

## Quantifying Language Degradation in Alzheimer's Disease

Vineeta Chand & Lisa Bonnici  
Department of Linguistics  
University of California, Davis

There exists no definitive means of diagnosing Alzheimer's Disease (AD) beyond autopsy. Linguistic degradation is a hallmark feature of AD, and the language of AD patients shows promise as a new means of earlier diagnosis and a measurement of decline in cognitive functioning. In particular, while grammatical complexity remains stable, idea density (ID), a measurement of the number of meaningful ideas expressed per 10 words, has demonstrated a strong correlation with the advance of AD in writing (Kemper et. al 1991).

ID is a measure of how much information is conveyed in an utterance relative to the number of words. ID measures individuals' efficiency of expression. High scores reflect an economy of expression, whereas low scores reflect vague and repetitious expression. Past research on ID has largely focused on written language, which is progressively more difficult to obtain as AD progresses. While some methods for capturing ID have been developed for speech, (e.g. Mitzner et al. 2003) they have failed to account for fundamental structural differences between written and oral language (Chafe 1985; Chafe & Tannen 1987), relying on traditional sentence boundaries and devaluing subject elision (e.g. *I went last year, [I] didn't go this year*) common in oral speech. Thus, these methods cannot be considered linguistically sophisticated in their approach to analyzing oral speech. Additionally, previous methods have been poorly documented, and have at times failed to distinguish grammatical complexity from ID, hence inconsistent in their treatment of similar ideas.

With the goals of resolving the shortcomings of past ID methodologies and of investigating correlations between ID in oral speech and progression of AD, this paper discusses our linguistically informed quantitative approach and results. Our goal was to create a system reliable across multiple coders and accessible to linguists and non-linguists alike, while also accounting for variation across speaking styles (Labov 1972) and dialects (Kortmann & Schneider 2004).

Our method has demonstrated excellent inter-rater reliability on a number of features: transcription reliability (total word count correlation between two raters on six narratives ICC = .9810), utterance divisions prior to ID analysis (ICC = .9745), and ID analysis itself (CCI = .9662).

Three groups were tested: patients diagnosed with AD, patients with mild cognitive impairment (MCI), and normal controls; all data were collected through the UC Davis Alzheimer's Disease Research Center. Using a one factor ANOVA, we found that ID scores significantly distinguish the three groups ( $F = 4.05$ ,  $p = .03$ ). In normal aging adults, ID remains stable over time; on the other hand, AD leads to a rapid decline in ID.

This approach is novel in its focus on targeting oral narratives about patients' lives, memories more readily available to patients and easily collected as AD progresses, thus offering a more fine grained means of measuring linguistic degradation related to AD over time. By quantifying fluency and coherence, linguistic analyses thus contribute to and extend the range of official medical diagnoses.

### References

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