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Screening for MCI in the Swedish H70 Birth Cohort Study using digital automatic speech biomarker tests for cognition and a machine Learning classifier

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Abstract

Background: Even if classic neuropsychological tests often have excellent psychometric properties to detect Mild Cognitive Impairment (MCI), they are not suitable for cost-effective low-burden screening at scale. Speech-based digital biomarkers can be deployed in a highly automated fashion. We present the results of an MCI screening algorithm based on a digital Speech Biomarker for Cognition (SB-C) in the Swedish H70 birth cohort study.

Method: We used a sample from the Swedish H70 Birth Cohort study (N = 404; 356 cognitively healthy (HC), 48 MCI). We automatically extract the SB-C score and its subscores (executive function, memory, semantic memory, processing speed) from SVF and RAVLT speech recordings using ki:elements' proprietary speech analysis pipeline including automatic speech recognition and feature extraction. We performed (1) inferential statistics comparing MCI and HC group based on the biomarker scores and (2) built a machine learning model to screen for MCI. For (1) we performed a non-parametric Kruskal-Wallis test to compare SB-C scores of both HC and MCI groups to check for general feasibility. For (2), we trained a support vector machine model with class weights and leave-one-out cross validation to classify between MCI and HC using the SB-C scores as input (overall score and the subscores).

Result: There was a group difference for the SB-C aggregated cognition score between the groups (HC > MCI; $\chi2 = 45.9$ (1), $p <0.001$; Figure 1), and also for the subscores (Table 2). To classify between MCI and HC, using a feature selection method, the best model was found for all the five biomarker scores selected with an Area Under Curve of 0.77 (Figure 2), a specificity of 0.77 and a sensitivity of 0.76 (Table 3).

Conclusion: We found that a machine learning-based screening algorithm based on the SB-C can detect probable MCI patients in representative population sample of older people using a speech biomarker read-out.
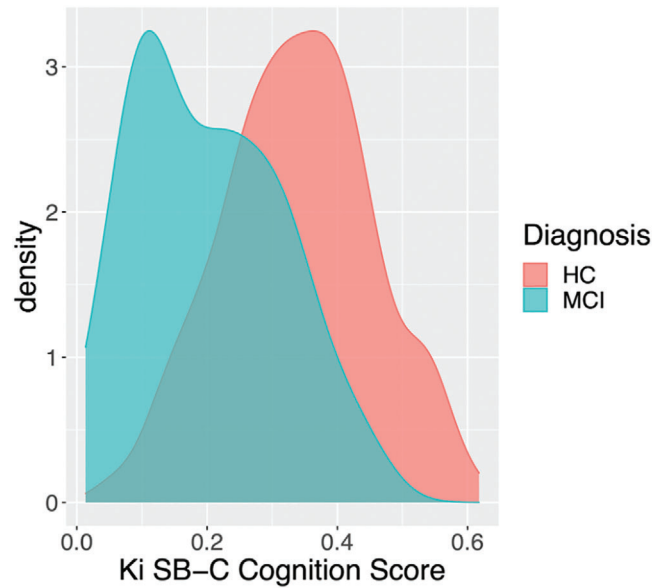
Table 1: Overview of biomarker scores between diagnosis groups (mean (standard deviation)). Group differences were computed using the non-parametric Kruskal-Wallis test.

Biomarker score	Total	HC group	MCI group	p
Executive function	0.23 (0.11)	0.25 (0.10)	0.13 (0.12)	<0.001
Memory	0.56 (0.18)	0.59 (0.17)	0.40 (0.15)	<0.001
Semantic memory	0.005 (0.19)	0.01 (0.19)	-0.06 (0.19)	<0.05
Processing speed	0.49 (0.16)	0.51 (0.15)	0.34 (0.13)	<0.001
Aggregated Cognition score	0.32 (0.13)	0.34 (0.11)	0.20 (0.11)	<0.001