Influence of Congruent and Incongruent Contexts on Prosodic Mood Recognition by Brain-damaged Adults

Connie A. Tompkins
Western Psychiatric Institute and Clinic,
University of Pittsburgh, Pittsburgh, Pennsylvania

Charles R. Flowers
Department of Speech and Hearing Sciences
University of Washington, Seattle, Washington

Experimental research assessing the ability of brain-damaged persons to profit from context indicates that the addition of relevant verbal cues, rather than increasing the difficulty of certain linguistic judgments, may facilitate comprehension for left hemisphere damaged (LHD) aphasic subjects (Pashek and Brookshire, 1982; Pierce and Beekman, 1983; Stachowiak, Huber, Poeck and Kerschensteiner, 1977; Waller and Darley, 1978). In contrast, subjects with right hemisphere damage (RHD) often have trouble integrating cognitive and situational information (Brownell, Michel, Powelson and Gardner, 1983; Cicone, Wapner and Gardner, 1980; Wapner, Hamby and Gardner, 1981; Winner and Gardner, 1977).

Although these data suggest that hemispheric brain injury may differentially affect contextual responding, "context" is a broad concept, and the precise influences of many varied contextual factors remain to be specified. A different level of contextual effect, described in the normal psychological literature, involves priming which results from a person's current mood or arousal state (Bower, 1981; Bower, Gilligan and Monteiro, 1981; Clark, Milberg and Ross, 1983). This literature indicates that mood influences subjects' free associations to neutral words, social perceptions, and stories generated to describe standard pictures. For example, Isen, Shalker, Clark and Karp (1978) report that good moods induced greater liking for a stranger, and more glowing performance judgments on a consumer opinion survey. They envision mood functioning as a cue to increase accessibility of congruent thoughts, memories, and associations, much in the same way as superordinate cues enhance word retrieval from specific categories. At the same time, particular mood states have been found to disrupt the encoding of affective material opposite in valence (Nasby and Yando, 1982).

Such findings are integrated in the framework of an associative network theory of learning and memory (c.f., Anderson, 1983). In this model, a single emotion unit or node consists of various aspects of that emotion, such as autonomic responses, verbal labels, expressive patterns, evoking situations, and cognitions from previous occasions in which that emotion has been experienced (Bower, 1981). Clark et al. (1983) assert that information about changes in arousal may be stored with mood representations as well. Excitation can be transmitted to and from each of these connections. In this way, spreading activation from a dominant mood acts to enhance both the salience of mood-congruent stimuli and the accessibility of emotion-congruent interpretations. At the same time, incongruent schemas become less available because they are relatively less prominent than the activated pathways.

This model and its predictions were applied in the framework of an experiment on prosodic mood recognition to assess another aspect of contextual use by brain-damaged subjects. Phrases of neutral semantic content judged to

indicate certain moods through prosody were preceded by short paragraphs. These described emotional situations that were congruent or incongruent with the phrase moods. The paragraphs were intended to serve as primes. It was anticipated that the biasing paragraphs would influence prosodic mood perception for LHD subjects, by priming mood-congruent interpretations. Unimpaired performance was expected for the LHD group when paragraph and prosodic stimuli were congruent in emotional tone. Relatively more errors labeling emotional prosody were predicted when paragraph and prosodic moods were incongruent.

Predictions for the RHD subjects were somewhat less certain. Even though they should comprehend the paragraphs, the contextual bias might not affect them since they have difficulty integrating inferences with a defined situation. If this was the case, their contextual prosodic judgments would be no better than those in an isolated condition, and errors labelling prosodic mood would be more equally distributed across incongruent and congruent context conditions. Alternatively, the priming task used in this experiment would seem to tap a more automatic level of contextual responding. It may be that this relatively automatic level is less impaired after RHD, in which case the RHD group might show facilitation and interference effects similar to LHD subjects.

METHOD

Subjects

Thirty-three right-handed males participated. Eleven had unilateral left (LHD) and 11 had unilateral right hemisphere damage (RHD), from a single stroke of vascular etiology. Side of lesion was verified by CT scan and neurological data. Eleven were nonneurological controls. Brain-damaged subjects were three to six months post onset, and passed screening tests of visual word recognition and audition. The prevalence of certain behavioral deficits documented on hospital admission is shown in Table 1. Ten LHD subjects were aphasic. At the time of testing, 8 of these 10 LHD subjects were receiving language therapy; two exhibited primarily physical sequelae.

Table 1. Prevalence of certain behavioral deficits documented in medical charts for RHD (N=11) and LHD (N=11) subjects.

	RHD	LHD
Contralateral hemiplegia/paresis	11	10
Aphasia	0	10
Visual field cuts or homonymous hemianopsia	3	3
Contralateral neglect/inattention	6	1
Dysarthria	8	7
Diminished sensation	6	6

Because subjects were referred from seven hospitals in three cities, no single standardized evaluation procedure was available at the time of testing. We collected connected speech samples using the Cookie Theft picture from the Boston Diagnostic Aphasia Examination (Goodglass and Kaplan, 1983), and administered the yes/no question subtest from the Western Aphasia Battery (Kertesz and Poole, 1974). Verbal expression was scored both for concepts per

unit of time (after Yorkston and Beukelman, 1977) and the phrase-length ratio (Goodglass, Quadfasel and Timberlake, 1964). Transcription and scoring was done by the first author and a second speech and language pathologist naive to the purposes of the experiment. Point-to-point agreement on both the concepts and phrase-length measures was better than 90%. Concepts per half minute ranged from 4.5 to 15.0 within the LHD group ($\bar{X}$=8.68). Phrase-length ratios ranged from 0.0 to 7.0 for LHD subjects ($\bar{X}$=2.04). Combining these measures allowed rough classification of LHD subjects relative to speech fluency. Seven exhibited mild to moderate nonfluent aphasic speech, two were primarily anomic, and two were essentially normal. Auditory comprehension errors ranged from 0 to 4 on the 20-item WAB subtest ($\bar{X}$=1.09), indicating a mild degree of comprehension impairment.

RHD subjects were differentiated from the LHD group by their performance on the Seashore Tonal Memory test (Seashore, Lewis and Saetveit, 1960) and showed qualitative differences in the combined concepts and phrase length measures of verbal output. As a group, the RHD subjects exhibited mild to moderate impairment on tests of judging line orientation (Benton, Hamsher, Varney and Spreen, 1983) and tonal memory (Seashore et al., 1960).

The LHD subjects ranged in age from 39 to 79 years ($\bar{X}$=59, S.D.=13.1), and in years of education from 10 to 16 ($\bar{X}$=12.8, S.D.=1.7). The RHD group ranged in age from 59 to 78 years ($\bar{X}$=65, S.D.=6.1) and years of schooling from 9 to 18 ($\bar{X}$=13.6, S.D.=3.2). Normal control subjects ranged from 39 to 73 years of age ($\bar{X}$=60, S.D.=11.1) and from 9 to 17 years of education ($\bar{X}$=13.3, S.D.=2.3). One way analyses of variance indicated that the three subject groups did not differ significantly in either age (F=1.23, df 2, 30, p=.31) or years of formal education (F=.31, df 2, 30, p=.73).

Procedures

Generating Stimuli. Stimuli were derived from recordings of three female speakers who read five sets of paragraphs designed to indicate happiness, anger, or fear (see Table 2). Each member of a set concluded with a quotation which was neutral in content (e.g., "What are you doing here?"), but which speakers read to convey prosodically moods congruent with the paragraphs.

Table 2. Sample paragraph set used to elicit prosodic stimuli (in quotations). The three contrasting paragraphs, without the final sentence, were used as contexts.

Mary was surprised by a visitor. It was [her favorite brother / a former boyfriend / a total stranger]. He [gave her some roses / started insulting her / climbed in her window]. She exclaimed, "What are you doing here?"

All paragraphs were recorded in a sound-attenuating audiometric booth for optimum quality. Recordings were made on an AM tape recorder (TEAC 3440) using a condensor microphone (TEAC ME-120) with a foam windscreen at a microphone-to-mouth distance of approximately 20 cm. High quality reel-to-reel tapes (Maxell UD 50-60) were used.

Because unambiguous stimuli were desired for use in the experiment, five normal male judges similar in age ($\bar{X}$=62, range 49 to 75 years) and education ($\bar{X}$=12 years, range 10 to 17 years) to the subjects, judged the emotions conveyed

by both the paragraphs themselves (contexts), and by the quotations extracted from the story contexts (prosodic stimuli). Only those prosodic stimuli for which all judges chose the same mood were retained for randomization onto the experimental tapes. All paragraphs were judged to convey the moods intended.

Stimulus Tapes. For the experimental task, the experimenter (CT) recorded each of the fifteen contexts in a neutral way, two times each, at approximately 110 words per minute. A prosodic stimulus selected quasi-randomly from the pool of good exemplars was recorded following each paragraph, for a total of 30 stimuli. For one occurrence of the story context, a quote congruent in mood followed; for the other, the quotation and paragraph moods were incongruent. All possible incongruent pairings were represented equally. An interval of three seconds was placed between each paragraph and its associated quote, and 10 seconds were left between each paragraph/quote pair.

A second stimulus tape had been prepared in the context of another experiment. Forty isolated prosodic stimuli from the pool of good exemplars had been recorded singly onto an audiotape with an interstimulus interval of seven seconds.

Tasks. Subjects heard the stimulus tapes and judged first the mood of the paragraph context, and then of its associated quotation. They selected the moods perceived from four choices, arrayed vertically on the testing surface: happy, angry, afraid, and no emotion. For the other experiment, the same subjects had selected from the same four choices the moods of 40 similar prosodic quotations presented in isolation. The order of all of these tasks was counterbalanced. Demonstration items came from the pool of potential stimuli, but none were identical to those used in the experimental task. Practice and corrective feedback were given as needed through six items, until subjects were correct two consecutive times.

It was important to demonstrate that the brain-damaged groups had similar understanding of the paragraph information intended as a prime. In part, the accuracy of their mood judgments about the paragraphs bears on this issue. To insure adequate lexical comprehension, brain-damaged subjects heard the paragraphs again and answered six factual yes/no questions about each. Two questions referred to each fact tested, one to be answered "Yes," and the other "No." A sample question pair constructed for the paragraph shown in Table 2 is as follows: "Was Mary surprised by her visitor?" (Yes); "Was Mary expecting her visitor?" (No). The order of questions was randomized for each paragraph. Subjects had to answer both questions about a single fact in order to receive credit for comprehension. The total possible correct score was 45 (15 paragraphs by 3 facts tested for each). Normal subjects were not tested for lexical comprehension.

RESULTS

Several factors indicated that the two brain-injured groups had similar access to the information expected to prime their prosodic judgments. First, a one-way ANOVA, with the number of errors assigning paragraph mood the dependent variable, was nonsignificant ($F=1.41$, df 2, 30, $p=.26$). Group mean error frequencies [and standard deviations] were quite small (0.82 [1.17], 0.73 [0.65], and 0.27 [0.47] for RHD, LHD and normal groups, respectively), indicating that the judgments were very easy for all subjects. Secondly, the brain-damaged subjects made very few lexical comprehension errors. Errors for both groups ranged from zero to six, with means (and standard deviations) of 0.91 (1.87) and 1.27 (1.90) for RHD and LHD subjects, respectively. These scores were not significantly different ($t=-0.45$, $p > .05$).

Several analyses were performed to examine contextual effects on comprehending moods expressed prosodically by stimulus quotations. The first was a two-way ANOVA (three Groups by two Conditions) with repeated measures on the Conditions factor (Congruent and Incongruent quotations). Figure 1 illustrates the results of this analysis. Of primary interest is the significant Groups by Conditions interaction (F=6.75, df 2, 30, $p < .004$). Newman-Keuls analysis of simple interaction effects showed that there were no differences between the three groups in the Incongruent condition. In the Congruent condition, LHD subjects ($\bar{X}$=0.818, S.D.=0.077) were as accurate as normals ($\bar{X}$=0.908, S.D.=0.062), but RHD subjects ($\bar{X}$=0.688, S.D.=0.139) were significantly less accurate than the other two groups. The Congruent condition was easier for all groups than the Incongruent condition, though the difference was more pronounced for LHD and normal subjects than for the RHD group.

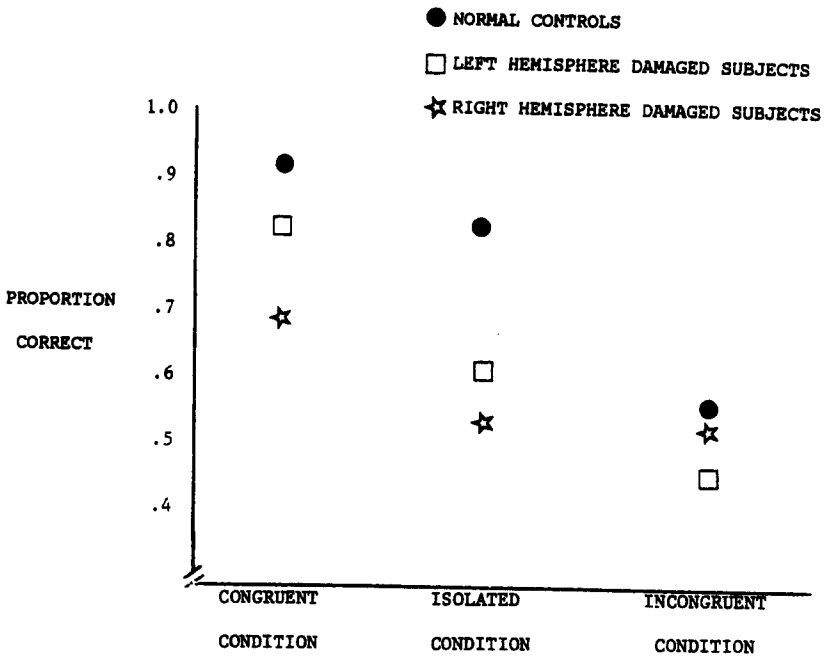

Figure 1. Proportion correct responses by three groups of subjects in Congruent, Isolated, and Incongruent conditions.

The second analysis examined facilitation and interference relative to the accuracy of prosodic judgments in the Isolated condition. On the isolated task, after correction for guessing, performance of the RHD group ($\bar{X}$=0.51) and the LHD group ($\bar{X}$=0.63) was found to be nonsignificantly different, but more impaired than that of normal subjects (Tompkins and Flowers, in press; see Figure 1). A test of contextual facilitation examined group differences in the percentage of incorrect responses to isolated quotes which became correct when preceded by a congruent paragraph. Of the 15 Congruent condition quotes, 11 had been used in the isolated task. Only subjects who made five or more errors responding to these 11 isolated quotations were used in the analysis (N=8, 6, and 3 from RHD, LHD, and normal groups, respectively). One-way ANOVA indicated that the group mean proportions were significantly different (F=6.90, df 2, 14, $p < .01$). Scheffe post hoc analyses of means showed that the RHD group ($\bar{X}$=0.510, S.D.=0.191) achieved a smaller facilitation effect than normals ($\bar{X}$=0.933, S.D.=0.115), but that LHD subjects ($\bar{X}$=0.657, S.D.=0.153) did not differ from either normal or RHD subjects.

The measure of contextual interference examined the proportion of judgments which were correct for isolated quotes, but became errors when preceded by incongruent paragraphs. Of the 15 quotes in the Incongruent condition, 10 had been used in the isolated task. Again, only subjects who had made at least five correct responses to this subset of isolated quotes were included in the analysis (N=6, 6 and 11 for RHD, LHD, and normal groups, respectively). One-way ANOVA was statistically significant ($F=3.50$, df 2, 20, $p < .05$). Scheffe tests showed that LHD subjects ($\bar{X}=0.590$, $S.D.=0.261$) were more likely than RHD subjects ($\bar{X}=0.287$, $S.D.=0.263$) to judge a previously correct item incorrectly when it was preceded by an incongruent context. The normal group's mean ($\bar{X}=0.350$, $S.D.=0.189$) did not differ significantly from those of either the LHD or RHD groups.

DISCUSSION

This study extends the literature regarding contextual processing after brain damage. Results for the LHD group were much as anticipated: they were as accurate as normal controls in judging emotional prosody in congruent contexts; they did better given congruent than incongruent contexts, and they exhibited facilitation or interference effects when presented with congruent or incongruent information, respectively. Facilitation effects for LHD subjects were equivalent to those for normal subjects, indicating that the two groups similarly benefitted from the priming contexts. While LHD subjects showed more interference than the normal subjects, it may be that the normal interference effect was attenuated by task characteristics. The normal group's interference index probably reflects both their superior processing of the isolated prosodic stimuli and an ability to overcome mood interference to a certain extent when the stimuli to be judged are unambiguous. Further, Bower (1981) has indicated that mood priming effects should be stronger for normal subjects in a recall task.

Performance of the RHD group indicated some preservation of contextual priming effects as well. Like the other two groups, they were more accurate at judging moods from prosody when given supportive contextual information than when incongruent situations were presented. They also showed facilitation effects which were on a par with those for the LHD subjects. As suggested in the introduction, this pattern of performance is better than what might be expected from tasks requiring more deliberate or interpretive use of contextual information. In contrast to previous studies of contextual interpretation following RHD, the demands for actively associating and remembering the affective material were minimized in this study. In fact, subjects were instructed that the moods conveyed by some of the contextual paragraphs would not "go with" those suggested by the quote that followed; thus they had been prepared to disregard rather than retain the contextual information. It may be, then, that the RHD subjects' success in the Congruent condition is related to sparing of a relatively automatic level of contextual priming.

Even though the two brain-injured groups were statistically equivalent, several LHD subjects overlapped with the normal group in the extent of contextual facilitation, while no RHD subjects achieved normal level. The RHD subject who demonstrated the smallest effect was the second poorest on the isolated task, and his brain damage involved the right middle cerebral artery distribution, presumably being some of the most extensive. However, another subject with comparable damage who was the most impaired at judging quotation mood in isolation achieved one of the highest facilitation scores in the RHD group. It is unclear what factors may underlie this difference.

RHD subjects also experienced contextual interference in the Incongruent condition, and to the same extent as normals, suggesting that misleading contexts could influence their previously accurate judgments to some degree. This apparent equivalence may be a spurious result of task characteristics, as has been suggested previously.

The contextual facilitation and interference effects observed in this study probably can be distinguished from a tendency to perseverate mood choice from the paragraph to the subsequent quotation. All subjects made some errors judging Congruent quotations, and all were accurate at labelling some in the Incongruent condition. Secondly, for all groups, only about half of the quotation errors in the Incongruent condition reflected the same emotion as the paragraph. These observations indicate that the subjects did select different moods for a paragraph and its associated quote on a regular basis.

In conclusion, the results of this study indicate a need to define and examine additional contextual influences to determine what aspects of contextual processing are more or less retained after hemispheric brain injury. While LHD subjects have been found to benefit from a broad range of contextual manipulations, RHD subjects are often characterized as insensitive to context. This conclusion is derived from tasks requiring overt manipulation or integration of contextual materials. This study has demonstrated, however, that subjects with mild-to-moderate RHD can profit from certain aspects of context. It may be that more nearly automatic priming of emotion-congruent interpretations remains relatively intact following damage to the right side of the brain.

REFERENCES

Anderson, J.R. A spreading activation theory of memory. Journal of Verbal Learning and Verbal Behavior, 22, 216-295, 1983.

Benton, A.L., Hamsher, K. deS., Varney, N.R., and Spreen, O. Contributions to Neuropsychological Assessment. New York: Oxford University Press, 1983.

Bower, G.H. Mood and memory. American Psychologist, 36, 129-148, 1981.

Bower, G.H., Gilligan, S.G., and Monteiro, K.P. Selectivity of learning caused by affective states. Journal of Experimental Psychology: General, 110, 451-572, 1981.

Brownell, H.H., Michel, D., Powelson, J., and Gardner, H. Surprise but not coherence: Sensitivity to verbal humor in right-hemisphere patients. Brain and Language, 18, 20-27, 1983.

Cicone, M., Wapner, W., and Gardner, H. Sensitivity to emotional expressions and situations in organic patients. Cortex, 16, 145-158, 1980.

Clark, M.S., Milberg, S. and Ross, J. Arousal cues material stored in memory with a similar level of arousal: Implications for understanding the effects of mood on memory. Journal of Verbal Learning and Verbal Behavior, 22, 633-649, 1983.

Goodglass, H. and Kaplan, E. Assessment of Aphasia and Related Disorders (2nd ed.). Philadelphia: Lea and Febiger, 1983.

Goodglass, H., Quadfasel, F.A., and Timberlake, W.H. Phrase length and the type and severity of aphasia. Cortex, 1, 133-153, 1964.

Isen, A.M., Shalker, T., Clark, M.S. and Karp, L. Affect, accessibility of material in memory, and behavior: A cognitive loop? Journal of Personality and Social Psychology, 36, 1-12, 1978.

Kertesz, A. and Poole, E. The aphasia quotient: The taxonomic approach to measurement of aphasic disability. Canadian Journal of Neurological Sciences, 1, 7-16, 1974.

Nasby, W. and Yando, R. Selective encoding and retrieval of affectively valent information: Two consequences of children's mood states. Journal of Personality and Social Psychology, 43, 1244-1253, 1982.

Pashek, G. and Brookshire, R.H. Effects of rate of speech and linguistic stress on auditory paragraph comprehension of aphasic individuals. Journal of Speech and Hearing Research, 25, 377-382, 1982.

Pierce, R. and Beekman, L. Effects of linguistic and extra-linguistic context on semantic and syntactic processing in aphasia. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1983. Minneapolis, MN: BRK Publishers, 1983.

Seashore, C., Lewis, D., and Saetveit, J. Seashore Measures of Musical Talents. New York: Psychological Association, 1960.

Stachowiak, F., Huber, W., Poeck, K., and Kerschensteiner, M. Text comprehension in aphasia. Brain and Language, 4, 177-195, 1977.

Tompkins, C.A. and Flowers, C.R. Perception of emotional intonation by brain-damaged adults: The influence of task processing levels. Journal of Speech and Hearing Research, (in press).

Waller, M.R. and Darley, F.L. The influence of context on the auditory comprehension of paragraphs by aphasic subjects. Journal of Speech and Hearing Research, 21, 732-745, 1978.

Wapner, W., Hamby, S., and Gardner, H. The role of the right hemisphere in the apprehension of complex linguistic materials. Brain and Language, 14, 15-33, 1981.

Winner, E. and Gardner, H. The comprehension of metaphor in brain-damaged patients. Brain, 100, 719-727, 1977.

Yorkston, K.M. and Beukelman, D.R. A system for quantifying verbal output of high-level aphasic patients. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1977. Minneapolis, MN: BRK Publishers, 1977.