

Speech Disfluency and the Structure of Knowledge

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It is generally accepted that filled pauses ("uh," "er," and "um") indicate time out while the speaker searches for the next word or phrase. It is hypothesized that the more options, the more likely that a speaker will say "uh." The academic disciplines differ in the extent to which their subject matter and mode of thought require a speaker to choose among options. The more formal, structured, and factual the discipline, the fewer the options. It follows that lecturers in the humanities should use more filled pauses during lectures than social scientists and that natural scientists should use fewest of all. Observations of lecturers in 10 academic disciplines indicate that this is the case. That this is due to subject matter rather than to self-selection into disciplines is suggested by observations of this same set of lecturers all speaking on a common subject. In this circumstance, the academic disciplines are identical in the number of filled pauses used.

It is an unusually glib and articulate person who, on hearing a tape recording or reading a literal transcript of his or her remarks, has not been shocked by his or her apparent verbal clumsiness, characterized often by agrammatic, redundant speech that is interrupted by repeated words, false starts, long pauses, and guttural interruptions such as *uh*, *ah*, and *um*.

That such disfluencies are an integral part of the speech production apparatus is suggested by studies of silent and filled (*uh*, *ah*, *er*, and *um*) pauses, which are based on the hypothesis that such interruptions in the flow of speech are indications of time for the speech production apparatus to search for the next word, phrase, or idea (Rochester, 1973). Such pauses, according to Lounsbury (1954), may be interpreted as indicative of the strength of association between sequential linguistic events. Alternatively, pauses have been interpreted in more cognitive terms as time for choosing among word or phrase options or for making decisions about the next thought (Goldman-Eisler, 1968).

Whichever theoretical view is favored, the content of the speech should have an impact on speech disfluency. If it is familiar material, there should be fewer pauses. Familiarity held constant, however, there is reason to suspect that the use of filled pauses may vary widely, depending on the nature of the subject matter. In support of this hypothesis are the finding of Reynolds and Paivio (1968) that pauses were more frequent when subjects defined abstract rather than concrete nouns and the finding of Siegman and Pope (1966) that subjects used more filled pauses when they described more ambiguous Thematic Apperception Test cards.

Accepting the view that pauses in speech indicate time for

making choices, it should follow that the more options at a choice point, the greater the likelihood that a speaker will say *uh*. The academic disciplines differ markedly in the extent to which, let us say, a speaker is required to choose among options in an undergraduate introductory lecture. In the pure sciences, we maintain, there are relatively few options. Consider a statement such as $E = mc^2$. There are no options; it cannot be c^3 or c^4 ; it is mc^2 and that is it. In contrast, consider the statement, "What Shakespeare probably meant in that passage from *Lear* was . . ." or "The reason Jackson Pollack put the patch of red in that corner of the canvas was . . ." The options seem limitless.

Even the basic terms of a natural science offer few options. There are no synonyms for *molecule* or *atom* or *ion*. *Salt* may serve as a substitute for *sodium chloride* or *NaCl*, but that's about it. In contrast, consider the alternatives for *affection*, *class structure*, *prejudice*, *beauty*, or *style*.

Next, the scientific method imposes limits on the number of options available. Given a reasonably precise set of assumptions, the derivations must follow. With varying success, the social sciences aspire to this model; the humanities are largely expositional.

Finally, science, pure or not, is eventually concerned with facts. Again, there are few options. There are no options, for example, in describing the orbit of a planet or the outcome of a chemical reaction.

One can, then, make a loose but plausible case that the various academic disciplines differ in the extent to which lectures in these disciplines are accompanied by filled pauses. If this characterization of the sciences as offering relatively few verbal options when compared with the humanities is correct, it should follow, from the hypothesis that filled pauses tend to occur at choice points in speech, that lectures in the humanities will be characterized by more frequent use of *uhs* and *ahs* than are lectures in the sciences. Intuitively, one might expect the social sciences to fall between the natural sciences and the humanities.

Method

To learn whether this expectation is correct, we observed undergraduate lectures in 10 different fields at Columbia University. About 75%

This research was supported by a grant, made for other purposes, from the Russell Sage Foundation.

We thank Robert Krauss, Barry Rodstein, Bidi Terrien-Sommerville, and Timothy Christenfeld for their considerable help at various stages of this research and Don Hood and Barbara Landau for critically reading the manuscript of this article.

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of the lectures were for introductory-level classes in each discipline, and the remainder were courses, one level up, that had an introductory course as a prerequisite. Columbia University's departments are, for administrative purposes, divided into the natural sciences, the social sciences, and the humanities. From each of these divisions, we selected three or four departments, and in each department, we observed four to seven classes. We knew little about the instructors of these various courses, except those in our own department (psychology), and had never heard any of them lecture. The choice of the people observed was fortuitous and depended entirely on who happened to be teaching undergraduate lecture courses during the three semesters in which we made these observations. The fields involved¹ and the number of lecturers observed in each are recorded in Table 1.

All told, 47 undergraduate lecturers were observed in 10 departments representative of the natural and social sciences and the humanities. Two of these 47 lecturers were eliminated from the data, because they were not what they seemed to be—one was a classics scholar teaching a course in accounting for the economics department, and the other had a PhD in physics and was teaching a philosophy course.² The remaining 45 lecturers represented roughly 15% of the resident faculty of these 10 departments, as listed in the Columbia College catalog.

As standard procedure, one of our group, always a student, would go into the classroom, inconspicuously take a seat, and systematically tally *uhs* and *ahs* as they occurred, or tape-record the lecture, or both. Our *uh* coders had extensive experience. In other studies, they had coded a great many speeches and had also practiced and compared their coding of numerous audio- and videotapes. They were trained to regard any sound such as *um*, *er*, *uh*, and *ah* as a filled pause, but to exclude any sound that formed part of a word, however garbled or incomplete. This task soon became second nature, so much so that our coders had to make a special effort to stop mentally coding these filled pauses when off duty. The only real ambiguity occasionally occurred between the indefinite article *a* and a filled pause, but this could almost always be resolved by paying attention to the context. If a speaker said *uh* several times in succession, each was counted as an individual occurrence of a filled pause.

To assess the reliability of our measures, we used the intraclass correlation, which is based on the analysis of variance (ANOVA), to arrive at an estimate of the part of the measurement that is attributable to true differences between individuals and the part that is attributable to error. Unlike the Pearson product-moment correlation coefficient, this measure is directly interpretable as the percentage of variance attributable to the true differences between subjects. (See Lord & Novick, 1968, and Fleiss, 1986, for more extensive discussions of this procedure.) Ten lectures were coded live by two or more observers, and the reliability calculated was .99. Because we were also the observers, we were, of course, not blind to the hypotheses. To check on this potential bias, we hired and trained a coder who knew absolutely nothing of what we were doing to code the *uhs* on 20 of the tape-recorded lectures that we had already coded. For these 20 lectures, picked randomly from the various fields, the reliability of the coded *uhs* per minute was .98. Although these reliabilities are almost disconcertingly high, they are essentially identical to reliability estimates reported by Mahl (1987); Feldstein, Brenner, and Jaffe (1963); and Panek and Martin (1959) in their coding of speech disfluencies. These are extremely simple observations to make.

Results

The results of these observations are in Table 1, which presents the mean *uhs* per minute of speaking for these 10 departments. Ignoring momentarily the a priori assignment of departments to the humanities or sciences, let us ask first if these 10

departments differ from one another in their lecturers' tendency to use *uhs* and *ahs*. They do, $F(9, 35) = 2.87, p < .01$. It is also evident that, with the exception of philosophy,³ these differences correspond to the sciences-versus-humanities distinction, for the natural sciences average 1.39 *uhs* per minute in their lectures; the social sciences, 3.84; and the humanities, 4.85, $F(2, 42) = 6.46, p < .01$. The natural sciences differ, using protected *t* tests, from the social sciences ($p < .02$) and from the humanities ($p < .01$), whereas the social sciences and the humanities do not differ significantly from one another.

Obviously, the differences among the disciplines are substantial and certainly consistent with the hypotheses that generated this study. However, these data are still far from proving that it is some structural characteristic of a body of knowledge that is responsible for the frequency of filled pauses. As with any non-experimental study, it is always possible to conceive of alternative explanations, some trivial, some interesting, for these data. We first consider artifacts that have little to do with cognitive structure or other possibly interesting psychological explanations but that could, in an almost mechanical fashion, produce the pattern of data obtained.

First, the academic disciplines differ considerably in the extent to which they rely on various teaching aids. Mathematicians and chemists use the blackboard, art historians use slides, biologists and psychologists occasionally use demonstration films, and so on. Conceivably, such differences could artifactually account for these results on filled pauses. Writing on the blackboard, for example, undoubtedly cuts down on sheer verbal output; the use of slides may increase verbiage while the lecturer describes the slide; and so on. The differences among the departments might be accounted for by differences in the sheer number of words spoken. If lecturers say less, it is likely that they will use fewer filled pauses as well as fewer words. To check this, we did a word count of the first 5 min (after routine announcements of class business such as assignments, office hours, examinations, etc.) of the formal lectures and calculated the number of *uhs* per 100 words as well as *uhs* per minute. Tape recordings had been made of 38 of the 45 lectures (the 7 psychology lectures were not tape-recorded). Of these, it was possible to make acceptable transcriptions of 31 tape recordings, the remainder being largely unintelligible because of street noise, equipment failure, or lecturers who mumbled.

¹ Although one may wish to dispute Columbia University's assignment of particular disciplines to these three categories, probably the only problem assignment is that of psychology to the natural rather than the social sciences. Not wishing to debate the issue, we note only that this is entirely an experimentally and quantitatively oriented department. There are no clinicians and no applied psychologists in this group.

² These two lecturers were eliminated solely for reasons of sample purity. In fact, they behaved much as did "legitimate" lecturers in each department, and their inclusion in the data has absolutely no effect on any of the trends or statistical analyses reported.

³ Although this exception was a great surprise to us, it was not to most of the philosophers with whom we have spoken of the matter. On the whole, they consider their field, with its historic concern with logic and continuing emphases on the philosophy of science and on analytic philosophy, closer in mode of thought to the natural sciences than to the humanities.

Table 1
Uhs per Minute During Lectures in the Natural Sciences, Social Sciences, and Humanities

Discipline	<i>n</i>	Mean <i>uhs</i> /min
Natural sciences		
Biology	5	1.13
Chemistry	4	1.62
Mathematics	4	1.29
Psychology	7	1.50
Total	20	1.39
Social sciences		
Economics	4	2.17
Political Science	4	5.61
Sociology	4	3.73
Total	12	3.84
Humanities		
Art history	5	6.06
English literature	4	6.54
Philosophy	4	1.65
Total	13	4.85

Natural scientists ($n = 11$) used 1.47 *uhs* per 100 words, social scientists ($n = 10$) averaged 2.67, and humanists ($n = 10$) averaged 4.76. It is evident that the trends were precisely the same for *uhs* per 100 words as they were for *uhs* per minute. In fact, the correlation between the two was .97. Natural scientists, social scientists, and humanists differed significantly in their use of *uhs* per word, $F(2, 30) = 5.09, p < .02$.

Next, we considered the possible impact of purely demographic factors such as age, sex, teaching experience, and native language (i.e., not English). One can make a plausible case that any of these variables might have an impact on the number of filled pauses used. However, as the data in Table 2 indicate, there were no differences in these respects among the three groups of disciplines.

A remaining class of artifacts that conceivably could account for these findings are those that are related to preparation of the lecture. Possibly there are differences among the disciplines in this regard, in which case it is reasonable to expect that lectures that are better prepared and well rehearsed are unlikely to contain many pauses. Although we have no direct measures of preparation time and effort, the observers did make note of lecturers who read extensively from prepared notes. If we assume that writing out one's lecture verbatim is an indication of particularly intensive preparation at some time, then we note that there were no differences among the disciplines in this respect. Twenty percent of the natural scientists read considerable portions of their lectures, whereas 17% of social scientists and 23% of humanists did so. From this indicator, at least, there is no reason to suspect that there are differences among these fields in preparation time and effort.

It does appear, then, that these interdisciplinary differences in the use of filled pauses cannot be explained artifactually by the use of teaching aids that differentially affect verbal output or by demographic factors such as age, teaching experience, or birthplace—or, it seems likely, by differences in lecture preparation. Although it is impossible to rule out all conceivable artifactual explanations, it seems to us that we have ruled out the

most likely of such alternatives, except for one—the possibility that these results have nothing to do with what we have called the structure of knowledge but simply indicate that the various disciplines attract very different sorts of people. Scientists may be people of steel who know and can firmly speak their minds; humanists may be ditherers. And there are certain clear-cut differences between those attracted to these various disciplines. For example, we know that those who go into the sciences tend to have higher mathematical ability than do those who go into the humanities. And, indeed, if we correlate the average number of *uhs* used by the faculty in each of these departments in their undergraduate lectures with the average quantitative scores on the Graduate Record Examination of graduate students admitted to each of these departments in 1988, we obtain a Pearson product-moment correlation of $-.92$, which is possibly the most absurd-sounding correlation since Pearson invented the technique.

To partial out the nature of the material from the nature of the lecturer, it is necessary to examine the speech disfluency of scientists and humanists when they are not lecturing about their academic specialties but are speaking on some common topic. To do so, we designed an interview that we attempted to administer to all of the lecturers we had earlier recorded. The interview was presumably concerned with graduate training procedures and practices within the various departments at Columbia University. The senior author phoned each of these lecturers, explaining that he was directing a study of graduate training that required interviews with a randomly selected sample of members of the various departments at Columbia University; he explained the presumed purpose of the study (to compare the effectiveness of different graduate training practices), estimated that the interview would take at most 15–20 min, and requested an appointment. Everyone approached agreed to be interviewed. However, by the time this phase of the study was underway, 2 of the 45 lecturers had left the university and the city. In addition, 2 members of the psychology department were by this time aware of what we were doing and were, therefore, not interviewed. All told, 41 of the 45 lecturers were interviewed.

The interviews were all conducted by graduate students identified as research assistants on the project. When the interviewer arrived, he or she explained briefly the purpose of the study and, taking out a miniature tape recorder, asked if, because of the difficulty of taking notes, the respondent minded being tape-recorded. Only 1 subject objected, and for this person the interviewer, an experienced observer of *uhs* and *ahs*, simply tallied all instances of filled pauses while taking notes on what was said.

Table 2
Demographic Characteristics of Lecturers in the Natural Sciences, Social Sciences, and Humanities

Category	<i>n</i>	Mean age	Years teaching	% Male	% Foreign born
Natural sciences	20	46.8	17.4	80.0	5.0
Social sciences	12	50.0	18.3	83.3	—
Humanities	13	47.4	17.6	92.3	—

The interview was a completely standardized, open-ended interview focusing first on the course, teaching, and research requirements for a PhD student and second on the nature of the relationship between a faculty member and his or her graduate advisees. Because the object of these interviews was to get a sizable sample of each respondent's verbiage, the interviewers were trained to use probes whenever necessary to keep the respondent talking. Following the interviews, the tapes were analyzed for the frequency of filled pauses.⁴

We have then two samples of each subject's verbal output—one while formally lecturing on his or her discipline, the other while informally talking about his or her department's graduate training requirements, which, incidentally, being in good part dictated by the Graduate School's formal requirements, were very similar in all departments. If it is the nature of the people attracted to these various fields that is responsible for the differences in speech disfluency among these fields, there should be little difference, for each individual, between the use of filled pauses during the lecture and during the interview. Scientists should be low in both and humanists high in both. If, on the other hand, it is the nature of the discipline that is responsible, there should, depending on the field, be differences between the lecture and the interview.

The relative frequency of filled pauses in these two contexts is recorded in Table 3 and Figure 1. These data were calculated only for those 41 people for whom we had both lecture and interview data, which accounts for the slight discrepancies between Tables 1 and 3. It is immediately evident that, unlike the lectures, the members of different departments were virtually identical in the tendency to say *uh* during the interview. A repeated measures ANOVA indicates that this interaction is significant, $F(2, 38) = 5.54, p < .01$. We conclude that the differences among the disciplines in the tendency to use filled pauses is not due to the selection of different sorts of people into the different disciplines, nor is it due to any of the variety of artifacts that, by field, are differentially associated with the preparation or delivery of a lecture.

Table 3
Uhs per Min During Lectures and Interviews

Discipline	n	Mean <i>uhs</i> /min during	
		Lectures	Interviews
Natural sciences			
Biology	4	0.97	5.75
Chemistry	4	1.62	5.73
Mathematics	4	1.30	4.40
Psychology	5	1.80	5.04
Total	17	1.45	5.22
Social sciences			
Economics	3	2.54	4.63
Political science	4	5.61	5.67
Sociology	4	3.73	4.57
Total	11	4.09	4.99
Humanities			
Art history	5	6.06	5.62
English literature	4	6.54	5.76
Philosophy	4	1.65	4.38
Total	13	4.85	5.28

Discussion

The phenomenon, then, appears to be real. The various academic disciplines differed markedly in the extent to which lecturers used filled pauses in their lectures to introductory classes, and these differences cannot be accounted for by any of the more obvious pedagogical or demographic artifacts identified. Furthermore, given the results of interviews with these lecturers, one cannot interpret these differences in terms of self-selection—that is, people with different degrees of speech disfluency are not, for some reason, differentially attracted to (or attractive to) the various academic specialties.

Given this array of facts, it does appear reasonable to interpret these facts as due to something inherent in the language, mode of conceptualization, and methodology of the different disciplines. Starting with the hypotheses that filled pauses are likely to occur at choice points in speech and that the greater the number of options at a choice point, the greater the likelihood of a pause, we have attempted to identify characteristics of a body of knowledge that should affect the number of options in discourse.

Although we are partial to this particular line of explanation, we readily concede that this nonexperimental, field demonstration of a relationship between filled pauses and academic discipline offers no compelling reason for preferring this explanation to alternatives not yet considered. Indeed, few readers of our article have not suggested an alternative explanation. To begin to limit the field of speculation, we consider here a few of the more plausible alternatives.

Given that all of the observed lectures were introductory, undergraduate classes, it has been suggested that the sciences use more technical terms whose comprehension is a prerequisite for understanding the subject. Definitional matters could, then, occupy more of introductory class time in the sciences than in the humanities, and definitions being pretty much familiar, standard textbook material might be accompanied by fewer speech disfluencies. Partially to test precisely this hypothesis, Wanner (1990) observed lectures in 42 advanced, graduate classes. For the 14 natural science classes, there was an average of 2.63 *uhs* per minute; for the 15 social science classes, the average was 3.40; and for the 13 humanities classes, the average was 4.75. These means differ, $F(2, 39) = 3.92, p < .03$. Obviously, the phenomenon persists at both the graduate and undergraduate level of lecturing.

It is also of interest to note that there is a distinct tendency for speakers to use more filled pauses in advanced lectures. For 19 of these 42 lecturers, Wanner (1990) was able to compare data on their use of filled pauses in both undergraduate and graduate lectures. Fifteen of these 19 lecturers said *uh* more often in their advanced lectures than in their undergraduate lectures.

⁴ There were four interviewers, each assigned to conduct at least one interview in each of the 10 departments. The interviewers, three of whom are authors of this article, were all familiar with the findings for lectures. However, because the interviewers were split evenly in their expectations for the interview results, two expecting similar patterns to the lectures and two expecting no differences among the disciplines, this is an unlikely source of bias. In any case, there were no differences in the data obtained by the two groups of interviewers.

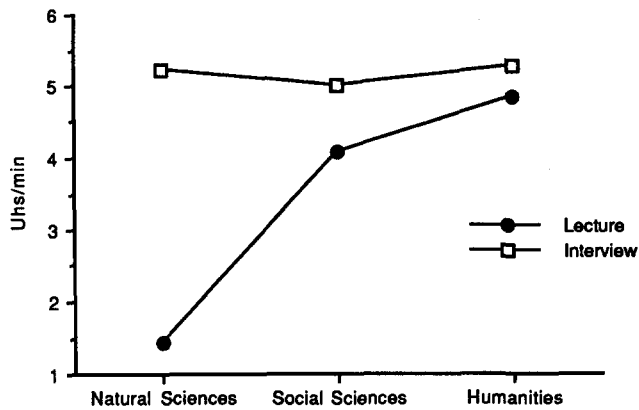


Figure 1. Uhs per minute during lectures and interviews in the natural sciences, social sciences, and humanities.

The mean for advanced lectures was 3.68, and for undergraduate lectures it was 2.53. This difference is significant, $t(18) = 4.17, p < .001$.

Another line of thought attempts to introduce more psychodynamic explanations of these findings, usually based on the assumption that filled pauses increase with anxiety. From the perspective, for example, of Schlenker and Leary's (1982) social anxiety theory, greater anxiety would result if lecturers in the humanities were more concerned with the impression they made on their students, or if they were more insecure about their material, or if they thought it unlikely that they would make a desirable impression. Surprisingly, however, although there is strong evidence that many speech disfluencies increase with anxiety, there is quite consistent evidence that filled pauses are unaffected by anxiety, either state or trait. Mahl (1987), who in his own research has repeatedly failed to find any relationship of anxiety to filled pauses, reviewed seven independent studies, none of which found the slightest indication that anxiety affects the frequency of filled pauses. Although many of these anxiety manipulations were not specifically manipulations of social anxiety, a few of them were very close. For example, in Kasl and Mahl (1965), the manipulation involved telling the subjects that they were being observed through a one-way mirror, which one would certainly expect to increase evaluation apprehension. This manipulation had no effect on filled pauses, although it did markedly affect other speech disfluencies. There have been occasional studies in which a possible link of anxiety to filled pauses in clinical interview situations was suggested, but the Boomer (1963) study was based on 1 subject, and the Panek and Martin (1959) study was based on 4 subjects. With these exceptions, the existing data seem to indicate that anxiety (of any sort) is unrelated to filled pauses.

Rather than continuing to list and feebly feud with competing interpretations, an exercise whose chief virtue is the demonstration that we are at least aware of our interpretive problems even if we can do little about them, we prefer at this point to more carefully develop our own interpretation and examine supporting data, independent of the major findings of our study. In addition, we attempt to spell out what we believe may be some of the limits of the basic findings.

In addition to the extent to which a field employs logico-deductive methodology, we have suggested two characteristics of an academic discipline that should affect the gross number of options confronting a lecturer discoursing on his or her subject. These are, first, the number of synonyms that exist for the technical terms and concerns of a discipline and, next, the extent to which a field is characterized by the search for and exposition of facts.

We hypothesized that the sciences are characterized by fewer synonyms for their basic terms, thus affecting the number of options in the working vocabulary of the discipline. If this is correct, we would expect that pure scientists would use fewer different words in lecturing about their subject than would humanists. To test this guess, we analyzed the 31 understandable tape recordings made of these lectures by counting the number of different words used in the first 400 words of the formal lecture proper. In the pure sciences, lecturers used 148.5 different words; in the social sciences, 155.8; and in the humanities, 189.2. These means, exactly in line with expectations, differ significantly, $F(2, 28) = 12.7, p < .001$. Furthermore, the general line of reasoning about synonyms, options, and filled pauses leads to the expectation that the number of different words used will be correlated with the number of filled pauses. They are, with $r = .44, p < .01$. The greater the number of different words, the greater the number of *uhs* and *ahs*.

Turning next to facts, the expectation that a field concerned with facts will use few filled pauses in public presentations is generated by the truism that a fact is a fact and there are no alternatives. Helium, for example, solidifies at -272°C under a pressure of 26 atm. And that is it, there are no options. Yet, a concern with facts is hardly the exclusive province of the sciences. The year 1492 is quite as much of a fact, in the common-sense use of the term, as is the freezing point of helium. If one speaks of Columbus and America, there are no alternatives to this particular fact. That this is clearly the case suggests that one can probably teach any course so that, in lectures, the options are many or few. A history course, for example, concerned largely with events, sequences, and dates probably permits the speaker few options except in areas where the facts are in doubt. A history course concerned with interpretation offers a running stream of options. Similarly, in science, a course that simply lays out the field for novices probably permits few options, whereas an advanced seminar in frontier areas undoubtedly brings the speaker face to face with many options. Again, interpretation is up for many grabs, but this is a possible explanation of Wanner's (1990) finding that the same lecturer will use more *uhs* in advanced classes than in introductory classes. However, although they are common sense, these suggestions that disciplinary differences in numbers of filled pauses may be malleable must be tempered by Wanner's other finding that the relative differences in the use of filled pauses persist even in advanced-level courses.

There is one further curious property of facts that suggests variables that may have direct effects on filled pauses. Because there are no alternatives, if memory fails there are no substitutes—a state of affairs that surely must lead to pauses, both silent and filled. And who among us, with age, has not been humiliated by some stumbling incoherence as, "Uh, you know, uh, what's-his-name, uh, uh—you know, good old what's-his-

name—the one who wrote the book about, uh, about, uh—spiders!” If it is correct that memory fails with age, it should, then, be anticipated that the relationship between age and the frequency of filled pauses should be stronger in fields that are fact oriented. The same might be expected with fatigue or lack of sleep. Unfortunately, we do not yet have enough data to test this notion, but we offer it as an instance of the kind of implication that follows from our characterization of what, for want of another term, we have called the *structure of knowledge*. Only by spelling out and testing such implications will it be possible to evaluate the merits or shortcomings of this particular explanation of the intriguing finding that humanists use far more filled pauses in their lectures than do scientists.

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Received January 11, 1990
 Revision received July 6, 1990
 Accepted September 20, 1990 ■