

Dementia Diagnostics from Discourse:

An Exploration of the Writings of two Famous Novelists

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Background: Language disruption is a prominent and early feature of Alzheimer's Disease (Nebes, 1989). The present study is part of an investigation into early diagnosis of Alzheimer's Disease (AD) using spontaneously produced natural language, as for example is plentifully available in the works of professional authors. We examined the writings of two notable 20th-century novelists: Agatha Christie (AC) and Iris Murdoch (IM). IM was diagnosed with AD in 1996 and this diagnosis confirmed at post-mortem in 1999 (Garrard et al., 2005). Recently it has been argued that AC also suffered from dementia in later life (Lancashire & Hirst, 2009).

Aims: An aim of this study was to examine differences and similarities in the way the language of these two authors changed over time, with a view to identifying variables that might be useful for early diagnosis of impending cognitive decline.



Material & Methods: 65 chapters written by each author were selected from published novels with known dates of composition. Measures of linguistic complexity were computed for both sets of texts. We developed an automated procedure to search among these variables for those exhibiting the greatest discrepancy between phases of an author's life. This procedure splits the data at all ages from 40 to 72 and fits separate regression lines to each data segment. The split at which the total squared deviation of the two separate linear regressions is the smallest fraction of that of a single regression is identified as a turning point.



Results: The variables that showed most dramatic change of trend in IM's works were two alternative measures based on Shannon's definition of information ($-\sum p_i \log(p_i)$), one character-based, the other word-based. For AC the two measures that showed most contrasting trends over time were two indices of word frequency (figures 1 & 2). Overall the progression from maturity to old age in AC showed smoother trends than in IM; and where turning points were found they were earlier than those of IM (figure 3). Many measures indicated a marked turning point for IM around age 69-70, reflecting a contrast between her last two books, written in the decade prior to her death, and the rest of her works (figure 4).

Conclusions: Linguistic variables that change steadily through the lifespan can be found. More important, we have shown that it is possible to detect and date change-points in the linguistic habits of authors, with implications for the early or even pre-symptomatic diagnosis of cognitive decline, and potentially for treatment.

References:

- Garrard, P., Maloney, L.M., Hodges, J.R. & Patterson, K. (2005). The effects of very early Alzheimer's disease on the characteristics of writing by a renowned author. *Brain*, 128(2), 250-260.
Lancashire, I. & Hirst, G. (2009). Vocabulary Changes in Agatha Christie's Mysteries as an Indication of Dementia: A Case Study. 19th Annual Rotman Research Institute Conference, *Cognitive Aging: Research and Practice*, 8-10 March 2009, Toronto.
Nebes, R.D. (1989). Semantic memory in Alzheimer's disease. *Psychological Bulletin*;106(3):377-94.

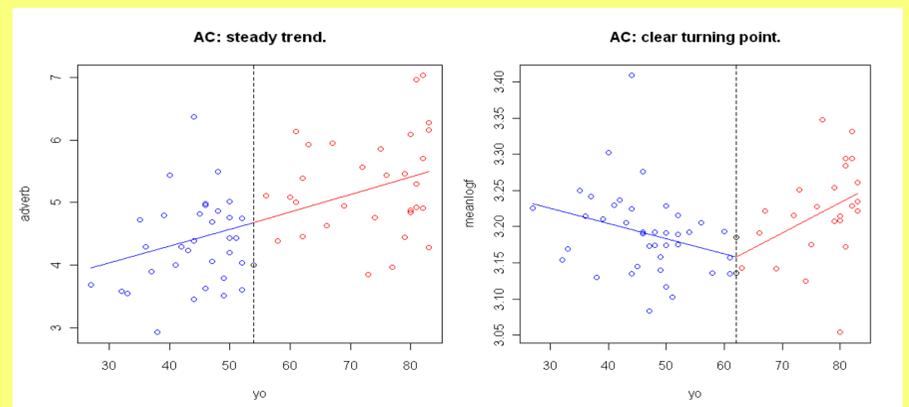


Figure 1, above, shows the variables with, respectively, the least and the most contrasting trends over time for Agatha Christie. Figure 2, below, shows the least and most contrasting variables over the course of Iris Murdoch's career.

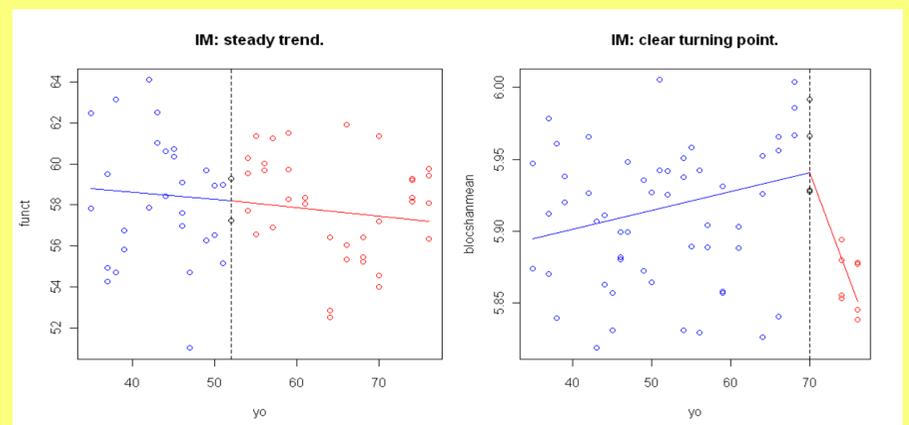


Figure 3, below. Both authors exhibit a marked change of trend in the vocabulary richness index blocvocmean (mean number of distinct words per 100 word tokens) but for IM the inflection point is later and more pronounced.

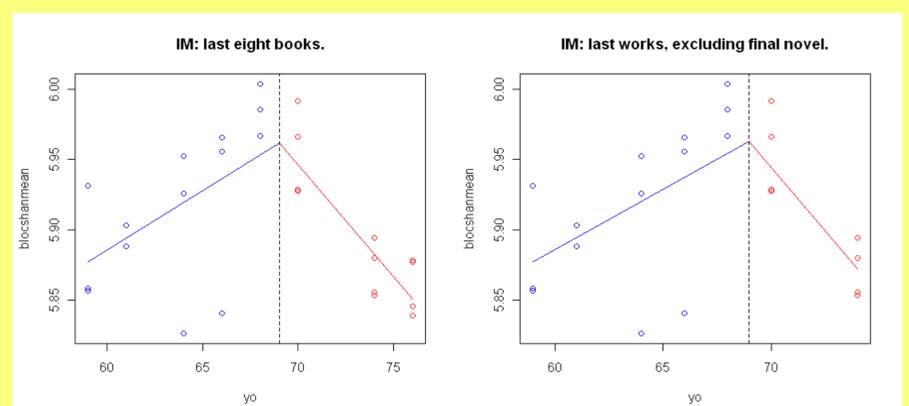
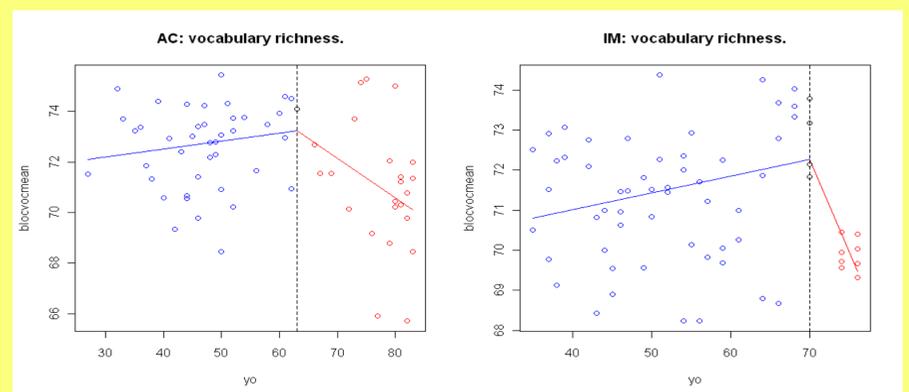


Figure 4. From a diagnostic point of view, an interesting finding is that a clear turning point can be detected for Iris Murdoch at age 69 by considering works from age 57 onwards, i.e. without the need to sample her whole career. More importantly, this change of trend is clearly marked even without her last book, which is when critics noticed something amiss. Thus her penultimate book already contained clues indicative of cognitive decline which were not readily apparent to careful readers.