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Introduction & Objective

Speech and language characteristics of connected speech provide a valuable tool for identifying, diagnosing and monitoring progress in Alzheimer's Disease (AD). However, our knowledge of linguistic features of connected speech in AD is primarily derived from English speakers; very little is known regarding patterns of linguistic deficits in speakers of other languages, such as Bengali. Bengali is a pro-drop, Indo-Aryan language with highly inflectional and complex morphosyntactic properties, and is structurally distinct from English. Given that the expected growth in neurodegenerative diseases will be from low- and middle-income countries where English is not the primary language, it is imperative to document, characterize and analyze the linguistic features of connected speech in languages native to these regions. The aim of this study was to characterize connected speech production and identify linguistic features affected in Bengali speakers with AD.

Methods

Participants were six Bengali speaking AD patients and eight matched controls from the urban metropolis, Kolkata, India. Narrative samples were elicited in Bengali using the Frog Story. Samples were analyzed using the Quantitative Production Analysis (Rochon et al., 2000) and the Correct Information Unit (Nicholas & Brookshire, 1993) analyses frameworks to quantify six different aspects of speech production: speech rate, structural and syntactic measures, lexical measures, morphological and inflectional measures, semantic measures and measure of spontaneity and fluency disruptions.

Results

Table 1 provides the descriptive statistics across the connected speech variables and results of statistical tests (group statistics and case-series analysis). In line with the extant literature from English speakers, the Bengali AD participants demonstrated decreased speech rate, simplicity of sentence forms and structures, and reduced semantic content (Sajjadi et al.,

2012; Slegers et al., 2018). Critically, differences with English speakers' literature emerged in the domains of Bengali specific linguistic features, such as the pro-drop nature of Bengali and its inflectional properties of nominal and verbal systems. Bengali AD participants produced fewer pronouns, which is in direct contrast with overuse of increase in pronouns by English AD participants (e.g., Ahmed et al., 2012; Fraser et al., 2016). Despite Bengali being a highly inflected language, the results showed no difficulty in producing nominal and verbal inflections, without any obvious errors. However, differences in the type of noun inflections were evident, characterized by simpler inflectional features used by AD speakers.

Conclusions & Implications

This study represents the first of its kind to characterize connected speech production in Bengali AD participants. The profile is one of semantic difficulties, alongside key differences in grammaticality of production, characterized by the choice of simpler and operationally less demanding options. Language-specific differences from English emerged in Bengali and was characterized by the use of fewer pronouns and fewer reduplications, similar level of noun and verb inflections, but opting for simpler inflections. This study is a significant step forward toward highlighting the importance of developing language specific linguistic markers for AD and provides a framework for cross-linguistic comparisons across structurally distinct and under-explored languages.

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Table 1. Summary of the key findings across the six domains of speech and language production, and information on the proportion of AD individuals who showed similar results to the group differences. Grey shading indicates significant group difference.

Variables	Alzheimer's Disease (AD)		Healthy Control (HC)		Between group significant difference	Direction of effect for AD	Effect size	Number (proportio of AD participant showing sign difference (total N=
	Mean	SD	Mean	SD				
Speech rate								
Total number of words	322.00	133.43	466.00	211.98	×			
Words per minute	60.07	29.52	135.92	31.89	✓	decreased	large	5 (83%)
Structural and syntactic measures								
Proportion of words in sentences	0.86	0.05	0.80	0.15	×			
Mean sentence length	4.26	0.64	7.68	0.82	✓	shorter	large	6 (100%)
Proportion of well-formed sentences	0.79	0.13	0.95	0.06	✓	lesser	large	2 (33%)
Embedding index	0.03	0.05	0.60	0.22	✓	lower	large	6 (100%)
Lexical measures								
Proportion of noun (N/all NW)	0.33	0.04	0.33	0.03	×			
Proportion of pronoun (P/all NW)	0.05	0.03	0.10	0.03	✓	decreased	medium	3 (50%)
Proportion of pronoun to noun (P/P+N)	0.14	0.08	0.24	0.06	✓	decreased	medium	4 (67%)
Proportion of verb (V/all NW)	0.27	0.02	0.24	0.04	×			
Proportion of nonfinite verb (NF/all V)	0.21	0.10	0.38	0.07	✓	decreased	large	5 (83%)
Porportion of matrix verb (MV/all V)	0.79	0.10	0.62	0.07	✓	increased	large	5 (83%)
Proportion of compound verb (CV/all V)	0.35	0.11	0.34	0.12	×			
Proportion of postposition (PP/NW)	0.09	0.03	0.08	0.02	×			
Number of reduplication	0.50	0.55	3.00	2.78	✓	decreased	medium	3 (50%)
Morphological and inflectional measures								
Nouns inflections								
Noun inflection index	0.98	0.03	1.00	0.00	×			
Proportion of inflected nouns	60.95	14.39	58.05	10.72	×			
Proportion of noun with 1 inflection	0.82	0.06	0.85	0.09	×			
Proportion of noun with 2 or more inflections	0.17	0.06	0.18	0.07	×			
Proportion of definiteness markers in %	60.38	19.95	27.09	12.07	✓	increased	medium	5 (83%)
Proportion of case markers in %	39.16	17.18	72.44	12.56	✓	decreased	large	5 (83%)
Verb inflections								
Verb inflection index	1.00	0.00	1.00	0.00	×			
Verb complexity score	1.99	0.01	1.99	0.04	×			
Semantic measures								
Number of CIU	135.67	29.65	161.63	5.71	✓	fewer	medium	4 (67%)
CIU% (Idea density)	62.48	12.44	90.87	5.54	✓	decreased	large	6 (100%)
CIUs per minute (Idea efficiency)	41.23	12.34	98.24	15.93	✓	decreased	large	6 (100%)
Measures of spontaneity and fluency disruptions								
Total count of disruptions of fluency (repetition, revision, reformulations)	11.33	5.96	3.13	2.90	✓	greater	large	3 (50%)