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Tracking Cognitive Trajectories in Mild Cognitive Impairment Using a Machine Learning Technique of Subtype and Stage Inference

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Conflict of Interest
The authors have no financial conflicts of interest.

ABSTRACT

Background and Purpose: Recognizing cognitive decline patterns in mild cognitive impairment (MCI) is crucial for early screening and preventive interventions. However, studies on the trajectory of individual cognitive functions in MCI are limited. Thus, the purpose of this study was to identify subtypes and stages of cognitive decline in MCI using a machine learning method.
Methods: A total of 944 subjects consisting of those who were cognitively normal and those with MCI were enrolled. Fifteen neuropsychological tasks were used in the analysis. The optimal number of subtypes was determined based on the cross-validation information criterion. Fifteen stages of cognitive trajectory were estimated for each subtype.
Results: The following three subtypes were identified: amnestic-verbal subtype, dysexecutive subtype, and amnestic-visual subtype. Of 723 (76.6%) subjects who had reached stage 1 at least, amnestic-verbal subtype accounted for the most (n=340, 47.0%), followed by dysexecutive subtype (n=253, 35.0%) and amnestic-visual subtype (n=130, 18%). The amnestic-verbal subtype had significantly more males (amnestic-verbal: 41.8%, dysexecutive: 31.2%, and amnestic-visual: 28.5%), younger subjects (amnestic-verbal: 72.01 years, dysexecutive: 74.43 years, and amnestic-visual: 75.06 years), higher educational years (amnestic-verbal: 11.06 years, dysexecutive: 9.53 years, and amnestic-visual: 9.79 years), lower Clinical Dementia Rating sum of boxes (amnestic-verbal: 1.40, dysexecutive: 1.61, and amnestic-visual: 1.71), and lower Korean-Instrumental Activities of Daily Living score (amnestic-verbal: 0.20, dysexecutive: 0.27, and amnestic-visual: 0.26).
Conclusions: Three types of MCIs were extracted using SuStaIn. Pathways of MCI deterioration could be different. The amnestic type could be bisected based on whether episodic verbal or visual memory is degraded first.

Keywords: Neuropsychology; Neurocognitive disorders; Mild Cognitive Impairment; Mental Status and Dementia Tests; Cognition

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Therefore, subtypes identified in this study need to be further validated with various aspects in the future.

We believe that this work using the SuStaIn to estimate deterioration pathways of MCI can provide various information on MCI subtypes that are not readily apparent. Most importantly, SuStaIn is a useful method for inferring longitudinal trajectories using data from a single point in time. Subtype-specific trajectories of cognitive decline identified in this study are expected to provide insights into early screening, preventive interventions, and early pathological mechanisms of MCI, a pre-dementia stage.

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