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Encounters with Language

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First of all, I am overwhelmed and humbled by the honor the ACL Executive has shown me, an honor that should be shared by the colleagues and students I've been lucky enough to have around me this past decade-and-a-half while I've been engaged in the FrameNet Project, at the International Computer Science Institute in Berkeley.

I've been asked to say something about the evolution of the ideas behind the work I've been associated with, so my remarks will be a bit more autobiographical than I might like. I'd like to comment on my changing views of what language is like, and how the facts of language can be represented. As I am sure the ACL Executive knows, I have never been a direct participant in efforts in language engineering, but I have been a witness to, a neighbor of, and an indirect participant in some parts of it, and I have been pleased to learn that some of the resources my colleagues and I are building have been found by some researchers to be useful.

I offer a record of my encounters with language and my changing views of what one ought to believe about language and how one might represent its properties. In the course of the narrative I will take note of changes I have observed over the past seven decades or so in both technical and conceptual tools in linguistics and language engineering. One theme in this essay is how these tools, and the representations they

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support, obscure or reveal the properties of language and therefore affect what one might believe about language. The time frame my life occupies has presented many opportunities to ponder this complex relationship.

1. Earliest encounters

This story begins in the 1930s and 40's, in St. Paul, Minnesota. There was nothing linguistically exotic about growing up there, except perhaps the Norwegian accented English of some of my mother's older relatives. But during much of my childhood I was convinced that I personally had difficulties with language: the symptom was that I could never think of anything to say. I was tongue-tied. I now suspect that it was mainly a problem of the shyness and awkwardness that goes along with growing up confused, and not an actual matter of language pathology. Nevertheless, it led me into my earliest attempt to work with language data.

At around age 14 I presented my problem to a librarian in the St. Paul Public library, and she found me a book called *5000 Useful Phrases for Writers and Speakers*. A memorable example was "With a haggard lift of the upper lip..." I took the book home, cut sheets of typewriter paper into eight pieces to make file slips, chose phrases I thought I should memorize, and copied them onto these slips. I held them together with rubber bands, and I kept them in a secret place in my room. Thus supported with the early 1940s technologies of paper, scissors, pencil and rubber bands, my earliest theory of language began to develop: *Linguistic competence is having access to a large repertory of ready-made things to say*.

I added to the collection over the years, as I came upon clever or wise expressions, and consulted a selection of them every night, scheming to create situations in which I could use them, in speaking or writing. In later years I held on to the suspicion that much of ordinary conversation in real life involves calling on remembered phrases

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rather than creating novel expressions from rules. Much later I learned that in many Eastern European countries influenced by the Moscow School, the divisions of the field of Linguistics were Phonology, Morphology, Lexicology, Phraseology, and Syntax. The study of phraseological units—*phraseologisms*—was seen as central, not peripheral, to linguistic inquiry.

My first exposure to the actual field of Linguistics came a year later, around age 15, when a missionary lady on leave, living on my block in St. Paul, Minnesota, gave me a copy of Eugene Nida's little book, *Linguistic Interludes* (Nida 1947). The text of this book takes the form of conversations in a college campus co-op between a clever and wise linguist and a caricatured collection of innocent and unsuspecting students and colleagues, among them a classicist who strongly defended the logical perfection of the classical languages, Greek and Latin.

This book succeeded in conveying simply many of the things that linguists believe:

- Relevant linguistic generalizations are based on speech, not writing.
- Almost all concepts of "correct grammar" are inventions, with no basis in the history of the language.
- There may be primitive communities, but there are no primitive languages.

The minor protagonists in the conversation contested each of these principles, and the linguist hero, from his vast knowledge of the most exotic of the world's languages, kept showing them how wrong they were. I liked the idea of knowing things that most people, including college professors, had wrong opinions about. I also liked the idea of being able to help them change their wrong opinions, so I decided to study linguistics.

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2. Formal studies begin

Before long I was enrolled in a fairly small linguistics program at the University of Minnesota. I could live at home, take a streetcar to Minneapolis for classes, and take another streetcar to Montgomery Wards in St. Paul, where I wrapped venetian blinds to support my studies.

In those days there were no linguistics textbooks in the modern sense; we studied two books called *Language*, by Edward Sapir (1921) and Leonard Bloomfield (1933), and we read grammars and treatises. I took two years of Arabic. I supplemented my training in linguistic methods through Summer Linguistic Institutes put on by the Linguistic Society of America, one in Michigan and one in Berkeley, where I learned about Thai, Sanskrit, and Navajo with Mary Haas, Franklin Edgerton, and Harry Hoijer.

2.1 First research experience: concordance-building

One of my professors at Minnesota was building concordances of some of the minor Late Latin texts, and he permitted the students in his class to work with him on these projects. For the advanced students this was a chance to get valuable hands-on research experience; for the lesser students it was an opportunity to get "extra credit."

This was in a sense my first exposure to corpus-based linguistics. For any given document, the professor would pass on the text to that year's students. This "first generation" of students copied word tokens onto separate index cards, together with each word's "parse" in the classical sense, and its location in the document.

Generation 2—the students in the next year's class—alphabetized these cards and typed up the concordances. Generation 3, in which I participated, took this same stack of cards and reverse-alphabetized them, so they could be used for research on suffixes. (Personal note: alphabetizing words from right to left is stressful at first, but you get

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used to it.) So with the tools of pre-cut index cards, a pencil and a typewriter, we students constructed a concordance—we physically experienced that concordance.

So you can imagine my surprise when, thirty some years later, I came upon UNIX commands like `sort`, `sort -r`, and `grep`. I don't remember if I actually wept. And these were nothing compared to the marvels I experienced later still, with key-word-in-context extraction, lemmatizers, morphological parsers, part-of-speech tagging, sorting by right and left context, and the full toolkit of corpus processing tools that exist today.

In those days it took a lot of patience and physical effort to build a concordance. But it also took a lot of patience and physical effort to use a concordance. A printed concordance to the Shakespeare corpus was a vast index in which, for each word, you could find every line it occurred in, and you learned where that line appeared in Shakespeare's writings. You would then go to the actual physical source text, look it up, and see it in its context. For example, if, when studying the phrasal verb *take upon* I want to find the full context of *This way will I take upon me to wash your liver* I only need to open up *As You Like It* to Act 3, Scene 2, and hunt for it there. Compare that to the fully-searchable Shakespeare app you can use while sitting on a bus holding your iPad.

3. Encounters beyond college

President Truman's Displaced Persons Act of 1948–50 brought thousands of Eastern European immigrants to Minnesota, enabling me to find work more satisfying than venetian-blind-wrapping. I began to teach English to Russians, Poles, Ukrainians and Latvians. Depending on which of the daughters of the families in my classes I was trying to impress, I was motivated to learn something about Slavic and Baltic languages.

Soon my student deferment would run out, and I had decide between waiting for the draft (two years) or enlisting (three years). A persuasive recruiting officer promised me one year at the Army Language School in Monterey, CA (now the Defense Language

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Institute) for my first year. Shortly after that, my head got shaved and I was suddenly a buck private. No one had any record of an offer to spend a year in sunny California learning Polish. I was not allowed to examine my file.

So I took the US Army Russian Language Proficiency Test instead. The questions were in spoken Russian, played on a record player, and the answers were multiple choice in English. In those days the art of designing guess-proof multiple choice tests had not yet been perfected. There was kind of a student sport to see how well you could do in choosing answers without looking at the questions (you could usually at least get a passing score); then you'd go back and read the questions to correct the choices that weren't obvious.

Although I didn't fully understand any of the questions, my score came out as "high fluent" based in large part on acquired test-taking skills. After basic training, I was sent to Arlington, VA, for a few months in radio training, after which I was assigned to Kyoto, Japan, to a small field station of the Army Security Agency. My duty: "listening to Ivan." The Ivans I listened to on short wave radio never had anything interesting to say: they were Soviet Air Force men reading numbers, which I was supposed to write down. Three days of the day shift, three days evening shift, three days night shift, three days off. I quickly acquired an uncanny ability to detect Russian numbers against noise and static. They were, of course, coded messages.

My job was to write the numbers down on the most modern typewriter of the day, a model that had separate keys for zero and one! (The ordinary office typewriter at that time had separate keys for only the numbers 2 through 9, since lower-case L could be used for 1 and upper-case O could be used for zero.) For this work I needed a very restricted vocabulary: the Russian long and short versions of the numbers 1–9,[1] plus a

1 The long form numbers were presumably more distinct in a noisy background.

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single version of zero, and the word for 'mistake.' If I had been permitted to say what I was doing I would have said I was in cryptanalysis, but of course actually I was only copying down the numbers I heard. Somebody smart, thousands of miles away, was figuring out what they meant.

The limited demands on my time and intellect allowed me to wander around in Kyoto, with notebooks and dictionaries, trying to learn something about Japanese. The linguistic methods I had learned back home stopped at morphology, the structure of words. I hadn't had any training in ways of representing the structure of a sentence, but I worked out a DIY style of sentence diagrams, for both Japanese and English, and I was fascinated when I found the occasional sentence in Japanese which could be translated into English word by word backwards, going from the end to the beginning.

When it was time to be discharged, I believed—wrongly—that I was close to mastering the language, and I wanted to stay another year or two, since I knew I couldn't afford to come back to Japan on my own. I managed, with the help of Senator Hubert Humphrey, to be the first Army soldier to get a local discharge in Japan. As a civilian there, I supported myself by teaching English. With two other visiting Americans I was permitted to work at Kyoto University with the endlessly kind and patient Professor Endo Yoshimoto (遠藤嘉基).

Professor Endo was the author of the main school grammar of Japanese and one of the founders of an organization favoring Romanized spelling for Japanese. With his help, my fellow students and I stumbled through old texts and became acquainted with the categories and terminology of the Japanese grammatical tradition.

One of the themes weaving through this essay is the reality that it is not possible to represent—in a writing system, in a parse, or in a grammar—every aspect of a language worth noticing. My study of Japanese confronted me with the realization that for any

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given representation system, it's important to understand what it represents, and what is missing. The Japanese *kana* syllabary presented me with an early experience of this. The pronunciation of Japanese words is represented by the symbols of a syllabary, but unfortunately the components of complex words in this language, in particular the inflected verbs, are *not* segmented at syllable boundaries.

Some verbs have consonant-final stems followed by vowel-initial suffixes, but this fact is not apparent in the written language. In the examples below, the verb stem means 'move' and it ends in a consonant, /k/. The suffixes all begin with vowels, but the red kana characters do not reveal the boundary between verb and suffix.

動く	ugok-u	*move (plain form)*
動きます	ugok-imasu	*move (polite form)*
動かない	ugok-anai	*does not move*
動ける	ugok-eru	*can move*

Table 1
Japanese *kana* and the obscuration of morpheme boundaries

It struck me that the written form of a language should not prevent one from discovering its boundaries. I later learned that in 1946 the American linguist Bernard Bloch had published a ground-breaking description of Japanese verb morphology based on a phonemic transcription (collected and republished as Bloch (1970)) , allowing the regularities in the system to become apparent.

Everyone knows that English spelling is a poor representation for English pronunciation, but it's also true that it is a fairly good representation for recognizing derivationally related words. Consider the second syllable in the three words *compete*, *competitive*, *competition*. If we had to write these words with different letters for the different vowels, we'd be missing something.

Yet of course some important generalizations about English can't be captured in the analysis of written English alone. Numerous phonological generalizations require a

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reduction to phonetic features of various kinds, but there are also grammatical generalizations that are hiding from us because of things like (1) **whose** (not *who's*), (2) **another** (not *an other*), and the problems that text-to-speech researchers have to face related to the pronunciation of large numbers and indications of currency, like the dollar sign. In post-war Japan, the fact that the *kana* writing system obscured morphological boundaries merely meant that linguists would use phonemic transcriptions. But as technology has advanced beyond cards and typewriters, supporting efforts such as text-to-speech and automatic speech recognition, we can see that written language obscurations (and affordances) are ubiquitous.

4. Graduate studies: phonetics and phonology

While living in Japan I had been keeping track of linguistics goings-on back home, and had heard that one of the best graduate programs for linguistics was at the University of Michigan in Ann Arbor. So when I finally came back to the States, that's where I went. There was a movement in linguistics in those days toward making linguistics more "scientific" by designing so-called discovery procedures for linguistic analysis and I wanted to participate in that work. The basic textbooks in beginning linguistics classes at Michigan typically provided step-by-step procedures for going from data to units, so this movement was well-supported there. Kenneth Pike's *Phonemics* book had the sub-title: *A technique for reducing language to writing* (Pike 1947).

I had noticed that there were alternative phonemic analyses for both English and Japanese, analyses that resulted in different actual numbers of consonants and vowels. If there's no consistent way to do phonemic analysis, how can we compare different languages with each other, or be confident in answering a simple question like, "how many vowels does this language have?" I resolved to help design the correct discovery procedure for phonemic analysis, founded on the distribution of phonetic primes. For

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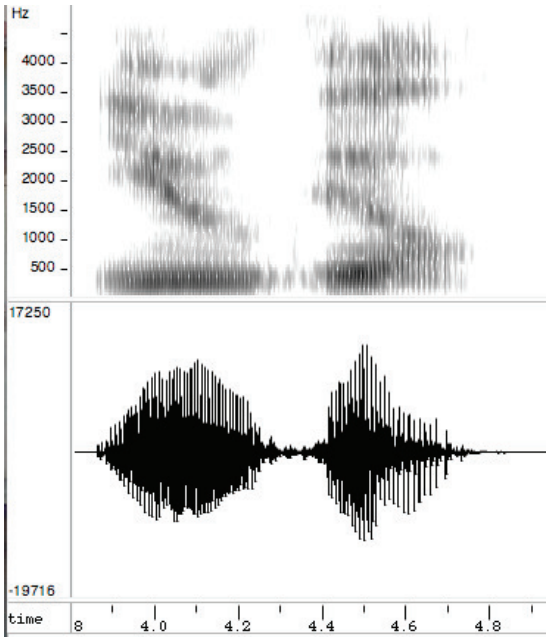

Figure 1
Unrevealing spectrograms: *you* and *ill*, spoken by Keith Johnson

that purpose I studied phonetics in the linguistics department and in the communication sciences program: practical phonetics for field linguistics, acoustic phonetics, and physiological phonetics in the laboratory.

During those years I worked part-time on a Russian–English Machine Translation project with Andreas Koutsoudas and met many MT researchers. I participated in a memorable interview with Yehoshua Bar-Hillel (some of you will remember the outcome of the nationwide tour that included this visit). I also worked with speech researcher Gordon Peterson and mathematician Frank Harary on automatic discovery procedures for phonemic analysis, a project that was eventually abandoned.

The speech lab was visited once by a group of engineers who proposed devising automatic speech recognition by detecting the acoustic properties of individual phones and mapping these to phonemes, and pairing phoneme sequences with English words. Ilse Lehiste put a damper on their enthusiasm by asking them to try to consistently

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distinguish acoustic traces of the two phonemically different English words, "you" and "ill." They couldn't do this. The properties of the representational system for individual phones would not allow them to get to the second step in their plan. This was obviously before anybody thought of large-vocabulary recognizers based on Hidden Markov Models or statistics-based guesses derived from language models.

5. On to syntax

Eventually it became necessary to take on syntax. At Michigan, sentences were spoken of as having a *horizontal* (syntagmatic) and a *vertical* (paradigmatic) dimension. In its *horizontal* aspect, a sentence could be seen as a **sequence of positions**. In its *vertical* aspect, each position could be associated with a **set of potential occupants** of that position.

In the English Department at Michigan, Charles Fries was constructing a grammar of English that was liberated from traditional notions of nouns and verbs and adjectives, counting on purely distributional facts to discover the relevant word classes. In the Linguistics Department, Kenneth Pike was elaborating an extremely ambitious view of language in which, at every level of structure, one could speak of linear sequences of positions, labeled roles naming the functions served by the occupants of these positions, and defined sets of the potential occupants (Pike's preliminary manuscripts appeared in the 1950s and were eventually published as Pike (1967)). **Slots**, **roles**, and **fillers**—it was all very procedural.

In the midst of all this, something big happened, and suddenly everything changed. I was among the first in Ann Arbor to read *Syntactic Structures* (Chomsky 1957). I became an instant convert, and I gave up all ideas of procedural linguistics. The new view was something like this:

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- The grammar of sentences is more than a set of linear structures separately learned.
- Sentences are generated by hierarchically organized phrase-defining rules.
- Regularities in the grammar are evidence for rules in the minds of the speakers.
- The existence of a variety of sentence types is accounted for in terms of the application of rules that move things within, add them to, or delete them from, initial representations.
- There is no procedural way to learn how language is structured; the linguist's job is to figure out what rules reside in the minds of speakers.
- Therefore, linguistics is theory construction.

The Chomskyan view flourished; universities that didn't have linguistics programs wanted one. After I finished my degree I joined William S-Y. Wang in the brand new program at The Ohio State University in Columbus. During my decade at Ohio State I was completely committed to the new paradigm. Robert Lees, Chomsky's first student, visited Ohio State for a time, and I spent lots of time talking to him, working on questions of rule ordering and conjunction. While discussing things with him, I wrote a paper on "embedding rules in a transformational grammar" that was the first statement of the transformational cycle (Fillmore 1963).

The view represented in Chomsky's *Aspects of the Theory of Syntax* (Chomsky 1965), with its sharp separation of deep structure and surface structure, became the mainstream, and I worked within it faithfully, participating eagerly in efforts to combine all the rules the young syntacticians had been writing into a single coherent grammar of

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English, an effort heavily supported, for some reason, by the U.S. Air Force. During this period I felt I knew what to do, and I believed that I understood everything that everybody else in the framework was doing. That feeling didn't last very long.

At one point I did a seminar in which a small group of students and I worked our way through Lucien Tesnière's *Éléments de Syntaxe Structurale* (Tesnière 1959), without necessarily understanding everything in it, and I became aware of a different way of organizing and representing linguistic facts. Anyone who looks closely at syntax knows that it becomes clear very quickly that you can never represent everything about a sentence in a single diagram. Tesnière, my first exposure to what evolved later on into **dependency grammar**, made me aware of the impossibility of displaying simultaneously the functional relations connecting the words in the sentence, the left-to-right sequence of words as the sentence is spoken, and the grouping of words into phonologically integrated phrases.

As an extreme example of the kinds of information a Tesnière-style dependency tree could contain, I offer you his analysis of a complex sentence from the Latin of Cicero. I'm certain many of you will remember this from your high school studies. *Est enim in manibus laudatio quam cum legimus quem philosophum non contemnimus?* ("There is in our hands an oration, which when we read (it), which philosopher do we not despise?") It has roughly the same structure as *Here's a sentence, while reading which, who wouldn't get confused?* Figure 2 presents the diagram, but I'll only point out the connections assigned to one word in it, the relative pronoun *quam*.

Instead of having lines pointing to a single token of the word, Tesnière breaks the word *quam* into two pieces connected by the broken line at the bottom. The word agrees with *laudatio* in gender and number and that connection is indicated by the upper broken line; it is the marker of the relative clause headed by *contemnimus*, as shown in

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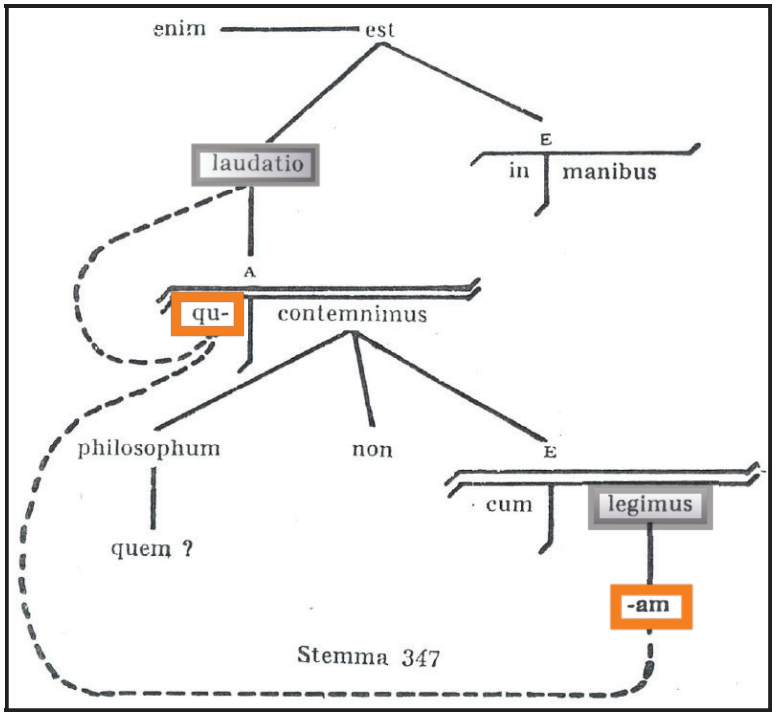

Figure 2
A Tesnière-style dependency tree

the horizontal structure it is hanging from, and it is the direct object of *legimus*, bottom right. This diagram shows more than simple dependency relations, and uses various ingenious tricks and decorations to smuggle in other kinds of facts. The word-to-word connections are shown, but it's really clear that a system for projecting from such a diagram to a linear string of words spread into phonologically separable phrases has to be incredibly complex.

The fact that dependency diagrams do not show the linear organization of the constituent words was presented by me as a representational problem, but in fact Tesnière uses precisely this separation to propose a typology of languages according to whether they tend to order dependents before heads or heads before dependents, and whether within each language these tendencies vary within different kinds of constructions. In

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a **centripetal** language the dependents precede the head, in a **centrifugal** language the head precedes the dependents. There are extreme and moderated varieties of each of these in his scheme.

Tesnière also described a number of conjoined structures in French for which he used the terminology of **embryological mistakes**, one kind being monsters that have one head and more than one tail. In general these correspond to Verb Gapping in our terms (*John likes apples and Mary oranges*). Another kind of 'embryological mistake' has more than one head and a single tail, like Right Node Raising (*John likes and Mary detests anchovies*), and the most monstrous of all are capital H-shaped monsters with two heads and two tails, like the kinds of sentences Paul Kay and Mary Catherine O'Connor and I played with in a paper (Fillmore, Kay, and O'Connor 1988) on "let alone" (*I wouldn't touch, let alone eat, shrimp, let alone squid*). I think these phenomena have more to do with sequencing patterns than with dependency relations, but I found it interesting that Tesnière delighted in exploring these kinds of structural complexities. (My sensitivity to tone in French prose isn't good enough to know whether in these descriptions of syntactic monsters Tesnière was having fun. I'm not helped in that uncertainty by photographs I've seen of the man.)

I ended up favoring phrase structure representations, partly because dependency representations have no easy way to identify a predicate or VP constituent, and I'd like to believe that the VP can in general be treated as naming a familiar category (eating meat, parking a car, being breakable, etc.). But I mainly preferred phrase-structural representations because they offer more material upon which to assign intonational contours.

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6. What about meaning?

When linguists turned to the predicate calculus as a representation for sentence meaning, many were interested mainly in quantification and negation, where it's possible to show how complex logical structures can be formulated in ways that pay no attention to the actual meanings of the words that name either the predicates or the arguments. I, however, was specifically interested in the inner structure of the predicates themselves. So I encountered a representational problem when working with the notation that was common at the time.

When working on meaning, linguists often used **prefix notation**, allowing the ordered list of symbols following the name of the predicate to stand for the "-arity"—the number of arguments—of the particular predicate. Thus **P(a)** could represent an adjective like *hungry* or a verb like *vanish*; **P(a,b)**, relating two things to each other, could stand for an adjective like *different* or a verb like *love*; and **P(a,b,c)** with three arguments could stand for an adjective like *intermediate* or a verb like *give*, *show*, or *tell*. This notation also allowed one to represent cases in which the arguments could themselves be predications, permitting recursion.

While working with the prefix notation I was struck by the fact that although this representation afforded one the chance to make claims across diverse classes of predicates, it simultaneously obscured certain information about the arguments of those predicates—important semantic commonalities about classes of arguments.

There are centuries-old traditions by which school-teachers explain that the subject names the *agent* in an event and the object tells us what is *affected* by the agent's actions, but it's trivially easy to find examples that show that such generalizations don't hold. Similarly, in a predicate–argument formula, there is nothing meaningful about being the first or second or third item in a list. Does it make sense to let the **position in an ordered**

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list represent the semantic role of an argument in a predication? Consider the following examples in which arguments are interchanged:

(1) He **blamed** the accident on me. ⟷ He **blamed** me for the accident.

(2) He **strikes** me as a fool. ⟷ I **regard** him as a fool.

(3) Chuck **bought** a car from Jerry. ⟷ Jerry **sold** a car to Chuck.

In (1) the second and third arguments of *blame* are interchanged in their grammatical realization. In (2), with the pair *strike* and *regard*, the first and second arguments are interchanged. And in (3), with *buy* and *sell*, the first and the third are interchanged.

I felt that there ought to be some way of recognizing the sameness of the semantic functions of these arguments independently of where they happen to be sitting in an ordered list. An alternative was spelled out in a rambling paper called "The Case for Case" published in 1968 (Fillmore 1968). It proposed a universal list of semantic role types ("cases"). Configurations of these cases could then characterize the semantic structures of verb and adjective meanings. In this way, lexical predicates could be shown as differing according to the collection of cases that they required (obligatory) or welcomed (optional).

The theory embedded in this view is that semantic relations ("deep cases") are directly linked to argument meanings. (So in the sentence *John gave Mary a rose*, John is the Agent, Mary is the Recipient, and a rose is the transmitted Object.) Grammatical roles (subject, object) and markings (choice of preposition, etc.) are predicted from case configurations. (So the Agent could be the subject, the Object could be the direct object, and the Recipient could be introduced with the preposition *to*.) Generalizations are

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formulated in terms of specific named cases, for which a hierarchy is defined, and the list of cases is finite and universal.

The variable "valences" (a term from Tesnière) of a single verb can be explained in terms of the cases available to it. The starting examples in this discussion were with the verb *open*. Its valences correlate with the cases available to it:

(4) **Agent>Instrument>Object hierarchy illustrated with V *open***

O	=	The door opened
AO	=	I opened the door
IO	=	The key opened the door
AIO	=	I opened the door with the key

The occupants of nuclear syntactic slots (subject and object) are determined by the hierarchy, the rest are marked by prepositions (or in the case of arguments whose shape is a VP or a clause, various other markers or complementizers).

There was a time when Case Grammar, so-called, was very popular, and partly because of that I ended up in Berkeley, California, and eventually participated in the vibrant Cognitive Science Program there. When I first arrived, I continued to work on case grammar and transformational grammar, disappointed that the former was not accepted as a contribution to the latter.

Gradually, the theory and representation of Case Grammar revealed a way to define entities at a different level: given lists of cases, it was possible to define **situation types** as assemblies of these. I referred to these assemblies as **case frames**. With a large number of case or semantic role names, it should be possible to define a very large number of situation types. For example, Agent-Instrument-Object is some kind of *caused change*. Object-Path-Goal is some kind of *motion event*, and so on:

(5) **Case Frame Situation Types exemplified**

- Agent, Instrument, Object: *I fixed it with a screwdriver*.

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- Object, Path, Goal: *The water flowed through the crack in the floor into the storage room.*
- Experiencer, Content: *I remember the accident.*
- Stimulus, Experiencer: *The noise scared me.*
- Stimulus, Experiencer, Content: *The noise reminded me of the accident.*

Various proposals emerged (by John Sowa among others) that greatly increased the number of cases, enabling descriptions of more and more kinds of situations and events. Researchers working with semantic roles tend to think of them as identifying the *roles of participants in the event*, in the case of verbs that describe events. But this conceptualization shed light on some problematic (and eventually revealing) cases. One of the first to hit me involved some uses of the verb *replace*. Consider this sentence: *Today I finally replaced that bicycle that got stolen a year ago.*

Notice that the bicycle that got stolen a year ago was not a *participant* in the Replacement event that happened today, at least not in the usual sense that is intended in work on semantic roles or cases. The bicycle can be *mentioned* in the sentence, given the grammatical requirements of the verb *replace*, because the bicycle was a participant in *the narrative that defines a replacement event*.

This led to a conceptualization that will be familiar to readers of this journal. Instead of defining frames in terms of assemblies of roles, what about *making frames primary, and defining roles in terms of the frames*? I then started thinking that the job of lexical semantics is to characterize frames on their own, and work out the participant structures frame by frame.

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7. Beyond syntax and semantics

At some point I got invited to give some lectures at Roger Schank's Artificial Intelligence lab at Yale, where I witnessed work on information retrieval in the form of a system that automatically collected information from newspaper accounts of traffic accidents. My impression was that the system was given texts that were known to be about traffic accidents, and it was already provided with a checklist of information to look for, based ultimately on the style sheets used by reporters working on traffic accident assignments, or, really, ultimately, on the reporting traditions of the local police departments.

The checklist included names, ages and addresses of drivers, passengers and victims, the make, model and year of the involved vehicles, location of the accident, directions of moving vehicles, presence of injuries or fatalities, reports from police authorities, etc. The system needed to recognize capital letters, punctuation, numbers, and a set of words like *driver*, *passenger*, *victim*, *ambulance*, *street*, *avenue*, *highway*, *sheriff*, *officer*, *vehicle*, etc., so that when it came upon something like the following it would know what to do:

> Walter O. Magnusson, 23, of 79 W. Walnut St., Hartland, was westbound on 28th Street near Blossom Road in a 1998 Chevrolet pickup when he and passenger, Wilma J. Alter, 27, same address, argued. According to Sheriff Deputy Carl Voegelin, Magnusson grabbed the steering wheel, causing the vehicle to strike a tree on the south side of the road. Magnusson was taken by private vehicle to Hartland Community Hospital with possible injuries. The pickup was registered to Clarence Barker of 66 Larkin Rd., Jarviston.

I wondered if a kind of general purpose information extraction process could be designed in which the system didn't know in advance what the text was about, but in which particular words in the text would evoke their own checklist—**a list of things to look for that come with the entry for the word**. The presence in a text of a word like *revenge*, for example, could initiate a search for the identity of the offender, the name of the injured party and the avenger, the punishment inflicted or intended, etc., a checklist

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that would also be evoked by a dozen other words in the same frame. In a case like the text above, the heading of a newspaper article such as "Fatal accident on Highway 17" would get things started. That is, a word could evoke a frame, and the **semantic parser's** job would be to find the elements of that frame in the text, sometimes in the same sentence, in positions determined by the grammar of the word, and sometimes in neighboring sentences.

The idea behind **frame semantics** is that speakers are aware of possibly quite complex situation types, packages of connected expectations, that go by various names—frames, schemas, scenarios, scripts, cultural narratives, memes—and the words in our language are understood with such frames as their presupposed background. Of course these terms are used to designate concepts developed with slightly different meanings, and for different purposes, in AI, Cognitive Psychology, and Sociology. I use the word "frame" promiscuously to cover all of them. However, in "frame semantics" I'm particularly concerned with those that are clearly linked to items of linguistic form: words or constructions.

8. RISK: the frame

In 1988, at a summer school in Pisa run by the late Antonio Zampolli, I met Sue Atkins, the lexicographer. I was teaching a course on frame semantics, and she was teaching a course on corpus-based lexicography that included an examination of concordance lines for the verb *risk*. Sue and I decided to join forces and come up with a complete frame description of *risk*, based on corpus evidence, that would show how the words that belong to this frame work. The title of the first paper that resulted from this research was "Toward a frame-based lexicon: the semantics of RISK and its neighbors." We presented the main arguments, jointly, at the 1991 meeting of ACL in Berkeley. The paper got published as Fillmore and Atkins (1992).

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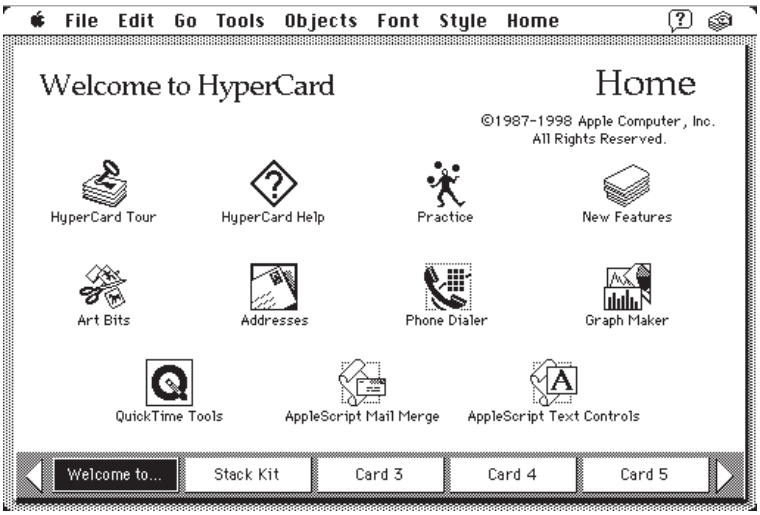

Figure 3
HyperCard: representational breakthrough

9. The gradual birth of FrameNet

Along with some colleagues, I decided to seek funding to build a resource that would feature a large number of frames, along with the words that belong to those frames. In any such funding request, the authors are challenged to represent the project in compelling detail so as to allow reviewers to envision the possibilities. Our first attempt, created by John B. Lowe, made use of a demo created using the new tool HyperCard. Sadly, the funders were not impressed.

Of course, all of this work was carried out against the backdrop of George Miller's ground-breaking project, WordNet[2] (Miller 1995; Fellbaum 1998). By 1992 the creators of WordNet had demonstrated the power and utility of a searchable and open database of English words, organized around core semantic relations such as synonymy, meronymy and holonymy, hypernymy and hyponymy, and so on. While WordNet was an inspiration to us, its purposes and structure are somewhat different than those of FrameNet.

2 http://wordnet.princeton.edu

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COMPLIANCE
Definition: This frame concerns Acts and States of Affairs for which Protagonists are responsible and which either follow or violate some set of rules or Norms.

Figure 4
Definition of the `Compliance` frame

The goal of the FrameNet project[3] (Fillmore, Johnson, and Petruck 2003) was to create a database, to be used by humans and computers, that would include a list of all of the Frames that we could possibly have time to describe. Frames are the cognitive schemata that underlie the meanings of the words associated with that Frame. The example of the frame `Compliance` is given in Figure 4. It begins with a definition of the frame in terms of Frame Elements (FEs), which are the things worth talking about when a given frame is relevant. (There are generally 3 to 8 FEs per frame.)

We currently have about 1200 Frames defined and described. A fragment of the list of Frames alphabetically surrounding `Compliance` runs as follows: `Compatibility`, `Competition`, `Complaining`, `Completeness`, `Compliance`, `Concessive`....

Next, we attempt to catalogue the Lexical Units (LUs) associated with the frame. These are words which, when encountered in a written or spoken text, may "evoke" the frame. Currently, our total number of Lexical Units across all 1200 Frames is about 13,000. (6) lists a sample of the LUs tied to the `Compliance` frame.

(6) *(in/out) line.n, abide.v, adhere.v, adherence.n, breach.n, breach.v, break.v, by-pass.v, circumvent.v, compliance.n, compliant.a, comply.v, conform.v, conformity.n, contrary.a, contravene.v, contravention.n, disobey.v, flout.v, follow.v, honor.v, in accordance.a, keep.v, lawless.a, noncompliance.n, obedient.a,*

3 http://framenet.icsi.berkeley.edu

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obey.v, observance.n, observant.a, observe.v, play by the rules.v, submit.v, transgress.v, transgression.n, violate.v, violation.n

Not all LUs are simple words. Many are phrasal words, such as *take off*, *talk down*, *work out*, *pick up*. Some are idiomatic phrases: *of course*, *all of a sudden*. Finally, some are products of constructions: *best friends*, *make one's way*.

Beyond the specification of cognitive and cultural frames, and their linguistic triggers or anchors, FrameNet analyses endeavor to catalogue the ways that Frame Elements of a Frame are linguistically expressed, specifically in terms of syntactic structures. For example, in the `Compliance` frame, what are the possible forms in which the FEs can be expressed?

To begin to answer this question, we compile for each Frame a set of Annotations. Each includes sentences that exemplify the Frame and its FEs, and demonstrate the use of the relevant Lexical Units. For example, (7–9) illustrate how the subject of a sentence can instantiate three of the FEs in the `Compliance` frame, given the lexical items used.

(7) The wiring in this room is in violation of the building code.

State of Affairs

(8) You have broken the rules.

Protagonist

(9) My action was in compliance with the school's traditions.

Act

Finally, lexical entries summarize the mappings of individual FEs, Lexical Unit by Lexical Unit. For example, for the FE Norm within the `Compliance` frame, we find the following LUs, where "X" is the variable whose value will be the Norm for each LU:

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(10) Lexical Units linked to the Frame Element Norm within `Compliance`

complies [with X]	*conforms [to X]*
is in breach [of X]	*abides [by X]*
violates [X]	*adheres [to X]*

Note that these Lexical Units (all of which would be linked to the Frame Element NORM in the `Compliance` frame) include antonyms, and thus these sets of LUs differ from synsets. Polysemous LUs can be linked to different frames. For example, *adhere* belongs not only to the `Compliance` frame but also to the `Attaching` frame.

The frames themselves are organized in a network, linked by various kinds of relations, including inheritance, part-of, presupposes,[4] etc. Here is a glimpse of the place held by the `Compliance` frame in the network.

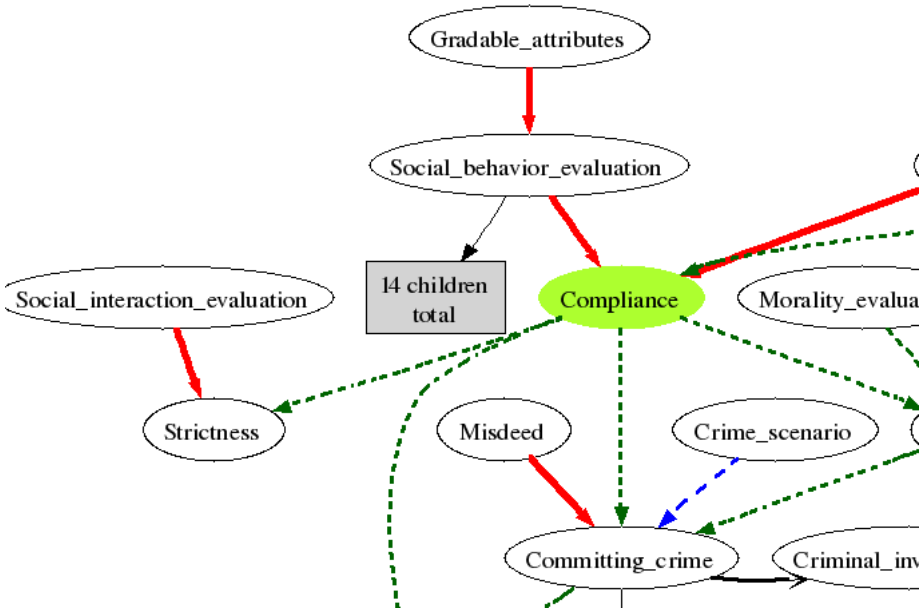

Figure 5
`Compliance` frame in a network of frames

`Compliance` inherits from both the `Social-Behavior-Evaluation` frame and the `Satisfying` frame. The `Satisfying` frame includes satisfying desires, fulfilling

4 Strictly speaking, the notion of frame presupposition is captured by several relations, including "Using" and "Perspective_on."

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ambitions, meeting one's goals, etc. `Compliance` elaborates on that by specifying that the Norm FE is some kind of institutionalized rule or law or principle or practice, and that the words in this frame evaluate people and their acts with reference to such norms.

Frame-to-Frame relations also include FE-to-FE relations: e.g. the Buyer FE of `Commerce_buy` is the Agent FE of `Transfer`. **Linking generalizations** familiar from "standard" thematic roles can be captured by relating smaller frames to the more schematic ones they inherit.

The FrameNet annotation sets include not only the "lexicographic" annotations, but also a number of "full-text" annotations, where all words are annotated, i.e., annotation layers are provided for each frame-relevant word. In such examples, we frequently encounter data that force us to expand and refine FrameNet.

In most examples we can see **core** FEs, those that are required by the frame, as well as **peripheral** FEs, those that fill out the roles traditionally described as adjuncts of time, place, manner, and so on. But as we expand our catch to include sentences beyond those that simply provide good examples of the Frames, we encounter FEs that we label as **extrathematic**. This name is given to expressions that are syntactically governed by a frame-bearing element, but convey information that is outside of the Frame. As Example (11) indicates, extrathematic elements frequently introduce a new Frame, and thus are crucial for the enterprise of automatic understanding of connected text.

(11) Types of FEs in a sentence.

The army	*destroyed*	*the village*	*yesterday*	*in retaliation*
(CORE)	***[target]***	*(CORE)*	*(PERIPHERAL)*	*(EXTRATHEMATIC)*

In our annotation work it has become necessary to notice contexts in which the semantic head of a phrase and the syntactic head of a phrase are not identical. Since we

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are interested in positioning frame-relevant words in their contexts, we have recognized **support verbs**, **support prepositions** and **transparent nouns**. What we find with support verbs and prepositions is that the governed noun is the LU that evokes the frame. In expressions like *take a turn*, *make a decision*, *wreak havoc*, *lodge a complaint*, *say a prayer*, and *give advice*, the frame is evoked by the noun. The same can be observed with *in trouble*, *at risk*, *under arrest*, *under consideration*, and *at rest*. The verb or preposition determines the grammatical functioning, but also (in the case of the verb) features of aspect, tone and voice.

Transparent nouns are nouns that intervene, in a [N1 of N2] structure, between the frame context and the frame-relevant noun. That is, in examples like *wreak this KIND of havoc*, *drink a DROP of vodka*, *divorce that JERK of a husband*, it is the second (underlined) noun that matters in our understanding of the semantic nature of the Frame Element. These grammatical types may also be helpful in the enterprise of automatic understanding of connected text.

We have noticed regularities that may be useful to expand upon for FEs: they can have "semantic types" associated with them, intended to say something about the types of entities, and thus phrases, that can serve in those roles. For example, Agents, Experiences, and Recipients are of the semantic type "sentient." This dimension is not well-developed, currently, consisting mostly of categories such as *artifact*, *container*, *factive* (for verbs), and so on.

The FrameNet wordlist is mostly from the "general vocabulary" and for the most part ignores the tens of thousands of words that either lack frames of their own or that have specialist frames for which ordinary lexicographic inquiry cannot help. These include artifact names, natural kinds, terrain features, and so on. For these we would like to make progress with what we call "Gov-X annotation": annotating words with

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respect to the frames they belong comfortably in. For example, *gun* would be annotated in sentences where it is governed by *brandish*, *fire*, *shoot*, *load*, etc.

10. Constructions

In recent years we have added to the FrameNet database something we call the **Constructicon**, which is a list of grammatical constructions, descriptions of their components, and descriptions of the properties and functions of the phrases or constituents that they license (Fillmore, Lee-Goldman, and Rhodes 2012).

Some members of the team are participants in a movement called Construction Grammar, supporting a view of grammar as a collection of constructions, where each construction constitutes a way of assembling the meaning of the components into a semantic whole, not obviously predictable, by familiar principles, from the meanings of the parts.

This collection includes special constructions like the ones that license *the bigger they come the harder they fall*, or rate expressions like *twenty gallons an hour*, or unusual symmetric-relation expressions like *I am friends with the President*. The collection is not limited to special-purpose or idiosyncratic constructions, but also includes major constructions with broad semantic import and cross-linguistic relevance, such as **conditional sentences**, **exclamations**, a large variety of **coordinating constructions**, and **comparative constructions**.

The constructions bring frames of their own, and the analysis task is to *integrate* the information from the LUs embedded within their Frames with those contributed by the constructions. The Constructicon is linked to a set of sentences annotated according to the properties of the construction being analyzed. Professor Hiroaki Sato of Senshu University in Japan has designed a temporary tool for viewing the constructional information.

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11. Conclusion

The ultimate goal is to be able to understand everything that can be known about a word, or a sentence, or a language, or speakers' knowledge of their language. This goal can never be achieved, but one keeps trying, piece by piece. I recently came upon, in my notes, a program from the 1988 Pisa Institute that showed I was on a panel one evening addressing the question "What would a linguist like to find in the Dictionary of 2001?"

I don't remember what I said, but I think that if everything could work the way we planned it, and if the project ever gets the funds to complete the job, the ICSI FrameNet database of 2020 will stand a chance of being close to that ideal dictionary of 2001. I want to thank the ACL Executive again for the recognition, and the conference participants for listening.

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