

Speech Biomarker for Cognition and Narrative Speech Markers Relate to Cognitive Status and Behavioral Symptoms

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Introduction

Characterizing the phenotypic heterogeneity of neurodegenerative disorders requires tools capturing both cognitive decline and neuropsychiatric symptoms. While digital biomarkers like the Speech Biomarker for Cognition (SB-C) track objective cognitive impairment, they may not fully reflect affective and behavioral shifts associated with early neurodegeneration. As a scalable alternative to traditional assessment, narrative speech may offer a distinct window into these changes. This study aims to validate the SB-C for classifying cognitive impairment and to investigate whether speech-derived indices provide incremental information regarding Mild Behavioral Impairment (MBI) symptoms.

Methods

61 participants from the OMICS-AD Swiss longitudinal cohort were included, and classified as having normal cognition (NC; CDR = 0, n = 47) or mild cognitive impairment (MCI; CDR = 0.5, n = 14) (see Table 1). Participants underwent in-clinic cognitive and neuropsychological assessments, including MoCA and the MBI-C, which assesses the following subdomains: decreased motivation, emotional dysregulation, impulse dyscontrol, social inappropriateness, and abnormal perception or thought content. Participants then completed an automated phone-based speech assessment comprising semantic verbal fluency, verbal learning, and positive and negative narrative storytelling tasks (pleasant memory and difficult experience). SB-C global score and subscores (memory, processing speed, executive function) were derived using ki:elements' proprietary speech analysis pipeline. Acoustic and linguistic features were extracted from the narrative speech tasks. Spearman correlations were used to examine associations between SB-C scores and cognitive measures, as well as MBI-C subdomain scores. Group differences in SB-C scores between CDR stages were assessed using Mann-Whitney U tests.

Table 1. Participant demographics and group characteristics, CDR = Clinical Dementia Rating

	Age (yrs)	Sex (F/M)	MoCA	Education (yrs)	CDR groups
Full sample	71.3 (5.5)	33 / 28	27.1 (2.2)	15.6 (2.8)	CDR 0: 47 / CDR 0.5: 14
CDR 0 (NC)	71.1 (5.4)	26 / 21	27.5 (2.1)	15.8 (2.7)	n=47

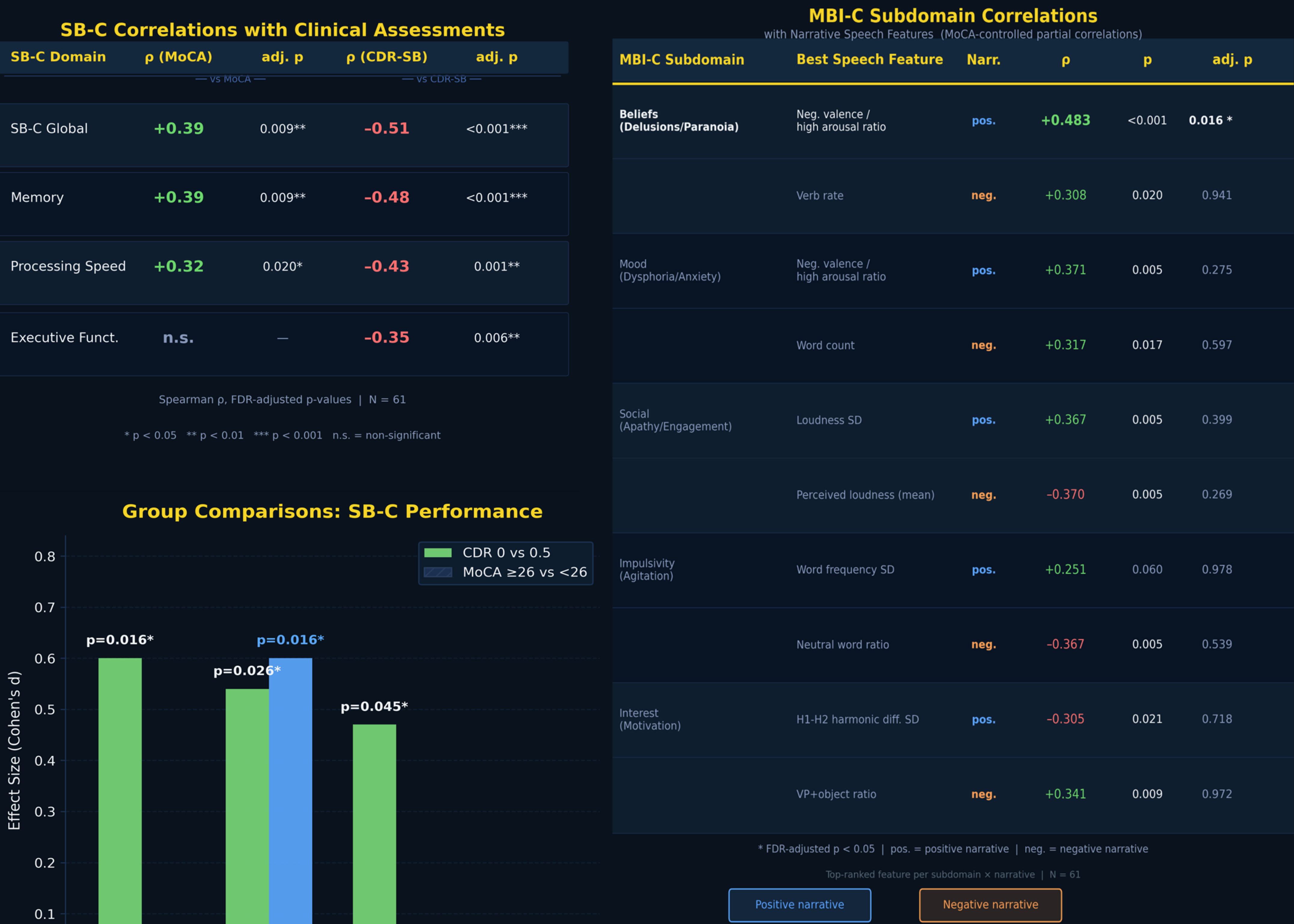


Figure 1. & 2. SB-C correlations with CDR and MoCA across cognitive domains (Spearman ρ , FDR-adjusted, N=61). Group comparisons based on SB-C scores

Results

SB-C scores showed strong convergent validity with established in-clinic assessments. Both SB-C Global and Memory correlated significantly with MoCA ($\rho = 0.39$, adj. p = 0.009 for each) and with CDR ($\rho = -0.51$, adj. p < 0.001; $\rho = -0.48$, adj. p < 0.001, respectively). Processing Speed showed significant correlations with both MoCA ($\rho = 0.32$, adj. p = 0.020) and CDR ($\rho = -0.43$, adj. p = 0.001). Executive Function was associated with CDR ($\rho = -0.35$, adj. p = 0.006) but not with MoCA (see Fig. 1). In group comparisons (CDR 0 vs. CDR 0.5), the MCI cohort scored significantly lower on SB-C Global ($p = 0.016$, $d = 0.60$), Memory ($p = 0.026$, $d = 0.54$), and Processing Speed ($p = 0.045$, $d = 0.47$), whereas Executive Function did not reach significance. Regarding MBI-C, the Beliefs subdomain (delusions/paranoia) was uniquely associated with negative-valence, high-arousal speech during the positive narrative task ($\rho = 0.483$, adj. p = 0.016, MoCA-controlled). None of the remaining MBI-C subdomains reached FDR significance (see Fig. 3).

Conclusion

The SB-C and its memory and processing speed subdomains are promising markers for cognitive characterization. Narrative-derived affective indices may provide insights into specific behavioral phenotypes such as the MBI Beliefs subdomain. These findings support a multi-layered digital phenotyping approach to track the full clinical spectrum of neurodegeneration. Ultimately, this highlights the potential of automated, phone-based tools as scalable, non-invasive solutions for monitoring patients in remote settings.

Figure 3. MBI-C subdomain correlations with narrative speech features (MoCA-controlled partial correlations)



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