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Written Language Clues to Cognitive Changes of Aging: An Analysis of the Letters of King James VI/I

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Reductions in language complexity normally occur in older adults because of decreased working memory and rate of language processing. Comparative measures can reveal whether linguistic change is due to normal aging or dementia. Linguistic analysis of a series of letters of King James, 1566–1625, investigate whether he exhibited a normative or atypical pattern of change. Fifty-seven letters from the years 1604 to 1624 were analyzed. Data modeling reveals a quadratic pattern of decline in written language complexity with increased diversity of vocabulary corresponding to historical reports of illness around 1618–1619. This investigation demonstrates how language analysis can provide valuable insight to normal and pathological cognitive changes of aging as well as to the understanding of historical figures.

IN healthy elders, a decline in working memory during late adulthood has been associated with a decline in the complexity of written and oral language (Baddeley, 1986; Kemper 1990, 1992; Kemper, Kynette, Rash, Sprott, & O'Brien, 1989; Kemper, Rash, Kynette, & Norman, 1990). In general, older adults produce shorter sentences with fewer embedded and subordinate clauses (Kemper et al., 1989). An-age related decline in linguistic abilities of healthy older adults occurs, between the ages of 65 and 80 because of working memory limitations affecting grammatical complexity and verbal processing limitations affecting propositional content and vocabulary. A decline in semantic content also occurs, although it is less marked than the loss of syntactic complexity (Kemper, Thompson, & Marquis, 2001).

Dementia also affects language (Kemper et al., 1993; Lyons et al., 1994) with a pattern that differs from healthy elders. The progressive decline in linguistic complexity and content characteristic of Alzheimer's disease (AD) can be distinguished from that of normal aging by three criteria: (a) the onset typically occurs in late 60s and early 70s, (b) the progression is more rapid, and (c) there is a marked loss of semantic content as well as syntactic complexity (Kemper et al., 2001). A third pattern occurs in vascular dementia resulting from cerebrovascular disease: (a) onset may occur in the 50s and 60s; (b) onset may be abrupt or stepwise, reflecting a series of strokes affecting the cerebral arteries; and (c) selective aspects of language may be spared if damage is limited to the large cerebral arteries (Bayles & Kaszniak, 1987).

We performed linguistic analysis of letters of King James VI/I of England to assess whether his pattern of language change reflected normal aging, AD, or vascular dementia. James Stuart ruled Scotland, as James VI, and England, as James I, in the sixteenth and seventeenth centuries. In 1619, at age 53, James suffered a severe bout of illness, after which his health and cognition deteriorated until his death at age 58 (Akrigg, 1984). On the basis of the literature, we anticipated that normal changes of aging reflected in James' correspondence would present as gradual declines in semantic and syntactic measures beginning in the late 70s; AD would feature semantic declines beginning in the late 60s or early 70s; whereas vascular dementia secondary to chronic cerebrovascular disease would result in selective declines in complexity beginning in the 50s and 60s.

Methods

We grouped 57 of James' letters in 2-year intervals spanning his reign and the 1619 period of illness and analyzed them for changes in linguistic complexity. Then we coded the final 10 sentences for each letter by using procedures developed by Kemper and colleagues (1989). We coded all main, embedded, and subordinate verbs. Also, we coded transcripts for DLevel, an indicator of grammatical complexity ranging from 0, simple one-clause sentences, to 7, complex sentences (Rosenberg & Abbeduto, 1987). By using the Systematic Analysis of Language Transcripts program (Chapman & Miller, 1984), we tabulated type token ratio (TTR; an index of words with different word roots indicating vocabulary variation), mean sentence length in words (MLU), and mean clauses per sentence (MCU). We established reliability at 80% or greater for transcription and coding by comparing a 10% sample of letters between three coders.

Results

Figure 1 presents the complexity measures for the intervals 1604–1605 through 1624–1625 as lowess curves fitting 50% of the data points. A decrease in the length of James' sentences occurred around 1618–1619: Before this interval his sentences averaged 38.48 words, whereas during and

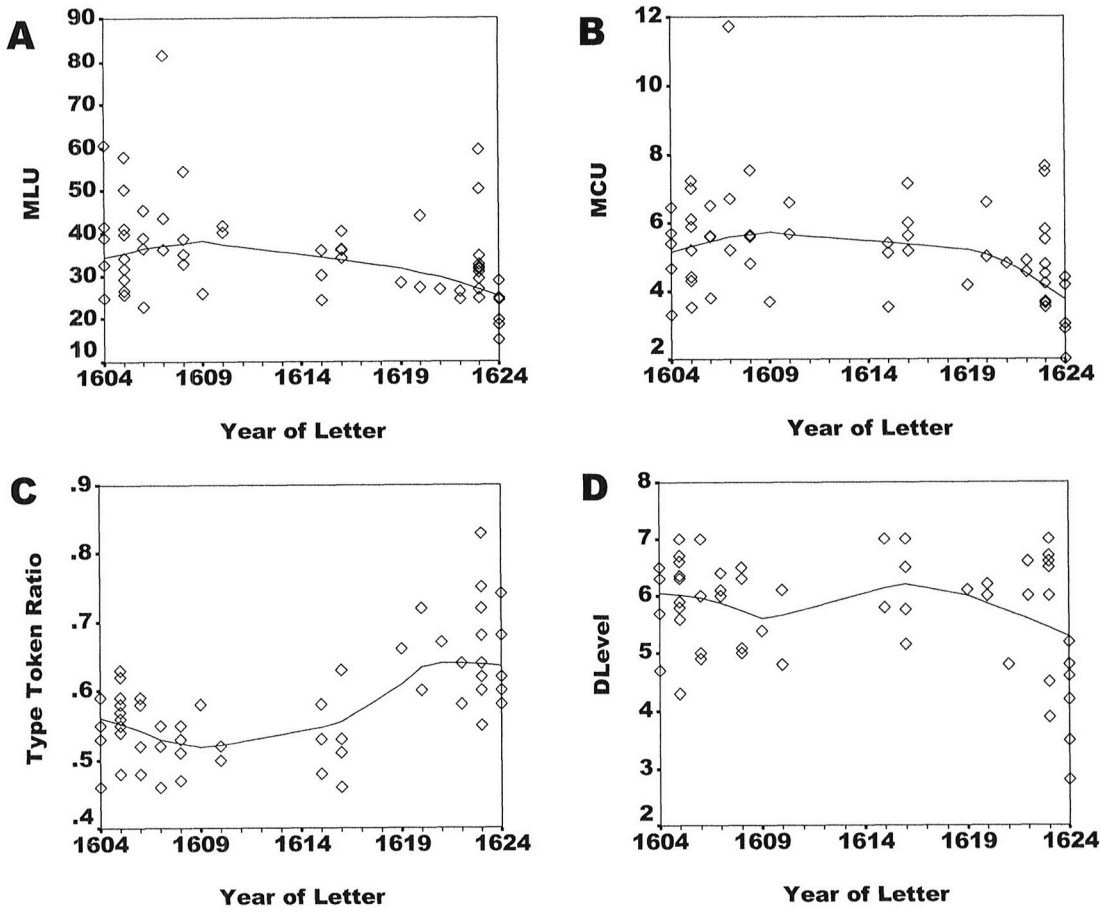

Figure 1. Lowess curve for language measures of James' letters: **A**, mean length of sentences in words (MLU); **B**, mean verb clauses per utterance (MCU); **C**, type token ratio; and **D**, DLevel. Lowess curves are fit to 50% of the data points.

after this interval they averaged 30.03 words. Around 1618–1619 a drop in James' use of verb clauses occurred; MCU declined from 5.58 to 4.55. TTR increased from .54 to .65 after 1619, indicating the use of a more diverse vocabulary. Means for the DLevel scores varied little, ranging from 5.97 prior to 1618–1619 to 5.48 following James' reported illness.

Statistical Analyses

Because the assumption of independence is violated by the correlation between letters all written by James, we used statistical modeling of growth curves with the SAS PROC MIXED program (SAS Institute, Inc., 2000) to determine whether a quadratic function occurred. The presence of a quadratic function indicated a change in the linear slope of decline in the measures, suggesting abnormal cognitive change. To avoid numerical difficulties, we centered data at 1616, just prior to James' illness.

Grammatical Complexity

We used two measures of grammatical complexity to examine changes in syntactic structure. As demonstrated in Figure 1, the slope of MCU decline became more dramatic corresponding to James' illness with a significant quadratic effect of age ($F(1,54) = 4.6, SE = .01, p < .05$). However, fixed effects of age on MLU failed to demonstrate a significant quadratic function ($F(1,54) = .66, SE = .04, p > .05$).

Semantic Complexity

Growth curve modeling for TTR demonstrated that James' semantic functioning remained intact. The fixed effect of age on TTR demonstrated a significant quadratic increase ($F(1,54) = 6.55, SE = .00, p < .05$), revealing increased diversity of James' vocabulary in writings after 1616. DLevel failed to change significantly over James' life span, possibly because of a ceiling effect for this measure.

Discussion

Our linguistic analysis demonstrates dramatic changes in written language occurring after 1616, in James'early 50s. Statistical modeling confirms a quadratic function of decline for the syntactic complexity measure MCU, but not MLU. A reverse pattern was noted for TTR, a semantic measure that increased quadratically during the same period. This increase may reflect reliance on semantic functions to compensate for declines in syntactic complexity. These findings are inconsistent with a pattern of gradual decline in syntactic and semantic complexity beginning in the late 60s for older adults experiencing normal cognitive changes of aging.

A retrospective diagnosis of AD is also unlikely because the onset of AD is typically later, progresses steadily over time, and features semantic losses. James' TTR, reflecting the diversity of his vocabulary, increased in his later life, inconsistent with the semantic declines characteristic of AD.

The selective decline in syntactic complexity (MCU) with preserved semantic function (TTR) reflects a pattern more consistent with cognitive decline caused by vascular dementia. The onset of these changes appears to be 1616, 3 years prior to his severe illness in 1619, although the date cannot be exactly determined because of limitations in the written record. The decline in syntactic complexity may reflect a preinfarct state, consistent with multiple small infarcts in small cerebral arteries (Emery, Gillie, & Ramdev, 1994) lasting from 1616 until 1619 followed by an exacerbation. His decline after 1619 may reflect progression of the chronic cardiovascular disease consistent with the quadratic decline in syntactic complexity. A larger cerebrovascular accident, or focal infarct, is not apparent because word usage (TTR) and basic syntax are unaffected. Historical data also support a diagnosis of vascular dementia caused by chronic cerebrovascular disease. Medical records indicate that James suffered from chronic kidney disease, and his autopsy revealed cardiac enlargement. These factors suggest James suffered from chronic hypertension putting him at risk for vascular dementia (Akrigg, 1984).

Because of the lack of modern knowledge of James' medical status, it is difficult to assess whether other health conditions may have contributed to his decline in linguistic complexity or whether his pattern indicates terminal drop. Gaps in data, lack of a cohort for comparison, and the unknown applicability of modern linguistic analysis to Elizabethan writing style also contribute to an inconclusive retrospective diagnosis. Similarly, health and life span differences of men from the 17th century may have led to different patterns of cognitive change with aging.

Modern knowledge of linguistic measures of normal and pathological language changes that occur with aging can provide useful clues to understanding the health and cognition of historical figures. This investigation supports the value of longitudinal case study analysis using written language samples as a technique for studying cognitive changes of aging. Linguistic analyses can provide clues to cognitive changes that occur with normal aging or as a result of pathological changes that impact communication. Future research should seek to clarify which linguistic measures are most sensitive to cognitive change.

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