Towards the Speech Features of Early-stage Dementia: Design and Application of the Mandarin Elderly Cognitive Speech Database

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Background and Motivation

- Speech and language features have been proven to be useful for the detection of Alzheimer's disease (AD) and its prodromal stage, mild cognitive impairment (MCI).
- However, high-quality speech database remains scarce, which limit its application in automatic screening and assessment of early dementia in clinical practice.

Aim of this Study

- Design a high-quality speech database of Chinese elderly with intact cognition and MCI, which comprises speech samples from multiple tasks.

An Overview of Mandarin Elderly Cognitive Speech Database

- The database consists of 110 hours of speech recordings from 85 native speakers of Mandarin Chinese (age range = 55 - 85 years).
- Manually transcribed materials with temporal information are included in the database
- Nine tasks, including conventional test batteries and connected speech productions, are used to obtain speech samples, producing a total of 8563 sentences and 49841 words.
- See the right panel for details concerning the design of the database

Tasks

- **Task 1: Self-introduction (SI)** - elicit spontaneous unstructured speech production
- **Task 2: Picture description (PD)** - elicit structured speech production by three picture stimuli chosen from Boston Diagnostic Aphasia Examination (BDAE) and Western Aphasia Battery (WAB)
- **Task 3: Speech fluency (SF)** - produce as many words as possible in a category
- **Task 4: Picture naming (PN)** - name each picture as quickly and accurately as possible
- **Task 5: Sentence repetition (SR)** - repeat each sentence immediately after presentation
- **Task 6: Poem reading (PR)** - read each Chinese poem aloud
- **Task 7: Articulation (AR)** - articulate syllables "pa-ta-ka" in a row for three times
- **Task 8: Span task (ST)** - recall sequences of increasing number (3 - 5) of monosyllabic Chinese morphemes having either the same tone or different tones
- **Task 9: Semantic matching (SM)** - Pyramid & Palm Tree Test (PPTT)

Comparison of DementiaBank and MECSD

	DementiaBank	MECSD
Institution	University of Pittsburgh	中国科学院深圳先进技术研究院 SHENZHEN INSTITUTES OF ADVANCED TECHNOLOGY CHINESE ACADEMY OF SCIENCES
Subjects	Probable and Possible AD	MCI
Data Quality	Varied	High
Tasks	Picture description, Speech fluency	Multiple tasks
Languages	English, German, Mandarin, Spanish, Taiwanese Chinese	Mandarin

Demographic information (mean, SD, and range) of subjects in the MECSD dataset

Task	MCI	Normal
Gender (F/M)	12/8	35/30
Age (years)		
- Mean	65.85	67.71
- SD	5.53	5.77
- Range	(60, 82)	(56, 82)
MoCA (30)		
- Mean	23.7	28.0
- SD	2.2	1.3
- Range	(18, 27)	(25, 30)
MMSE (30)		
- Mean	25.4	29.2
- SD	2.7	1.0
- Range	(20, 30)	(26, 30)

The duration of speech samples in each task (Unit: minute)

Task	MCI	Normal
SI	22.77	83.71
PD	74.75	256.17
SF	60.89	198.77
SR	22.92	68.19
PR	33.77	102.21
Total	215.10	709.05

Number of sentences, words, and unique words produced by MCIs and Normal Controls

	MCI	Normal
Sentences	2050	6513
Subjects	11722	38119
Unique Words	1195	3496

Pilot ASR Experiment - Performance of GMM-HMM and Hybrid DNN systems (Character Error Rate)

GMM-HMM
Normal: PD01 37.79, PD02 42.22, PD03 43.43, SI 36.86, Overall 39.5
MCI: PD01 52.51, PD02 59.52, PD03 53.67, SI 56.58, Overall 55.38

GMM-HMM-MLLR
Normal: PD01 31.92, PD02 35.55, PD03 36.69, SI 30.81, Overall 33.28
MCI: PD01 47.28, PD02 53.9, PD03 49.49, SI 51.4, Overall 50.37

Hybrid DNN
Normal: PD01 24.74, PD02 27.44, PD03 28.96, SI 24.68, Overall 26.03
MCI: PD01 42.86, PD02 49.69, PD03 45.76, SI 50.68, Overall 47.03

Hybrid DNN-SAT
Normal: PD01 21.27, PD02 23.04, PD03 24.56, SI 20.02, Overall 21.95
MCI: PD01 34.01, PD02 40.39, PD03 38.9, SI 38.65, Overall 37.7

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