Features of Spontaneous Language in Speakers With Amyotrophic Lateral Sclerosis and Dysarthria

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Language samples (picture description) produced by moderately dysarthric speakers with ALS were compared with those of gender- and age-matched controls. Results indicated that dysarthric speakers produced the same number of concepts but fewer words than controls. Efficiency (as measured by content units/minute and words/content unit) was maintained in the dysarthria group by shortening phrases, reducing the proportion of mazes, and increasing the number of nongrammatical phrases. Measures of vocabulary were not different for the two groups. Three possible explanations for the "economy of wording" strategy are: (a) response to increasingly effortful speech, (b) subtle language deficits, and (c) response to slowed speaking rates.

Although language deficits are a common consequence of neurologic disorder, they are not commonly associated with amyotrophic lateral sclerosis (ALS), a progressive motor neuron disorder in which dysarthria is a frequent symptom. Language usage patterns of individuals with ALS and dysarthria are interesting for both theoretic and clinical reasons. In most models of speech production, as well as in theoretical discussions of acquired neurologic communication disorders, speech is portrayed as distinct from language. One need only turn to colleagues in speech and language development for confirmation that, theoretically, the lines of demarcation between speech and language, and between language deficits and dysarthria, are not always clear. Clinicians and researchers in child development argue that a prominent motor speech disorder may influence a child's language development (Strand, 1992). This view can be extended to adults by asking about the effects of moderate dysarthria on spontaneous language production of individuals with ALS.

Interest in this work has also been spurred by the clinical impressions of how individuals with ALS cope with increasing dysarthria. With moderate dysarthria, speech intelligibility may remain high but individuals report a marked increase in effort. Later, with severe dysarthria, even maximal effort does not preserve speech intelligibility. Changes in language may reflect a response to increasingly effortful speech. The focus of this preliminary investigation was on the language produced by speakers with moderate dysarthria who are maintaining speech intelligibility but indicate that they are doing so only with great effort. Specifically, we used a picture description task to elicit a sample of spontaneous language and asked the following questions:

Does language produced by speakers with ALS and dysarthria differ from that produced by controls?

Does language change as dysarthria severity increase?

Method

Subjects

Nine speakers with ALS and nine age- and gender-matched controls completed the "cookie theft" picture description task (Goodglass & Kaplan, 1983) on two occasions. In addition to having a confirmed diagnosis of ALS, subjects were native speakers of American English; had dysarthria that increased in severity from session 1 to session 2; used speech as their primary means of communication; and were willing to participate in the research project. Subjects with ALS averaged 15 months postdiagnosis for session 1 and 24 months postdiagnosis for session 2. Sentence intelligibility averaged 91% for session 1 and 79% for session 2 (see Table 1).

Data Analysis

The language samples were audio recorded, orthographically transcribed, and analyzed for the following: (a) quantity of linguistic units [number of words, content units, and *t*-units (Hunt, 1970)], (b) efficiency (words/minute, content units/minute, and words/content unit), (c) vocabulary (type token ratio, and syllables/words), and (d) grammatical integrity (words/*t*-units, proportion of words in the sample that were in mazes, and proportion of words in the sample that were in nongrammatical phrases).

Interjudge reliability between two judges was measured for transcription on 10% of the samples. Average number of disagreements per 100 words was 0.5. Intrajudge reliability (for all samples) and interjudge reliability (for 33% of the samples) were completed for quantification of linguistic units and grammatical integrity. Pearson product correlations between first and second scoring and between two judges were consistently high (at least .99).

Results

Group Differences

In order to evaluate group and session-to-session differences, a series of two-way analyses of variance (ANOVA) for dependent variables was computed. Level of significance was .05 with a Bonferroni correction for multiple tests. Results of these analyses suggested that there were no significant session-to-session differences for either group on any of the measures in the four domains. Therefore, data reported here are collapsed across sessions.

TABLE 1. Subject characteristics.

ALS Subject	Age/ Gender	Control Subject Age/Gender	Month Post-Diagnosis: Session 1/ Session 2	ALS Severity Scale Score: Speech: Session 1/ Session 2[a]	Percentage Sentence Intelligibility: Session 1/ Session 2[b]
S1	54/F	54/F	3/8	7/6	99/99
S2	68/M	70/M	5/24	8/7	98/98
S3	63/F	61/F	9/12	6/5	92/60
S4	76/F	75/F	2/9	6/5	85/98
S5	57/F	59/F	18/33	8/7	97/94
S6	39/M	39/M	66/74	6/5	72/75
S7	71/M	73/M	24/36	8/5	94/82
S8	65/F	63/F	5/12	8/7	95/97
S9	54/F	51/F	5/9	5/3	79/9
Mean	61	61	15/24	7/5[c]	90/79

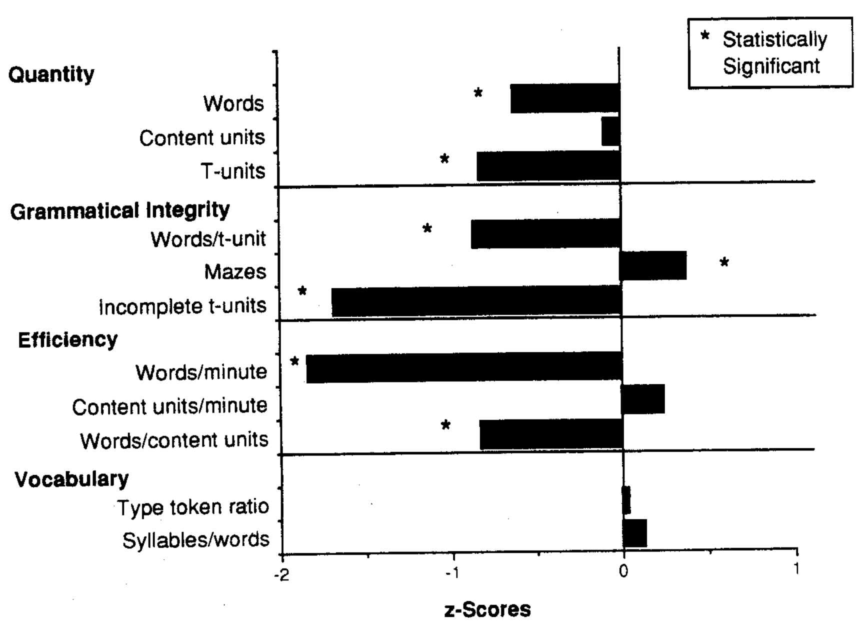
[a]From Yorkston, Strand, Miller, Hillel, & Smith, 1993.
[b]From Yorkston, Beukelman, & Traynor, 1984.
[c]Median scores.

In order to compare across variables of interest, data from the subjects with ALS have been converted to *z*-scores relative to the control subjects. Figure 1 illustrates data for each measure organized by domains. In the domain "quantity of linguistic units," there were significant differences in the number of words ($F = 5.78, p = .022$) and the number of *t*-units produced by dysarthric subjects ($F = 6.56, p = .015$) as compared to controls. There were no differences between the groups in number of content units. Thus, the subjects with ALS said less but communicated the same amount of information as the controls did.

In the domain "grammatical integrity," subjects with ALS and dysarthria produced fewer words per *t*-unit than did controls ($F = 9.46, p = .004$). For subjects with ALS, a greater proportion of the total speech sample was represented by incomplete *t*-units (phrases that would have been grammatically correct if functor words had not been deleted) ($F = 11.55, p = .001$). Although the absolute number of mazes (false started, fillers, asides to the examiner, and the like) produced by ALS subjects was greater than that of normal subjects, the relative proportion of the total sample was less, due to the decreased output of these subjects. Again, there appears to be an economy of wording characterized by a reduction of "unneeded" words such as functor words or those in mazes.

In the efficiency domain, as would be expected, the speaking rate (words/minute) for ALS subjects was slower than for controls ($F = 16.8, p = .0002$). However, despite their slow rate, they were not different from controls in the rate at which content units were communicated (content units/minute). They appeared to compensate for their slowed rate by using fewer words than did the controls to communicate a content unit; note that the measure words/content unit was smaller for ALS subjects than for controls ($F = 7.76, p = .008$). Finally, in the vocabulary domain, no significant differences were found for either type-token ratio or syllables/word. Thus, subjects with ALS do not appear to alter their word selection patterns.

FIGURE 1. Mean *z*-scores of subjects with ALS and dysarthria as compared to controls for selected measures of spontaneous language production. Asterisks indicate measures for which the groups are significantly different.



Case Presentations

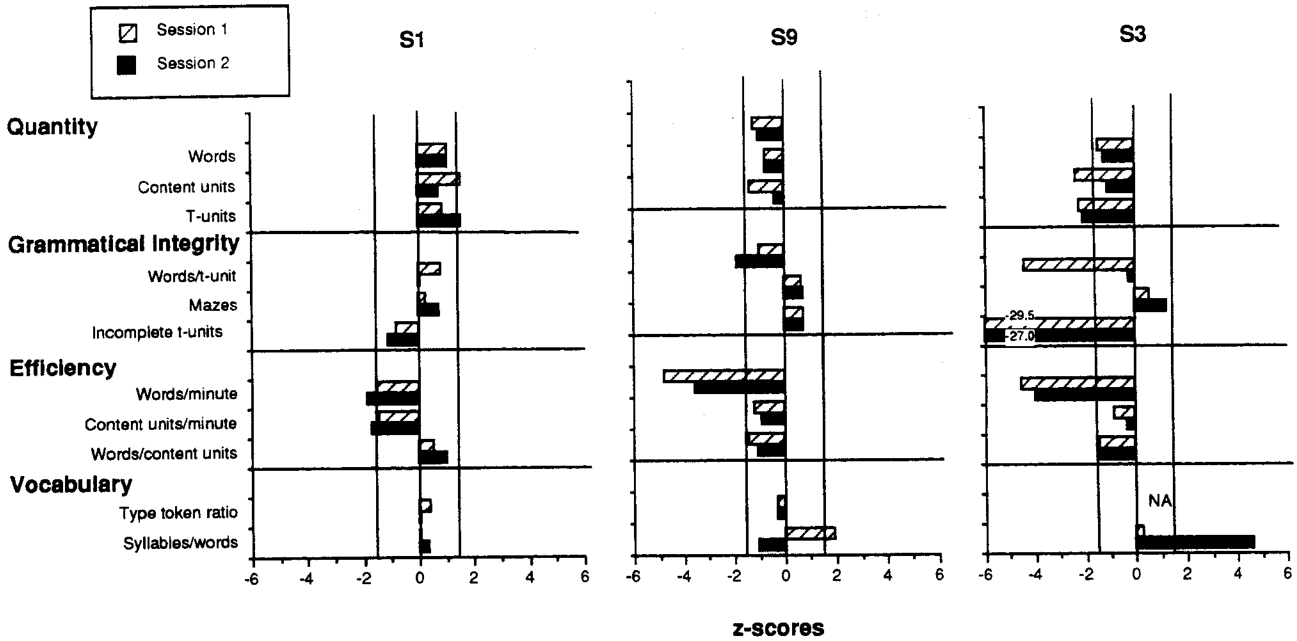
Because the impetus for this study was a clinical one, and because intersubject variability in this population is known to be large, the individual performances of some of our cases are of interest. The following three cases with ALS were selected because of the diversity of their performance on this spontaneous language production task.

Case S1 was a woman whose speech intelligibility was 99% for both sessions 1 and 2. Figure 2 illustrates all measures expressed as *z*-scores relative to the mean of the control group. Note that S1 produced a sample slightly longer than the control samples and that her utterances were grammatically well formed. Our interpretation of these data suggests that she did not change her language style because of the dysarthria.

Case S9 was a woman whose intelligibility decreased from 79% to 9% from session 1 to session 2. With the exception of speaking rate, her language measures were within two standard deviations of the controls. Thus, despite the dramatic change in speech intelligibility, she maintained grammatical integrity and good content.

Case S3 was a woman for whom changes in language measures were substantial. Her speech intelligibility declined from 92% to 60% from session 1 to session 2. The data in Figure 2 indicate that her sample was characterized by fewer words, content units, and *t*-units, and by an extremely high proportion of incomplete

FIGURE 2. *Z*-scores of subjects S1, S9, and S3 as compared to controls for selected measures of spontaneous language production. Performance is noted for Sessions 1 and 2. Vertical lines are placed at ±1.5 standard deviations from the mean of the control population.



grammatical phrases. This woman apparently had adopted a telegraphic style in response to her moderate dysarthria.

Discussion

Measures of spontaneous language production from the three cases presented earlier suggest that language changes vary from one speaker with ALS to another. Language does not universally become telegraphic as dysarthria becomes more severe and intelligibility declines. In selected cases, however, the changes are pronounced and may warrant clinical attention to evaluate the impact of the reduction in grammatical completeness on speech intelligibility. For individuals with severe dysarthria, listener's knowledge of the syntactic structure of an utterance improves intelligibility (Carter, Yorkston, Strand, & Hammen, in press). When listening to telegraphic utterances, the listener is deprived of this important information. For some speakers, the benefit they obtain by shortening utterances, and therefore reducing effort, may be counteracted by a loss of speech intelligibility.

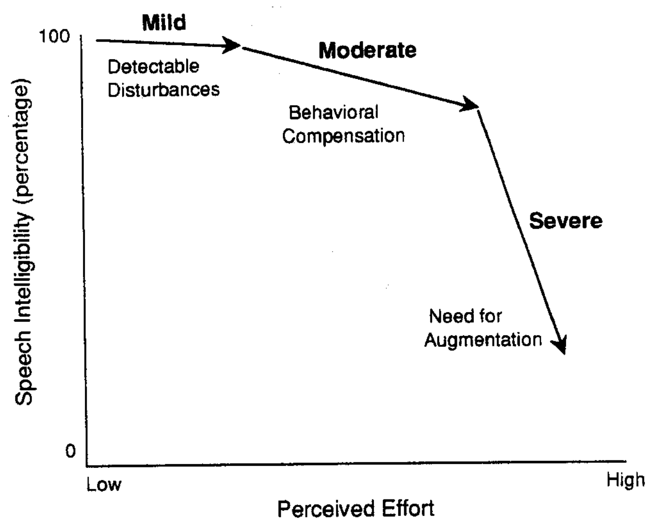
Results of this study indicate that the subjects with ALS adopted an "economy of wording" strategy that was characterized by fewer words, shortened *t*-units that were at times incomplete, and a reduced proportion of mazes. Despite an overall shortening, subjects with ALS conveyed the same amount of information that controls did. Several explanations are possible for the changes seen in the spontaneous language production of individuals with ALS and dysarthria. Three such explanations will be addressed here.

One explanation for the economy of wording strategy is that speakers are compensating for increased speech production effort. All subjects with ALS in this study reported that increasing effort was needed to maintain intelligibility. Because it is increasingly difficult to talk, they try to make every word count. Figure 3 illustrates a hypothetical relationship between speech intelligibility in ALS and perceived level of effort. Note that in normal speech or with mild dysarthria, perceived effort is low. As dysarthria becomes more severe, level of effort increases markedly, often with maintenance of fairly high intelligibility. With moderate dysarthria and high intelligibility, language changes may be a response to perceived effort. Solomon, Robin, Mitchison, VanDaele, and Luschei (in press) reported a measure of fatigue in two experiments designed to examine the effects of constant effort on exerted pressure. Because fatigue and increased effort are often reported by dysarthric subjects, the constant effort task may be useful to study the contribution of fatigue to dysarthric speech and would be useful to monitor changes in fatigue and effort during disease progression. The "increased effort" hypothesis should be tested to determine to what degree fatigue and/or effort relate to changes in language and intelligibility.

Another explanation for the results is that individuals with ALS may be experiencing subtle language problems. Two lines of evidence offer some support for the co-occurrence of cognitive changes and ALS (Yorkston, Miller, & Strand, 1995). The first is a series of case reports documenting early motor and cognitive signs in ALS. For example, Horoupian and colleagues (1984) presented three cases with sporadic ALS who exhibited early changes in intellectual ability and memory. The second line of evidence comes from studies in which groups of individuals with ALS are compared to control subjects on measures of neuropsychologic function. For example, Kew and colleagues (1993) compared 16 nondemented individuals with ALS with controls on neuropsychologic testing and found differences in verbal fluency and picture recall. Montgomery and Erickson (1987) suggest that dementia occurs in 1% to 2% of individuals with sporadic ALS. This figure may underestimate the problem because of lack of clinical testing with sufficiently sensitive neuropsychologic instruments and misinterpretation of compromised cognition as depression or withdrawal.

Despite the suggestion that cognitive changes may accompany ALS, language processing deficits probably are not responsible for the changes in language production seen in this study. One argument against the "subtle language deficit" explanation is that

FIGURE 3. Hypothetical representation of changes in intelligibility and perceived effort as dysarthria associated with ALS progresses.



performance of individuals with ALS is different from that of individuals with mild aphasia. For example, mildly aphasic speakers are slower than controls in the generation of content units (Yorkston and Beukelman, 1980). The individuals with ALS in this study produced content units at a normal rate despite their slow speaking rate. The subtle language deficit explanation could be tested by in-depth language assessment employing high level tasks that are independent of normal motor function.

A final explanation for the results is that the differences between speakers with ALS and controls are the result of the slowed speaking rate of the ALS group. This may be a plausible explanation for some but not all of the differences noted. For example, a slowed speaking rate may explain a reduction in mazes. ALS speakers, because of their slow rate, have more time to plan and therefore can avoid mazes that may be used for cognitive planning in normal speakers. However, this hypothesis does not adequately explain other differences, such as the higher proportion of incomplete grammatical utterances in speakers with ALS. The slowed rate hypothesis could be tested experimentally by enforcing a slowed speaking rate on nonimpaired subjects and examining its effects on their language production.

It is obvious that we do not completely understand the changes in language production that occur in the ALS population. However, this study has reinforced our belief that the line of demarcation between language and motor speech production is not always clear. For example, as the ALS dysarthria increases in severity, language output increasingly resembles the telegraphic speech characteristics of Broca's aphasia. Though the underlying causes for telegraphic speech among the ALS population and those with Broca's aphasia may differ, their speech is at least superficially similar. This should compel us to consider more broadly the implications of the interaction of motor speech processes on language formulation. It is reasonable to ask whether and to what degree the constraints on the motor planning processes and subsequent deficits in the production of articulatory movement influence the language formation of individuals with apraxia of speech. It is appropriate to posit that the apraxia of speech that commonly accompanies Broca's aphasia is in part responsible for the telegraphic language output. That is, patients may adapt to their failed motor speech system by simplifying syntactic structure in an effort to complete communicative intent. In this way, the motor speech disorder influences ongoing language formulation. Clinicians should consider the possibility that disorders of motor speech production may have an impact on language production and that this impact should be accounted for in the interpretation of assessment data and in treatment approaches.

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