Informational Content in the Discourse of Patients with Probable Alzheimer's Disease and Patients with Right Brain Damage

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Recent research has suggested that language impairment is present in all stages of dementia of the Alzheimer's type (DAT). Attempting to better understand the language deficits associated with DAT, many investigators compare DAT characteristics with those of different aphasic syndromes. DAT language has been characterized as similar to that of a fluent aphasia such as anomic, Wernicke's, or transcortical sensory aphasia, depending on the stage of the disease (Appell, Kertesz, & Fisman, 1982; Hier, Hagenlocker, & Schindler, 1985; Horner & Heyman, 1982; Murdoch, Chenery, Wilks, & Boyle, 1987; Nicholas, Obler, Albert, & Helm-Estabrooks, 1985). However, many language differences in DAT and aphasia have also been highlighted. Some of these communicative differences—such as reduced organization and relevance of language (Horner & Heyman, 1982), the presence of unrelated, irrelevant, vague, and incomplete responses (Fromm & Holland, 1989; Murray, Marquardt, Richardson, & Nalty, 1984), the production of empty phrases (Nicholas et al., 1985) and the failure to use language to convey information (Hier et al., 1985)—are also typical of the right-brain-damaged patient (Burns, 1985; Diggs & Basili, 1987; Gardner, Brownell, Wapner, & Michelow, 1983; Joanette, Goulet, Ska, & Nespoulous, 1986; Myers, 1984; Uryase, Duffy, & Liles, 1990). These findings suggest that comparing DAT to patients with right brain damage would be fruitful.

Further evidence suggests that right hemisphere lesions contribute to the overall language disorder in DAT. First, neuroanatomic and neurophysiologic studies have shown that the lesions in DAT are diffuse, affecting both cerebral hemispheres. Second, neurolinguistic research in aphasia suggests that phonology and syntax are strongly localized to the left hemi-

sphere, while semantic and pragmatic processes—typically affected in DAT to a greater extent—may be less localized and may involve the right hemisphere. Third, a number of cognitive and perceptual deficits that are present in DAT and may impact functional communication skills have also been observed in patients with right hemisphere lesions.

This study was designed to provide preliminary data regarding the possible contribution of right hemisphere lesions to the language of DAT. The informational content of the discourse of 10 patients with early Alzheimer's disease (DAT), 10 with focal right hemisphere brain damage (RBD), and 10 healthy elderly individuals was analyzed and compared. Major research questions were posed:

(1) How effectively do DAT and RBD patients convey information in their discourse?
(2) Do the changes in communicative effectiveness of DAT and RBD patients exceed the effects of normal aging on discourse production?
(3) Does the ability to convey information correlate with the severity of the accompanying cognitive deficits?
(4) Does the informational content vary with the task?
(5) Which measures of informational content contribute most to the differentiation of DAT, RBD, and healthy elderly individuals?

METHOD

Subjects

All subjects were more than 65 years old, premorbidly right handed, with no history of depressive or other psychiatric illness, and no history of drug or alcohol abuse. All subjects passed a pure-tone audiometric screening at 30 dB HL in their better ear to ensure that a hearing loss did not interfere significantly with communication. Corrected visual acuity was sufficient to read newspaper print.

The DAT group included seven female and three male subjects, all of whom were living at home but required some supervision. The diagnosis of probable DAT was made in accordance with criteria specified by the NINCDS-Alzheimer's Disease and Related Disorders task force (McKhann et al., 1984). These included general cognitive impairment; history of gradual symptom onset and progressive cognitive decline with no evidence of remission or acute exacerbation; absence of focal motor, sensory,

cerebellar, or cranial nerve defects early in the course of the illness; and absence of any other diagnosable forms of dementia such as normal pressure hydrocephalus, prior head injury, cerebral infarcts, vitamin deficiency, infectious processes, history of psychiatric problems, and drug or alcohol abuse.

The RBD group included five female and five male subjects, all of whom suffered unilateral brain damage from a single CVA. Diagnosis of unilateral right brain damage was made by a physician and based on clinical signs such as hemiplegia, sensory loss, and visual field cuts. CT scan reports were available for all the patients. One CT scan was unremarkable; four scans confirmed the presence of infarcted tissue in the right cerebral hemisphere. Time since onset of the CVA ranged from 1 to 3 months.

The healthy elderly control group included six female and four male subjects who were volunteers from the community. None were being treated for neurological or vascular disease, nor were any taking medications known to produce changes in mental status.

Demographic data for all 30 subjects are summarized in Table 1. The three groups did not differ significantly on the variables of age [$F(2,27) = 2.68$, $p > .08$], education [$F(2,27) = 0.92$, $p > .41$] or premorbid estimated IQ [$F(2,27) = 1.40$, $p > .26$] (Wilson et al., 1978). Differences among groups were significant for the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975) scores, which was used to determine the severity of the cognitive deficits [$F(2,27) = 9.75$, $p < .001$]. As anticipated, the control subjects displayed little or no cognitive decline, while the RBD group displayed cognitive deficits of a lesser magnitude than the DAT subjects.

Test Procedures

Three types of discourse were elicited: descriptive, procedural, and narrative. Descriptive discourse included description of the Cookie Theft picture from the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983) and an object description task in which the subject was asked to describe a nail, marble, envelope and button (Kirk, 1968). In the procedural discourse task, subjects were asked to explain how to change a light bulb in a ceiling fixture and how to make a sandwich (Ulatowska et al., 1988; Ulatowska, Doyel, Stern, Haynes, & North, 1983). For the narrative discourse task, the Story Retelling Task-Immediate of the Arizona Battery for Communication Disorders of Dementia (Bayles & Tomoeda, 1991) was used.

Testing for each subject was completed within a single session. To control for practice and fatigue effects, the order of administration of the four

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF THE ALZHEIMER'S (DAT), RIGHT-BRAIN-DAMAGED (RBD), AND ELDERLY CONTROL GROUPS

	Group					
	DAT		*RBD*		*Control*	
	MEAN	SD	MEAN	SD	MEAN	SD
Age	80.48	5.75	74.07	5.77	77.95	7.12
Education	13.20	2.86	11.10	3.32	12.60	4.38
Estimated IQ	118.56	8.97	110.80	8.95	116.80	13.88
MMSE	20.50	4.35	23.70	3.09	27.00	2.00

discourse tasks was randomized. All responses were tape recorded, transcribed verbatim, and analyzed for informational content. This analysis, adapted from the framework suggested by Cannito, Hayashi, and Ulatowska (1988) and Ulatowska et al. (1988), yielded six major measures: proportions of essential, elaborative, irrelevant, redundant, off-topic, and incorrect productions. Definitions and examples of each of these categories are included in Appendix A. Rate of speech (words per minute) and a communicative efficiency index (ratio of number of essential units to total number of words produced) were also calculated. Interscorer reliability between the investigator and a second rater was established on one-third of the transcripts indicating a satisfactory level of consistency between scorers. Reliabilities of 98.6% for essential information, 92.5% for elaborations, 90.3% for irrelevancies, 96.8% for redundancies, 85% for off-topic information, and 87% for incorrect information were achieved.

RESULTS

Figure 1 shows the mean proportion of responses produced within each category, for each group of subjects, and for all tasks combined. To control for group differences in the quantity of total output, we used proportion of utterances produced in each category rather than absolute numbers. Tasks were combined to permit analyses of each type of discourse measure. The overall pattern of distribution of each type of content unit was similar in the DAT and RBD groups. Both groups produced a large proportion of irrelevant utterances, with the DAT group producing slightly more redundant information and the RBD group having proportionately more off-topic comments. Only 42% of the utterances of both clinical groups were genuinely informative (essential or elaborative). In contrast, approximately 75% of the productions of the healthy elderly were infor-

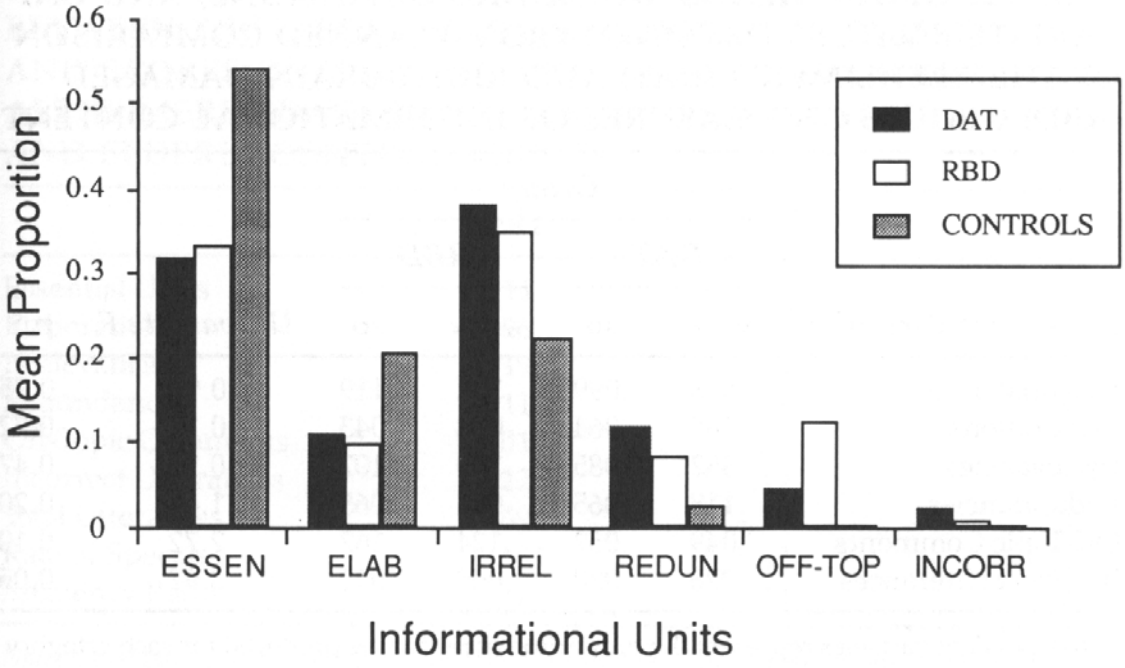

Figure 1. Mean proportion of each category of informational content units for all tasks combined produced by the Alzheimer's (DAT), right-brain-damaged (RBD) and healthy elderly control groups.

mative. While some irrelevancies were evident in the discourse of the healthy elderly control group, very few redundant, off-topic or incorrect utterances were present.

Two planned comparisons with orthogonal a priori contrast coefficients were conducted to compare directly the DAT and RBD groups and to contrast the pooled data obtained from these two groups with that of the healthy elderly controls. The analyses failed to show a significant difference between the DAT and RBD subjects [F (6,22) = 2.25, $p > .07$]. When the DAT and RBD groups were pooled and compared with the healthy elderly controls, significant differences were evident [F (6,22) = 7.10, $p < .001$] indicating that the DAT and RBD groups were both impaired in conveying information relative to the healthy elderly controls.

To help assess the specific differences among the three groups, the univariate Fs for each of the dependent variables obtained from the planned comparisons were examined. Table 2 shows that the DAT and RBD groups did not differ significantly in any of the categories of informational content. Table 3 shows that the combined DAT and RBD groups differed significantly from the healthy elderly controls in their ability to convey meaningful information. The clinical group produced proportionately less essential and elaborative information, and more irrelevant, redundant, off-topic and incorrect information than the healthy elderly control group. These results indicate that the reduced informational content in the discourse of

TABLE 2. GROUP MEANS, STANDARD DEVIATIONS, AND UNIVARIATE *F* VALUES OBTAINED FROM PLANNED COMPARISON OF THE ALZHEIMER'S (DAT) AND RIGHT-BRAIN-DAMAGED (RBD) GROUPS ON MEASURES OF INFORMATIONAL CONTENT

	Group					
	DAT		*RBD*			
Dependent Variable[a]	MEAN	SD	MEAN	SD	*Univariate F*	*p>*
Essential units	.318	.099	.332	.119	0.09	0.75
Elaborations	.108	.064	.098	.043	0.12	0.72
Irrelevancies	.382	.085	.350	.107	0.55	0.47
Redundancies	.118	.065	.086	.065	1.66	0.20
Off-Topic Comments	.049	.057	.124	.167	2.72	0.10
Incorrect Utterances	.026	.030	.009	.012	3.92	0.05

[a]All dependent variables represent the proportion of responses produced for each category.

TABLE 3. GROUP MEANS, STANDARD DEVIATIONS, AND UNIVARIATE *F* VALUES OBTAINED FROM PLANNED COMPARISON OF THE HEALTHY ELDERLY CONTROL GROUP AND THE POOLED ALZHEIMER'S (DAT) AND RIGHT-BRAIN-DAMAGED (RBD) GROUPS ON MEASURES OF INFORMATIONAL CONTENT

	Group					
	DAT/RBD		*Control*			
Dependent Variable[a]	MEAN	SD	MEAN	SD	*Univariate F*	*p<*
Essential units	.325	.106	.540	.109	25.98	0.001
Elaborations	.103	.053	.205	.085	15.52	0.001
Irrelevancies	.366	.096	.224	.090	15.08	0.001
Redundancies	.102	.066	.030	.021	11.70	0.003
Off-Topic Comments	.086	.127	.000	.000	4.80	0.04
Incorrect Utterances	.017	.024	.002	.005	4.27	0.05

[a]All dependent variables represent the proportion of responses produced for each category.

DAT and RBD patients is probably not attributable to aging, but rather to the underlying pathology.

One-way analysis of variance procedures revealed significant group differences for both the efficiency ratio [F (2,27) = 8.79, $p < .002$] and rate of speech [F (1,27) = 5.69, $p < .009$]. Post hoc comparisons between all cells using the Tukey HSD test were conducted. While the DAT and RBD groups did not differ in the efficient production of essential units of information [t (1,27) = .09, $p > .88$], both groups were significantly less effi-

TABLE 4. PEARSON PRODUCT-MOMENT CORRELATIONS BETWEEN THE INFORMATIONAL CONTENT VARIABLES AND SCORES ON THE MINI-MENTAL STATE EXAM FOR ALZHEIMER'S (DAT), RIGHT-BRAIN-DAMAGED (RBD), AND ELDERLY CONTROL GROUPS

	DAT	*RBD*	*Controls*
Essential Units	-.14	.60	-.28
Elaborations	.16	.43	.31
Irrelevancies	.19	-.15	.05
Redundancies	.11	.13	-.06
Off-Topic Comments	.01	-.50	**
Incorrect Utterances	-.22	.12	.23
Total Utterances	.69*	-.19	.27
Rate of Speech	.69*	-.13	-.03
Efficiency Ratio	-.12	.43	-.28

Note: Correlations were calculated on the proportions of the informational content unit.
*$p < .05$
**could not be calculated because mean and *SD* are 0

cient than the elderly controls in conveying essential information ($p < .002$ for each). The DAT group produced speech at a significantly slower rate than either the RBD group [t (1,27) = -2.05, $p < .05$] or the healthy elderly controls [t (1,27) = -3.34, $p < .003$]. Although the RBD group tended to speak more slowly than the healthy control group, the difference was not reliable [t (1,27) = -1.29, $p > .2$]. The mean rate of speech of the DAT subjects was 67.8 (*SD* = 28.93) words per minute, compared to 90.63 (*SD* = 23.45) for the RBD group and 105.03 (*SD* = 21.72) for the control subjects.

To investigate whether a decline in the ability to convey information was related to the severity of the cognitive deficits, Pearson product-moment correlations were conducted between scores on the Mini-Mental State Examination (MMSE) and each of the informational content variables. Table 4 shows that a different pattern of correlation in the DAT and RBD groups. In the DAT group, the moderate correlations for MMSE scores with total number of utterances produced (r = .69) and with rate of speech (r = .69) suggest that even in the early stages of DAT, there is a trend for the quantity of verbal output and rate of speech to decrease with cognitive decline. The weak correlations between the MMSE score and all measures of informational content indicate that ability to convey information was not associated with cognitive status. In contrast, the RBD subjects tended to produce proportionately less essential information (r = .60) and more off-topic utterances (r = -.50) with decreasing cognitive status. Cognitive performance in the healthy elderly control group did not appear to be

TABLE 5. SUMMARY OF TWO-FACTOR ANALYSIS OF VARIANCE COMPARING GROUP (ALZHEIMER'S, RIGHT-BRAIN-DAMAGED, CONTROLS) AND TASK (PICTURE DESCRIPTION, OBJECT DESCRIPTION, PROCEDURAL DISCOURSE, STORY RETELLING) FOR EACH INFORMATIONAL CONTENT VARIABLE

	Group		*Task*		*Interaction*	
	F	*p*	*F*	*p*	*F*	*p*
Proportion Essentials	18.32	.000	41.01	.000	7.81	.000
Proportion Elaborations	6.84	.004	65.44	.000	4.00	.002
Proportion Unrelated[a]	22.10	.000	4.17	.009	3.96	.002
Total Information Units	3.43	.046	46.91	.000	0.16	.986
Efficiency Ratio	17.91	.000	41.28	.000	11.98	.000

[a]Unrelated units included irrelevancies, redundancies, off-topic, and incorrect utterances.

associated with informational-content and efficiency measures. However, the narrow range of scores on the MMSE (24–30) may have obscured some true associations.

Analysis of Task Differences

The discourse data used in the previous analyses had been combined for each subject so that the effects of the specific discourse tasks on performance were not apparent. To identify any possible task differences, separate analyses of variance procedures were conducted on each of five dependent variables: the efficiency ratio, the total number of informational units, and proportions of essential units, elaborations, and unrelated units of information. Unrelated units included irrelevancies, redundancies, off-topic comments, and a small number of incorrect comments that were summed for analysis purposes. Independent variables were group (DAT, RBD, normal controls) and task (picture description, object description, procedural discourse and story re-telling). Table 5 shows that the interaction between group and task was significant for all the dependent variables, except total informational units. The major effects for both group and task were also significant for all variables. These results suggest that production of informational content is affected by the type of task. Although post hoc comparisons of the four tasks were conducted within each group on each dependent variable, the resulting data could not be readily interpreted.

Discriminant Function Analysis

Identifying of a group of variables that could differentiate the three subject groups was an important goal. In particular, it was considered clinically important to differentiate healthy elderly individuals from those with a pathology, and to differentiate early DAT patients from RBD patients. Different combinations of variables were evaluated systematically in a series of standard discriminant analyses until we identified a small group of variables that could discriminate maximally between the groups of subjects (Wilkinson, 1987). The size of the *F* statistic guided the selection of variables for the discriminant function analysis.

Using only two variables, rate of speech and the proportion of essential units of information, the healthy elderly control group was differentiated from the pathological groups with 100% accuracy. The Chi-square test of independence for the resulting 2×2 contingency table was significant at the .01 level, indicating that the healthy elderly individuals were differentiated from the DAT and RBD subjects at a level greater than chance. Only partial discrimination of the early DAT and RBD groups was accomplished with rate of speech and the proportion of essential units of information. The DAT subjects were classified with 70% accuracy, while the RBD subjects were classified with 80% accuracy. The addition of other variables to the discriminant function equation did not improve the classification of the DAT and RBD subjects, indicating that, for these small samples, the discourse variables examined did not appear to make important contributions.

CONCLUSIONS

The similarities found between the DAT and RBD groups have been particularly interesting. Although these results support the contention that right hemisphere dysfunction contributes in part to the language deficits of DAT, a more precise understanding of the role of the right hemisphere in the language of DAT is awaited.

Because of the small number of subjects within each group, results should be interpreted cautiously. In the future, this study should be replicated with larger, more homogeneous subject groups. To more precisely separate out the effects of normal aging from the effects of disease, the control group should be large enough for grouping by age.

This investigation identified two major issues that are clinically relevant to speech-language pathologists involved with the diagnosis and management of individuals with DAT. First, DAT is often difficult to identify in its early stages because of its insidious onset and subtle language deficits.

Further, confirmatory neuropathological findings are often not available. This indicates the importance of the discriminant function analysis, which indicated that healthy elderly subjects could be differentiated reliably from either DAT or RBD on the basis of speech rate and the proportion of essential units of information provided. Easily scored and calculated, these measures suggest that a language screening tool could potentially be developed to help identify early DAT. The discriminant function analysis should be replicated with new subjects to assess how well the selected variable combination is predictive for classifying new cases.

Second, the analysis of task differences indicated that the discourse of DAT and RBD subjects differed depending on the type of task. Therefore several types of discourse should be used during an evaluation to ensure that discourse disturbances are not overlooked. Research should be directed toward identifying those factors that contribute to task differences both within and across groups. A single discourse task that best differentiates the three patient groups may be identified in the future.

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APPENDIX A
MAJOR MEASURES OF INFORMATIONAL CONTENT

Essential information. Relevant units of information that are consistent with the major details and have been selected a priori for each task. Essential units were selected in accordance with studies reporting normal subjects' performance on these tasks. A maximum of 8 essential units of information was possible for the picture description task (Nicholas et al., 1985), 8 for the procedural discourse task (Ulatowska et al., 1983, 1988), 17 for the story retelling task (Bayles & Tomoeda, 1991), and 33 for the object description task.

Elaboration. Informational units that provide additional relevant information beyond that which was established a priori (for example on the picture description task, the statement "there are cabinets above and below" would have been classified as an elaboration).

Irrelevancy. Informational units that are related to the topic but are inconsistent with the task requirements (such as describing what a light bulb looks like instead of how to change one). Irrelevancies also include interpretations and judgments ("she keeps the kitchen clean," "most people don't get their wallets returned"), personal comments ("I have a button like that," "I once lost my wallet"), and comments either about the task or to the examiner ("this is a silly thing to do," "what do you think?").

Redundancy. Informational units that do not add any new information but repeat information that has been given previously.

Incorrect information. Informational units that are inconsistent with the picture or object stimuli are not included in the original story, or are not a part of the performance of a procedure.

Off-topic information. Digressions that are unrelated to the topic or task.