent attempts at their justification.

AI: Excuse me, I think I need some more explanation of the nature of all the above ‘awareness.’

L: OK, take a look at this. (A piece of paper changes hands; it contains the following:

(a) Louis XV loved Madam de Pompadour.
(b) Napoleon loved Brigitte Bardot.
(c) The present king of France is bald.
(d) There exists a unique person who is the present king of France.
(e) I got up rather late. I washed and dressed and had some breakfast. It is intended as an introductory text. I barely managed to get to work in time.
(f) Kissinger conjectures poached.
(g) How do you think President Ford likes his eggs?

Truth value awareness makes the speakers assign ‘true’ to (a) and ‘false’ to (b); understanding of (c) necessarily presupposes (d); the third sentence in (e) does not pass the coherence test; (f) is understood only in the context of (g), or in a similarly revealing context. In clustering all these notions under one roof Raskin does not leave any stone unturned. The criteria involve the emphases maintained by most of the influential schools of thought in linguistics and philosophy of language over the last quarter of the century (and more). It is important to consider these tools as possibly applicable to justifying theories of language use.

AI: The problem with the above criteria, as I perceive them, is that they are not, as you say, tools. Just like the metric system is not a tool for measuring the width of this table. A ruler is still to be invented!

L: A linguist is not responsible for specifying concrete procedures for the application of these criteria, if this is what you imply. Raskin overtly leaves this job to psychologists: “... grammars can be directly evaluated in information-eliciting experiments with informants based on one of the natural manifestations of their linguistic competence” (1979:161). Once again, mind you, I object to the last word: I would use “knowledge and experience” instead. Of course, a possibility should be discussed of using computer models instead of informants.
AI: You are overly indulgent. No linguist will 'buy' any such judgment. Besides, justification in artificial intelligence is perceived along different lines. Consider the following view of how theories can be tested, where the first way is suggested for artificial intelligence: "One strategy in testing a theory (derived from the more traditional sciences) is to identify what phenomena it would exclude, and then to verify that the predicted ones indeed occur, and that the excluded ones do not. In linguistics this strategy often takes the following form: the grammars set out by proposed theories are tested to ensure that they reject so-called 'bad' sentences (those with syntax unacceptable to native English speakers). The purpose of making sure that theories exclude phenomena which do not occur is to guard against the construction of overly general (and therefore content-free) theories" (Brachman and Smith 1980:106).

L: Look how your colleagues misrepresent linguistic views! We have seen already that it is not only syntactic well-formedness that makes an utterance acceptable or unatisfactory to the speakers of English.

AI: You should pay better attention to the newly found possibility of testing theories of language by predicting behavior of computer models. Also, it is a long way from being aware of the 'awarenesses' and actually putting them to use. Linguistics must elaborate on this point. Notice that Raskin does not suggest any kind of interaction among his criteria, nor a scale of 'weights' corresponding to their relative 'judgmental force.' In the meantime the artificial intelligence people will be best advised to be concerned about predictive verification. This is not a universal device, but it is probably the best to answer the (as yet) modest demand for justification theories in a field (AI) that is often considered as pre-theoretical even by its own practitioners (cf. Brachman and Smith 1980:106–7).

L: It seems to me, though, that when Winograd writes that "much of the work in AI is based on the methodological assumption that it is most profitable at this stage of the science to develop a body of alternative blueprints—to explore the possibilities before focusing on closely honed explanation" (1977:172), he risks being ostracized in his own community. Moreover, even such a prudent position is shaky, on the very 'no-observation-without-a-theory' grounds that we already discussed.

AI: OK, I grant you that the 'groping in the dark' has a theory behind it. The problem is, this is not yet acknowledged by the 'gropers' themselves. To be sure, some of them are but remotely interested in formulating such a theory. But others see no way of doing so without the accumulation of knowledge and experience in the area. This is what Winograd has in mind. Moreover, such admonitions may express one's reluctance to commit oneself to a theory 'before time.' Statements like, 'This is too risky to undertake right now; it will be impossible to take into account X, find a theoretical measure of Y and provide a formal mechanism for Z—so let us postpone constructive work and think the whole thing over and over again,' is one possible philosophy. It may be argued that had everybody always thought this way, not much would have been accomplished in the history of science. Another approach is to prod along and do 'the best you can' as regards
explanations. Both approaches are appropriate at times. Now is the time to attempt the second approach in artificial intelligence. We might just as well concede that our work is pre-theoretical. Anyway, the problem of justification is one of the less transparent in any science. Let us simply agree not to disregard the concern for it in the future.

L: A good final remark on this topic will be the following quotation from Pylyshyn (1979:25–6), in which X is substituted for the name of a scientific discipline: “The delicate balance between rational systems and empirical observations which is the hallmark of mature science has been absent in much of X. . . . Among the consequences of this is that X is splintered with micro-models. . . . The discipline is rather paradigm-driven, rather than being guided by major theoretical systems. Without such larger, formally structured systems the local puzzle-solving activities lack a convergent direction and may in fact degenerate into . . . a . . . task dominated by local maxima.”

AI: You mean that X stands here for artificial intelligence, don’t you?

L: No. It is not linguistics, either. It is psychology. But I doubt that our own fields can boast a different situation.

AI: It is with surprise that I discern an unexpected convergence course that our discussion takes. Don’t let us forget a peculiar, at times dormant and at times turbulent history of relations between our subjects in the short lifetime of artificial intelligence. It is interesting that this discipline’s relations with psychology and even with philosophy have been discussed rather abundantly (cf. Ringle 1979). The emergence of cognitive science, “the newest science of the artificial” (H. Simon), signifies the high degree of mutual interest. At the same time, there have been no comparable developments between AI and linguistics.

L: There was at least one memorable contact, or should I rather say, skirmish. I refer to the exchange between the linguists Dresher and Hornstein and artificial intelligence workers Winograd and Schank and Wilensky in Cognition in 1976–77. It all began with Dresher and Hornstein (1976). Schank and Wilensky (1977) and Winograd (1977) replied, and Dresher and Hornstein (1977a and b) were responses to the latter. Dresher and Hornstein criticize the work on natural language understanding within artificial intelligence, concentrating on the proposals of Minsky (the frame theory 1975), Schank (conceptual dependency theory 1975), Winograd (SHDRLU 1972) and the ATNs (they addressed Kaplan’s and Wanner’s work; we mentioned that of Woods and Bates above). They argue that all of the above proposals are essentially non-theoretical, limited in possible applications (that is, inextendable, not explaining anything), and that where they are ‘coherent,’ they do not contribute anything new to our understanding of human linguistic behavior. Thus, both Winograd and Schank were taken to task for providing no explanations of why they chose their approaches to parsing and representation, respectively. The stinging implication is that they overly relied on common sense at the expense of constructing a unifying theory. A unifying theory of Minsky’s was claimed to be vacuous because it did
not provide meaningful constraints, thus being reduced to the status of an alternative notation by allowing itself to express anything. Drescher and Hornstein discussed the details of the above proposals at some length. They argued, for example, that Winograd's decision to adopt the approach of the systemic grammar (Halliday, e.g., 1970) proved simplistic, that his semantic component was adequate only in a limited way, that conceptual dependency graphs were built uncritically and were largely arbitrary (if one did not consider the equally arbitrarily delineated set of possible inferences on an utterance to be complete and justified). In short, they discerned a number of low-level 'factual' deficiencies, and thus exposed the lack of 'linguistic culture' in artificial intelligence.

AI: This part of the criticism should have been rather welcomed by the community criticized. As a matter of fact, Winograd in his reply agrees with "many of the comments which deal with technical details" (1977:151-2). Your remark about the 'linguistic culture,' which I'd rather call 'experience,' may also be true. Of course, you might have forgiven us if you took into account the quite extensive knowledge from other fields that we had to master in order to build even these 'simple' systems. But the thrust of the matter is that, based on the technical comments, Drescher and Hornstein claim that "not only has work in AI not yet made any contribution to a scientific study of language, there is no reason to believe that the type of research that we have been discussing will ever lead to such theories; for it is aimed in a different direction altogether" (1976:377). This direction is, of course, technology. The implied meaning: stop any work other than building specific machines and build those without any claims as to their linguistic abilities or to their being models of human language use. I might add that the tone of the article was quite vitriolic, which, while reflecting the authors' 'uneccenmical' state of mind and being distantly amusing, seemed to me quite excessive.

L: Leaving the modality aside for a minute, don't you agree that this criticism displayed the limitations in the approach of artificial intelligence to the science of language?

AI: I don't think that this point was appropriate in the given context. Drescher and Hornstein criticize the research in artificial intelligence as 'unscientific,' lacking explanatory power, and not based on general principles (this latter phrase crops up twelve times on the mere three pages of their response to Schank and Wilensky). But what about the linguistic theory itself? Is there a single proposal made in the framework of generative linguistics that has not yet been proven false or at least has not been contested with weighty evidence? Does this make linguistics unscientific? Let us rather see what strategy of rebuttal was chosen. Schank and Wilensky counterattack on the grounds that artificial intelligence is not interested in language in the same way as is linguistics: it is interested in processes, not in general principles and rules; there is no explanatory adequacy for a theory—only procedural adequacy; nobody in artificial intelligence is interested in grammaticality (they understand it as a purely syntactic
notion); what does it take a person or a machine to understand the meaning of an
utterance—this is what counts. In short, "their way is not our way."

*L:* We have already discussed the status of syntax. I was, however, surprised to find a line where Schank and Wilensky (1977:135) actually admit something: "In producing such [performance] theories, AI also tries to simplify the problems it studies. In fact, almost every AI model of language use is an ideal user." This is not, however, the impression one gets after studying Schank's works where one is made to understand that what one reads is the theory behind language use. No qualifiers. Also, at least outside the context of an argument, statements like "universal principles may constitute answers to transformationalists [but] they merely pose questions for AI researchers, who would find it necessary to account for the rules procedurally" (op. cit.:137) seem too empiricist. Moreover, Schank and Wilensky are not convincing in denying Drescher and Hornstein's claim that computer programs for natural natural language processing, in their present-day state, are not theoretically valuable since they cannot distinguish between competing theories.

*AI:* The key phrases in Schank and Wilensky's paper are 'processes' and 'programs as tests for theories.' Though they refer to the paradigmatic difference between linguistics and AI, it is Winograd who makes this the key phrase for this reply. He makes ample reference to Kuhn's *The Structure of Scientific Revolutions* (1962) in describing how Drescher and Hornstein's arguments are misled or outright invalid. The friction between linguistics (Winograd calls it the Chomskian paradigm) and artificial intelligence (the computational paradigm) is described as a most general phenomenon in the history of science understood as a succession of revolutions and periods of 'normal science.' In the case in point, the Chomskian paradigm represents the established 'normal science' and AI, the revolutionary new paradigm. Accusations of being unscientific are parried by quoting Kuhn: "The reception of a new paradigm often necessitates a redefinition of the corresponding science" (Winograd 1977:153). A rather detailed analysis of the Chomskian paradigm follows, in which it is shown rather convincingly that, to put it simply, its adherents use "a neat piece of intellectual legerdemain which gives the illusion that the detailed methodology of Chomskian linguistics must follow logically from any attempt to understand universal principles of language" (op. cit.:155). According to Winograd, the Chomskians start with proclaiming that all studies of language must be based on the notion of 'universal grammar' defined as "the system of principles, conditions and rules that are elements or properties of all human languages" (cf. Chomsky 1975:29), and then substitute the more familiar notion of grammar instead. This is followed by divorcing grammar from the study of linguistic processes, postulating that the 'innate linguistic faculty' of the language user creates this grammar and, finally, constricting the notion of grammar still further, identifying it with a formal syntactic system and making an inept attempt to justify this in terms of language learning.
After presenting an extensive and thoroughly entertaining biological metaphor of the Chomskian paradigm, Winograd goes on to present his understanding of the computational paradigm. He presents four major points central to this approach, in which the great influence of psychological and computational considerations are quite transparent: "(1) The essential properties of language reflect the cognitive structure of the human language user, including properties of memory structure, processing strategies and limitations. (2) The primary focus of study is on the processes which underlie the production and understanding of utterance in the linguistic and pragmatic context. The structure of the observable linguistic forms is important, but serves primarily as a clue to the structure of processes. (3) Context is of primary importance, and is best formulated in terms of cognitive structures of the speaker and hearer. . . . (4) It is possible to study scientifically the processes involved in cognition, and in particular in language use. Some parts of these processes are specialized for language, while other parts may be common to other cognitive structures" (Winograd 1977:169). Winograd's emphasis is on principle (2).

Another important strategic point discussed by Winograd is the one we referred to already: programs as theories. Here he makes several comments that stand in sharp contrast to the views of Schank and Wilensky: "A program which completely duplicates the processes of human language use would still not be a theory. But any program which is built can be viewed as a hypothesized partial blueprint and can be a step towards understanding . . ." (op. cit.:172–3). And later: "The state of artificial intelligence . . . is in some ways . . . akin to that of medieval alchemy. We are at the stage of pouring together different substances and seeing what happens, not yet having developed satisfactory theories. The analogy was proposed by Dreyfus (1965; see also Dreyfus 1972 for a more extensive criticism) as a condemnation of artificial intelligence, but its aptness need not imply his negative evaluation. Some work can be criticized on the grounds of being enslaved to (and making too many claims about) the goal of creating gold (intelligence) from base materials (computers). But nevertheless, it was the practical experience and curiosity of the alchemists which provided the wealth of data from which a scientific theory of chemistry could be developed" (op. cit.:174).

L: Well, this is indeed a very prudent description. I would say that this really makes many of the methodological accusations of Dresher and Hornstein invalid. Also, unlike Schank, Winograd is very careful to avoid declaring that the current achievements in the field are theories. By the way, what will be the X in the proportion: alchemy : chemistry = AI : X?

AI: It may well be called artificial intelligence! Or cognitive science. The name does not matter. They will come up with more than one anyway. It will be a science studying human intelligence through modelling the latter. The computer will, most probably, be the principal tool of this modelling for years to come.

L: Maybe we should ask Winograd. But I haven't got a chance to comment
on the principle of the computational paradigm as presented by him. It really seems that Winograd speaks not about a linguistic science paradigm as seen by Chomskians like Dresher and Hornstein, but about a different science, which is interested in language only insofar as it sheds light on cognition. It is then small wonder that Dresher and Hornstein would find the approach ‘non-linguistic’ (they actually used the accusing epithet ‘unscientific’). But not every linguist is an orthodox Chomskian, many do think that pragmatics is important. Still, we are concerned primarily with language. It indeed seems that the thrust towards broadening the limits of linguistics to include cognitive aspects is too strong. It also baffles me, in this connection, that Winograd still chooses to distinguish the ‘linguistic’ from the ‘pragmatic’ context in the small manifesto above. I’d assume that the computational paradigm of linguistics subsumes pragmatics. . . .

AI: It still remains to be shown that any viable linguistic theory can be put forward which does not take into account cognitive processes, and at a deep level, too.

L: It is interesting that in his Language as a Cognitive Process (1983) Winograd, after reiterating the paradigm differences, speaks about the similarities of the ‘generative’ and ‘computational’ paradigm, even uniting them tentatively in a ‘cognitive’ paradigm (cf. 20–21). This may be due both to the absence of overt polemical attitude that was so obvious in Winograd (1977) and to a reluctance to pursue the paradigm metaphor too far. If it serves to justify the lack of understanding on the part of the linguists, let me suggest that it is entirely unnecessary for the two people to belong to different scientific paradigms in order for them to be unable to engage in rational argument. The current scene in both linguistics and artificial intelligence can supply multiple examples. I must say that in the polemics we have discussed just now I tend to feel more at home on the artificial intelligence side. I am not alone among the linguists to think this way. I refer to George Lakoff and to his ‘afterword’ to the polemics in question. Quite predictably, Lakoff (1978:267) starts by criticizing both sides in the dispute for paying little attention to “the opinions of linguists, both generative and nongenerative, outside the interpretivist school.”

AI: But he immediately proceeds to point out a most peculiar point: it appears that the background of the whole enterprise was not purely scientific, after all. “One thing that the exchange never mentioned but that seemed to be lurking in the background was money—in the form of research funding. With government funding sources running low and with a decision by the Sloan Foundation to pour millions of dollars into Cognitive Science, the competition for research funding has been keen. A number of people I have spoken to, both in AI and linguistics communities, viewed the timing and nature of the Dresher–Hornstein attack as being related to funding issues” (ibid.). What is your opinion on this? Do you feel deprived by the relatively high level of funding the research in my field?

L: Well, I think it would be fair to say that yes, I am. It hurts when the
bright young people who would have become graduate students in linguistics fifteen years ago choose artificial intelligence instead. Also, some extra funding has never done any harm and is really needed now. But this is a different issue. Let’s discuss it next time.

4. Act Three. Convergence

L: Lakoff’s paper contains a perspective of the linguistic scene and linguistic problems vis-à-vis artificial intelligence. Since now we want to consider the areas of possible cooperation, Lakoff (1978) is as good a starting point as any.

AI: Lakoff actually attacks the narrowly Chomskian linguistics by challenging its very goals, and with all the fervor of a renegade. He cites four false assumptions that led to the definition of these ‘gratuitous or implausible’ goals. He maintains that a) one cannot speak about a ‘language faculty’ that is independent from ‘sensori-motor and cognitive development, perception, memory, attention, social interaction, personality and other aspects of experience’; b) language acquisition does not consist of ‘constructing grammars on the basis of purely linguistic data’; c) linguistic structure is dependent on linguistic function; d) it is preposterous to speak about phrase structure rules and transformations as the right (or only) devices in terms of which linguistic laws can be formulated (op. cit.274).

L: Also, he shows that the mode of argumentation in the Cognition polemics was off mark, since it was assumed by Dresher and Hornstein (and quietly accepted by their opponents) that they possess a claim to the study of language universals and language acquisition. Lakoff correctly points out that most of the recent (and not so recent, too) research in both fields has been done outside the linguistic school that these authors represent.

AI: Both parts of the argument are taken to task for being too extreme in their views and hence too narrow in the choice of the problems discussed. “Nothing was said in the exchange . . . [about] linguistic phenomena which indicate that either processing models or AI-like representations are needed to account for empirical linguistic facts” (op. cit.:269).

L: Lakoff mentions several such facts: indirect speech acts, amalgams, interjections, correction and editing devices. More importantly, he also speaks about language formulae and, still more importantly, about the approaches to semantics. Every notion mentioned has been studied in linguistics, with varying amounts of effort. It will not be appropriate here to discuss them at length, but some comments may well be in order: after all, these are the first candidate areas of study where our disciplines can proceed jointly.

Speech acts in general and indirect speech acts in particular, have been studied quite extensively in linguistics and philosophy of language. Searle (1969) and Cole and Morgan (1975) are most frequently mentioned as useful references.

AI: Lakoff mentions this as a linguistic topic. But Wilks (1981:399) believes
that linguistics failed with speech acts and that artificial intelligence can help: "[An] area of research, now booming in AI, [is] the analysis of conversations in terms of plan structures, beliefs and perspectives, loosely what has been known in philosophy and linguistics as speech acts. 'Speech acts are dead,'" said an eminent linguist to me the other day, which I interpret by saying that philosophy and linguistics encountered problems with the notion that their theoretical machineries did not allow them to solve." Incidentally, in the same paper Wilks warns researchers of natural language against the dangers of technology taking the place of science: "One danger to theoretically interesting natural language analysis in AI is the trend to expert systems: on that view, language about car repair or electrical circuits, say, becomes no more than a side effect . . . satisfying as it may be to commercial interests and Government sponsors" (ibid.). This opinion alone should refute Dresher and Hornstein's position: it shows that artificial intelligence workers are at least as aware of the dangers of immediate technological thinking as are theoretical linguists.

L: Amalgams are sentences like This is a present from you know who on we all know which occasion. Parsers presently in use will have a difficult time consuming amalgams. And obviously no patchwork relaxation techniques will help. A sound linguistic proposal for treating amalgams is on the agenda. Treating interjections has long been neglected, but nobody can, uh, deny the contribution they make to the overall meaning of an utterance. Correction devices of various kinds, that is, from bona fide corrections as in the people of Bolivia, I mean, Brazil to such, well, quasi-corrections as in the racial, or rather, racist, policies, where the structure is used as a rhetorical device. Now, the topic of language formulae seems even more productive for a joint linguistic-AI study.

A I: The fact that both have been pointedly non-productive notwithstanding.

L: Exactly. It has been a point of interest for linguists for some time now that productive constructions in our speech are used at a much smaller scale than one would imagine. Any language is full of 'canned' phrases that are used in quite well defined situations. Tell me, wouldn't you immediately recognize the structure of a situation in which the notorious Have a nice day! is pronounced? Does this string of sounds really warrant the regular semantico-syntactic processing?

A I: Lakoff comments on the similarities between formulae and scripts (cf. Schank and Abelson 1977). "Both have the same form as productive structures—sentences on the one hand, and plans, on the other. Both are frozen forms of otherwise productive structures . . . Both . . . seem to develop historically out of their productive counterparts" (Lakoff 1978:272). Another peculiarity pinpointed by Lakoff is that both scripts and formulae are devices for saving mental energy.

L: There is, however, a flaw in Lakoff's comparison which relates to the discrepancies in perception of the two notions. Intuitively, a script is not an
equivalent of a phrase. There is a clear difference of scale. Rather, a script is an equivalent for a text. Of course, one can speak of the almost non-scriptal ‘instrumental’ scripts (cf. Schank and Abelson 1977:65–6) as being parallel to sentences. But it seems promising to speak not about separate canned phrases but rather about the whole canned conversations. The productivity of such conversations will tend to be greatly restricted, to the point of filling a small number of slots. In the environment quite inevitable for such a discussion the following conversation can take place:

A: Good evening, sir. How many people in your party?
B: Just the two of us.
A: Please follow me.

C: Are you ready to order?
B: Yes. I will have X with Y and Z. Does it come with W?
C: Uh-huh.
B: OK. And for the lady here, P, medium rare, and no Q, please. (and so on)

I think that only X, Y, Z, W, P, and Q are the relatively productive slots to be filled. All the rest is not very informative conversation (it might be if something interesting, like a distraction or an obstacle, happens), it does not need a lot of mental energy for anybody familiar with the rules and goals of this kind of institutions; and the roles in the above conversation are too easily discernible to be even mentioned. In short, we have a canned text, a linguistic counterpart of a script of whose instance it is a perceivable manifestation.

AI: But what about paralinguistic behavior? The above text can be just as meaningful had it been:

A: (looks up inquisitively)
B: Two.
A: (motions A. and his companion forward with his hand)

C: (approaches, and stands with his pencil poised on a notebook page)
B: (points in the menu) This here, and this. (gestures towards the companion)
(ands o on)

L: Let us study the paradigmatic context together, my friend. As they say in scientific jargon, let this be the topic of a separate study. On the notion of semantics, Lakoff suggests that "the idea that the processing of the sentence itself might have something to do with its meaning and its truth conditions is not
considered" in linguistics. "The meaning of the sentence," claims Lakoff, "depends in an important way on how it is processed" (Lakoff, 1978:273). He quotes Fillmore's example, "If you want to save your life, press the little red button in front of you right . . . now!" and claims, correctly, that the time for executing the command depends on the processing of the sentence in real time, which is impossible when it is suggested that the sentence must be processed as a whole.

AI: The question of the use of semantics in knowledge representation within the artificial intelligence paradigm has been discussed along different lines. First of all, there is no unity as regards the meaning of the term 'semantics' itself. A recent survey of projects in knowledge representation (Brachman and Smith 1980) showed that one-third of all the respondents adhered to logical (denotational) semantics; one-fifth, to procedural semantics; and less than ten percent thought about using the notion as it is used by the linguists. Also, a number of other, more or less outlandish, kinds of semantics were quoted: relational, operational, referential, intentional, functional, conceptual, and analogical. I still have to learn exactly what most of these theories claim. An interesting statistic was the relative prominence of procedural semantics. You will say, of course, that 'procedural' is a catchword for anything computational, and as such, for any expostulations against the linguists.

Very roughly, and leaving all the development of the notion out, procedural semantics has its roots in the semantics of programming languages. The latter is concerned with the proofs that computer programs actually do exactly what they are supposed to. Programs are, as a rule, written in some high-level programming language, such as LISP or PASCAL, then translated (compiled) into a machine language of primitive instructions; the machine executes the code, and the results appear to be judged semantically correct or otherwise. The application of the 'compile–run–verify' strategy to natural language analysis was controversial enough; such loaded comparisons do not generally go unnoticed in scientific research. The journal Cognition—which seems to welcome the idea of becoming the arena for intellectual shootouts—featured a polemic between Johnson-Laird, a proponent of procedural semantics, and Fodor (Johnson-Laird 1977, 1978; Fodor 1978, 1979).

L: You could also mention Woods (1981:4), where procedural semantics is taken to be not a theory of meaning, but rather "a paradigm or a framework for developing and expressing theories of meaning." Just like the augmented transition networks are frameworks for expressing theories of syntax?

AI: This idea has more links to the old 'declarativist vs. proceduralist' controversy in knowledge representation, which has long been a prominent feature of the artificial intelligence scene. This is as much an organizational issue as a theoretical one. Anyway, Fodor dismisses procedural semantics on the grounds that, first, computer models do not provide any semantic theory in the sense of a theory of the relation between language and world; and, second, that procedural
semantics is rooted in verificationism which "practically nobody except procedural semanticists takes seriously any more" (1978:229).

L: Note, however, that the term 'procedural' does have something to do with the context of the linguistics-AI debate. It is not by chance that Winograd, a prominent proceduralist in representation, also chides linguists for disregarding the importance of processes.

AI: Much more important is the statistic that only a small fraction of the artificial intelligence community considers linguistic semantics the right tool for their research.

L: My personal belief is that when the extensive economy I referred to is no longer possible—in the case at hand, when the procedural semanticists encounter first difficulties that cannot be solved with cleverer computational devices; or, if you wish, when the compiler metaphor wears itself sufficiently thin—the logical trend would be to look again at the linguists' work for possible insights. This is a natural 'division of labor.' Of course, if we take Woods' position, then such a trend is possible right now.

AI: So, you predict a convergence trend.

L: Yes, and my reasons are not only theoretical. It's not a secret that the linguistic community in this country and elsewhere no longer possesses the same clout it did some ten, fifteen years ago. This is reflected not only in the relative scarcity of research funding, but also in the number of students in the departments of linguistics. Artificial intelligence, on the other hand, has a good line of credit, so to say. Linguists should naturally desire to collaborate with artificial intelligence workers in mutually interesting projects. I believe that AI, in the sense of the term that we clarified here, did, does, and will benefit from contacts with linguistics, in applications such as information retrieval, computer-aided instruction, machine translation, etc. Because linguistics is the only source for a body of knowledge about language to draw from and, peculiarly, to reject as a possibility in favor of newborn ideas.

AI: I think that departments of linguistics must become flexible enough in the philosophical sense to offer courses covering the 'computational' paradigm, just as they sometimes offer them in historical and structural linguistics, in addition to the generative paradigm topics. It is also important for the linguists to understand that the computer may well become the major tool for the justification of linguistic theories. Please understand that it is unnecessary (though it will not hurt) to become a first-class computer programmer to be able to use the computer not only for the storage of dictionaries and the calculation of frequencies.

L: And more recently, for word processing. Permit me one final comment on our principal controversy. Chaffin (1979) has conducted a number of experiments to shed light on whether people process knowledge of language differently from knowledge about the world (he checked the response times in making 'necessary' and 'invited' inferences—cf., e.g., Geis and Zwicky 1971). A necessary inference, made manifest in the acceptability of (lb) and unacceptability of
(lc) below depends on the meaning of the verb *make* and commits the speaker to its conclusion

(1) (a) The trainer made the hungry lion wait before it ate its prey.
(b) The lion waited before eating.
(c) *But the lion did not wait.

The invited inference in (2) below, made manifest by the acceptability of both (2b) and (2c), depends on factual knowledge about how lions behave and invites (predicts) the conclusion that the lion did not wait. But the speaker is not committed to this conclusion.

(2) (a) The trainer did not make the hungry lion wait before it ate its prey.
(b) The lion did not wait before eating.
(c) *But the lion did wait.

The constraint that makes (1c) unacceptable is purely linguistic. The premise for the experiments was that if the response time for ‘necessary’ inferences is shorter than that for ‘invited’ ones, then language is distinct from the world.

*AI:* Chaffin describes the two opinions as the ‘formalist’ and the ‘naturalist’ positions but we can see that the formalists are what we called ‘Chomskians’: they claim that linguistic and world knowledge are distinct, that language can be studied independently of its use, etc. The naturalist position is that linguistic abilities share the same underlying mechanisms as other cognitive abilities. Note that Winograd’s (1983) book is entitled *Language as a Cognitive Process,* and that Chaffin also mentions Schank, Abelson, Norman, and Rumelhart (cf. Norman and Rumelhart 1975) as ‘naturalists,’ and you can see that we have the same dispute, even thought the word *processing* has never been uttered.

*L:* Chaffin mentions, though, that the formalist school dismisses the communicative function of language from the latter’s scientific study. Also, he perceives the debate as transcending the boundaries of linguistics, reaching into philosophy (the formalist Carnap vs. the naturalists Austin and Grice) and psychology (where, according to Chaffin, the general trend was from the naturalism of pre-Chomskian days to formalism roughly in 1957–66 (cf., e.g., Miller 1962), and then, gradually, back to naturalism). But the bottom line is that the results of the experiments actually supported the formalist hypothesis (although, in Chaffin’s words, “equivocally”). In two of the four experiments Chaffin conducted, necessary inferences were processed faster than invited inferences and, moreover, attenuated the processing of those of the latter that were unnecessary for the task. In the other two experiments the response times were equal. “This indicates that the distinction between world knowledge and linguistic knowledge is more than just a heuristic convenience for linguists and philosophers” (Chaffin 1979:327).
Wait, before you say that this conclusion brings us back to square one in our discussion. Let me say that, without questioning the set-up of the experiments themselves, we can try to provide another interpretation of their results. One might think of changing the status of the language processing as juxtaposed to world information processing from the two quite polar opinions to one that might be mutually acceptable. Norman (1980) draws a diagram of a cognitive system which (the diagram) becomes the basis for describing the issues that this field should tackle. Language is not specifically addressed there; and the impression is that it is considered important only as a tool in perception or, at the most, the interface between physical signals and memory structures (this is, of course, a strong simplification of the matter). Norman did not find a place for a ‘language processes’ module alongside those of ‘thought processes,’ ‘emotions,’ ‘desires, intentions and motivations,’ ‘attention allocation,’ etc., in the diagram of a cognitive system structure he uses in his paper.

Please don’t tell me that Norman’s ‘issues’ are not components: in the diagram they are components all right, even though these are treated as lines of research in the text. So what we have is a language module that is not at all autonomous, being a part of a complex cognitive system—indeed, we have criticized the autonomous ‘innate language faculty’ in sufficient detail; and at the same time, this module is distinguishable enough to be responsible, for instance, for the processing of ‘necessary inferences’ as well as many other phenomena that depend on the ‘self-understanding’ of language. To name just a few, what about the linguistic ‘near misses,’ such as *I look on you* in the speech of a non-native speaker of English; or why *Fantastic Faye* and *Terrific Terry* are not the same as *Terrific Faye*.

In short, I think that the consequences of the methodological tour de force I suggest, namely, to declare a ‘linguistic processes’ module alongside the ‘thought processes’ one, have to be explored.

*AI*: It may actually bring our sciences closer together by defining the area of efforts a linguist may undertake within the linguistic-philosophical-psychological-computational paradigm of cognitive science.

### 5. Epilogue

The discussion featured the following main points:

1. Although linguists and the artificial intelligence community have a different approach to the study of language, this dissonance can be diminished, if not alleviated, if the emphasis is on the centripetal rather than on centrifugal forces within both communities. Both communities will profit from this. In fact, definitions can be found for both fields that will be acceptable for many people in both groups. The tendency for dispute tended to blur this understanding.

2. At the theoretical level, the computational or procedural approach to the study of language should be recognized as a valid direction of studies, whether it
is considered a separate paradigm or just another variant of the established ‘cognitive’ one. In any case, this approach is to produce a general theory of language comprehension that will become the basis of future developments and, yes, a target of widespread criticism, a theory whose role will be not unlike that of Chomsky’s a quarter of a century ago.

(3) At the methodological level, special attention must be paid, in both artificial intelligence and linguistics, to the problem of justification. In particular, it is crucial to study the question of when and which computer models can be considered valid means for justifying theories of language (and cognition, on a more general basis).

If we understand linguistics as our linguist does and artificial intelligence as our AI researcher does, then the following paraphrase of Pylyshyn’s words about artificial intelligence and cognitive psychology will be quite appropriate: “The field of AI is co-extensive with the field of linguistics. What I mean by this is that as intellectual disciplines they are concerned with the same problems and will stand or fall together because the same criteria of success must ultimately adjudicate them both” (Pylyshyn 1979:25).

REFERENCES

Linguistics and Artificial Intelligence


