Unveiling Acoustic Markers of Cognitive Decline: Automatic Detection of Putative Mild Cognitive Impairment from Speech in Mandarin-Speaking Elders

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Mild cognitive impairment (MCI) is widely regarded as the intermediate stage between normal cognitive aging and early Alzheimer's disease (AD). To date, the reliable detection of MCI has remained a great challenge for clinicians. Very few studies investigated the sensitivity of acoustic features in detecting Mandarin-speaking elders at risk for MCI, specifically referred to as "putative MCI" (pMCI). This study aimed to investigate the feasibility of employing automatically extracted acoustic features to detect pMCI and uncover potential acoustic markers of cognitive decline at an early stage.

Forty-one Mandarin-speaking elders with pMCI and 41 Mandarin-speaking healthy controls completed four reading tasks (syllable utterance, tongue twister, diadochokinesis, and short sentence) from which acoustic features were extracted automatically to train three machine learning classifiers including Random Forest, Support Vector Machine, and Naive Bayes. Correlation analysis was employed to evaluate the relationship between classifier predictions and participants' cognitive ability measured by Mini-Mental State Examination-2 (MMSE-2).

Our findings indicated that some temporal features (e.g., speech rate, utterance duration, and number of silent pauses), spectral features (e.g., variability of F1 and F2 of vowel /a/), and energy features (e.g., SD of peak intensity and SD of intensity range) were effective predictors of pMCI. The Random Forest classifier demonstrated the best classification performance, achieving an accuracy of 0.81 and an AUC of 0.81. Correlation analysis revealed a strong negative correlation between participants' cognitive test scores and the probability estimates of pMCI in the Random Forest classifier and a moderate negative correlation in the Support Vector Machine classifier.

In conclusion, this study highlights the utility of acoustic features extracted from speech data in detecting pMCI, with implications for early identification and tracking of cognitive impairment in the aging population.

Keywords: speech, Mandarin, machine learning, mild cognitive impairment