Sentence Comprehension in Context:
Influence of Prior
Visual Stimulation?

Michael P. Cannito
Deanie Vogel
Robert S. Pierce

Aphasic persons frequently give the impression of greater understanding of conversational interactions in context than would be expected on the basis of standardized testing at the level of isolated words and sentences. Such clinical impressions have been supported by research studies demonstrating aphasic subjects' ability to utilize linguistic and extralinguistic contextual information to interpret nonliteral intent (Stachowiak, Huber, Poeck, and Kerschensteiner, 1977; Wilcox, Davis, and Leonard, 1973; Meyers and Linebaugh, 1981). This is not particularly surprising in as much as reliance on context is pervasive in normal language comprehension (Marisler-Wilson and Tyler, 1980; Salasoo and Pisoni, 1985).

Recently, it has been demonstrated that prior linguistic contexts, in the form of short narrative paragraphs, are also facilitative of aphasic individuals' comprehension of syntactic structures (Nicholas and Brookshire, 1983). This effect has proved to be quite robust. Cannito, Jarecki, and Pierce (1986) have similarly demonstrated a facilitative effect of paragraph context on aphasic subjects' comprehension of reversible active and passive sentences. Subject/object relationships were comprehended better when they were preceded by paragraphs, which were not predictive of the outcome of those sentences. In addition, this effect was insensitive to violations of expected given-new relationships within the paragraphs. Hough, Pierce, and Cannito (1987) have found contextual facilitation to persist regardless of whether the context is predictive of the outcome of the target sentence. Both predictive and nonpredictive paragraphs were equally facilitative of comprehension of reversible passive sentences in comparison to an isolated sentence condition. These studies have found contextual facilitation to be greater in the more severe ranges of comprehension impairment, while not varying on the basis of expressive fluency. Cannito and co-workers' findings of contextual facilitation of auditory comprehension in aphasia was replicated by Boyle and Canter (1986), who argued that it is predictive information in the paragraph context that allows the aphasic subject to infer the correct outcome without necessarily comprehending the syntax of the target sentence (we note that the findings of Cannito et al. were misrepresented by these authors in their discussion as of no significant effect of nonpredictive context). Their interpretation, however, is at odds with the empirical findings of Cannito and colleagues and Hogue and colleagues. If reversible sentences are comprehended better following nonpreditive paragraphs, it would appear that the underlying sequential relations must be derived from syntactic structure.

Regardless of its psycholinguistic basis, the phenomenon of contextual facilitation may offer some clinical utility, to the extent that verbal contexts could be systematically manipulated to facilitate aphasic comprehension during treatment. While contextual facilitation appears to be reliable and

replicable, one methodological issue has been recognized that may impact on the clinical significance of these results. In the Cannito and colleagues, Hough and colleagues, and Boyle and Canter studies, subjects selected their responses from pictures that were exposed only *after* the auditory stimulus had been presented. This required that the aphasic subjects encode the information on an auditory basis and hold it in memory until a decision regarding the correct outcome could be achieved. Thus it is possible that reported contextual facilitation might be (1) an artifact of the cognitive complexity of the unnaturalistic stimulus conditions or (2) unrepresentative of the degree of facilitation that would be achieved in settings wherein the linguistic content of a communicative event is supported by its visual surroundings. Potential clinical applicability of the contextual facilitation effect would appear to be diminished by the former outcome, but strengthened by the latter. This study sought to determine whether the magnitude of the facilitative effect on comprehension generated by preceding narratives would differ depending on whether the pictured response choices were exposed to the aphasic subject *before* or *after* the auditory stimulus was presented. Potential relationships among performance across conditions and subject variables such as age at onset and severity of receptive aphasia were also examined.

METHOD

SUBJECTS

Twelve male aphasic patients receiving speech-language therapy in a large Veterans Administration hospital served as subjects for this study. Each had suffered a single left-hemisphere cerebrovascular accident. A description of individual subject characteristics is provided in Table 31-1. Subjects ranged in age at onset from 50 to 71 years, with a mean of 60.5. Experimental testing was performed from 4 to 74 weeks post-onset, with a mean of 23.3. Although all subjects exhibited significant degrees of aphasia, none was identified as *globally* aphasic at the time of testing. Aphasia type was noted, but fluency was not considered a relevant grouping factor, since it has not proved statistically significant in the previous contextual facilitation research. All subjects were able to identify the nouns corresponding to those used in the experimental task by choosing between two pictures when named by the examiner with an accuracy level of 80 percent. However, inclusion criteria required a severe deficit of auditory language comprehension as determined by a combined score of 22 or less on the Oral Commands and Complex Ideational Materials subtests of the

TABLE 31-1. CLINICAL CHARACTERISTICS OF 12 APHASIC SUBJECTS

Subject	Age at onset	Weeks post-onset	SEV	COMP	Type
1	66	4	1	3	Wernicke's
2	56	4	1.5	8	Broca's
3	52	68	1	15	Broca's
4	64	70	2	9	Unclassifiable
5	62	11	1	5	Broca's
6	64	9	2	6	Anomic
7	58	21	1	9	Broca's
8	50	74	1	7	Broca's
9	63	2	1	3	Wernicke's
10	61	10	1	9	Broca's
11	60	3	2	11	Anomic
12	71	4	4	22	Anomic

Key: SEV = BDAE Severity Rating; COMP = BDAE Complex Materials and Oral Commands composite score.

Boston Diagostic Aphasia Examination (BDAE) (Goodglass and Kaplan, 1983). Hearing assessments performed within 1 week prior to participation in the study indicated that subjects' estimated speech reception thresholds (SRT = average thresholds of 500 Hz and 1 kHz minus 2 dB) were no poorer than 40 dB in the better ear. Two subjects wore hearing aids, with aided SRTs of 15 dB and 25 dB.

MATERIALS

Experimental auditory stimuli included 10 reversible passive sentences occurring in isolation and 20 reversible passive sentences occurring at the ends of short narrative paragraphs. Each paragraph (including the target sentence) was five sentences in length and constructed for uniformity of linguistic complexity. Half of these paragraphs were predictive of the subject/object of the target sentence and half were not (Table 31-2). The isolated sentences were made comparable to the passives in the contextual condition by using similar types of nouns and verbs. Reversible active sentences, occurring in isolation and in paragraphs, were added as distracter items to create a 42-item test. Two test versions were constructed using different randomizations. Details of materials' development have been reported in Hough and colleagues (1989).

TABLE 31-2. SAMPLE PARAGRAPHS

NONPREDICTIVE CONTEXT

Many kings and queens were partying in a garden. This garden was filled with visiting royalty. Suddenly, a king began walking toward an old friend among the royalty. Soon there was a polite kiss in the courtyard. *The king was kissed by a queen.*

PREDICTIVE CONTEXT

Many kings and queens were partying in a garden. This garden was filled with visiting royalty. Suddenly, a king saw someone whom he loved very much. Soon there was a polite kiss in the courtyard. *The queen was kissed by the king.*

PROCEDURES

All experimental stimuli were presented live voice by the examiner. Following each target sentence, the subject was requested to "show me what happened" by choosing between two pictures. Comprehension was tested in two conditions of picture presentation. In the *unexposed* condition, the subject heard the stimuli prior to being shown the pictures. In the *exposed* condition, the subject saw the pictures first. In the case of isolated sentences in the exposed condition, a 5-second delay period was interposed between picture exposure and reading of the sentence, so that visual processing time would be more comparable to that allowed for the exposed paragraph condition. For all items, the two pictures were two black-and-white line drawings, vertically arranged, which depicted two possible subject/object relationships. An example picture pair is presented in Figure 31-1, which corresponds to the paragraphs given in the previous table.

EXPERIMENTAL DESIGN

Six subjects received the *exposed* picture condition first and the *unexposed* condition second. The remainder received the picture conditions in reverse sequence. Test versions were counterbalanced across picture conditions. The two test versions were administered on different days within a 1-week period. Only number of correct responses on the passive sentences was scored for purposes of statistical analysis. Since predictiveness of paragraph contexts was not relevant to this investigation, data from the two paragraph conditions were pooled by averaging. This resulted in a total of 10 possible points for isolated passives and 10 possible points for passives in paragraph contexts. Hypotheses included the a priori predic-
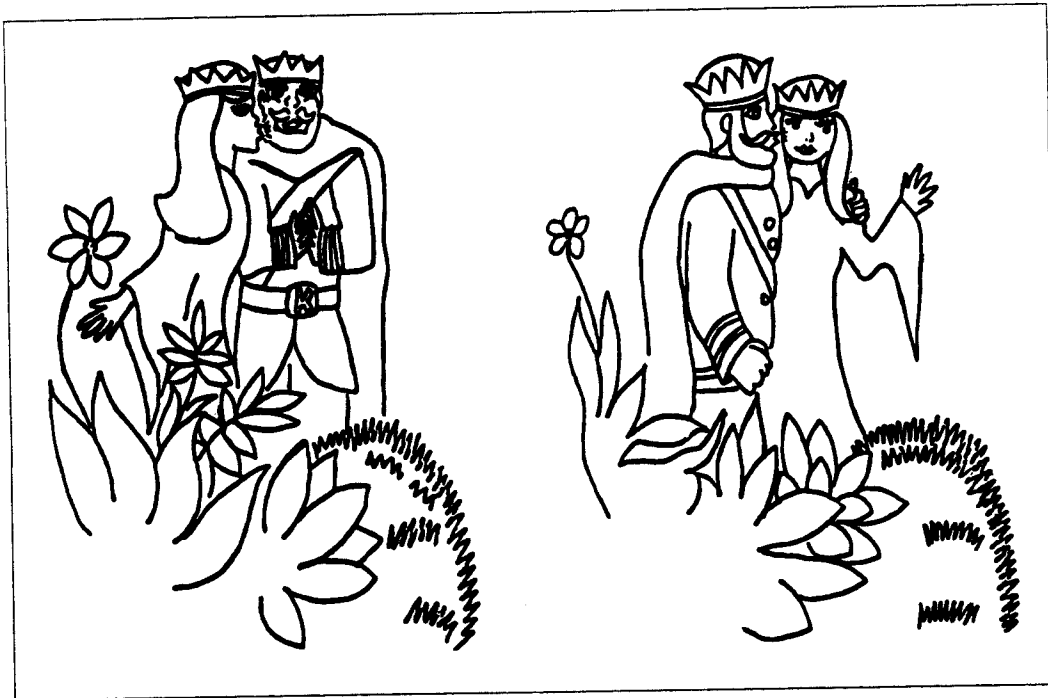
Figure 31-1. Line drawings illustrating possible subject/object relations for "The king was kissed by the queen" and "The queen was kissed by the king." Pictures were presented vertically, not horizontally as shown.

tion of overall better performance for paragraphs than for isolated sentences, and the null hypothesis of no difference between picture presentation conditions. Both hypotheses were tested using t-tests for correlated samples (Winer, 1971) at the alpha level 0.05.

RESULTS

Means and standard deviations for 12 aphasic subjects in four contextual conditions are summarized in Table 31-3. It can be seen that the subjects performed slightly better in both paragraph conditions. A t-test of number correct for combined isolated sentences versus combined paragraphs was statistically significant ($t = 1.89$, df = 11; $p < 0.05$; one tailed). No differences were observed on the basis of order of presentation of visual exposure conditions. Having established the presence of the expected contextual facilitation effect, the magnitude of that effect for the two exposure conditions was computed by determining the difference between the isolated sentence and paragraph scores of each subject within each exposure condition. This difference may be regarded as an index of contextual facilitation. The mean contextual facilitation score for the unexposed condition was 0.33 (SD = 1.32) and for the exposed condition 1.04 (SD = 1.90). A t-

TABLE 31-3. NUMBER CORRECT RESPONSES OF 12 APHASIC SUBJECTS IN FOUR SENTENCE CONDITIONS

	Unexposed		Exposed	
	Isolation	*Paragraph*	*Isolation*	*Paragraph*
Mean	5.16	5.50	4.83	5.92
Standard deviations	1.80	0.97	2.25	1.65
Range	2–8	4.5–7.5	1–8	4–9

test on these difference scores failed to achieve statistical significance (t = 1.26; df = 11; p = .023; two tailed). There was, however, considerable variability between subjects with respect to exposure conditions. Seven subjects exhibited increased contextual facilitation for the *exposed* condition, four showed decreased facilitation, and one demonstrated no change. Among those who showed greater contextual facilitation in the *exposed* condition were two subjects whose performance improved dramatically, by 2.75 (p = .003) and 3.51 (p < .001) standard deviations relative to the distribution of the *unexposed* condition.

Pearson product-moment correlations were computed among experimental measures of auditory comprehension and subject variables. Resultant r values are provided in Table 31-4. Among subject variables, statistically significant correlations were observed between severity with age at onset and severity with BDAE comprehension subtest scores. Among experimental measures, a statistically significant negative relationship was observed between isolated sentences and the contextual facilitation score. In addition, age at onset was negatively correlated with the contextual facilitation score but positively correlated with the difference between visual exposure conditions. Severity was positively correlated with sentence comprehension in isolation and in context, as well as with age at onset. BDAE comprehension score was significantly correlated with sentence comprehension in context and with overall aphasia severity.

Of particular interest was the relationship between age at onset and the difference between visual exposure conditions, pictured in Figure 31-2. This scatter plot illustrates that as age increases, so does the benefit to be derived from prior visual exposure. This raised a question as to whether there might be an age-specific difference between visual exposure conditions. To address this issue, subjects were divided equally into two subgroups (N = 6), above and below the median age of 61.5 years. The mean age for older aphasics was 65 and for younger aphasics 54 years. For each subgroup, a t-test was computed to compare the difference in contextual facilitation scores between exposure conditions to a predetermined mean

TABLE 31-4. CORRELATIONS FOR SUBJECT VARIABLES AND EXPERIMENTAL MEASURES

	ISO-S	CTX-S	EXP-DIF	CTX-DIF	AAO	SEV
CTX-S	.438					
EXP-DIF	−.222	.164				
CTX-DIF	−.687*	−.021	−.374			
AAO	.288	.122	.606*	−.658*		
SEV	.564*	.555*	.339	−.523	.563*	
COMP	.550	.600*	−.082	−.229	.132	.714*

*p < 0.05.
ISO-S = isolated sentences; CTX-S = sentences in context; EXP-DIF = difference in contextual facilitation between exposure conditions; CTX-DIF = difference between isolated sentence and paragraph conditions; AAO = age at onset; SEV = BDAE Severity Rating; COMP = composite score for BDAE Complex Materials and Oral Commands subtests.

Figure 31-2. Scatter plot of amount of contextual facilitation gained by prior visual exposure as a function of age at onset. The regression line and associated equation are also provided.
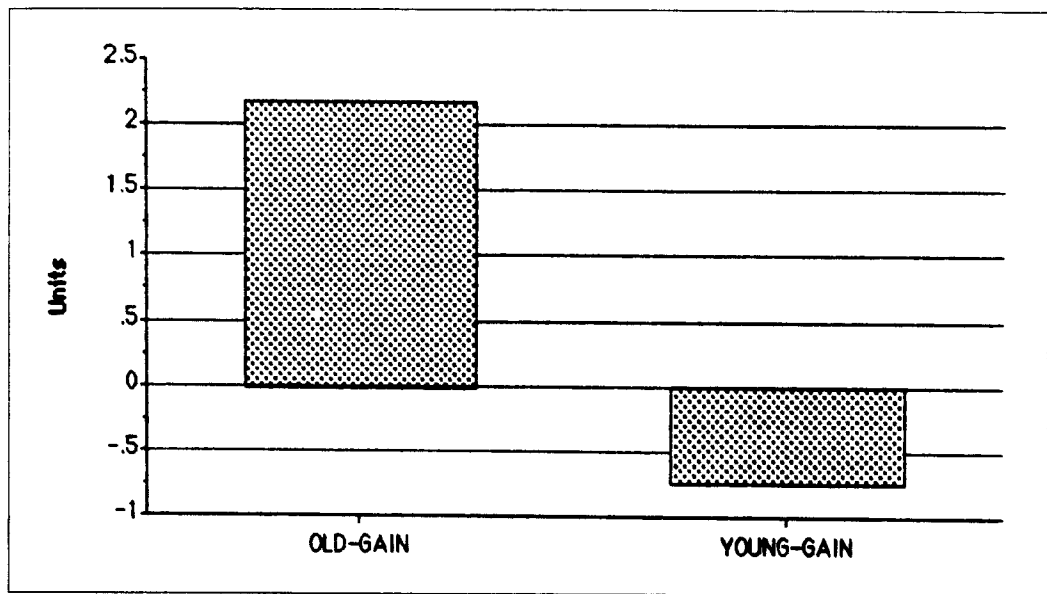

y = .2x − 11.402, R-squared: .367
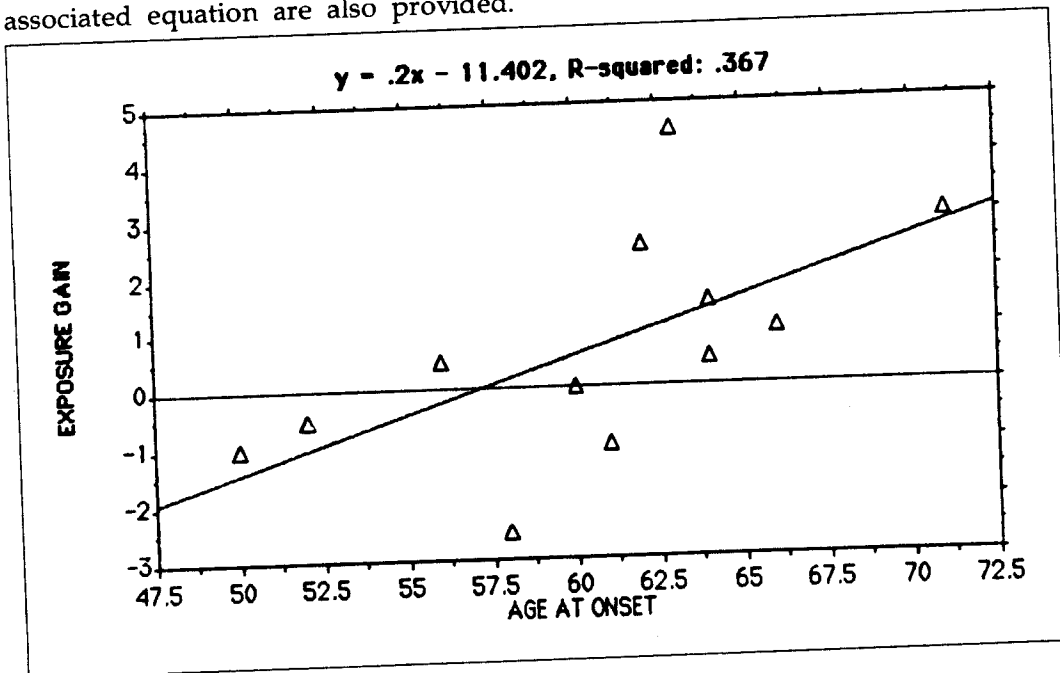
Figure 31-3. Histograms illustrating the amount of contextual facilitation gained by prior visual exposure (relative to the unexposed condition) for the older versus younger aphasic subgroups.

of zero (= the expected value if exposure conditions were identical). The difference scores favoring the *exposed* condition were statistically significantly greater than zero only for the older aphasic subgroup (t = 3.61; df = 5; p = 0.016; two tailed). Average amount of contextual facilitation gained from prior visual exposure by each age group is depicted in Figure 31-3.

DISCUSSION

The prediction of contextual facilitation was upheld: Aphasic subjects performed better on short, cohesive narrative paragraphs terminating in reversible passive sentences than on similar sentences presented in isolation. We have interpreted this effect to result from an opportunity for greater depth of semantic processing afforded by the antecedent text and to redundancy of information presented within the text (Cannito et al., 1986; Hough et al., 1989). Whether the paragraphs actually facilitated syntactic decoding of the target sentences remains open to interpretation, although our prior findings for nonpredictive contexts suggest that it does. We hypothesize that the presence of the discourse context activated cognitive and suprasentential language (e.g., referential, inferential, schematic, and thematic) processes that are not common to the grammatical

interpretation of isolated sentences taken out of context (Ulatowska and Bond, 1983). It is encouraging to think that even severely aphasic persons might utilize high-level discourse knowledge to their advantage during auditory comprehension. The negative correlation between isolated sentence performance observed in this study (as well as in our previous reports) indicates that the more severe the sentential comprehension impairment, the greater the benefit to be derived from context.

Lack of statistical significance initially noted between the two visual exposure conditions seemed surprising, given the widely held clinical assumpton that concurrent visual stimulation is supportive of auditory comprehension in aphasia. While this did turn out to be true of the older aphasic subjects, it was not so for the younger group. The latter were more likely to benefit from context generally (contextual facilitation correlated with age at onset) and did so about equally in both exposure conditions. It is generally established that there is perceptual and cognitive decline associated with the aging process (Birren, 1970; Craik, 1977). Normal age-related deterioration of semantic discourse content has also been reported (Ulatowska, Hyashi, Cannito, and Fleming, 1986), whereas discourse structure in normal and aphasic elderly remains relatively well preserved (Cannito, Hyashi, and Ulatowska, 1988). Thus it is likely that the older subjects in the present study exhibited aphasic comprehension impairment overlaid upon normal age-related information processing decline. The presence of static visual stimuli may have facilitated encoding and representation of the discourse context so that it could be utilized in the interpretation of the outcome described by the target sentence. Obviously, supportive visual material should be incorporated in discourse level approaches to auditory comprehension treatment for older aphasic persons. The issue of aging as a confounding variable should be dealt with in future studies of contextual facilitation effects.

Although this was not a treatment study, we contend that contextual facilitation phenomena have immediate clinical significance for aphasia treatment. If controlled manipulation of discourse structure leads an aphasic person to more accurate responses, ostensibly by engaging aspects of the language system that are not activated by sentential stimuli, such activity is a worthy component for that individual's treatment program. This view is quite compatible with Schuell's principles of aphasia treatment:

> When a patient listens and makes an appropriate response, a whole cycle of activity is set in motion. This cycle involves discrimination, selection, integration, and facilitation of ensuing responses (Jenkins, Jimenez-Pabon, Shaw, and Sefer, 1975, p. 297).

This argument holds regardless of how the predictiveness issue (i.e., that context facilitates syntactic decoding versus inference of outcome) is ultimately resolved. The effects of diverse types of antecedent contexts upon

comprehension of a variety of sentence types and their possible utility for aphasia treatment warrant exhaustive additional research.

ACKNOWLEDGMENT

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DISCUSSION

Q = question; A = answer; C = comments.

Q. I enjoyed your paper. It's going to force me to go home and look with my colleagues at some data we presented last year where I had not been able to understand the variability. I think it says something about looking at group studies versus — thank God for single-subject designs. Some would have criticized you for going beyond the group data to look within and you're seeing subgroups. But I think what I see here is a wonderful finding. You're saying that it may be age-related. And we found that some patients benefitted from double visual-auditory stimulation on a phonemic-semantic word processing task, and we've never been able to figure out which ones. Now, I want to go back and look at the age factor. I think we do need to look at information processing deficits in our older patients.

A. Glad to help out. I hope that turns out to be the explanation, that it didn't help the younger subjects. For our study this interpretation, at least, seems to be reasonable.

Q. I had a couple of questions. Number one, you didn't state, but just for my assurance, do we know much about the auditory function in these individuals across age to assure us that the relative benefit acquired in the elderly is not because they are not hearing and they can see and, in fact, do better when they have *some* stimulus? Do we know that their hearing assessments are not a factor here?

A. All of our subjects' clinical audiological records were examined by the speech pathologist who was responsible for subject selection — that is, my co-author, Dr. Vogel, and criteria was that they had functional hearing based on the estimated SRT, which in some cases was aided.

Q. One last question. Recently Heilman and his group reported on the phenomenon of vertical visual suppression with simultaneous stimulation. I noticed that your stimuli are vertically stacked and simultaneous, and the question is whether or not if you look at errors in your subjects, was there any preference for them selecting the upper or the lower case more often and does verbal-visual suppression with simultaneous stimuli have any role in the phenomena of errors of selection?

A. We looked at pointing bias in the initial study, the 1986 study, and didn't find any indication of it, and we did counterbalance correct responses across vertical positions. We chose to use vertical orientation rather than left to right because there have been shown to be

left-right pointing biases. So I think you're damned if you do and damned if you don't. Boyle and Canter used four pictures, and I think this helped to offset these postional effects and also to show that it's not an artifact of only having two pictures to choose from. That was an important contribution.

Q. That's a great lead into my question. You had two pictures for them to choose from so they had a 50-percent chance of getting the right response, and it seemed to me if I recall that the means in the four conditions that you showed were around 5 out of 10. I'm wondering if you looked at whether your subjects moved from chance performance to non-chance performance and what you can tell us about that whether even with the improvement they remained at a level of just chance performance, and what does that tell us about whether or not this is a real effect that we're seeing?

A. It's deceptive to look at the mean. The mean is actually a nonexistent score that no one makes. Half of the subjects fell below the mean and half fell above the mean, gravitating progressively farther away from chance as they went. We didn't compute the binomial probabilities for each subject, but that is an interesting question. If performance goes from below chance level or slightly above chance level, what do we make of it in this aphasia research? And I think it's beyond the scope of this report. We've shown this statistically significant effect repeatedly. This is the third replication that we've done and you've replicated it yourself with more pictures.

Q. Did you talk about the difference in severity levels for the older versus the younger group?

A. The older subjects were somewhat more severely involved on the average than the younger subjects. I don't have that severity data broken out at this time. It was an exploratory post hoc analysis; but it will be something to examine more closely.

Q. You gave a cognitive perceptual explanation for your age finding. I'm curious who was in that age group, especially since we know that Wernicke's aphasics are by and large older than other types of aphasic patients. You had several Wernicke's patients in your sample. Were they in that group?

A. There were two Wernicke's aphasic patients, and they were both in the older group.

C. I wonder if what you are dealing with is that your older group is just more severely impaired than the younger group and perhaps the confound of age may not be as significant as one might want to expect.

A. Although severity was correlated with age, it was unrelated to the amount of contextual facilitation gained by prior visual exposure. So severity cannot explain the age-related finding in this limited sample. It's a possibility that we'll have to continue to assess as we go along with this.

Q. It seemed to me that your predictive context may in some cases have interfered with comprehension rather than facilitated it because in that predictive paragraph, a *king* is foregrounded — he's the person of mention throughout and suddenly, we're faced with the key sentence in which the *queen* is suddenly foregrounded. In fact, when I read the paragraph, I assumed that the last sentence said, "The king was kissed by the queen." And it was only when I saw the picture that I went back and recoded that sentence. So maybe that's one of the reasons that some of your people were below chance level; they were being mislead by the context.

A. It's an important point. It's one that we had anticipated as well when we started doing this work (reported at BABBLE in 1982 and ASHA in 1983). We addressed that very issue. If you violated the expected given-new relationships, by giving the topic in a prior paragraph and then putting the new information first in the final sentence, we thought there would be an effect on aphasic patients' comprehension. But, in fact, we found there was no effect for these violations. Paragraphs that maintained given-new relationships and those that violated them both facilitated comprehension about equally in the aphasic subjects relative to the isolated sentence condition. And again, this was true of both active and passive sentences.