COMPLEX DISCOURSE PRODUCTION IN PERSONS WITH MILD DEMENTIA: MEASURES OF RICHNESS OF VOCABULARY

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Abstract

Dementia is characterized by the breakdown of intellectual and communicative functioning accompanied by personality change (DSM IV, American Psychiatric Association, 1994). Differentiating mild dementia from normal cognition in aging is a compelling social, clinical, and scientific concern. The present study aimed to determine whether a complex discourse production task distinguished normal older adults from adults with dementia with the measures of richness of vocabulary. Considered for the study were 10 healthy elderly adults and 10 persons with mild dementia. Spontaneous, conversational speech in dementia participants and healthy elderly was analyzed using three linguistic measures of richness of vocabulary. These were evaluated for their usefulness in discriminating between healthy and persons with dementia. The measures were, type token ratio (TTR), Brunet's index (W) and Honore's Statistic (R). Results suggest that these measures offer a sensitive method of assessing spontaneous speech output in dementia. Comparison between dementia and healthy elderly participants demonstrates that these measures discriminate well between these groups. These findings also suggest that performance on a complex elicited discourse production task uncovers subtle differences in the abilities of persons with dementia (mild) such that measures of length and quality differentiated them from individuals with normal cognition. This method serves as a diagnostic and prognostic tool and as a measure for use in clinical trials.

Key Words: dementia, conversational speech, quantitative measures.

Discourse is a naturally occurring linguistic unit that entails the use of suprasegmential, generative language, and requires complex ideation that involves planning, organisation and cognitive flexibility (Brownwell, Michel, Powerson & Gardner, 1983; Patry & Nespoulous, 1990 and Brookshire, 1997). Discourse production activates and highlights the interrelatedness of multiple cognitive processes, and various discourse genres seem to require different cognitive processes and cognitive efforts (Coelho, Liles & Duffy, 1991; Harris, Rogers & Qualls, 1998; Hartley & Jensen, 1991 and Ulatowska, Allard & Chapman, 1990). Discourse comprehension and production tasks are integral to the diagnostic repertoire of clinical speech-language pathologists precisely because discourse behaviors provide a rich corpus for a wide variety of cognitive-linguistic analyses. Thus, an elicited discourse sample seems especially well suited for taxing and assessing the cognitive-communicative abilities of persons with dementia.

Discourse analysis is acknowledged as an important tool for speech-language pathologists, although it is often not the assessment tool of choice due to its apparent time-consuming nature and the overwhelming number of options available. The wide range of analyses available to clinicians such as the number of T-units and total words produced or Pragmatic Protocol checklists make it difficult to choose assessment measures.

Discourse analysis and speech-language pathology in the 20th century:

The developments in the 20th century have led to a staggering proliferation of different theoretical perspectives underlying discourse analysis and the publication of multiple complex levels of analysis. Since the early discourse studies (E.g., Mentis &

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Prutting, 1987; Milton, Prutting, & Binder, 1984 and Ulatowska, North, & Macaluso-Haynes, 1981), there has been increasing attention paid to different types of discourse genres and an array of approaches to measure them. Most of these approaches have been borrowed from the disciplines of pragmatics, behavioral psychology, and sociolinguistics. Particular techniques in discourse analyses have been derived from both the psycholinguistic and sociolinguistic perspectives. The psycholinguistic analyses include measures of syntax (Chapman et al., 1992; Glosser & Deser, 1990 and Liles, Coelho, Duffy & Zalagens, 1989), productivity (Hartley & Jensen, 1991 and Mentis & Prutting, 1987), and content (Hartley & Jensen, 1991).and Mentis & Prutting, 1987), and content (Hartley & Jensen, 1991). On the other hand, sociolinguistic techniques include cohesion analysis (Coelho, Liles, & Duffy, 1991; Hartley & Jensen, 1991; McDonald, 1993 and Mentis & Prutting, 1987), analysis of coherence (Chapman et al., 1992; Ehrlich & Barry, 1989 and McDonald, 1993), analysis of topic (Mentis & Prutting, 1991), and compensatory strategies (Penn & Cleary, 1988). There are a number of published books from the last decade, which focus on the analysis of discourse samples from individuals with neurological impairment (E.g., Bloom, Obler, DeSanti & Ehrlich, 1994; Brownell & Joanette, 1993; Cherney, Shadden & Coelho, 1998 and Joanette & Brownell, 1990).

Dementia is characterized by the breakdown of intellectual and communicative functioning accompanied by personality change (DSM IV, American Psychiatric Association, 1994). Communication disorders are a common feature of dementia (Bayles et al 1987, Kemper, 1992), being present in 88-95% of sufferers (Thompson, 1987). They are particularly pronounced in probable dementia of Alzheimer's type (DAT, Cummings et al.,1985) and include word finding deficits, paraphasias and comprehension impairment (Alzheimer,1907; Appell et al., 1982, Bayles, 1982; Obler, 1983 and Irigaray, 1973). More recent research has found additional evidence for impaired performance on verbal fluency tasks (Phillips et al., 1996 and Becker et al., 1988), circumlocutory responses (Hodges, Salmon & Butters, 1991) and impairments in discourse, which worsen over the course of the disease (Hutchinson & Jensen, 1980; Ripich & Terrell, 1988 and Ulatowska & Chapman, 1991). Phonemic and syntactic processes, however,

have been shown to be relatively preserved (Hodges et al., 1991; Kertesz et al., 1986; Appell et al., 1982; Hier et al., 1985; Kempler & Zelinski, 1994 and Schwartz et al., 1979).

The role of speech language pathology in the assessment and treatment of cognitive communicative disorders like dementia is well established (American Speech-Language Hearing Association, 1990, 2005; Brookshire, 1997). Thus, the cognitive-communicative problems associated with dementia fall within the scientific and clinical purview of communication sciences and disorders professionals, who will increasingly participate in the identification and assessment of individuals with a range of expertise on aspects of cognitive-communicative processes across the lifespan and can contribute to the comprehensive work-up on individuals with dementia.

Many 'structured' tasks have been used to assess individuals with DAT, such as confrontation naming (Eg. Bayles et al., 1987; Bayles et al., 1989 and Hodges et al., 1991), single word production (Eg. Martin & Fedio, 1993), or generation of words beginning with a certain letter (Phillips et al., 1996) However, although previous researchers have found deficits in qualitative aspects of DAT sufferer's conversation using discourse techniques (Ripich et al., 1991 and De Santi et al., 1994), a search of the literature yielded little previous research into quantitative characteristics of conversational, spontaneous speech in DAT. Many of the studies purportedly assessing spontaneous speech have actually measured picture description (Nicholas et al., 1985; Hier et al., 1985 and Crioisile et al., 1996).

Three other studies used spontaneous speech. The first used a semi-standardized interview to compare the performance of 10 DAT, 5 Wernicke's aphasics and 5 normal older controls on spontaneous speech (Blanken et al., 1987). Participant's speech was transcribed and a mixture of methods used to analyse the conversations, including measures of average sentence length (divided into simple and complex sentences), number of words in each class (nouns, verbs, adjectives and adverbs), type token ratio and instances of word finding difficulties. Significant differences between participant groups were found, though the study was compromised by a difference in the total length of speech recorded for each group and the relative brevity (5-10minutes) of the interviews.

Sevush et al. (1994) assessed language in 150 patients with DAT using spontaneous speech, comprehension, repetition, oral reading, writing and naming. Spontaneous speech was evaluated for fluency, syntax and paraphasias. Each participant's performance was graded as normal, mildly impaired, or markedly impaired. They found differences in early and late onset DAT patient's performance on these measures. Interestingly, object naming was worse in late onset DAT, but spontaneous speech was worse in early onset DAT participants.

Romero and Kurz (1996) studied 63 patients with Alzheimer's disease and rated their spontaneous speech during a 4 minute interview on 6 scales (communication, articulation and prosody, automatic speech, semantic structure, phonemic structure and syntactic structure). Despite large samples, the study was limited by the use of qualitative rating scores, which might have reduced the sensitivity of the measures employed.

To date, there are very few standardized tests of cognitive-communicative function designed specifically for persons with dementia. Nevertheless it follows that, as in dementia, subtle changes in communicative abilities may be the important symptom of declining neurological status. Assuming that subtle decline may first occur within the context of relatively complex linguistic behaviours, detection of minor changes should be enhanced by using a task sufficient complexity to tax seemingly intact cognitive-linguistic abilities.

Bucks, Singh, Cuerden and Wilcock (2000) analysed linguistic measures in spontaneous conversational speech in probable dementia of Alzhemier's type. They considered 24 participants (8 persons with dementia and 16 healthy elderly) for the study. They measured noun rate, pronoun rate, verb rate, adjective rate, clause-like semantic unit (CSU), type token ratio (TTR), Brunet's index (W) and Honore's Statistic (R). Results suggest that these measures offer a sensitive method of assessing spontaneous speech output in DAT and that these serve as diagnostic and prognostic tools for use in clinical trials.

Calderon, Perry, Erzinclioglu, Berrios, Dening, and Hodges (2001) tested the hypotheses that visuoperceptual and attentional ability are disproportionately impaired in patients having dementia with Lewy Bodies (DLB) compared with Alzheimer's disease (AD). Patients with DLB have substantially greater impairment of attention, working memory, and visuoperceptual ability than patients with AD matched for overall dementia severity. Semantic memory seems to be equally affected in DLB and AD, unlike episodic memory, which is worse in AD. These findings may have relevance for our understanding of the genesis of visual hallucinations, and the differential diagnosis of AD and DLB.

Silveri, Reali, Jenner and Puopolo (2007) aimed to investigate whether attention may be specifically impaired in Alzheimer's disease from the early stages of the disease. Subgroups of patients with different types of mild cognitive impairment were selected according to standard criteria. Patients and controls were given tasks exploring various subcomponents of attention and executive functions. Only subgroups of mild cognitive impairment characterized by memory disorders obtained lower scores than controls on attention and executive tasks. On the basis of the scores obtained on the Clinical Dementia Rating at the 1-year follow-up, patients were redistributed into 2 groups: those who developed and those who did not develop dementia. Patients who presented evolution to dementia already had, at baseline, lower scores than patients who did not evolve on tasks exploring attention and executive functions. The results suggest that not only memory disorders but also attention/executive deficits may characterize dementia at the onset.

The purpose of the present study was to determine whether a complex discourse production task distinguished typical older adults from adults with dementia with the measure of richness of vocabulary. Specifically the question was whether group differences existed in terms of generated discourse complexity.

Method

Sample

There were 20 participants: 10 persons with diagnosis of mild dementia (6 males and 4 females) and 10 healthy elderly (5 males and 5 females). The dementia group comprised of persons suffering with mild cognitive impairment as measured by the Mini-Mental Status Examination (MMSE: Folstein et al., 1975). Each patient attended a geriatric clinic at National Institute of Mental Health and Neurosciences (NIMHANS) where they underwent thorough medical screening in order to rule out any other treatable pathology that could explain their impairment. This included neuropsychological assessment, laboratory blood testing and Computerized Tomography (CT) scanning of the head. In addition, the following criteria

were fulfilled for the participants from dementia group.

- The age range of the participants should be between 65-89 years
- All participants should have a minimum of 12 years of formal education
- All of them should have Kannada as their first (L1) and English as their second language (L2).
- All the clinical population must be diagnosed by neurologists/ psychiatrists/ neurosurgeon or geriatric specialist.
- At least 12yrs of formal education.
- Vision and hearing acuity corrected to normal / near normal limits.
- A Score of "1" (mild) should be obtained from

Clinical dementia rating scale (Hughes, Berg, Danziger, Coben & Martin, 1982).

Healthy elderly participants were not suffering from any neurological or psychological illness likely to impair performance and were not complaining of memory or other cognitive difficulties. Table 1 shows the mean age, years of education, and handedness of all the participants, MMSE scores and duration of illness for persons with dementia. There were no significant differences in the distribution of males and females (p> 0.05). Also the participants in the dementia group exhibited similar cognitive decline despite having different types of dementia

Table 1. Demographic and neurological details of patient participants.

Sl no.	Age/ sex	CDR score	Diagnosis of dementia	Neuroimaging result
1	67/f	1	Mild AD	Bilateral medial temporal atrophy
2	72/f	1	Mild AD	Diffuse central atrophy
3	69/f	1	Mild Frontotemporal	Left fronto-temporal atrophy
4	68/m	1	Mild Frontotemporal	Bilateral fronto-temporal lobe atrophy
5	86/f	1	Mild AD	Bilateral medial temporal atrophy
6	68/m	1	Mild vascular	Diffuse brain atrophy
7	66/m	1	Mild AD	Bilateral sub-cortical infarcts
8	71/m	1	Mild vascular	Multiple cerebral infarcts
9	69/m	1	Mild frontotemporal	Left fronto-temporal atrophy
10	75/m	1	Mild AD	Bilateral medial temporal atrophy

(CDR= Clinical dementia rating, m= male, f = female, AD = Alzheimer's dementia).

Table 2. Age, years of education, and handedness of all the participants, MMSE scores and duration of illness for persons with dementia

	Healthy elderly N= 10		Participants with dementia N= 10	
	M	SD	M	SD
Age	72.6yrs	6.39792	70.8yrs	6.97296
Years of education	12.8yrs	1.68655	11.9	2.46982
MMSE scores	29.6	1.07497	21.1	1.10050
Duration of illness (in months)			7.7months	1.82878
Handedness	right		right	

Procedure:

All the participants were interviewed using a semi structured interview format in which they were encouraged to talk about two topics. The first one being the arrangements to be made for a marriage and the second one is the differences in present generation as compared to that of previous generation. Participants were asked open ended questions, which did not restrict or control either the extent or the nature of their response. Responses were not corrected by the interviewer and no stimulus or interruption was provided unless the participants were clearly becoming distressed by their inability to respond. Clear interview guidelines were followed. Questions were asked slowly and repeated or reworded as necessary. Interviews were recorded with a Handycam (Sony digital recorder H302233). Interviews lasted between 15-25 minutes allowing as much time as was needed to collect at least 700 words of conversation from each participant.

Transcription:

Interviews were transcribed using IPA (International Phonetic Alphabets) rules. Only words spoken by the participants were transcribed. Transcripts were analyzed using Systematic Analysis of Language Transcripts (SALT: Miller & Iglesias, 2006). As it was an exploration of the technique in dementia, initially all words were transcribed exactly as they had been spoken, including repetitions, incomplete words, interjections, paraphasias and mispronunciations. Subsequently, the discourse was rephrased deleting repetition, incomplete words and interjections and were therefore were not counted for analysis. Stereotypical set phrases such as, "ninig gotta" (you know) "alvamma" (right girl) were excluded, because such expressions were not acceptable as proper clauses or full sentences. Numbers were transcribed as words. Multiple attempts at the same word were only recorded once. For each participant, transcription and lexical analysis were performed by the same researcher in order to maintain consistency. Data was analyzed for the complexity and mainly the vocabulary was considered for this study and assessed.

Three measures of the richness of vocabulary were used: type token ratio (TTR), Brunet's index (W) and Honore's Statistic (R). Type-Token Ratio (TTR):

TTR represents the ratio of the total vocabulary (V) to the overall text length (N). It is the measure of vocabulary size, which is generally found to correlate with the length of text sampled (N).

Brunet's index (W):

Brunet's index was included because, it quantifies lexical richness without being sensitive to text length (Brunet, 1978). It is calculated according to the following equation: $W = NV^{(-0.165)}$ where N is the total text length and V is the total used by the participant.

Honore's Statistic (R):

Honore's Statistic (Honore, 1979), is based on the notion that the larger the number of words used by a speaker that occur only once, the richer the lexicon. Words spoken only once (V1) and the total vocabulary used (V) has been shown to be linearly associated. Honore's Statistic generates a lexical richness measure that establishes the number of words used only once by the participant as a proportion of the total number of words used, according to the following formula: $R = 100 \log N / (1 - V1/V)$ where, R is the Honore's Statistic, N is the total text length, V1 is the words spoken only once and V is the total vocabulary. The higher the values of R, the richer the vocabulary used by the participant.
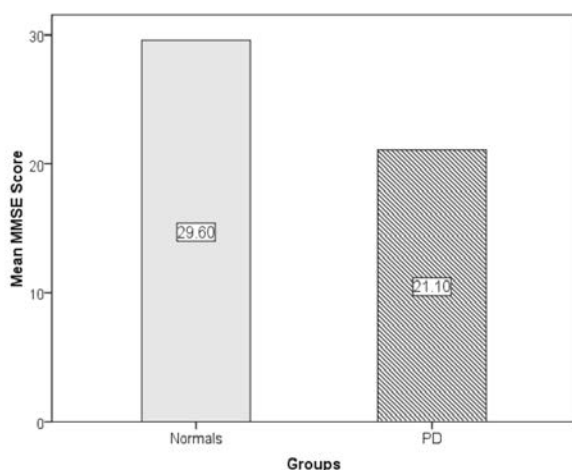
Results

Three linguistic measures, Type-Token Ratio (TTR), Brunet's index (W) and Honore's Statistic (R) were calculated for each participant and between the groups (healthy elderly and participants with dementia) comparisons of the measures were carried out using independent sample t test as p<0.001 level. The results of these measures are depicted in Table 3. As it is seen from the table, the three linguistic measures of richness of vocabulary in conversation speech showed statistically significant differences between the groups at p<0.0001 level. Graphs 1, 2, 3 and 4 show the mean scores of all the participants for MMSE and three measures of richness of vocabulary respectively.

Table 3: results showing the measures of richness of vocabulary

	Groups	Mean	SD	t	df	Sig. (2 tailed)
MMSE	HE	29.60	1.07	17.472	18	.000**
	PD	21.10	1.10			
Type Token Ratio	HE	0.40	0.05	7.040	18	.000**
	PD	0.20	0.07			
Brunet's Index	HE	9.614	1.39	6.797	18	.000**
	PD	5.186	1.51			
Honore's Statistic	HE	362.9	28.8	11.434	18	.000**
	PD	233.1	21.4			

(HE= healthy elderly, PD = participants with dementia, SD = standard deviation, df = degrees of freedom, Sig. = significance, ** = highly significant).

As it is seen from graph 1, significant difference between the groups for MMSE helped to discriminate healthy elderly from mild cognitive impairment. A closer inspection of the data revealed that participants with dementia (PD here after) used more pronouns. Healthy elderly (HE here after) used fewer pronouns (nearly 3 times more) than PD (refer graph 2, 3 and 4). All three measures of lexical richness showed that most of the HE had lexically richer speech than PD. Statistically significant difference in the results suggest that there were clear differences between PD and HE in lexical items and lexical richness measures.

As seen from graphs 2, 3 and 4, Type-Token Ratio (TTR), Brunet's index (W) and Honore's Statistic (R) appears to represent a lexical richness and phrase making factors which was clearly different for the two groups. This study demonstrated that there are significant objectively measurable lexical differences in the spontaneous conversational speech of person with a diagnosis of dementia and healthy elderly.
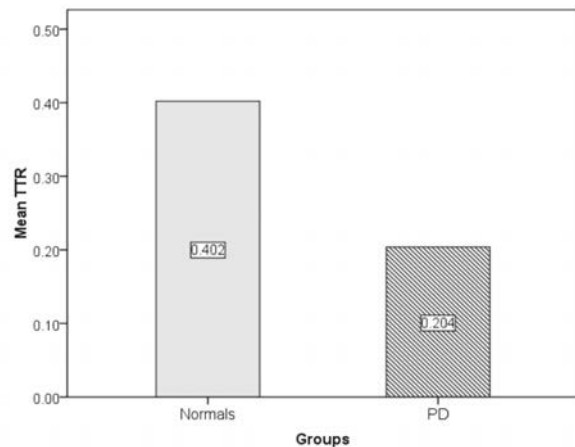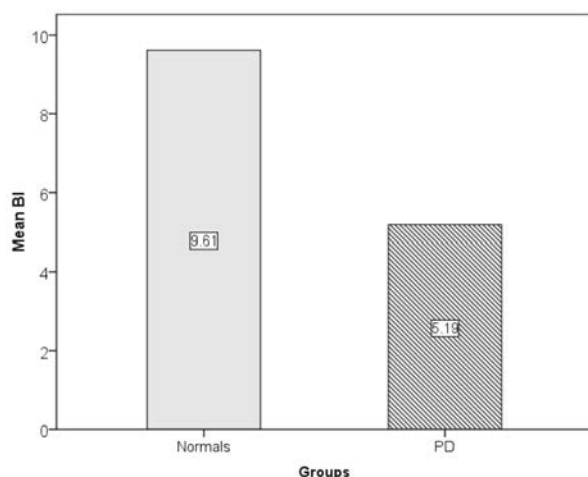

PD = Participants with dementia.
TTR = Type Token ratio.
Graph 2: Mean scores for Type-Token Ratio.

Discussion

As anticipated, HE adults produced richer spontaneous speech on all three lexical richness measures. Lexical richness measures for different classes of lexical units such as nouns and verbs will

PD = Participants with dementia

Graph 1: Mean scores for Mini-Mental Status Examination.

also be useful way of investigating the significant differences between the groups. Research studies focused on deficits associated with PD have proposed a breakdown of semantic memory (Martin, 1992 and Roger & Hodges, 1994). Hence there is no doubt that working memory deficits account for poor vocabulary in the mild stage of dementia. It is also evident from the present findings that semantic representation breakdown occurs at this stage (Nebes & Brady, 1988; Barr & Brandt, 1996). Impaired performance in PD reflect an impaired ability to maintain all the information in working memory that is necessary for successful and complete discourse output (Smith et al., 1995 and Johnson, Bonilla & Hermann, 1997).
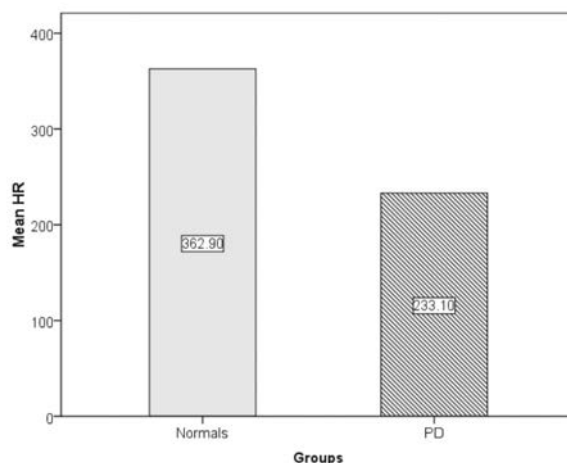

PD = Participants with dementia.
BI = Brunet's Index
Graph 3: Mean scores for Brunet's Index

Complex task of discourse and the measurement of richness of vocabulary, detected subtle changes in communicative ability between the groups in terms of complexity (as it can be seen form graphs 2, 3 and 4). The HE used more words to complete the task as compared to PD group. The sparseness in description by the PD group seems to reflect the inability of the PD group to retrieve words and provide a detailed discourse sample. The complex discourse task was enough to detect the subtle deficit in word retrieval. This difference in the complexity was more related to PD group's decreased competence in planning, problem solving and organisational abilities. This decreased higher order cognitive skills also seems to be reflected in the qualitative differences in the discourse sample as measured by the measures of richness of vocabulary. The scoring and calculations from these measures explored the depth of the

spoken discourse samples. The PD group's inability to produce the discourse with rich vocabulary seemed to highlight decreased planning, organisation and cognitive flexibility skills which are the hallmark of dementia (Cummings, 2000).

PD = Participants with dementia.
HR = Honore's statistic
Graph 4: Mean scores for Honore's Statistic.

Planning, organisation and cognitive flexibility are important components of executive functions (Crawford, 1998 and Godefroy, 2003) and they have been shown to influence discourse production in traumatic brain injury (Coelho, Liles & Duffy, 1995). However, it is beyond the scope of the present study to determine specifically how executive function will influence the discourse or word retrieving abilities. Nevertheless, the HE adults in this study demonstrated richer vocabulary as measured by three measures of richness of vocabulary. Measures of vocabulary seem to reflect both intact and preserved planning, problem-solving and organisation abilities. These higher-order cognitive skills may be the first to deteriorate in dementia and they are least likely to be captured by less complex linguistic tasks such as naming.

All participants in the present study readily responded to the discourse task. This indicates that task-requirement familiarity was not a confounding variable for the participants in this sample.

Another explanation for the finding in the present study will be reduced vocabulary for the PD group are reflective of impaired memory and reduced ability to retrieve information from their general knowledge stores (Rusted, Gaskell, Watts & Sheppard, 2000). Additionally persons with dementia lack cognitive

inference ability. The topics of conversation in the present study required multiple inferences based on the instruction to "imagine" a hypothetical situation i e., participants had to provide conceptual content to a virtually empty frame.

Although, the HE adults used more words, there was no difference between the groups in terms of syntactic complexity. Syntactic complexity in persons with dementia appears relatively spared in mild stage (Cummings, 2000). Such complexity in speech challenges the act of detecting decrements in communicative ability. Hence to a casual listener, decreased length of output and sparseness of thematic detail may be misunderstood as structurally complete sentence pattern. This supports previous studies that phonological and syntactic abilities are spared in early dementia (Bayles, 1982; Bayles, Kaszniak & Tomoeda, 1987). Although we did not compare the syntactic complexity between the groups, the length of discourse indirectly accounted for the same. There was no difference between the groups studied in the length of discourse produced.

The use of a complex discourse production task confirmed the need for a cognitively demanding task to magnify subtle changes in communication with PD. The subtle changes are better identified through length and complexity of a spoken discourse that sufficiently trigger the cognitive system. Our results seem to support the use of complex generative discourse production task, to differentiate typically aging adults from persons with dementia.

Conclusion

In conclusion, complex discourse production distinguishes persons with typical cognitive aging and from those with dementia. Differences emerged in terms of length and richness of the vocabulary in their spoken discourse sample. The HE scored higher than PD group. The outcome of this study is expected to contribute to knowledge of changes   nce of PD and healthy older participants have been demonstrated using measures of richness of vocabulary. These measures discriminate well between participants groups. An additional advantage of the method used in this study is that all measures are word-frequency dependent and can therefore be combined to yield a final index of performance. This index helps one to measure pre and post therapy improvements, or the performances at different stages of dementia. This study has identified the relative importance of such

variables in discriminating across PD and HE, which is helpful in understanding of qualitative deficits in PD. Further work is now necessary to explore specific type of deficits among varieties type of dementia. This would show the path to discriminate between types of dementia using linguistic measures alone. And off course, the suggestion from different professionals/ multidisciplinary team input is taken into consideration for identification and assessment of dementia.

The method used in this study adds to the sensitivity of the technique, and to investigate the relationship between these measures and other aspects of cognitive functioning such as semantic memory, working memory etc. Further studies should examine higher order abilities such as cognitive flexibility and planning to determine, if they are predictors of spoken discourse production. This information can provide answers to the questions on the importance of these abilities to spoken discourse production. In addition to using linguistic analysis of conversation to further understanding of dementia, the measures of richness of vocabulary may also be used as a basis for developing new tests of language function. There is a need for clinical tools which can be administered more easily by psychologists and speech-language pathologists and which may in turn help to improve diagnostic and prognostic accuracies.

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