

Lack of Error Awareness in an Aphasic Patient with Relatively Preserved Auditory Comprehension

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The neuropsychological mechanisms underlying unawareness of speech/language deficits are unknown, but four possibilities have been suggested: impaired lexical-semantic representations associated with impaired speech comprehension, a failure of feedback, reduced attentional capacity, and psychological denial. We studied a patient who was unaware of his jargon aphasia despite only a mild auditory comprehension disturbance. Delaying auditory feedback altered his speech patterns. He recognized more of his errors in a recording of his voice than he did while speaking. He also recognized more errors in a recording of the examiner making errors than he did when listening to the recordings of his own speech. Based on these results, we suggest that none of the proposed mechanisms can exclusively account for this man's performance and that each may contribute to his failure to detect and correct errors in speech production.

The term anosognosia as it was first introduced by Babinski in 1914 refers to a denial or lack of awareness of hemiplegia. Subsequently it has been used to describe denial or lack of awareness of a variety of neurological disabilities, including aphasia (Prigatano & Schacter, 1991). In certain aphasic patients this lack of awareness for the speech-language failures has been reflected in the absence of notable self-correction of speech production errors. For example, patients with jargon aphasia, charac-

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terized by fluent speech output replete with semantic and phonemic paraphasias and neologisms, make little effort to correct their errors (Lebrun, 1987) and are seemingly unaware that their speech is incomprehensible. The presence of self-correction behavior is frequently cited as evidence of self-monitoring and error detection (Marshall, Rappaport, & Garcia-Buñel, 1985; Levelt, 1983); however, it may be erroneous to equate self-correction behavior with error awareness (or error detection). Aphasic patients (and normals for that matter) may fail to self-correct for a variety of reasons other than a lack of error awareness. They may determine that they are unable to provide a better approximation to the target or that it is not worth the effort it would take to correct the error. It may be that they determine the error is close enough to the target so as not to merit a repair. However, if the aphasic patient detects an error but fails to attempt to correct the error, they should be able to identify if their response was correct or not. The patient with anosognosia for aphasia, however, when asked about the adequacy of their verbal productions may explicitly deny that there is anything wrong with their speech, suggesting that they are unaware that their verbal output is flawed.

The neuropsychological mechanisms accounting for the unawareness of speech/language errors associated with aphasia have not been entirely elucidated. In general four mechanisms have been posited to account for anosognosia of speech/language errors in aphasia: a loss of linguistic representations (Heilman, 1991; McGlynn & Schacter, 1989; Rubens & Garrett, 1991), impaired feedback to these representations (Peuser & Temp, 1981), a reduced capacity to mediate simultaneous activities (Lebrun, 1987), and psychological denial (Weinstein & Kahn, 1955; Kinsbourne & Warrington, 1963). We will briefly describe these mechanisms and the support that each has received.

One mechanism that has been proposed to explain anosognosia is a loss of the linguistic representations used to generate speech and to compare the speech output with the intended message (Heilman, 1991). Evidence for this "linguistic representation hypothesis" is found in the observation that anosognosia of speech/language errors in aphasia is typically associated with impaired auditory comprehension (Rubens & Garrett, 1991; Heilman, 1991; Lebrun, 1987; Goldberg & Barr, 1991). This suggests that impaired semantic access and/or a degradation of the semantic system results in a patient's inability to recognize the inadequacy of their own responses.

The observation that auditory comprehension deficits and anosognosia often coexist might suggest that the same areas of the brain that are important for comprehension may also be important for self-monitoring. However, this hypothesis is inconsistent with the finding that not all jargon or sensory aphasic patients demonstrate anosognosia. For example, Lecours and Joanette (1980) described a 66-year-old woman with a

left temporal lobe lesion, a severe jargon aphasia, and severely impaired auditory comprehension, who nevertheless demonstrated that she was aware of her language deficits by complaining at length about her poor performance on certain speech production tasks. Marshall et al. (1985) reported a patient who, despite severe auditory comprehension impairment, attempted to correct her phonemic paraphasias, implying awareness of the phonemic inaccuracy of her speech output. Marshall and Tompkins (1982) studied the self-correction efforts of patients with a variety of aphasic syndromes and found that patients with each of the aphasic subtypes, including Wernicke's aphasia, attempted to correct more than half of their errors. If auditory comprehension and error detection were processed by a common mechanism, one would expect anosognosia to consistently co-occur with poor auditory comprehension in aphasic patients.

This notion of a dissociation between auditory comprehension and error correction is further supported by Schlenck, Huber, and Willmes (1987) who found that, despite the fact that patients with Wernicke's aphasia make many more speech errors than patients with Broca's aphasia, there was relatively no difference between these patient groups with respect to the number of speech production errors self-corrected. When examining the number of "repairs" (errors corrected after being produced) versus the number of "prepairs" (errors corrected prior to production as indicated by a delay of greater than 2 sec), neither group demonstrated a significant number of repairs. Furthermore, the comprehension impairment of the Wernicke's group did not prevent a significant amount of prepairst in their speech production. Were anosognosia simply a failure in comprehending one's own speech, one might have expected the patients with Broca's aphasia (with relatively preserved comprehension) would have corrected their errors more often than the Wernicke's patients (who have impaired comprehension) and Wernicke's patients would have demonstrated relatively few prepairst as well as repairs in their speech output. Finally, Alajouanine (1956) and Kinsbourne and Warrington (1963) point out that patients with jargon aphasia may recognize the jargon output of others as being inadequate, but judge their own jargon played back to them as acceptable. One would expect that if the failure to self-correct "on-line" (i.e., during the speech attempt) were due to an inability to judge one's own verbal output because the lexical or semantic representations were impaired, then those impaired representations should also preclude adequate "off-line" (i.e., at any point in time beyond the moment of the speech attempt) judgments as well. However, it has been demonstrated that patients with jargon aphasia may be able to reject the jargon output of others (i.e., off-line monitoring). Therefore, the lack of self-correction in the aphasic patient with anosognosia for speech-language errors cannot be explained on the basis of a disruption

of the linguistic representations necessary to compare speech output with an intended target.

Auditory comprehension requires multiple linguistic processes. For example, auditory comprehension for single words requires at least the ability to perceive the auditory signal, decode its phonologic form, and access the corresponding lexical and semantic representations. These multiple processes may be fractionated such that one process is impaired (e.g., semantics) while the others (e.g., phonological and lexical) are spared. Assuming a sequential model of speech processing (phonological, lexical, semantic), if a patient had an adequate lexical semantic system with impairment in either decoding the phonological form or gaining access to the lexicon, that patient would not only be unable to detect errors, but also would have impaired comprehension. Auditory comprehension may also be poor as a result of impaired semantic access but the input lexicon (i.e., that component that recognizes the phonological representations of familiar words) and access to the lexicon may be operational. In such a case, despite poor comprehension, phonemic errors may still be recognized and corrected. Kinsbourne and Warrington (1963) described two patients with jargon aphasia who failed to correct their errors and denied their deficits despite relatively preserved auditory comprehension. The lack of self-correction of jargon in these cases cannot be explained by a fractionation of the processes leading to comprehension. Rather, these two cases raise the possibility that we need to look at other potential explanations for lack of self correction. These might include reduced capacity, faulty feedback, and denial.

Kinsbourne and Warrington (1963) posited that their patients adopted the strategy of rapid, uninterrupted, and, when necessary, neologistic speech to bolster a psychogenically motivated, explicit denial of a deficit, similar to that proposed by Weinstein and Kahn (1955). Under these circumstances, monitoring of speech output is sacrificed to maintain the interpersonal facade of speech competence. Whereas Weinstein and Kahn (1955) suggested that anosognosia was an adaptive response to the psychological stress of disability, it is unclear how "motivated denial" can account for the finding that anosognosia is most often associated with fluent aphasias induced by post-Rolandic lesions. Furthermore, patients with anosognosia may not be globally unaware of their defects, but rather experience a selective unawareness for only certain deficits (Brown, 1981; McGlynn & Schacter, 1989). For example, a patient may be unaware of their speech deficit but acutely aware of their hemiplegia. Therefore, it is unclear how a hypothesis of motivated denial alone would result in a selective denial of some symptoms and not others.

It may be that some aphasic patients do not self-correct because they are not attending to themselves and are therefore unaware of their own speech. Their unawareness of their own speech may be related to either

a reduced processing capacity of the speech–language system or a failure of a feedback loop. In regard to the former, Lebrun (1987) has suggested that perhaps these patients can no longer perform two tasks, i.e., speech production and speech monitoring, at the same time. This would explain the preserved ability of these patients to recognize the jargon of others, which is a single task, although not recognizing their own speech errors while speaking, which is a dual task. Other similar mechanisms, such as limitations in attentional focus during speech production (Rubens & Garrett, 1991) and disconnection of the speech system from inspection (Geschwind, 1965), have also been proposed to explain anosognosia of speech/language errors in aphasia. With respect to a failure of the feedback loop, this feedback may be either external (via the auditory system) or internal (neuronal and entirely within the brain). The purpose of this case study is to describe an aphasic patient whose auditory comprehension is relatively spared but who is anosognosic for his speech/language errors. In addition, we describe our investigation of the four proposed mechanisms for the lack of self-correction in this case.

CASE HISTORY

A.S., a 65-year-old man with a history of poorly controlled hypertension, was admitted with the sudden onset of aphasia, following a short period of loss of consciousness. A computed tomographic scan at that time revealed a left temporal lobe intracerebral hemorrhage with subarachnoid extension. The patient underwent subsequent evacuation of the hematoma and anterior and middle cerebral artery clippings.

Computed tomography (see Fig. 1) revealed a large lesion involving the left inferior frontal gyrus, precentral gyrus, post central gyrus, supra-marginal gyrus, angular gyrus, and the superior temporal gyrus, extending deep to the subcortical white matter and possibly involving the basal ganglia. Approximately 1 month after this incident the patient was referred for a speech and language evaluation. The patient's past medical history is significant for a moderate to severe hearing loss in the right ear subsequent to mastoid surgery. This patient's results on the Western Aphasia Battery (WAB, Kertesz, 1982) are presented in Table 1.

The patient presented with jargon aphasia characterized by a severely impaired verbal output, including semantic and phonemic paraphasias and neologisms. His speech was fluent in that it filled temporal space once initiated, with some lengthy pauses between phrases and initial phoneme and syllable repetitions, particularly immediately preceding a neologism. He also produced long strings of fluent output that were peppered with intelligible "filler" phrases lacking in specific content. Prosody was seemingly well preserved but the topic of his conversation was obscure at best and often unrecognizable. Despite numerous opportunities to do

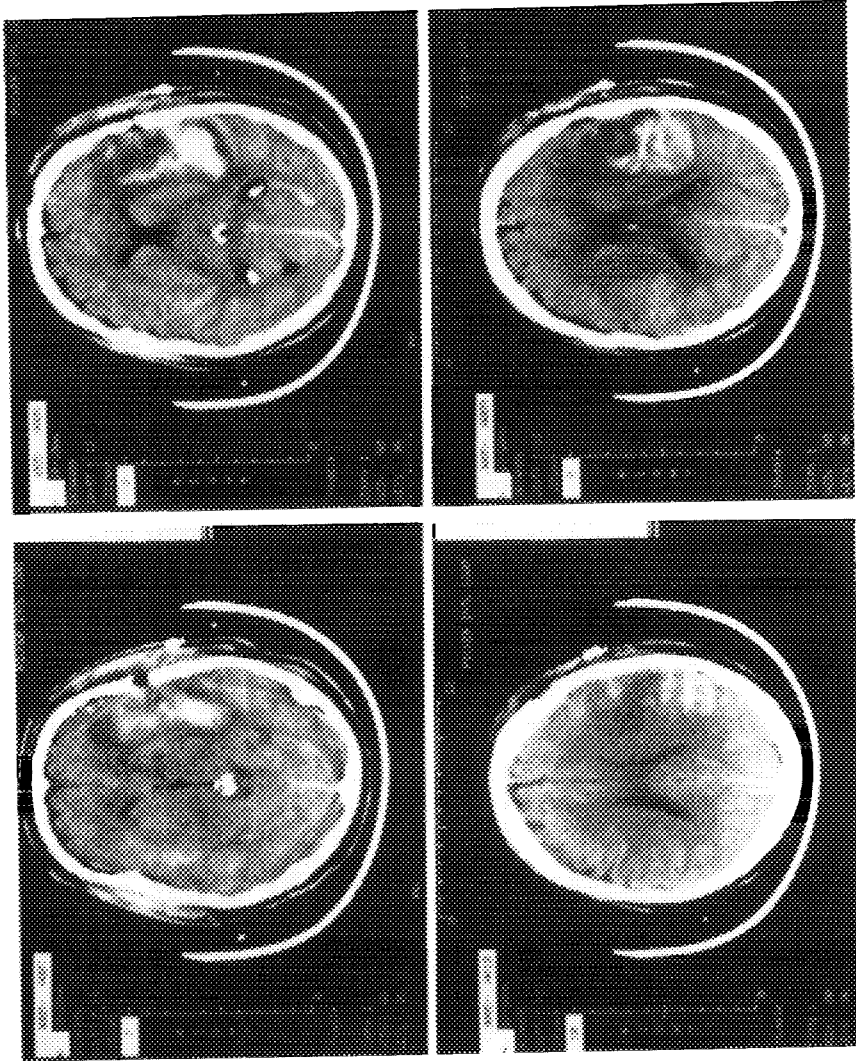


FIG. 1. Computed tomographic scan taken 10 days following intracerebral hemorrhage.

TABLE 1
Results of Subject's Western Aphasia Battery 1 Month and 2 Months after Stroke

Western Aphasia Battery score	Total possible	Subject's scores	
		1 Month	2 Months
Spontaneous Speech			
Information content	10	4	5
Fluency	10	7	7
Comprehension	10	8.5	8.8
Yes/no	60	54	57
Auditory word recognition	60	57	56
Sequential commands	80	66	63
Repetition	100	10	59
Naming	100	43	—
Aphasia quotient	100	50.8	—

so, he made no apparent effort to self-correct his speech output and most often seemed to be unaware of any defect in speech production. For example, on the object naming subtest on the WAB (Kertesz, 1982) A.S. named only 9 of the 20 items correctly, generating a combination of semantic and phonemic paraphasias and neologisms on the 12 error productions (see Appendix A). The patient attempted to correct only one of the errored responses and did so without success.

Connected language was equally disturbed, as evidenced in his verbal description of the cookie theft picture from the Boston Diagnostic Aphasia Examination, obtained approximately 2 months following the stroke (Goodglass & Kaplan, 1983):

"on the left hand side, the oldest, fernest is the boy who is standing up on the char stealing a back of ocke bells. She's the one is up there trying to talk him into it to hand him more free ones so he can get all simper broken chicken jar and pushin jar down. The other one over here I guess is steaker the rum walf over the front of the tish, left it futter running of the grain barf on the ground. That's about all there is here."

In this sample, there were only occasional pauses, and there was no evidence of self-correction.

In contrast to his verbal production skills, the patient's auditory comprehension was remarkably better by comparison. He was able to follow two and three stage commands, to respond appropriately to yes/no questions, and to follow topical shifts in conversation. The nursing staff had no difficulty with the patient maintaining his own schedule or following directions on the ward. Though not perfect, his auditory comprehension was not deficient enough to explain the lack of self-correction in his speech.

Despite his severe speech production deficit, the patient readily initi-

ated and responded in conversation and was cooperative as long as he perceived that the tasks he was completing were for our benefit. He was less cooperative in speech rehabilitation as he did not see the need for the service and within each rehabilitation session he quickly refused to continue with treatment tasks. When pressed about his speech deficit, the patient would at times admit that he had some difficulty, but always remained unconcerned about the condition.

Consistent with what has been described by Weinstein and Kahn (1955), A.S.'s family reported that premorbidly the patient did tend to ignore illness and continued to work even when he was sick. However, it should be noted that the patient also presented with a mild lower extremity weakness for which he was not anosognosic and went willingly to daily physical rehabilitation. The subsequent studies were conducted between 5 and 7 weeks following his stroke. During that time A.S. received five 30-min speech therapy sessions designed to facilitate speech production, but his speech-language profile showed little change, with the exception of a fair improvement in repetition, as can be seen in Table 1.

STUDY ONE—DELAYED AUDITORY FEEDBACK

In normal subjects, when auditory feedback is delayed, it results in a disruption in speech fluency marked by a decrease in the rate of speech, an increase of substitutions and omissions of phonemes, and increased vocal amplitude (Fairbanks & Guttman, 1955), hereafter referred to as the delayed auditory feedback (DAF) effect. DAF has been used to investigate the integrity of feedback loops in patients with jargon aphasia. Studies by Peuser and Temp (1981) and Boller, Vrtunski, Kim, and Mack (1978) have demonstrated that patients with neologistic jargon show little if any DAF effect, suggesting that they may display faulty speech feedback. In turn, this faulty feedback may be related to their failure to self-correct. This feedback loop would not be implicated in error detection off-line, but instead would contribute to on-line monitoring. However, if A.S. does demonstrate a typical response to DAF, then the failure to detect/self-correct on-line cannot be attributed to a failure of feedback. Instead the failure to correct may be better explained by an alternative mechanism. The patients with jargon aphasia, anosognosia for their speech-language errors, and an absence of DAF effect that have been described in the literature have also had impaired auditory comprehension. Therefore, there is a confound between the integrity of the feedback loop and the integrity of the linguistic representations necessary to use the feedback loop for self-monitoring. In contrast, A.S. presents with a reasonably functioning lexical-semantic system as demonstrated by his relatively preserved auditory comprehension. Therefore, if he fails to

demonstrate a DAF effect, his lack of error awareness could not be described as a defect in linguistic processing, but would more likely be a result of a defect in feedback.

We attempted to use delayed auditory feedback with A.S. to assess the integrity of the feedback system. If the patient's failure to self-correct his errors on-line was due to defective feedback, then we predicted that this defective feedback would manifest itself in the absence of a DAF effect. Furthermore, we postulated that if A.S.'s failure to self-correct was simply due to an inability to attend to his output at the same time as he was producing it, then with a temporal delay in the DAF condition there may even be an increase in self-correction behavior.

Methods

A portable Phonic Mirror DAF machine (Model PM 505, Phonic Ear, Inc., Mill Valley, CA) with a 200-msec delay was used while a portion of the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983) was administered. The patient was also asked to make judgments regarding the accuracy of his responses. Immediately following each picture-naming response, the patient was asked if his naming response was correct. The DAF machine was also used on tasks of reading aloud and reciting over-learned nurse-y rhymes.

Results

As shown in Table 2, A.S. scored comparably on this task to his previous naming performance with only 30% naming accuracy and an on-line judgment accuracy of only 30%. Although A.S. continued to demonstrate errors in his speech with no evidence of improved self-correction behavior, there was evidence of a DAF effect in that the patient's speech became subtly but noticeably slower and louder, and he appeared to be

TABLE 2
Results of Naming Performance and Judgment Accuracy for 20 Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983) Items under the Four Experimental Conditions of Study One and Study Two

Condition	No. words named correctly	No. named words judged to be correct	No. words misnamed	No. misnamed words judged to be incorrect	Judgment accuracy
DAF	6	6	14	0	6/20 = 30%
Immediate self-judgment					
Session 1	4	4	16	2	6/20 = 30%
Session 2	5	5	15	0	5/20 = 25%
Delayed self-judgment	5	3	15	10	13/20 = 65%
Examiner judgment	20	17 ^a	20	18 ^b	35/40 = 87.5%

^a Errors: "bench," "comb," "camel."

^b Errors: "w" for "camel;" "fence printsy" for "bench."

physically bothered by the device. This effect was most noticeable during the reading task and recitation of nursery rhymes. A.S. read the same 96-word paragraph under both neutral (earphones only) and DAF (200-msec delay) conditions. In the neutral condition, his reading took 2 min, averaging 48 words per minute. He produced 22 phonemic paraphasias and 21 semantic paraphasias with three whole-word or phrase repetitions and no vowel prolongations. The relatively high rate of phonemic and verbal paraphasic errors in his verbal output in the absence of DAF made it difficult to identify this aspect of the DAF effect. Even without DAF the patient made a phonemic or semantic error 50% of the time. Under the DAF condition, A.S. took 2 min and 45 sec to read the same paragraph, averaging 36 words per minute. He produced roughly the same number of phonemic and semantic paraphasias, but generated eight whole-word or phrase repetitions and five vowel prolongations. Similar results were observed when A.S. recited "Mary had a little lamb" with and without DAF. In the absence of DAF, A.S. generated 22 "words" (three phonemic errors) in 9 sec, but with the DAF he produced 20 "words" (six phonemic errors) and increased his speech time to 17 sec. We believe that there is enough evidence to suggest that A.S. was receiving the delayed auditory feedback via the external perceptual loop and that his speech production was significantly altered as a result of this feedback. The presence of this DAF effect suggests that the patient was experiencing feedback, confirming the relative integrity of the feedback loop in this patient and suggesting that A.S.'s failure to correct his speech and language errors cannot be attributed entirely to a loss of feedback.

STUDY TWO—ON- AND OFF-LINE JUDGMENTS

Since defective feedback cannot account for our patient's lack of self-correction, we wanted to examine the other three factors that may influence error detection. The Boston Naming Test (Kaplan et al., 1983) was re-administered and the patient was asked to make judgments regarding the accuracy of his responses in the following four conditions.

(1) Immediate (on-line) self-judgement condition: Immediately following each response the patient was asked if that was the correct response. The patient was told that for each response he produced he would be asked if that was what he really called that item.

(2) Delayed (off-line) self-judgment condition: The patient listened to a tape recording of his own responses with the corresponding picture and was asked if each was the correct response. The tape recorder was placed on the patient's left side and adjusted to an adequate volume to account for his hearing loss. Although the patient was not explicitly told that he was listening to his own voice, he indicated that he recognized it was his voice.

(3) Examiner (off-line) judgement condition: The patient's responses were transcribed and then the test was re-administered with the examiner responding, using the patient's responses and the patient indicating if each response was correct or incorrect. Owing to his right-ear hearing loss, the examiner sat to the patient's left side. The patient was free to watch the examiner's mouth, if he so chose. Under both the on-line and off-line conditions, A.S. was asked to judge if the response was what he typically called the item.

(4) Repetition: A.S. was simply asked to repeat the target words after the examiner.

By comparing the patient's judgment accuracy in these four conditions, it may be possible to discern the role a limited-capacity language processing system may play in self-monitoring. If the patient fails to detect and correct his errors because he is unable to process them on-line owing to a capacity limitation (rather than a feedback failure), then we predicted that in the second condition, where the judgment is made off-line, the patient should be successful in judging the accuracy of his performance. However, if the patient is unsuccessful in judging his performance in the single task, off-line condition, then the mechanism for his lack of self-correction cannot be attributed solely to an inability to perform a dual task on-line, but must be related to something other than a limited capacity.

The purpose of the third condition, where the patient evaluated the accuracy of his responses as presented to him in the examiner's voice, was to examine if the patient was denying his deficit as an adaptive strategy to being confronted with his disability. If the patient was successful in judging the accuracy of the examiner's imitation of his errors off-line but not successful in judging his own performance off-line, then this may support the hypothesis that his apparent lack of awareness was more a motivated denial than an inability to detect error. However, if the patient continued to fail to identify his errors, then this would support a true lack of detection of the error, perhaps based on a defect of lexical or semantic access or degradation of these representations. It must be noted, however, that these two conditions are also different in the method of presentation, and, if A.S. failed to detect errors in the self-judge condition but succeeded in the examiner condition, it may be due to the presence of visual cues that are only available in the examiner condition.

The repetition condition was included to assess A.S.'s auditory input system for single words. If he was able to repeat the target words, it suggested there was sufficient input processing at least to process single words. If he was not able to recognize his errors on any of the other three conditions but could repeat the words, then his failure to recognize the errors could not be attributed solely to an auditory processing failure. However, if he failed to repeat, this may be due to phonological input

or output failure and does not necessarily implicate the auditory input system.

The patient's performance was videotaped and scored by one of the authors (LMM). A subset (25%) of the responses were scored by a second author (LJGR) for reliability. Interjudge reliability was 90%. Judgment accuracy was defined as the number of responses performed correctly and judged by the patient to be correct, plus the number of responses performed incorrectly and judged by the patient to be incorrect.

Results

The first 20 items of the Boston Naming Test (Kaplan et al., 1983) were administered on two separate occasions, the results of which are presented in Table 2. The patient was asked to make accuracy judgments during the immediate self-judgment condition on both occasions, which he did correctly with 30 and 25% accuracy on the first and second testing, respectively (see Appendix B). The delayed self-judgment condition was based on the second naming set and was presented to the patient approximately 24 hr after the immediate self-judgment condition. In this condition, A.S.'s judgment accuracy improved to 65% (a significant difference of 40% judgment accuracy between the on-line and off-line conditions, $\chi^2 = 5.91$, $df 3$, $p < .05$). This improvement is consistent with the hypothesis that A.S.'s failure to self-correct his naming errors was in part related to a lack of on-line error recognition. The difference in performance in these two conditions cannot be explained on the basis of motivated denial or an impaired lexical-semantic system. The critical difference between the two tasks is the processing demand on the system. However, if the sole cause for A.S.'s lack of error awareness and correction was a limitation of processing capacity, then why did he only improve to 65% accuracy in this condition and not higher? Were it simply a capacity problem, we would have expected to see a much more dramatic improvement in accuracy judgment.

The third condition, the examiner judgment condition, was based on the first naming set and presented to the patient approximately 1 hr following the immediate self-judgment condition. Both the correct form of the target and the patient's incorrect response were presented randomly to the patient. A.S. correctly evaluated the examiner's productions 88% of the time, improving 58% over the immediate self-judgment condition ($\chi^2 = 20.38$, $df 3$, $p < .001$), and almost an additional 20% over the delayed self-judgment condition. The errors in detection that persisted under this condition were three failures to identify the correct target as correct and two failures to identify verbal paraphasias as incorrect. This further improvement in error detection cannot be explained on the basis of a decrease in demands on the processing capacity of the language system in that both delayed judgment conditions presented the same,

single-task processing requirements. Thus the improvement on this third condition over the delayed self-judgment condition may be related to a relaxation of any adaptive denial mechanisms that may be influential when the patient is judging his own performance. The persistent failure in judging verbal paraphasias as incorrect is suggestive of a residual lexical-semantic failure once the other mechanisms for error detection are controlled. Unfortunately, we did not assess the patient's semantic knowledge for these specific items at that time; however, the patient had demonstrated the ability to point to one of the items (comb) previously on the WAB. Furthermore, if a lexical-semantic failure was the source of his lack of self-correcting, we might have expected more item consistency across both naming administrations (see Appendix B). The role of a semantic access failure or semantic degradation in this patient's remaining lack of error detection is a plausible if only speculative explanation.

A.S. repeated 14 of the 20 items correctly. His errors (listed in Appendix B) were perseverative (3/6), phonemic (1/6), and semantic (2/6). Although his performance is not perfect, it does suggest that there is enough auditory processing ability to repeat many of the single words he both failed to name and failed to self-correct. However, his performance does not conclusively rule out a contributory auditory processing failure to his lack of self-correction.

DISCUSSION

In summary, we report a patient with jargon aphasia who was anosognosic for his aphasia despite relatively preserved lexical-semantic processing. Testing of the proposed mechanisms for anosognosia suggests that the patient's deficit cannot be explained by a failure of any one of the four mechanisms described in the literature (i.e., impaired lexical-semantic representations, impaired auditory feedback, reduced attentional capacity, and psychological denial).

There has been considerable research as to the nature of speech production monitoring in normals. Levelt (1983) in examining the self-correction behaviors of normals on a task requiring accurate descriptions of verbal directions found that normals fail to self-correct their lexical errors almost 50% of the time. It is unclear, however, how many of these errors were undetected, but since the task required accurate verbal descriptions it is assumed by Levelt that these errors were uncorrected because they were undetected. Nooteboom (1980) reported a similar finding, 53% of lexical errors were corrected. Conversely, phonemic errors were detected and corrected better than 70% of the time, suggesting that there is a differential correction rate (and possibly detection rate) for lexical errors, which are by nature real words, versus phonemic errors, which by nature result in nonwords. Along this line of reasoning it is interesting that in the off-line examiner condition the only errors that remained undetected by A.S. were semantic errors.

Other studies using normals have demonstrated that the rate of error detection can differ as a result of task demands (Levelt, 1983) and speakers can vary which aspects of their speech they monitor (Levelt, 1989). Both semantic and syntactic biases have been manipulated on tasks of error detection and correction (Baars, Motley, & MacKay, 1975; Motley, Camen, & Baars, 1982). McNamara, Obler, Au, Durso, and Albert (1992) found that normal older controls detected and corrected 72 to 92% of their errors on cookie theft descriptions, considerably higher than the rate reported by Nooteboom (1980). Again, the task demands were different, which likely accounts for the differences in performance. Marshall et al. (1985) and Marshall and Tompkins (1982) reported that self-correction attempts for aphasic patients were observed more often on naming tasks than on other verbal output tasks, such as picture description, perhaps because the task demands for naming are more confined and therefore allow for greater attentional capacity to be freed for monitoring. Alternatively, self-correction may occur more frequently on naming tasks because the nature of the task is such that the patient responds to the requirement of producing the accurate name rather than accepting an approximation to the target. The fact that A.S. never self-corrects on our naming tasks speaks to the severity of his lack of error correction and/or detection.

Laver (1973) has suggested that each component of the production process, i.e., semantics, output lexicon, phonological buffer, and so on, can be accessed by the monitor and compared to some target criteria. On the other hand, Levelt (1983) and Garnsey and Dell (1984) have suggested that speech monitoring in normal speech production occurs as part of the input process, much like in normal speech comprehension, and can occur on a prearticulatory and postarticulatory level. Other researchers, such as Schlenk et al. (1987), have claimed that speech monitoring involves components of both input and output processing systems. Although the controversy as to the nature of the speech production monitor cannot be resolved based on the current study, it is clear from these data that the systems that mediate auditory comprehension are alone not sufficient to accomplish speech error detection and correction. This does not preclude the possibility that these systems are still necessary for error detection and correction. The success of the hypothetical speech production monitor may be dependent upon intact perceptual, phonological, lexical, and semantic systems as well as an adequate attentional processing capacity and an ability to accept disability. We propose that a deficit in any of these mechanisms may be sufficient to cause an anosognosia for aphasia. In the patient with Wernicke's aphasia, the failure to detect and correct errors may be more related to impaired lexical-semantic representations as was proposed by Heilman (1991), whereas in the current patient with relatively preserved lexical-semantic processing, the anosognosia for aphasia seems to be more related to atten-

tional capacity. However, none of the proposed mechanisms can fully account for our patient's performance, and psychological denial cannot be excluded as a possible contributory factor.

APPENDIX A

Errors of A.S. on the Western Aphasia Battery Naming Test 1 Month Following His Stroke

Target	A.S.'s response
Toothbrush	Ringer bus
Eraser	Resolver
Padlock	Slip
Screwdriver	Stignel
Paper clip	Tom
Pipe	Man smokes it
Comb	Hunkin
Elastic	Rubber
Spoon	Pineapple
Scotchtape	Sk . . . staples
Fork	Plastic slip

APPENDIX B

A.S.'s naming response

Target	1st Administration	2nd Administration	A.S.'s repetition
1. Bed	Badingful	Bed ^{a,b}	Bed ^a
2. Tree	Kiss	Tree ^{a,b}	Tree ^a
3. Pencil	Pencil ^{a,b}	Pumpkin	Pencil ^a
4. House	Two story house ^{a,b}	House ^{a,b}	House ^a
5. Whistle	Seagul	Twimber	Whistle ^a
6. Scissors	Scissors ^{a,b}	Pincers	Scissors ^a
7. Comb	Cromar	Beer	Comb ^a
8. Flower	Fran	Normal	Comb
9. Saw	Sinkle ^b	Hand cutting saw ^{a,b}	Saw ^a
10. Toothbrush	Sof baang	Hand bess	Saw
11. Helicopter	Heliclopter ^{a,b}	Heliclopter ^{a,b}	Ilkapalor
12. Broom	Mussin	Speel	Broom ^a
13. Octopus	Step-gloss	Parshin cotter	Color
14. Mushroom	Mahsk	Cleanhoppers	Color
15. Hanger	Ansick	Rectamil	Hanger ^a
16. Wheelchair	Erbindacker	Tomradafrom	Wheelchair ^a
17. Camel	Double-u	Nano double mana	Salmon
18. Mask	Stick-man	Face	Mask ^a
19. Pretzel	Patchem ^b	Water animals	Pressel ^a
20. Bench	Fentense printsy	Open year	Bench ^a

^a Correct response.

^b A.S. judged accurately.

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