Performance Deviations in the Connected Speech of Adults With No Brain Damage and Adults With Aphasia

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A rule-based system was used to score performance deviations in the connected speech of 40 adults with no brain damage, 10 adults with fluent aphasia, and 10 adults with nonfluent aphasia. Performance deviations were productions that did not qualify as words or as correct information units (CIUs) (Nicholas & Brookshire, 1993). They were assigned to 2 *nonword* categories (part-words or unintelligible productions and nonword filler) and 8 *non-CIU* categories (inaccurate words, false starts, unnecessary exact repetitions, nonspecific or vague words, filler words, the word *and*, off-task or irrelevant words, and uncategorizable productions). Speech samples from both aphasic groups contained significantly greater percentages of inaccurate words, false starts, and part-words or unintelligible productions than those of the non-brain-damaged group. In comparison with the non-brain-damaged group, speech samples from the fluent aphasic group contained significantly greater percentages of unnecessary exact repetition, whereas those of the nonfluent aphasic group contained significantly greater percentages of the word *and* and nonword filler. The only significant difference between the two aphasic groups was for nonword filler, with the nonfluent aphasic group producing more than the fluent aphasic group. Individual aphasic subjects showed performance that generally was consistent with that of their group.

During the last decade, concern with how the connected speech of adults with aphasia adheres to language rules and standard usage patterns has been declining, while interest in the informativeness and efficiency of their connected speech has been growing. This change in focus has been motivated, at least in part, by the realization that communicative success is likely to depend less on the form of the message than on its informativeness and how efficiently it is communicated. Increased interest in aphasic adults' communicative informativeness and efficiency led to the development of several standard measures of these aspects of connected speech. These measures quantify how much of what a speaker says conveys information that is accurate, relevant, and informative about a topic (Nicholas & Brookshire, 1993; Yorkston & Beukelman, 1980), or how well the main information about a topic is conveyed (Nicholas & Brookshire, 1995). However, they do not quantify the specific features that make the connected speech of aphasic adults distinctive (e.g., inaccurate or vague words, revised utterances)—speech behaviors that Loban (1976) called "performance deviations." Several studies of performance deviations in the connected speech of aphasic adults have been published (Glosser & Deser, 1990; Glosser, Wiener, & Kaplan, 1988; Golper, Thorpe, Tompkins, Marshall, & Rau, 1980; Hier, Hagenlocker, & Shindler, 1985; Nicholas, Obler, Albert, & Helm-Estabrooks, 1985). The primary purpose of these studies was to compare performance deviations produced by aphasic adults with those produced by non-brain-damaged adults, adults with right-hemisphere damage, traumatic brain injury, or probable dementia of the Alzheimer's type. The results of these studies generally suggest that aphasic adults produce more of some categories of performance deviations than non-brain-damaged adults, and that the performance deviations produced by groups of adults with aphasia differ from those of groups of adults with other neurogenic communication impairments, although no consensus is obvious regarding which categories account for the differences.

The existing literature provides a general sense of the nature of performance deviations in the connected speech of aphasic adults, and of how their performance deviations may differ from those of non-brain-damaged adults or adults with other neurologic impairments. However, the measures generally have not been described in sufficient detail to permit satisfactory replication, and, except for the two studies by Glosser and associates, the measures were based on short speech samples elicited only by the Boston Diagnostic Aphasia Examination (BDAE; Goodglass & Kaplan, 1983) "cookie theft" picture. Moreover, in most of these studies the non-brain-damaged group was small and comparisons of non-brain-damaged subjects and those with aphasia generally were limited to group mean scores, with no analysis of how well the group means represented the performance of individual subjects. Consequently, we have limited knowledge of the frequency of various performance deviation categories in the connected speech of aphasic adults and how performance deviations in their connected speech differ from those of non-brain-damaged adults. Acquiring this information is a necessary first step in investigating the effects of performance deviations on listeners' impressions of a speaker's informativeness and their sense of how effortful it is to comprehend what a speaker attempts to communicate.

In this paper, we will describe a rule-based system for reliably scoring performance deviations in connected speech. Then we will describe how the performance deviations of aphasic adults differ from those of non-brain-damaged adults, both at the group level and for individuals in the groups.

Method

Subjects

Subjects were 40 adults with no brain damage (21 M, 19 F) and 20 adults with aphasia (18 M, 2 F). All were right-handed native speakers of English. The non-brain-damaged subjects were nonhospitalized adults who lived independently and reported no history of neurologic, psychiatric, speech, or language problems. The aphasic subjects were at least 3 months postonset of a single left-hemisphere thromboembolic cerebrovascular accident. Ten exhibited fluent aphasia (good articulatory agility and literal and verbal paraphasias) and 10 exhibited nonfluent aphasia (labored articulation and agrammatism). The severity of their aphasia was estimated by their overall percentile on a four-subtest shortened version (SPICA; Disimoni, Keith, & Darley, 1980) of the Porch Index of Communicative Ability (Porch, 1971). Age and education were similar for the three subject groups. Descriptive information for the groups and information about their speech rate and their production of correct information units (Nicholas & Brookshire, 1993) and main concepts (Nicholas & Brookshire, 1995) are given in Table 1.

Stimulus Materials

Speech was elicited with 10 stimuli. Four were single pictures. One of the single pictures was the "cookie theft" picture from the BDAE and another was the "picnic" picture from the Western Aphasia Battery (WAB; Kertesz, 1982). The other two single pictures were drawn to the authors' specifications and each depicted a story-like situation with a central focus and interactions among pictured elements. Two of the speech elicitation stimuli were picture sequences, drawn to the authors' specifications. Each contained six pictures that portrayed a story. (These two single pictures and two picture sequences are shown in Nicholas & Brookshire, 1993.) Two stimuli were requests for personal information ("Tell me what you usually do on Sundays;" "Tell me where you live and describe it to me"), and two were requests for procedural information ("Tell me how you would go about doing dishes by hand;" "Tell me how you would go about writing and sending a letter").

Procedures

Elicitation of Speech Samples. Subjects were evaluated individually in a quiet room. To ensure that subjects produced enough speech to permit meaningful scoring of content and that their speech was sufficiently intelligible to allow accurate transcription, they were asked to describe a three-picture sequence that portrayed a short story. To participate in the study, subjects had to produce at least 10 intelligible, relevant, nonrepeated words in response to the three-picture sequence. Subjects who did not meet this criterion on their first try were given one additional chance to describe the picture sequence. Two potential subjects who exhibited severe nonfluent aphasia were unable to meet the criterion and were not included in the study.

The 60 subjects who qualified for the study were given a short interval of practice and training with two stimuli ("Tell me what you like to spend your time doing;" "Tell me how you would go about making a sandwich"). Instruction and feedback were provided until the examiner felt that the subject understood the task. No subject needed more than two trials and associated training with the practice stimuli to understand the task. Additional procedure information is provided in Nicholas and Brookshire (1993).

Transcription and Scoring of Speech Samples. Each subject's spoken responses to the elicitation stimuli, together with any prompts delivered by the examiner, were recorded on audiotape. Speech samples were orthographically transcribed by a speech-language pathologist familiar with the speech of aphasic adults. A second speech-language pathologist independently checked the transcriptions against the tapes. When these two speech-language pathologists disagreed on how a speech event should be transcribed, a third speech-language pathologist reviewed the event in question, and a consensus decision was reached concerning how the event should be transcribed. Then the speech samples were scored for words and correct information units using published rules (Nicholas & Brookshire, 1993). To qualify as words, productions had to be intelligible in context. To qualify as correct information units (CIUs), words had to be accurate, relevant, and informative relative to the eliciting stimulus, but they did not have to be used in a grammatically correct manner.

Selection of Performance Deviation Categories and Development of Scoring Rules. The coauthors formulated a set of prototype performance deviation categories by partitioning the speech behaviors that did not qualify as words or CIUs (the non-CIUs) in the transcripts of both groups of subjects into categories that seemed to represent qualitatively different performance deviations. Then they wrote rules for identifying instances of each category. The scoring categories and rules were then evaluated and modified across a series of trials in which the coauthors and others used the prototype categories and rules to score transcripts until the coauthors were satisfied that the categories were reliably scorable and provided a comprehensive inventory of the performance deviations that were likely to occur in the connected speech of non-brain-damaged adults or adults with aphasia.

Scoring of Performance Deviations. Then the second author and another speech-language pathologist assigned all nonwords

TABLE 1. Descriptive information for 40 adults with no brain damage (NBD), 10 adults with fluent aphasia (FLA), and 10 adults with nonfluent aphasia (NFA).

Group	Statistic	Age	Education	MPO	SPICA	#Words	#CIUs	%CIUs	WPM	%ACMC
NBD	Mean	66	13	—	—	1258	1075	86.2	168	79.3
	Std Dev	7.4	2.1	—	—	511.4	413.7	4.6	19.8	13.2
	Range	50–79	8–17	—	—	538–2973	475–2467	75–93	105–204	51–96
FLA	Mean	65	13	38	70	939	635	67.3	95	49.8
	Std Dev	5.1	1.6	44.9	10.4	297.2	209.8	7.8	33.0	15.4
	Range	54–74	11–16	3–133	51–82	464–1592	298–952	58–78	48–145	25–68
NFA	Mean	58	14	99	67	537	361	68.4	40	38.3
	Std Dev	8.4	1.9	69.5	8.5	201.8	121.9	8.0	14.3	17.9
	Range	45–73	12–16	19–192	53–85	297–890	203–552	58–85	12–66	15–64

Note. MPO = months post onset of aphasia. SPICA = overall percentile on a short version of the *Porch Index of Communicative Ability.* CIUs = correct information units. WPM = words per minute. ACMC = accurate and complete main concepts.

and non-CIUs in the 60 subjects' speech samples to one of the following performance deviation categories using the written rules. Productions that did not qualify as words were assigned to one of two performance deviation categories—part-words or unintelligible productions and nonword filler. Productions that qualified as words but did not qualify as CIUs (the non-CIUs) were assigned to one of eight performance deviation categories—inaccurate words, false starts, unnecessary exact repetitions, nonspecific or vague words, filler words, the word *and*, off-task or irrelevant words, and uncategorizable. None of the subjects' productions in this study were judged to be uncategorizable. Consequently, this category does not appear in subsequent analyses or discussion. Definitions and examples for the remaining nine categories are provided in Table 2.

To assess interjudge agreement for scoring the performance deviation categories, a third individual independently scored transcripts for 14 randomly selected subjects (8 of the 40 non-brain-damaged subjects, 3 of the 10 fluent aphasic subjects, and 3 of 10 the nonfluent aphasic subjects). Point-to-point interjudge agreement was 85% or greater for each of the nine categories, for each of the three groups. [The interjudge agreement for scoring words and CIUs has been reported previously (Nicholas & Brookshire, 1993), and exceeded 90% point-to-point agreement for each selected subject.]

Results

The percentage of productions that fell into each of the two nonword categories for each subject was calculated by dividing the number of productions in each of those categories by the total words plus nonwords produced by that subject. The percentage of words that fell into each of the seven non-CIU categories for each subject was calculated by dividing the number of words in each non-CIU category by the total number of words produced by that subject. These results are summarized in Table 3.

To determine which of the between-group differences shown in Table 3 were statistically significant, a one-way analysis of variance was calculated for each of the nine categories. An adjusted Type 1 (alpha) error level was established for the multiple comparisons by dividing the target alpha (.05) by the number of tests (9) to yield an adjusted alpha level ($p < .006$). When the main effect for groups was significant, Sheffe's tests were calculated to determine which of the differences among group means were significant ($p < .05$).

There was no significant group main effect (df = 2,57; $p < .006$ for all effects) for three of the categories—nonspecific or vague words ($F = 4.87$), filler words ($F = 4.40$), and off-task or irrelevant words ($F = 0.35$), suggesting that differences among the three groups on these categories were not significant. There were significant group main effects for the percentage of inaccurate words ($F = 42.82$); false starts ($F = 56.22$); unnecessary exact repetition ($F = 7.05$); the word *and* ($F = 11.29$); part-words or unintelligible productions ($F = 55.69$); and nonword filler ($F = 49.15$). The results of the follow-up tests on these significant group effects are summarized in Table 4.

The non-brain-damaged group differed significantly from the nonfluent aphasic group on five of the six categories for which there was a significant group main effect—inaccurate words, false starts, the word *and*, part-words or unintelligible productions, and nonword filler. The non-brain-damaged group differed significantly from the fluent aphasic group on four of the six categories—inaccurate words, false starts, unnecessary exact repetition, and part-words or unintelligible productions. Table 3 shows that in each case the non-brain-damaged group produced fewer deviations within each category. The fluent aphasic group differed significantly from the nonfluent aphasic group only on nonword filler, with the fluent group producing less nonword filler than the nonfluent group (Table 3).

Because the non-brain-damaged group contained approximately equal numbers of males and females, whereas the aphasic group contained mostly males, we compared the performance of the non-brain-damaged males with that of the non-brain-damaged females to determine if a subject's sex affected his or her production of performance deviations. The distributions of inaccurate words, unnecessary exact repetitions, nonspecific or vague words, filler words, and part-words or unintelligible productions were too constricted to permit legitimate comparisons using parametric statistics. Therefore, we randomly paired 19 of the male non-brain-damaged subjects with the 19 female subjects and calculated nonparametric sign tests to evaluate their production of these categories. The sign tests yielded no significant differences between the male

TABLE 2. Categories of performance deviations in connected speech.

Category	Definition	Examples
Nonword		
Part-word or unintelligible production	Word fragments or productions that do not result in a word that is intelligible in context.	...on a ***st..sk.***.stool ...on a ***frampi***
Nonword filler	Utterances such as "uh" or "um."	..on a..***um***..stool..***uh...***
Non-CIU		
Inaccurate	Not accurate with regard to the stimulus, and no attempt to correct.	...on a ***chair*** (for stool)
False start	False start or abandoned utterance.	...on ***a chair..no***, a stool
Unnecessary exact repetition	Exact repetition of words, unless used purposefully for emphasis or cohesion.	...on a..***on a*** stool
Nonspecific or vague	Nonspecific or vague words or words lacking an unambiguous referent.	...on a ***thing*** ...on ***it*** (with no referent for "it")
Filler	Empty words that do not communicate information about the stimulus.	...on a..***you know***..stool
And	All occurrences of the word *and.*	...a boy ***and*** a stool
Off-task or irrelevant	Commentary on the task or the speaker's performance	***I've seen this one before.*** ***I can't say it.***

Note. In the examples, only nonwords and words printed in boldface italics were scored as performance deviations.

TABLE 3. Group means (and standard deviations) for the percentage of words plus nonwords that fell into two categories of nonwords and the percentage of words that fell into seven categories of non-CIUs, plus upper limits for 90% confidence intervals (CI UL) based on non-brain-damaged (NBD) subjects' performance.

Category	NBD	90% CI UL	FLA	NFA
Nonword				
Part-word or unintelligible	0.7 (0.38)	1.3	5.9 (3.01)	5.3 (2.61)
Nonword filler	3.4 (2.15)	6.9	7.0 (5.28)	22.8 (11.30)
Mean percent nonwords	4.0 (2.24)	7.7	12.9 (6.41)	28.0 (12.97)
Non-CIU				
Inaccurate	0.2 (0.19)	0.5	1.7 (0.86)	1.9 (1.27)
False starts	2.9 (2.37)	6.9	14.8 (4.81)	11.4 (5.16)
Unnecessary repetition	0.8 (0.73)	2.0	1.9 (0.97)	1.6 (1.63)
Nonspecific or vague	0.8 (0.63)	1.9	1.8 (1.67)	0.7 (0.92)
Filler	1.2 (0.73)	2.4	2.0 (1.31)	2.5 (2.67)
And	6.4 (1.35)	8.6	8.6 (2.80)	11.1 (5.78)
Off-task or irrelevant	1.5 (2.85)	6.2	1.9 (2.04)	2.3 (2.15)
Mean percent non-CIUs	13.8 (4.60)	21.4	32.7 (7.85)	31.6 (8.04)

Note. FLA = fluent aphasia, NFA = nonfluent aphasia.

TABLE 4. Results of Scheffe's follow-up tests on significant group main effects.

Category	NBD vs FLA	NBD vs NFA	FLA vs NFA
Inaccurate	**	**	ns
False start	**	**	ns
Part-word or unintelligible production	**	**	ns
Nonword filler	ns	**	**
The word *and*	ns	**	ns
Unnecessary exact repetition	**	ns	ns

Note. NBD = no brain damage, FLA = fluent aphasia, NFA = nonfluent aphasia.
** = significant at $p < .05$; ns = nonsignificant.

and female groups ($p < .01$).[1] We calculated t-tests to compare male and female non-brain-damaged subjects' production of false starts, off-task or irrelevant words, the word *and*, and nonword filler, plus their overall production of non-CIUs and nonwords. None of the differences proved statistically significant ($p < .01$). These results indicate that a subject's sex had no meaningful effect on the production of the nine categories of performance deviations.

To determine the extent to which the performance of individual aphasic subjects was consistent with the group results, a 90% confidence interval for normal performance was calculated for each category, based on the performance of the 40 non-brain-damaged subjects [$M + (1.65 \times SD)$]. The performance of individual aphasic subjects with regard to the upper limit of these confidence intervals is summarized in Figures 1, 2, and 3. Figure 1 presents the results for categories for which no significant differences among groups were found. Figure 2 presents the results for categories for which the non-brain-damaged group differed significantly from both aphasic groups. Figure 3 presents the results for categories for which the non-brain-damaged group differed significantly from only one of the aphasic groups.

In general, the performance of individual aphasic subjects was consistent with that of their group. There were only two categories for which more than 4 of the 20 aphasic subjects performed differently than the group results would predict—filler words and the word *and*. Seven of the 20 aphasic subjects scored outside the normal limit for filler words, even though the differences between the non-brain-damaged group and the fluent and nonfluent aphasic groups were not significant. Although the group results showed that the nonfluent aphasic subjects produced significantly more occurrences of the word *and* than the non-brain-damaged subjects, 4 nonfluent aphasic subjects scored within the normal limit for this performance deviation. In addition, 4 fluent aphasic subjects scored above the normal limit for the word *and*, even though as a group they did not differ significantly from the non-brain-damaged subjects.

Discussion

These results suggest that adults whose aphasia type and severity are commensurate with those in this study are not appreciably more likely to substitute nonspecific words for specific ones, produce more filler words, or produce more off-task words than non-brain-damaged speakers. In most cases, these performance deviations are each likely to account for no more than 5% of the words produced by an aphasic speaker.

Three categories of performance deviations dependably separated aphasic speakers from those without brain damage—inaccurate words without attempts at self-correction, false starts, and part-words or unintelligible words. Inaccurate words with no attempt at self-correction were quite rare for all subjects—18 of the 20 aphasic subjects produced fewer than 3% inaccurate words. The significant difference between the non-brain-damaged group and the two aphasic groups for this category appears to be a consequence of the extreme rarity of inaccurate words in non-brain-damaged adults' connected speech.

Only one performance deviation category dependably separated the two groups of aphasic subjects. Nonfluent aphasic subjects' production of nonword filler significantly exceeded that of both the fluent aphasic group and the non-brain-damaged group. Production of nonword filler was outside the normal limit for all 10 nonfluent aphasic speakers.

The individual-subject results for the word *and* and unnecessary exact repetition were somewhat at variance with the group findings. The group findings indicated that the non-brain-damaged subjects produced significantly fewer occurrences of the word *and* than those with nonfluent aphasia, but did not differ significantly from those with fluent aphasia. Based on this result, nonfluent aphasic subjects should score outside the normal limit and fluent aphasic subjects should score within it. That four subjects in each aphasia group did not conform to these expectations somewhat limits the group findings. Group results also indicated that the non-brain-damaged subjects produced significantly less unnecessary exact repetition than those with fluent aphasia, yet 7 of the 10 fluent aphasic subjects performed at or within the normal limit for this performance deviation. That the performance of 6 of these 7 subjects was

[1]For both t-tests and sign tests, the Type 1 error for individual comparisons was adjusted for multiple comparisons to control familywise Type 1 error rate.

FIGURE 1. Performance of individual aphasic subjects on categories for which no significant differences among groups were found. The stars represent subjects with fluent aphasia and the diamonds represent subjects with nonfluent aphasia. The solid horizontal line represents the upper limit of a 90% confidence interval for the non-brain-damaged group.

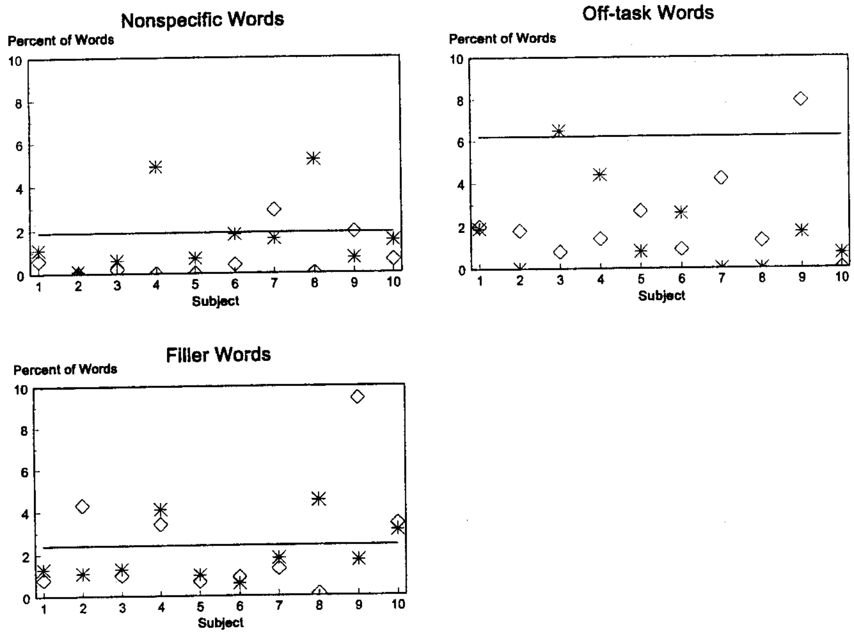
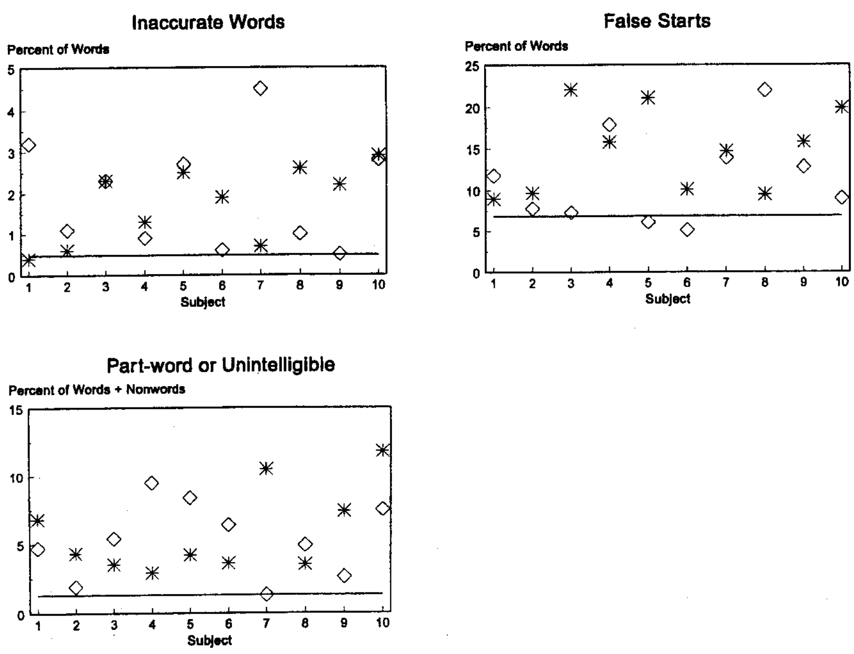


FIGURE 2. Performance of individual aphasic subjects on categories for which the non-brain-damaged group differed significantly from both aphasic groups. The stars represent subjects with fluent aphasia and the diamonds represent subjects with nonfluent aphasia. The solid horizontal line represents the upper limit of a 90% confidence interval for the non-brain-damaged group.



at or slightly below the limit may at least partially explain this inconsistency.

It is no doubt useful to know how groups of non-brain-damaged speakers and those with aphasia differ, on the average, in how frequently they produce various categories of performance deviations. However, our results suggest that group average differences may not always accurately predict whether an individual aphasic speaker will fall within or outside the normal limit for any given performance deviation. Consequently, group differences such as those reported herein and in previous studies are perhaps most useful in providing the clinician with a general sense of what to expect from aphasic speakers, and what constitutes the normal limits for those behaviors, rather than enabling predictions about the performance of specific aphasic (or non-brain-damaged) individuals.

Knowing the frequency of performance deviations in non-brain-damaged adults' connected speech, and knowing which ones typically differentiate aphasic speakers from non-brain-damaged ones may provide some clues as to how performance deviations in the connected speech of aphasic speakers might affect listeners. Performance deviations that are common in non-brain-damaged adults' connected speech seem likely to be less disruptive to communication than less common ones, because listeners may be accustomed to them and may either ignore them or compensate for them with little or no expenditure of processing resources.[2] In fact, it may be that the frequency with which given performance deviations occur in the connected speech of non-brain-damaged speakers will prove more important to communicative success than whether aphasic speakers as a group produce significantly more of them than non-brain-damaged speakers.

We know that comprehension of spoken discourse depends strongly on the listener's appreciation of the topic, essence, or point of what a speaker is saying, and that appreciation of a speaker's point depends strongly on the listener's identification of the main ideas in the discourse. Once the listener has identified the topic or point, the way is cleared for the listener to use general knowledge or other "macroprocesses" to deduce what the speaker is saying, which reduces the need for laborious word-by-word processing (Kintsch & van Dijk, 1978; Meyer, 1977; van Dijk, 1985; and

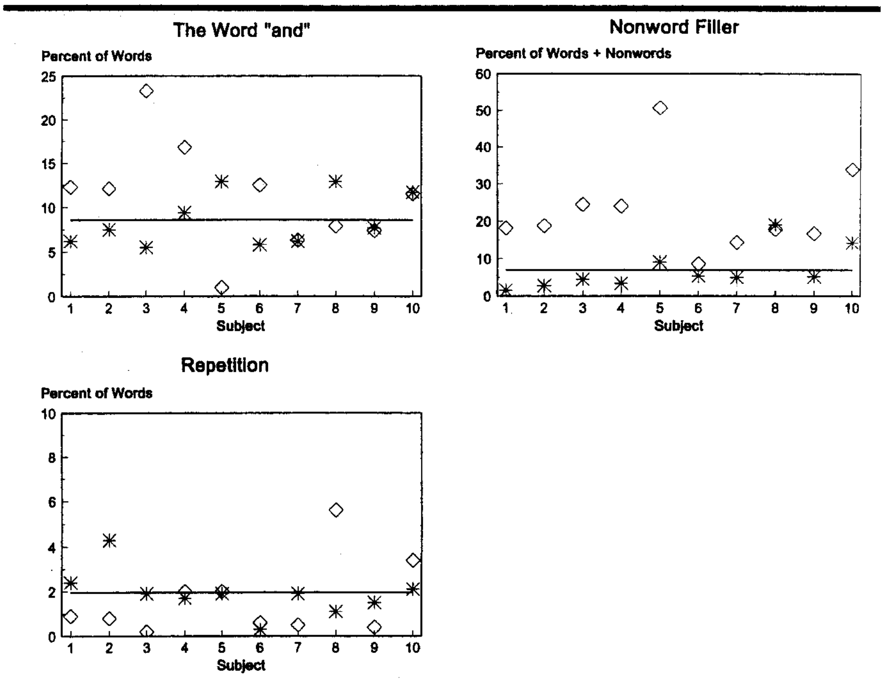
[2]It may be that common performance deviations are common because they do not seriously interfere with communicative success. This may help to explain why inaccurate words are extremely rare in non-brain-damaged adults' connected speech, whereas false starts, off-task words, and nonword filler are more common.

others). Because main ideas play a crucial role in the listeners' appreciation of the overall topic or point of what the speaker is saying, it seems likely that when performance deviations compromise listeners' comprehension of thematic elements or main ideas of discourse, they will have greater negative effects on communication than when they affect peripheral details.

Clinicians (and investigators) should keep in mind that performance deviations may sometimes be used intentionally both by non-brain-damaged speakers and by those with aphasia for purposes such as keeping the conversational "floor," social housekeeping, or marking units of thought, and by speakers with aphasia as self-prompts or self-cues, or for maintaining the listener's attention while they search for words or formulate utterances. Attempting to eliminate performance deviations that serve such functions would, of course, be inadvisable unless the treatment program were first to eliminate any underlying processing impairments that made them necessary.

Evaluating performance deviations in the connected speech of adults with aphasia may provide a useful supplement to other measures of communicative informativeness and efficiency. These measures, in combination, can allow clinicians to begin quantifying, in a standard way, what is normal and what is abnormal about the connected speech of adults with aphasia. However, knowing this is not necessarily equivalent to knowing what is handicapping, in terms of negatively affecting either a listener's comprehension of what is said, or a listener's subjective reaction to the speaker. Determining which of the differences between the connected speech of non-brain-damaged adults and those with aphasia make a difference to their listeners in daily life appears to be an important focus of future research.

FIGURE 3. Performance of individual aphasic subjects on categories for which the non-brain-damaged group differed significantly from one of the two aphasic groups. (The two groups with aphasia also differed significantly from each other on nonword filler.) The stars represent subjects with fluent aphasia and the diamonds represent subjects with nonfluent aphasia. The solid horizontal line represents the upper limit of a 90% confidence interval for the non-brain-damaged group.



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