Dissociable Discourse Signatures of Reading Ability and General Cognition:

Towards Targets for Generative AI Text Transformation

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INTRODUCTION

Spoken language samples are widely used in clinical settings, yet it remains unclear which features of connected speech reflect word reading ability versus broader cognitive function. This distinction matters: if we can identify which discourse features track word reading and which track cognition, we can use this as a starting point to target specific text dimensions for customized adjustment.

We frame this using Cattell-Horn-Carroll theory, [7] which distinguishes crystallized ability (accumulated knowledge built through experience) from fluid ability (capacity to reason and process information efficiently, independent of prior knowledge).

Hypothesis 1: *Features reflecting vocabulary knowledge (more reflective of crystallized ability) will predict word reading outcome measure specifically.*

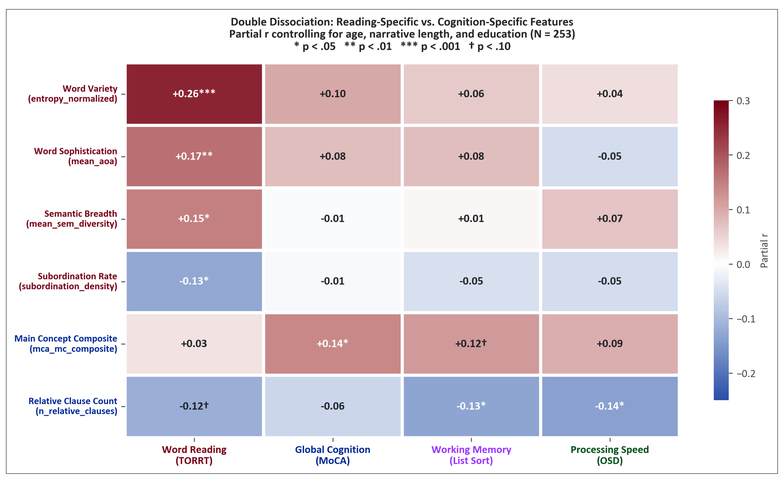
Hypothesis 2: *Features reflecting online processing demands (more reflective of fluid ability) will predict cognitive outcome measures specifically.*

METHOD

Participants were 253 community-dwelling adults aged 20–80 (M = 48.7, SD = 19.7; 73.5% female; 82% White) from the Aging Brain Cohort at the University of South Carolina. [5]

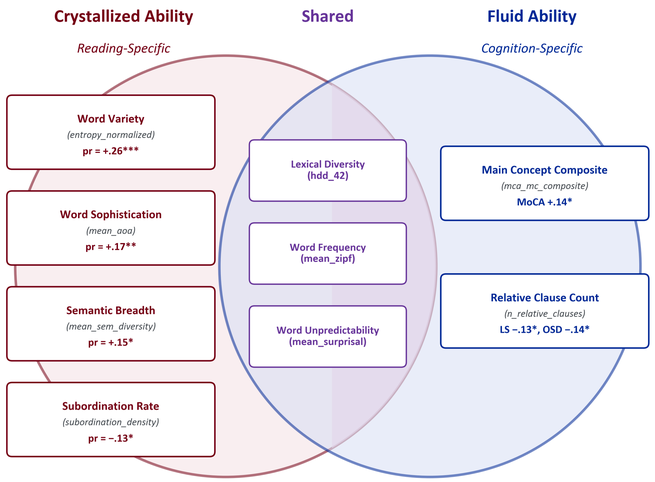
Each participant completed the Cat Rescue picture description task (spoken narrative) and four assessments: the NIH Toolbox Oral Reading Recognition Test (TORRT), List Sort Working Memory Test (LSWM), Oral Symbol Digit Test (OSD), and the Montreal Cognitive Assessment[4] (MoCA). We computed partial correlations between 114 discourse features and each outcome, controlling for age, narrative length, and years of education.

RESULTS

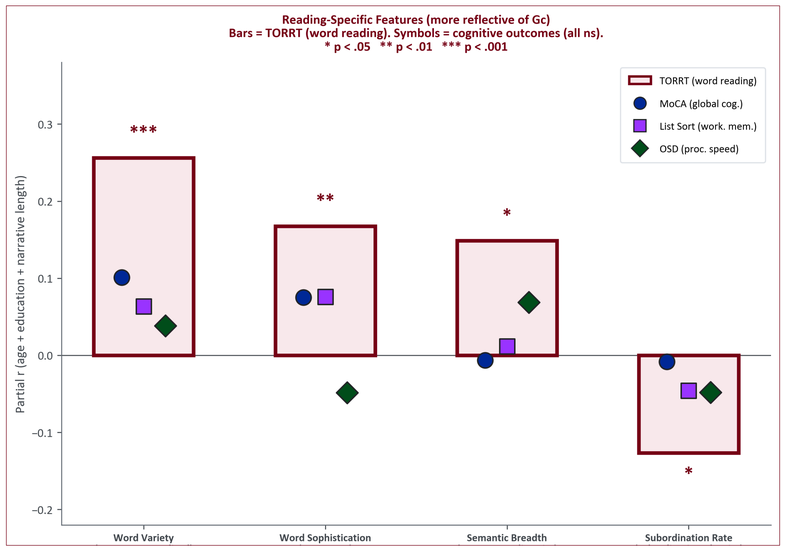


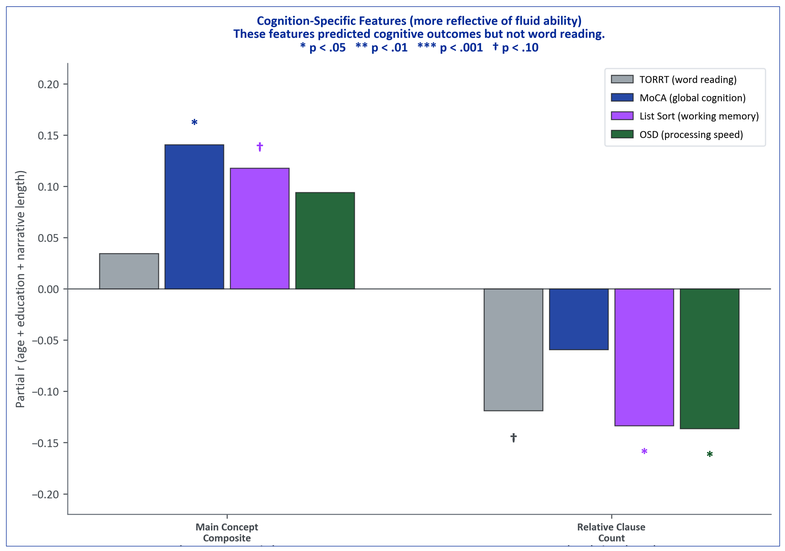
Sensitivity analyses confirmed the dissociation held after additionally controlling for sex & race.

Six discourse features showed a double dissociation: four predicted reading only, and two predicted cognitive outcomes only.



Three shared features: word frequency (e.g., rarity), lexical diversity, and lexical surprisal (unpredictability) were associated with both word reading and cognitive outcomes.





KEY FINDINGS

Hypothesis 1 *(crystallized ability):* Supported

Four features predicted word reading but not cognition: word variety , word sophistication, semantic breadth, and subordination rate. These reflect accumulated vocabulary (e.g., crystallized) knowledge.

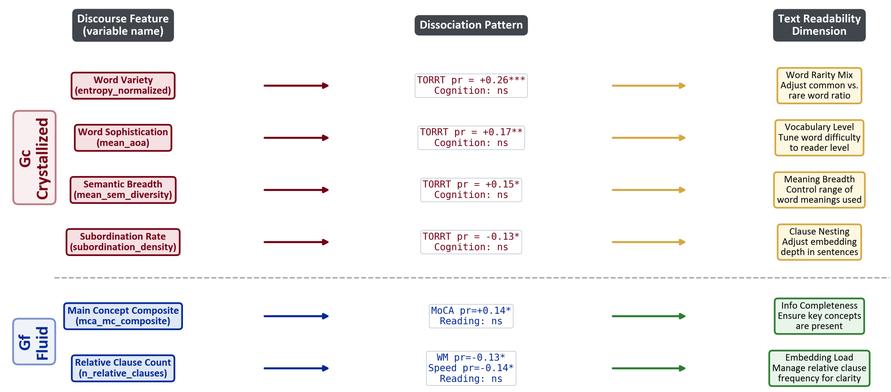
Hypothesis 2 *(fluid ability):* Supported

Two features predicted cognition but not reading: main concept composite (mca_mc_composite) predicted global cognition (MoCA). Higher relative clause count predicted lower working memory (LSWM) & lower processing speed (OSD), though trend with word reading (p = .06) suggested partial (*ns*) overlap

DISCUSSION

Features more reflective of crystallized ability capture accumulated vocabulary knowledge: speakers with stronger word reading use a wider variety of words, produce later-learned vocabulary, and draw on words with broader semantic range. Better word readers also showed a lower rate of subordination, a finding that parallels age-related declines in syntactic complexity, though the mechanism linking subordination specifically to word reading is unclear.

Features more reflective of fluid ability capture real-time processing demands. Main concept composite predicted MoCA (a global cognitive screen with limited language-specific subtasks.). Relative clause count predicted the domain-specific measures (LSWM & OSD): speakers with stronger working memory and processing speed produced fewer relative clauses per unit of speech, consistent with more efficient syntactic planning that avoids center-embedded structures (“that” or ”who” clauses nested within clauses that require holding multiple incomplete propositions in memory.)



Each feature corresponds to a dimension of written text that could potentially be adjusted. Rather than relying on grade-level difficulty levels derived from formulas developed for children, these features offer insights into how text characteristics relate to individual adult reader ability.

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