

Self-Monitoring Behavior in a Case of Severe Auditory Agnosia with Aphasia

ROBERT C. MARSHALL, B. Z. RAPPAPORT, AND LUIS GARCIA-BUNUEL

Veterans Administration Medical Center, and Department of Neurology, Oregon Health Sciences University, Portland, Oregon 97207

This case report describes an unusual combination of speech and language deficits secondary to bilateral infarctions in a 62-year-old woman. The patient was administered an extensive series of speech, language, and audiologic tests and was found to exhibit (1) a fluent aphasia in which reading and writing were extremely well preserved in comparison to auditory comprehension and oral expression, and (2) a severe auditory agnosia. In spite of her auditory processing deficits, the patient exhibited unexpected self-monitoring ability and the capacity to form acoustic images on visual tasks. The manner in which she corrected and attempted to correct her phonemic errors, while ignoring semantic errors, suggests that different mechanisms may underlie the monitoring of these errors. © 1985 Academic Press, Inc.

The neurobehavioral literature includes several case studies of auditory agnosia (Oppenheimer & Newcomb, 1978; Goldstein, Brown, & Hollander, 1975; Albert, Sparks, Von Stockert, & Sax, 1972; Klein & Harper, 1956). Albert and his colleagues (Albert, Goodglass, Helm, Rubens, & Alexander, 1981) point out that these patients usually have difficulty understanding both speech and nonspeech sounds secondary to bilateral temporal lobe lesions. Too frequently, however, the fact that patients with auditory agnosia exhibit aphasic symptoms in addition to their auditory processing deficits is overlooked. While thorough examination of the speech and language functioning with these unique cases has been stressed (Marshall & Stevenson, 1977; Goldstein, 1974; Vignolo, 1969), this may not always

This research was supported by a Merit Review grant from the Veterans Administration Central Office and the Research and Development Committee of the V.A. Medical Center, Portland, OR. The authors are indebted to Dr. Leslie G. Rothi, University of Florida Medical School, Gainesville, FL and Dr. Lee Ann C. Golper and Sandra Neuburger, V. A. Medical Center, Portland, OR., for their assistance with the manuscript. Send requests for reprints to Robert C. Marshall, Ph.D., Chief, Audiology and Speech Pathology Service (126), V. A. Medical Center, Portland, OR 97207.

be accomplished because of an overriding interest in the patient's auditory disorder.

Aphasic language performance has been viewed as being dependent upon the auditory system not only for decoding information but for regulation and production of speech mediated through feedback loops (Schuell, Jenkins, & Jiminez-Pabon, 1964). The importance of auditory feedback has also been assigned a role in the monitoring of normal speech production (Yates, 1963; Fairbanks, 1954). The failure of some aphasic patients to monitor their speech production errors has been felt to result from deficits in auditory processing (Marshall & Tompkins, 1982; Albert et al., 1981; Sparks, 1977). A patient with an auditory agnosia in addition to aphasia would, therefore, not be expected to monitor verbal production errors. This report describes the examination of a 62-year-old woman who exhibited this unusual combination of deficits secondary to bi-hemispheric infarctions. She demonstrated verbal self-monitoring behaviors on metalinguistic tasks and in conversation which were unexpected in light of her severe auditory processing deficits.

CASE REPORT

This right-handed, college-educated Caucasian woman was in good health until February 22, 1977 when she "collapsed" while cooking dinner. One month earlier, she had experienced a few minutes of "numbness" in one hand, but her husband could not remember which side. Prior medical history was significant for a carcinoma of the uterus (2 years previously) which was successfully treated by surgery and irradiation.

At admission, she was noted to be alert with a severe fluent aphasia. She was unable to follow simple commands, name objects, or repeat. Neurological examination revealed a right visual field cut, and a right hemiparesis with equal involvement of arm and leg. Deep tendon reflexes were increased on the right, with a right Babinski sign. Laboratory data included skull and chest x-rays, CBC, chemical screens, platelet aggregation, and bleeding studies which were all normal. An electroencephalogram (4 days postonset) was mildly abnormal, showing some left temporal slowing. A brain scan (5 days postonset) showed a slightly increased radioisotope uptake in the left parietal area. A CAT scan report (7 days postonset) documented a relatively large area of diminished tissue density in the left upper temporal and parietal regions and a more discrete one in the anterior right temporal lobe.

The patient's motor signs resolved within a few days, but her profound expressive and comprehension deficits persisted. She was discharged to her home 8 days postonset of her symptoms.

Posthospital course. Following hospital discharge, the patient resumed her normal household responsibilities; however, she complained of being unable to see after waking up in the mornings and of hearing "noises

in her head." Speech and language functioning remained unchanged. Her husband reported that in addition to her difficulty with auditory comprehension, she was occasionally inattentive to environmental sounds such as the telephone and doorbell. A repeated neurological examination and EEG 2½ months postonset indicated no change from the prior examination. The patient received 18 months of speech and language therapy. She improved her reading and writing skills. Occasionally, she produced an understandable word or phrase, but her verbal expressive abilities did not improve. Auditory comprehension of speech and other meaningful environmental sounds were also unchanged.

We first saw the patient in February of 1980. Neurological examination showed full visual fields and no residual motor deficits. Her husband, however, indicated that she sporadically dropped utensils held in her right hand, and tended to drag her right foot when overly fatigued. There was a slight hyperreflexia as well as mild sensory inattention of the right extremities. Cranial nerves and cerebellar function were intact.

The CAT scan (Figs. 1 and 2) was repeated without contrast using a high resolution scanner. In the right hemisphere, there was an area of decreased density involving the anterior one-third of the middle temporal gyrus, and the anterior two-thirds of the superior temporal gyrus. The hypodense area primarily involved the cortical and the most superficial subcortical structures. The lesion appeared to extend into the inferior portions of the transverse temporal convolutions (areas 41 and 42) and the geniculotemporal tract (auditory radiations). In the left hemisphere, a hypodense area occupied most of the cortical and the most superficial subcortical structures of the superior temporal gyrus, including the geniculotemporal tract, but spared most of the optic radiations. The lesion also involved a major portion of the transverse temporal convolutions and the inferior parietal lobe, and extended into the posterosuperior portion of the insula. Both the right and the left hemisphere lesions were interpreted as resulting from vascular infarctions in the corresponding areas.

TEST RESULTS

The patient was administered an extensive series of speech, language, and audiological tests. As she was not able to understand instructions presented auditorily, it was necessary to use written instructions, pantomime, and to give her practice in providing required responses to behavioral tests until reasonably consistent responses were obtained. She could also identify some words and phrases on the basis of initial phoneme visibility. This made it necessary to eliminate these cues when assessing auditory comprehension. Finally, because her verbalizations were frequently incomprehensible, she was allowed to respond in writing or with a "pointing" response whenever possible.

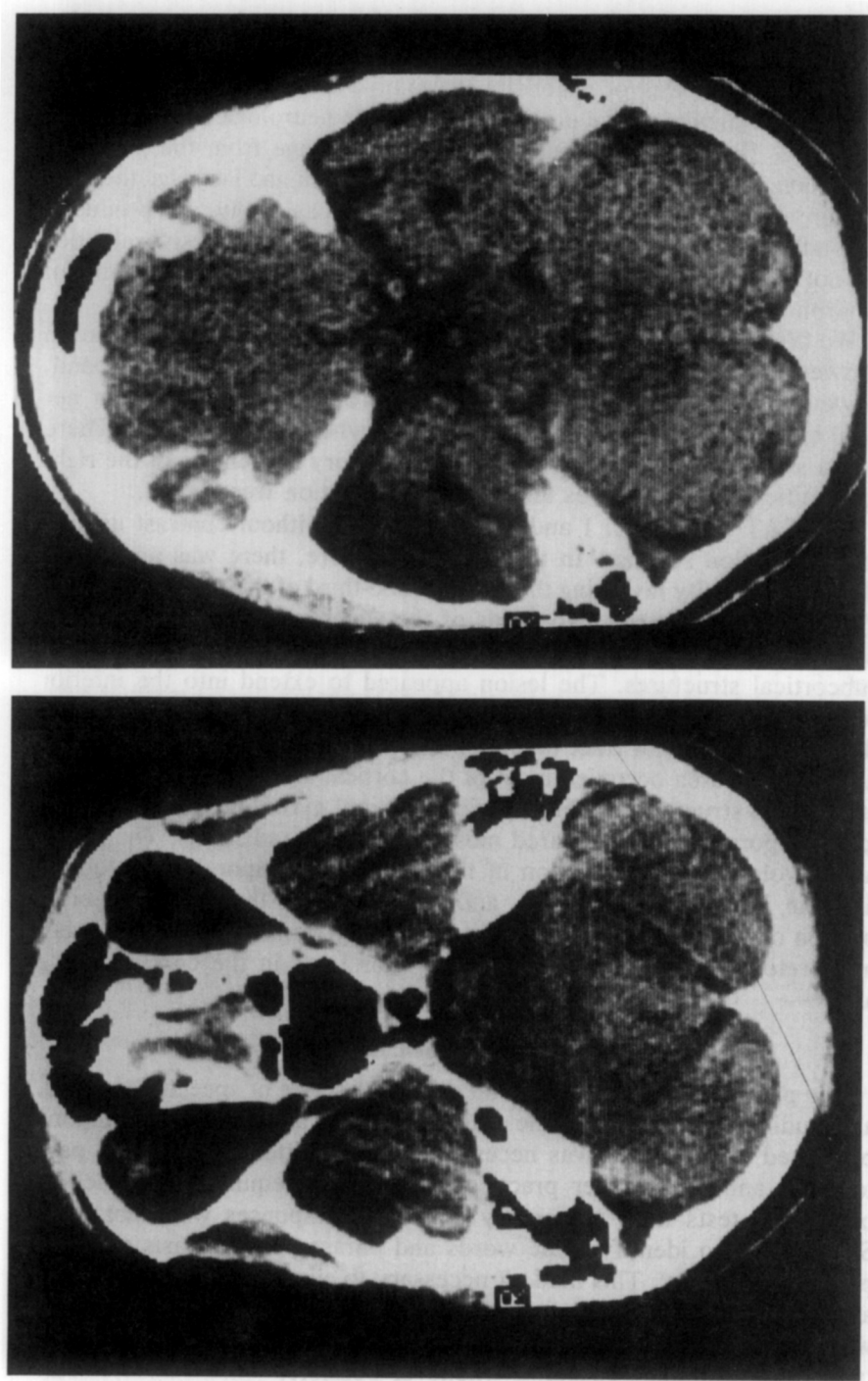


FIG. 1. Computerized tomographic scan (CAT scan) of the brain. Lower tomographic cuts show bilateral temporal infarctions.

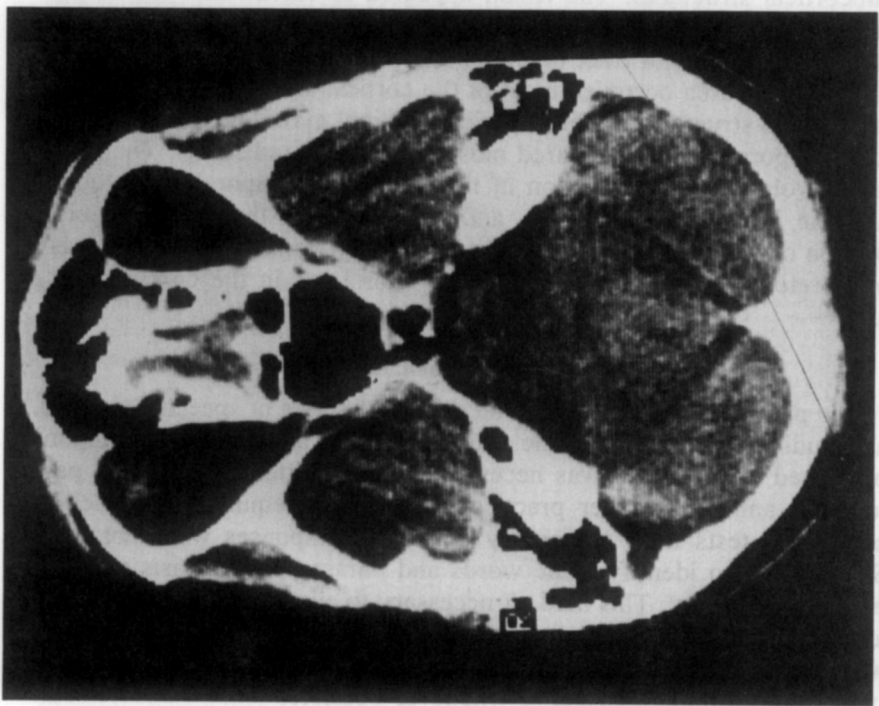
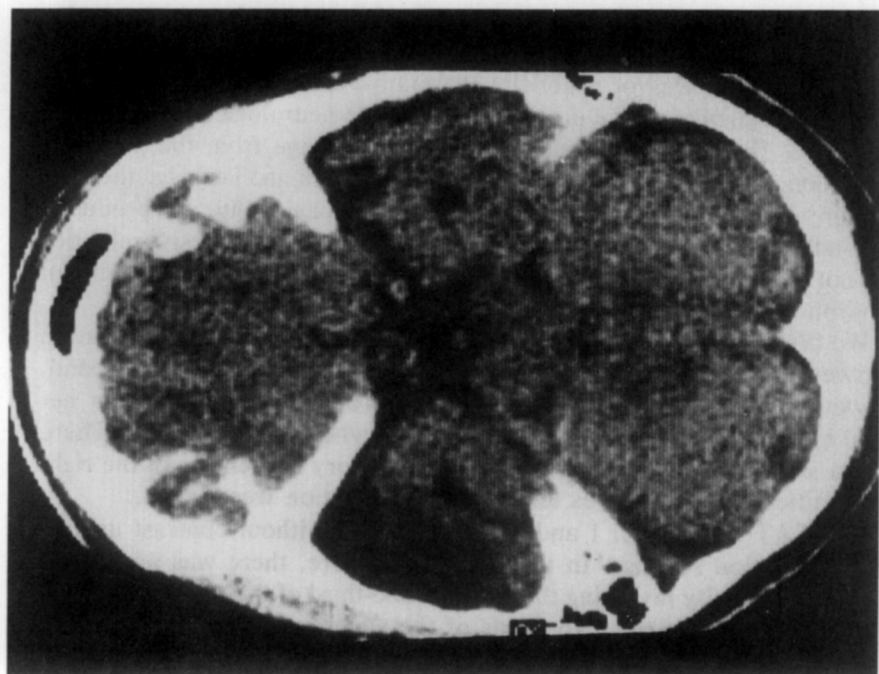


FIG. 1—Continued.

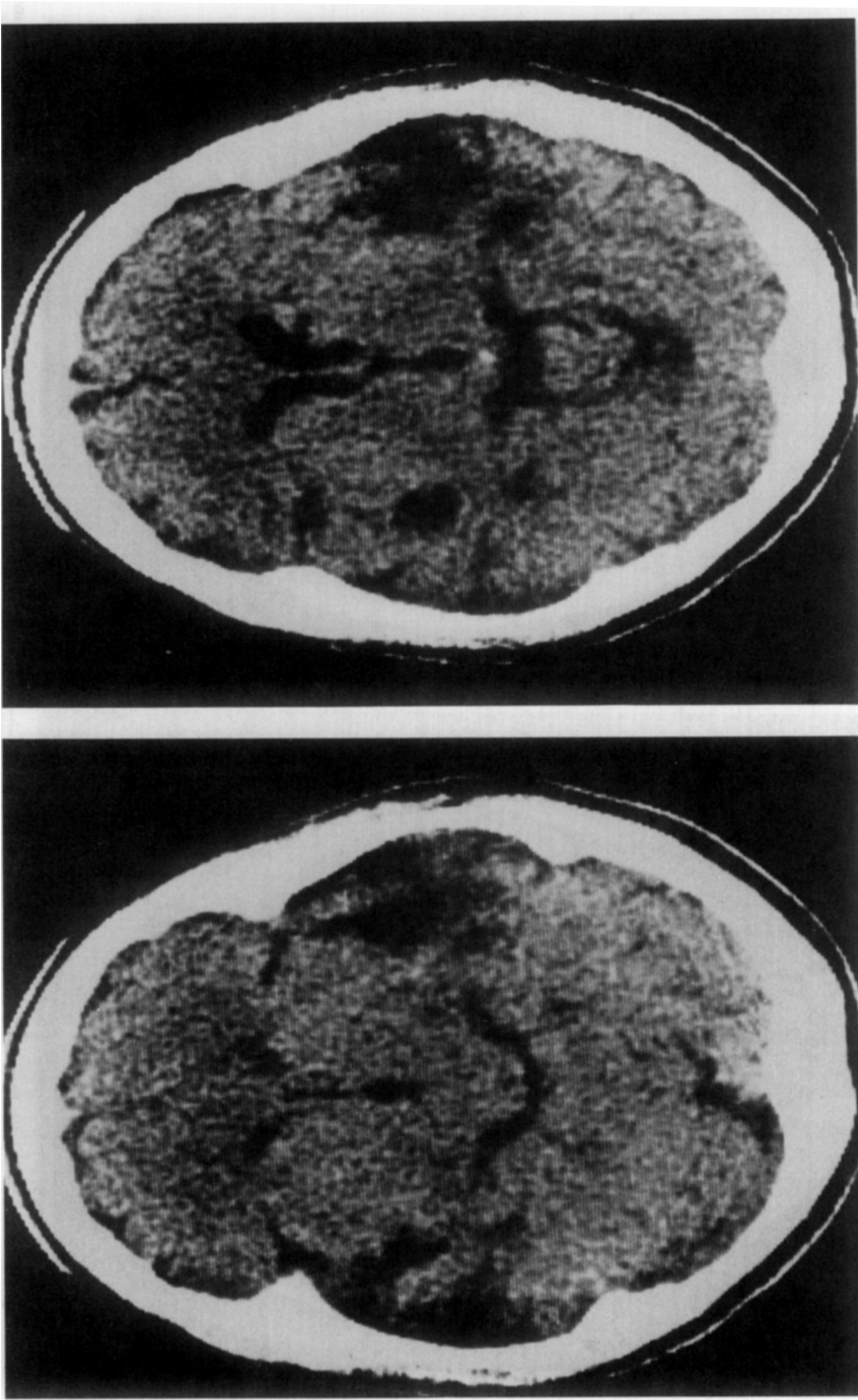


Fig. 2. CAT scan of the brain. Upper tomographic cuts show extension of the mass on the left into the transverse temporal convolution and inferior parietal lobe

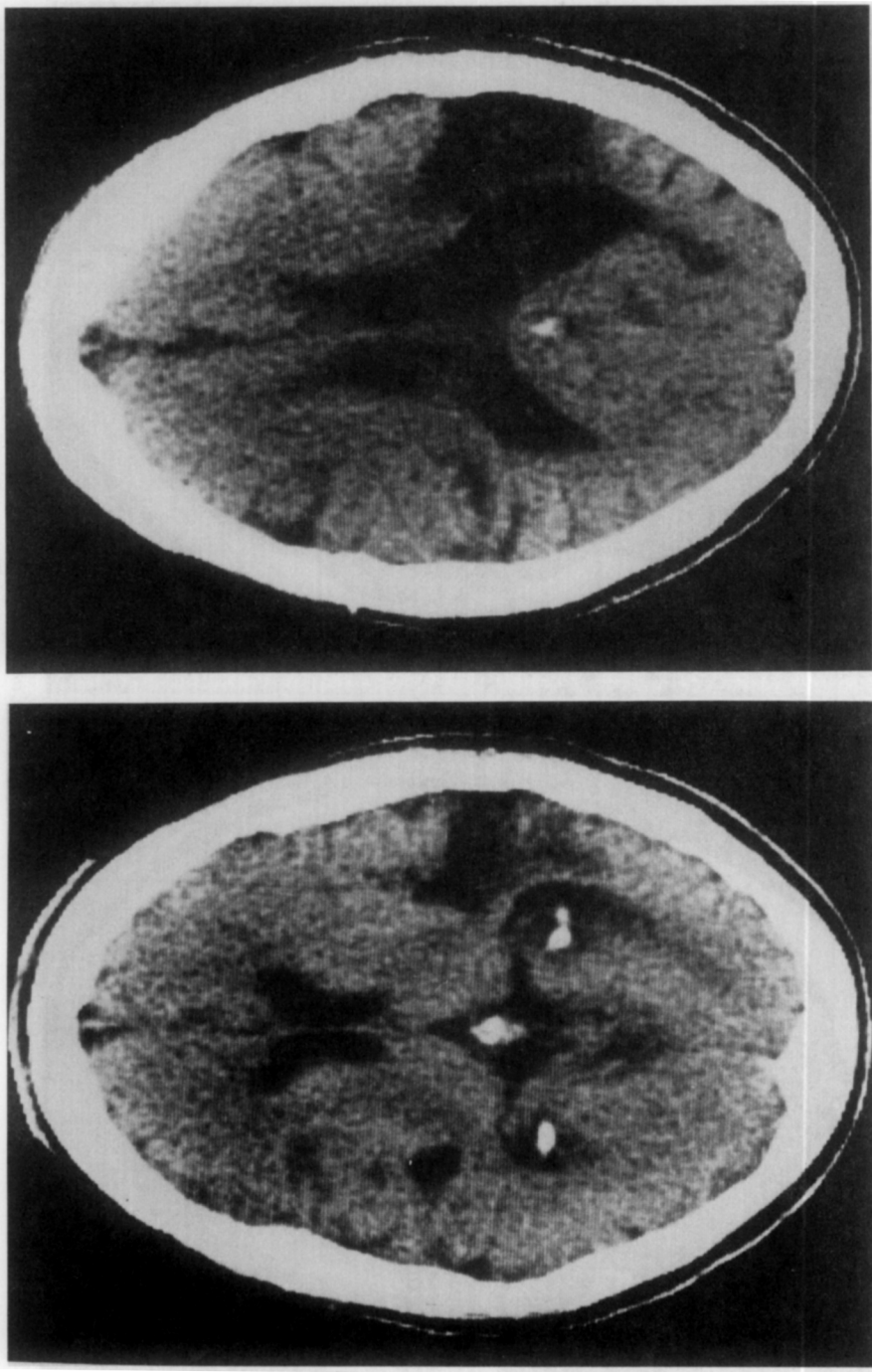


Fig. 2—Continued.

Audiological Evaluation

All audiologic tests were administered in a sound-treated environment. Pure-tone thresholds were within normal limits with the exception of a mild sensorineural loss at 4000 and 8000 Hz in the right ear. Speech detection thresholds were obtained since the patient could not provide intelligible verbal responses. These were normal bilaterally. To assess word discrimination, the Word Intelligibility Picture Identification test (WIPI) (Ross & Lerman, 1971) was administered at 60 dB HL. Without benefit of visual cues, she correctly identified 4% of the stimuli on the right and 24% on the left. When speechreading was allowed and presentations were given at a conversational level, her score improved to 60%.

Tympanometry revealed normal peak compliance and middle ear pressure bilaterally. Acoustic reflex thresholds were obtained for pure-tone stimuli both ipsilateral and contralateral to the probe tone and were normal for all stimuli except the contralaterally elicited reflex at 4000 Hz on the right which was present at a slightly reduced sensation level. Acoustic reflex decay was within normal limits at 500 and 1000 Hz bilaterally.

Auditory brainstem responses (ABR) were measured monaurally for click stimuli of 80 dB HL with contralateral masking. Stimuli were presented at a rate of 11 per second and the response to 2048 clicks was bandpass filtered at 150–1500 Hz. Waves I–V were visualized bilaterally. Absolute wave latencies, interpeak latencies and interear latency differences were all within normal limits. Auditory evoked responses were also obtained for latencies up to 60 msec (Middle Latency Response) using stimuli identical for ABR testing. The response was obtained for 1024 clicks and was bandpass filtered at 30–250 Hz. On both sides, there was a positive-going wave at approximately 13 msec and a negative-going wave at approximately 18 msec. There was no consistent wave form present beyond this point on either side.

Speech and Language Testing

Auditory comprehension. All auditory comprehension tests were administered without allowing the patient to speechread. She did not respond correctly or indicated she could not respond to any items of the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1956), the Token Test (Boller & Vignolo, 1966), and the Auditory Comprehension Test for Sentences (ACTS) (Shewan, 1979). Correct responses on these tests increased when visual cues were permitted, but deteriorated to chance levels when items increased in length or complexity. She was unable to identify the number of syllables in a word presented auditorily, distinguish stress contrasts (e.g., black bird versus blackbird), or identify words within common categories.

The patient's ability to understand several types of tape-recorded sounds was assessed with both recall and recognition forms. Stimuli included 10 human nonlinguistic sounds (e.g., kissing), 10 environmental noises (e.g., typing), 10 animal sounds (e.g., cow mooing), and 10 familiar melodies. All tasks were demonstrated with examples not included as test items. Stimuli were presented at a comfortable loudness level preceded by the alerting phrase "Get ready" and each item was repeated three times (except for the melodies). When asked to write the name of each sound, she identified 4 human sounds and 1 item in each of the other categories. When selecting the correct response from a set of 4 alternatives, she was more successful, but performance was below chance level.

Reading comprehension. In most instances, it was possible to assess reading comprehension with stimuli identical to those used in testing auditory comprehension. Items from the PPVT were printed on 3 × 5-in. cards and presented singly. She identified 140 of 150 items correctly. Commands for the Token Test and the ACTS were presented on 5 × 8-in. cards. The time each card was exposed was controlled so as to prevent a direct comparison of each word with the picture stimuli or token arrangements. She made no errors on Parts I, II, and III of the Token Test. On Part IV (e.g., "Touch the little red circle and the big blue square"), she made three errors, but these consisted of missing a single element only. On Part V which required the reading of syntactic and order constraints, she made only 5 correct responses out of 22 items. She clearly comprehended the token and color names, but did not understand directional prepositions such as "in front of," "beside," or "under." She responded correctly to 15 of 21 commands of the ACTS, but 5 of her 6 errors occurred on items where the task demanded the understanding of negative constructions (e.g., "Cars were not hit by the train").

Several other reading tasks were also administered. These included the Reading Comprehension Battery for Aphasia (RCBA) (LaPointe & Horner, 1979), various reading subtests from the Porch Index of Communication Ability (PICA) (Porch, 1967), the Boston Diagnostic Aphasia Examination (BDAE) (Goodglass & Kaplan, 1972), and the Minnesota Test for Differential Diagnosis of Aphasia (MTDDA) (Schuell, 1965). Her score on the 100-item RCBA was 87%. She comprehended single words and simple paragraphs, but had difficulty with the syntactic comprehension subtest. On the visual and word-picture matching tests of the PICA, BDAE, and MTDDA, she made no errors. Minor errors were observed on the paragraph and sentence comprehension reading tests of the BDAE and MTDDA. She did not respond to the prepositional directions on the reading subtests of the PICA.

Verbal expression. The patient's performance on all tasks requiring verbal expression was markedly impaired. On the serial speech tasks of

the BDAE, she emitted paraphasias and neologistic jargon. On the BDAE confrontation naming tasks, she correctly named one object, three actions, three colors, and one number, but no shapes or letters. Similarly, she named 3 of 10 and 7 of 20 nouns on the naming subtests of the PICA and MTDDA, respectively. Oral reading of words and sentences reflected many paraphasias, but was superior to confrontation naming. The patient was unable to participate in repetition tasks without benefit of speech-reading. Word length and phonemic complexity negatively affected the accuracy and quality of her speech on all metalinguistic tasks. She seldom produced words of more than one syllable and these consisted of simple consonant-vowel combinations. Those few multisyllabic words she could produce were simple, highly familiar words such as "baby," brother," and "funny," or verb + ING forms.

Spontaneous speech was easily articulated and at times abnormally rapid. Melodic line and intonational contours were intact. Literal and verbal paraphasias could be identified in spontaneous speech; however, most spontaneous output consisted of neologistic jargon. The patient occasionally produced brief runs of correctly articulated and linguistically correct speech. For example, when asked "Are you having Tom turkey for Thanksgiving?" she replied, "No, it's a hen." After seeing the name of a television personality, she commented, "No, I don't like him. Do you like him? He's awful." When describing a picture of a skunk, she said, "It's black, black and white, and it's awful." Many of these utterances were functional and personally utile phrases such as "Want some coffee or tea?", "He's my brother," "Go on a trip," and "It's funny."

Self-monitoring. The patient was aware of her verbal production deficits. She attempted to correct many of her erroneous responses, but these efforts sometimes resulted in productions that were more aberrant than her first response. Self-correction efforts were most noticeable following phonemic errors (literal paraphasias). For example, in attempting to say the word "big" she produced¹ /bæbi/, /bigəz/, /bigon/, /gon/, bigəz/, and /big gon/. For "coffee" she said, /səm kət/, /səm kæt/, sām kəts/, /oə kəts/, /sām k ɔpi/, /kɔpi/, /kɔpis/, and /sām kɔpi/. Correction efforts were more likely to be successful following minor phonemic errors. For example, she successfully corrected the errors /driks/ ("drinks"), /suz/ ("shoes"), and bats/ ("bus"). When multiple phonemic errors occurred within a word or phrase, her self-correction attempts resulted in neologistic jargon.

The patient tended to ignore her semantic errors. She was observed to pause and use fillers (e.g., "um," "er") when searching for a particular

¹ Some of these utterances were actually real words, however, the patient did not appear to realize this. She treated them as articulation errors and usually attempted to correct them immediately with varying degrees of success.

word. Production of a lexical item however resulted in multiple repetitions of the word regardless of its semantic accuracy. For example, when reading the sentence "she's my sister" the patient said "he's my brother" five times. When naming a picture of a "cat," she said "it's a dog, a dog, it's a dog, a dog, dog." She also tended to repeat literal paraphasias that closely approximated the target word (e.g., /speɪk/ ("Spain"), /breɪd/ ("brain"), and /brʌni/ ("money")). Even when instructed not to repeat, she could only reduce the number of repetitions, but could not eliminate the behavior entirely.

Written expression. The patient's written responses were far superior to her verbal responses and, in most instances, indistinguishable from normal. Her writing was fluent and mechanically unimpaired. She seldom made spelling errors; when she did, she corrected them or indicated that she had misspelled the word. On the written confrontation naming tasks of the PICA and BDAE, she made no errors. She could also write the names of objects presented tactily to either hand. She wrote correctly the names of 20 nouns on the confrontation naming subtest of the MTDDA. In writing the names of 50 pictures of nouns (Collins & Cunningham, 1978), she made only two semantic errors ("chess" pieces for "checkers" and "shark" for "whale"). Ability to produce written names of abstract stimuli was assessed with the 30-item naming subtest from the Multilingual Aphasia Test (Benton & Hamsher, 1978). On this test, she made six errors. Five of these were semantically related (e.g., "lake" for "peninsula"). Written word fluency was also relatively unimpaired. She produced 14 animal names in 90 sec, and 6, 10, and 7 words in 60 sec for the letters "C", "F", and "L", respectively.

When written responses beyond a single word were required, the patient had considerably more difficulty. While her sentence productions typically contained some accurate semantic information, she made paragrammatical errors. On the sentence writing subtest of the PICA, she wrote "matches burn it," "a key in a lock," and "toothbrush of the cleaning." For her written story about the Cookie Theft picture from the BDAE, she wrote "A lady of the dishes and water spilled. A girl is a jar of the cookies. A boy is setting of the stool." She recognized syntactic errors and usually attempted to correct them. However, she was seldom successful in these efforts.

Other Testing

Internal speech representations. In order to determine whether the patient could form internal acoustico-articulatory representations of words, several tasks were administered all which involved visual stimuli. In the first task, she was given a list of 25 one- to five-syllable words randomly arranged and instructed to write next to each word the number of syllables it contained. She correctly indicated the number of syllables in 20 of 25

words (80%). Her mistakes were all underestimates by a single syllable of four- and five-syllable words and were corrected when pointed out to her. Throughout this task, she was observed to count on her fingers and to rehearse verbally before responding.

A second task devised by Corcoran (1966) involved giving the patient a sheet of text and asking her to read through it quickly and cancel out all the "e"s. The fact that normal subjects tend to miss significantly more "e"s which are silent, than those which are sounded, has been interpreted as support for the premise that visual material is transferred into an acoustic code, making it more likely that pronounced "e"s will be noticed. On this task, she demonstrated a normal performance pattern canceling out 29 of 50 (58%) sounded "e"s and only 2 of 27 (7%) silent "e"s.

On another task, the patient was asked to pick out visual stimuli whose names rhymed. She was given a sheet of paper with 20 one-syllable words printed on the left side of the page. To the right of each word were four one-syllable words, one of which rhymed with the stimulus. The correct choice occurred equally often in each position in a random order. Moreover, visual similarity between words was not a reliable cue. For example, the four choices for the stimulus "chute" were "chart," "loot" (the correct choice), "church," and "glass." She correctly selected the rhyming word in 16 of 20 instances. Again, when errors were pointed out, she could correct them.

Finally, the patient was asked to match 12 three-letter printed words with letters having the same sound, a procedure utilized by Kirshner and Webb (1981) in evaluating a similar type of patient. An example would be the word "cue" with the letters A, T, Q, B, C, and R, with the letter "Q" being the correct choice. Precautions were taken to insure correct choices occurred in random positions within the letter array. She made 8 correct matches in 12 attempts. Similarly to previous tasks, she could correct her errors when they were pointed out.

Nonverbal intellectual functions. A limited assessment of the patient's nonverbal intellectual functions was accomplished through administration of the performance subtests of the Wechsler Adult Intelligence Scale (WAIS) (Wechsler, 1955), the Raven's Coloured Progressive Matrices (RCPM) (Raven, 1947), and by having her draw the complex figure from the Rey-Osterrieth Battery (Osterrieth, 1944). On the WAIS her scores were within the normal range on the Picture Completion and Digit Symbol subtests, approximated normal limits on Picture Arrangement and Object Assembly, and were slightly below normal on Block Design. Her overall performance IQ was 106. On the RCPM, she produced 31 correct responses (36 possible) on sets A, B, and AB. Her drawing of the Rey-Osterrieth figure was accurate, logically sequenced, and showed good organization and strategy.

Activities of daily living. Observations of the patient in many daily living activities indicated that she was performing normally. She ran her house with meticulous precision, went shopping, attended social events, kept a calendar, organized files, and typed some of her husband's correspondence. She hosted dinner parties and prepared gourmet meals following complicated recipes. Her judgment was not impaired, and although she had difficulties communicating verbally and understanding speech, she behaved appropriately in social situations, appearing to appreciate humor, and observing social conventions and courtesies as demanded by the situational context.

DISCUSSION

This case report describes an acquired communication disorder in a 62-year-old woman approximately 5 years postonset. The anatomical basis of the patient's deficits involved bilateral infarctions. Although the CAT scan abnormalities in the left hemisphere coincided with an episode of right hemiparesis, no similar correlation was apparent for the right hemisphere abnormalities. Since the lesion in the right hemisphere did not involve major motor, sensory, or visual pathways, it may have been relatively "silent" from a clinical viewpoint.

The auditory comprehension and attentional deficits exhibited by the patient were similar to previously reported cases with bilateral lesions and auditory agnosia (Goldstein, 1974). She did not understand speech and she had marked difficulties identifying nonspeech sounds. Audiological evaluation revealed normal pure tone and speech detection thresholds and normal impedance measurements including acoustic reflexes bilaterally. Brainstem auditory evoked responses showed normal brainstem waves I-V bilaterally indicating normal auditory functioning up to the level of the inferior colliculi. Middle latency responses, however, were inconsistent beyond 18 msec on either side suggesting involvement of both auditory pathways above the brainstem level and consistent with CT scan findings of bilateral geniculotemporal tract lesions.

Aphasic deficits. The patient's speech was well articulated and highly paraphasic. Although she demonstrated some aphasic deficits in all language modalities, reading comprehension was vastly superior to auditory comprehension and written expression was much better than oral expression. The symptom pattern coincides with that of a posterior aphasia, but type of aphasia is difficult to ascertain because of the contaminating influence of her right hemisphere lesion. Our case does, however, offer an interesting contrast to the one reported recently by Kirshner and Webb (1981). Their patient also demonstrated marked auditory comprehension deficits secondary to bihemispheric lesions, but was "mute" while our patient had fluent speech.

The most intriguing aspects of the patient's speech and language were

her self-monitoring behaviors and ability to form acoustic images in spite of a severe auditory processing disorder. Differences in self-monitoring ability among aphasic patients have been felt to reflect the degree of the individual's impairments in auditory processing (Marshall & Tompkins, 1982; Albert et al., 1981; Sparks, 1977; Wepman, 1958). Our patient demonstrated a near total loss of the ability to understand speech and nonspeech sounds, yet she was aware of her verbal production errors and sometimes corrected them in spontaneous discourse and on metalinguistic tasks. This suggests that self-monitoring in acquired aphasia cannot be solely attributed to the intactness of the patient's auditory processing system.

Correction of an erroneous response involves two steps: (1) recognition of the error by the speaker, and (2) modification of the response. Our patient recognized many of her verbal production errors, but had substantially more difficulty correcting these errors. In her case, auditory comprehension cannot be responsible for her error recognition skills since she could not understand speech. This suggests that the status of the patient's auditory processing system may have less to do with error recognition than has been suggested previously. Perhaps aphasic persons who truly ignore their production errors do so, not because of their comprehension deficits, but because they are anosognosic for their errors. Gainotti (1972) found that patients with right parietal lesions are often anosognosic for illness and that some Wernicke's aphasics (but not Broca's or amnesic aphasics) have an anosognosia for their speech errors. While the lesion in Wernicke's aphasia classically involves the left temporal lobe, it may be argued by analogy that a lesion that extended into the left parietal area could result in an anosognosia for speech errors. Our patient's propensity for recognizing speech production errors could therefore result from the fact that her parietal areas were relatively spared.

The patient could correct or modify some of her speech errors. This was, however, extremely difficult for her. Often her attempts resulted in productions that were more aberrant than her original effort. This indicates that the ability of aphasic individuals to convert inaccurate responses to accurate responses is probably related to the integrity of the auditory processing system. While Marshall & Tompkins (1982) found most aphasic patients to be aware of their production errors on single-word tasks, patients differed significantly in terms of how successful they were in correcting their errors. These differences were related to severity and type of aphasia. Subjects with relatively well-preserved auditory comprehension (Broca's, conduction, anomic) were more successful than those for whom auditory comprehension is typically impaired (Wernicke's). Our patient, a posterior aphasic with temporal lobe lesion in the dominant hemisphere, performed like the Wernicke's subjects in the Marshall and Tompkins study. That is, she recognized production errors, but was not proficient in correcting them.

As was stated earlier, our patient treated her phonemic and her semantic errors differently. She recognized and occasionally corrected phonemic errors, but essentially ignored her semantic errors. Failure to recognize semantic errors was reflected in the persistent repetition of words and phrases. The repetitions did not resemble the pathological reiterations of persons with palilalia (LaPointe & Horner, 1981). Instead they seemed to be a verification from the patient that she had produced a correctly articulated word or phrase. Our patient's differential treatment of phonemic and semantic errors supports the contention that some aphasic patients used different mechanisms for the monitoring of these errors. Alajouanine and Lhermitte (1973) have observed that some aphasics attempt to correct their phonemic errors but ignore their semantic errors. They found that, similar to normal subjects, the speech of these patients was disrupted by delayed auditory feedback (DAF). This reaction to DAF contrasted to that of a group of patients who were annoyed by their semantic paraphasias, oblivious to their phonemic errors, and illustrated little speech disruption with DAF. When our patient was administered DAF she immediately stopped talking and stated "I can't hear." She became so upset that the procedure had to be discontinued. This response in conjunction with the manner in which she recognized phonemic errors and ignored semantic errors in speaking supports the observations by Alajouanine and Lhermitte.

The patient's response to DAF and to some of the audiologic tests indicated she was aware of sound. Recognition and correction of speech production errors, however, demands more than sound awareness and the mechanisms underlying the patient's attentiveness to phonemic errors warrant some explanation. We believe that her ability to monitor phonemic errors stems from the capacity to perform phonological recoding operations. The patient performed extremely well on a series of visual tests designed to determine her ability to form internal speech representations (e.g., letter cancellation). Studies by Ross (1983) and Locke and Deck (1982) have illustrated that aphasic subjects retain the capacity for phonological recoding during silent reading. Both of these studies used the letter cancellation task described by Corcoran (1966) and found aphasic persons to perform like normals. Conversely, investigations of deaf individuals' ability to perform phonological recoding operations during silent reading (Locke, 1978; Chen, 1976) have yielded opposite results. Our patient's performance on Corcoran's task was similar to that of an aphasic and not a deaf individual. This suggests that her retention of acoustic images was related to phonological recording ability and not influenced by her auditory agnosia *per se*. This is commensurate with her heightened awareness for phonemic errors in speech production, her near normal spelling performance in writing, and her somewhat better speech performance with a visual stimulus (e.g., written word or sentence). Accordingly, it

would be interesting to assess the ability of other aphasic patients to do phonological recording operations in relation to their self-monitoring ability.

REFERENCES

- Alajouanine, T. & Lhermitte, F. 1973. The phonemic and semantic component of jargon aphasia. In H. Goodglass & S. Blumstein (Eds.), *Psycholinguistic aspects of aphasia*, Baltimore: Johns Hopkins Univ. Press. pp. 218–329.
- Albert, M. L., Goodglass, H., Helm, N. A., Rubens, A. B., & Alexander, M. P. 1981. *Clinical aspects of dysphasia*. New York/Berlin: Springer-Verlag.
- Albert, M. L., Sparks, R., Von Stockert, T., & Sax, D. 1972. A case study of auditory agnosia: Linguistic and non-linguistic processing. *Cortex*, **8**, 427–443.
- Benton, A. L., & Hamsher, K. 1978. *Multilingual Aphasia Examination*. Iowa City: Univ. Hospitals, Department of Neurology.
- Boller, F., & Vignolo, L. A., 1966. Latent sensory aphasia in hemisphere-damaged patients: An experimental study with the token test. *Brain*, **89**, 815–830.
- Chen, I. 1976. Acoustic image in visual detection for deaf and hearing college students. *Journal of General Psychology*, **94**, 243–246.
- Collins, P. J., & Cunningham, G. W., 1978. *Vocabulary Instructional Program: Nouns* (Box 1). Tigard: CC Productions.
- Corcoran, D. W. J. 1966. An acoustic factor in letter cancellation. *Nature, (London)*, **210**, 658.
- Dunn, L. 1956. *Peabody Picture Vocabulary Test*. Circle Pines: Amer. Guidance Service.
- Fairbanks, G. 1954. A theory of the speech mechanism as a servosystem. *Journal of Speech and Hearing Disorders*, **19**, 133–139.
- Gainotti, G. 1972. Emotional behavior and hemispheric side of lesion. *Cortex*, **8**, 41–55.
- Goldstein, M. N., Brown, M., & Hollander, J. 1975. Auditory agnosia and cortical deafness: Analysis of a case with three-year follow-up. *Brain and Language*, **2**, 324–332.
- Goldstein, M. N. 1974. Auditory agnosia for speech ("Pure word deafness"). *Brain and Language*, **1**, 193–204.
- Goodglass, H., & Kaplan, E. 1972. *The assessment of aphasia and related disorders*. Philadelphia: Lea & Febiger.
- Kirshner, H. S., & Webb, W. G. 1981. Selective involvement of the auditory verbal modality in an acquired communication disorder. Benefit from sign language therapy. *Brain and Language*, **13**, 161–170.
- Klein, R., & Harper, J. 1956. The problem of agnosia in the light of a case of pure word deafness. *Journal of Mental Science*, **102**, 112–120.
- LaPointe, L. L., & Horner, J. 1979. *Reading comprehension battery for aphasia*. Tigard: CC Pub.
- LaPointe, L. L., & Horner, J. 1981. Palilalia: A descriptive study of pathological reiterative utterances. *Journal of Speech and Hearing Disorders*, **46**, 34–38.
- Locke, J. L. 1978. Phonemic effects in the silent reading of hearing and deaf children. *Cognition*, **6**, 175–187.
- Locke, J. L., and Deck, J. W., 1982. The processing of printed language by aphasic adults: Some phonological and syntactic effects. *Journal of Speech and Hearing Research*, **25**, 314–319.
- Marshall, R. C., & Stevenson, S., 1977. Pure word deafness: Fact or fiction? In R. Brookshire (ed), *Clinical aphasiology*. Minneapolis: BRK. pp. 248–256.
- Marshall, R. C., & Tompkins, C. A. 1982. Verbal self-correction behaviors of fluent and nonfluent aphasic subjects. *Brain and Language*, **15**, 292–306.
- Oppenheimer, D. R., & Newcombe, F. 1978. Clinical and anatomic findings in a case of auditory agnosia. *Archives of Neurology*, **35**, 712–719.

- Osterrieth, P. A. 1944. Le test de copie d'une figure complexe. *Archive de Psychologie*, **30**, 206–356.
- Porch, B. E. 1967. *Porch Index of Communicative Ability*. Palo Alto: Consulting Psychologists Press.
- Raven, D. 1947. *Raven's progressive matrices*. New York: The Psychological Corp.
- Ross, P. 1983. Silent reading in aphasic patients. *Brain and Language*, **19**, 191–203.
- Ross, M., & Lerman, J. 1971. *Word intelligibility by picture identification*. Pittsburgh: Stanwix House, Inc.
- Schuell, H. 1965. *Minnesota Test for Differential Diagnosis of Aphasia*. Minneapolis: Univ. of Minnesota Press.
- Scheull, H., Jenkins, J., & Jimenez-Pabon, E. 1964. *Aphasia in adults*. New York: Harper & Row.
- Shewan, C. M. 1979. *Auditory Comprehension Test for Sentences*. Chicago: Biolinguistics Institute.
- Sparks, R. W. 1977. Parastandardized examination guidelines for adult aphasia. *British Journal of Disorders of Communication*, **13**, 135–146.
- Vignolo, L. A. 1969. Auditory agnosia: A review and report of recent evidence. In A. L. Benton (Ed), *Contribution to clinical neuropsychology*. Chicago: Aldine. pp. 173–231.
- Wepman, J. M. 1958. The role of self-correction in recovery from aphasia. *Journal of Speech and Hearing Disorders*, **23**, 302–305.
- Wechsler, D. 1955. *Wechsler Adult Intelligence Scale*. New York: Psychological Corp.
- Yates, A. J. 1963. Delayed auditory feedback. *Psychological Bulletin*, **60**, 213–232.