<Cognitive Neurology and Alzheimer's Disease Center>

NM Northwestern Medicine®
Feinberg School of Medicine

Morpho-lexical Recognition Ability and Related Brain Regions in Individuals with Mild Cognitive Impairment, Alzheimer's Disease, and Cognitively Normal Elderly

JungMoon Hyun[1], Alexandre Nikolaev[2], Yawu Liu[3,4], Eve Higby[5], Minna Lehtonen[6], Sameer Ashaie[1], Tuomo Hänninen[4], Merja Hallikainen[4], Hilkka Soininen[3,4]

[1] Northwestern University, [2] University of Helsinki , [3] University of Eastern Finland , [4] Kuopio University Hospital , [5] University of California, Riverside, [6] Abo Akademi University, Turku, Finland

Background

❑ Language functions are differentially vulnerable to normal aging and Alzheimer's disease (AD).
 • Word finding ability and semantic processing – decline early
 • Syntax of language production - relatively preserved in AD
 • Changes in morpho-lexical processing in aging – not clear

❑ Brain regions associated with morphology in lexicon – not clear

❑ Finnish word forms – morphologically complex.
 Finnish nouns can appear in at least a dozen different case forms.
  e.g., lasia - glass
    lasin - the glass
    lasiin – into the glass
    lasissa – in the glass

❑ Finnish is ideal for measuring changes in morpho-lexical knowledge in normal aging and pathological aging.

 Unlike English, knowledge of morphology in words can be differentiated from syntactic knowledge in Finnish.

Research Questions

• Does the ability of word recognition decline in patients with MCI or mild AD who speak Finnish?

• Which areas of the brain are associated with the ability of word recognition in adults with normal aging / dementia?
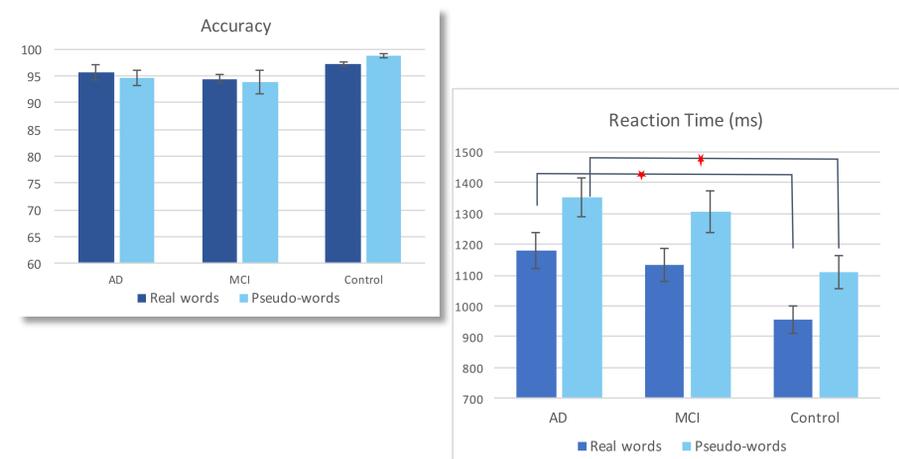
Methods

❑ Participants: Finnish speakers of Probable AD (n=19), MCI (n=22) and cognitively healthy older adults (n=17).
 • Age / Education / Gender

❑ Diagnostics : Included comprehensive clinical, neuropsychological, CSF, & neuroimaging evaluations
 • NINCDS-ADRDA criteria for AD[1]
 • Mayo Clinic Alzheimer's Disease Research Center criteria for MCI [2,3]
 • All procedures were performed in the Neurological department of University Hospital of Kuopio or at the Brain Research Unit of the University of Eastern Finland.

❑ Lexical decision task : Participants read each word and pressed a button to indicate whether it was a real word or not.
 • 177 real words (nominative singular forms of monomorphemic nouns)
 • 177 pseudo-words (follow the phonotactic rules of Finnish)

❑ Reaction Time (ms) and Accuracy (%) –ANOVA & Tukey Post Hoc

Methods

❑ Cortical thickness in our ROIs: Structural MRI data (1.5T), T1 weighted, MPRAGE (TR = 2400 ms, TE = 3.5 ms, TI = 1000 ms, flip angle = 6°, and voxel size 1.2 × 1.2 × 1.2 mm³). Analyzed with FreeSurfer.

❑ Brain regions that significantly predicted the reaction time (RT) for word recognition - control for age, gender and handedness / multiple comparison - Monte Carlo Null-Z simulation threshold 2.0

Results – Behavioral Data

❑ Homogeneity of Variance Tests (Ravene) - Not significant

❑ **Accuracy**: No group differences
 • real words ($F_{(2,56)}$ = 2.33, p = .107)
 • pseudo-words ($F_{(2,56)}$ = 2.49, p = .092)

❑ **Reaction Time**: Significant group differences.
  Tukey Post Hoc : AD > MCI = Control

 • AD group took significantly longer time than healthy control to recognize real words (p =.015) and pseudo-words (p =.030).

 • Difference between MCI and control approaching significance in real words (p =.080) and pseudo-words (p =.084).

Accuracy

Reaction Time (ms)

Acknowledgements & References

1. McKhann et al. (1984). Clinical Diagnosis of Alzheimer's Disease. Neurology, 39, 939-944.
2. Petersen RC. (2004). Mild cognitive impairment as a diagnostic entity. Journal of Internal Medicine. 256:183–194.
3. Petersen RC. et al. (1999). Mild cognitive impairment: clinical characterization and outcome. Arch Neurol. 1999; 56(3):303–308.

Results – Cortical Thickness

Significant correlation between cortical thickness and RT/ACC
❑ Across all groups: Bilateral superior temporal gyri
❑ AD
 • Real words: L. superior temporal gyrus & R. pars orbitalis
 • Pseudo-words: L. superior temporal gyrus & R. pars triangularis
❑ Healthy Control- Real words: L. lingual gyrus
❑ MCI: no significant regions
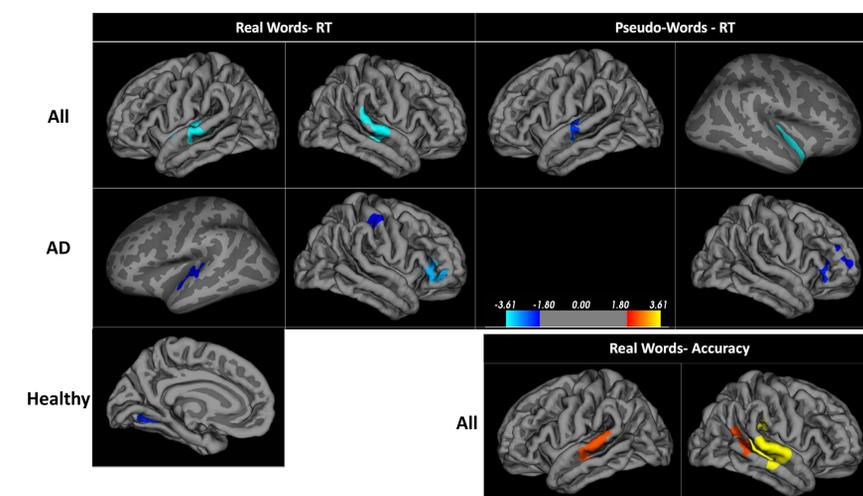
Conclusion and Discussion

❑ Accuracy scores did not differentiate 3 groups- a less sensitive measure than RT.

❑ Reaction time shows group differences.
 • Only AD group was significantly slower than control: Individuals with AD needed longer time to read and accurately process words.
 • The word recognition ability still remain intact in people with MCI (even though it is getting slower).

❑ Word recognition task with RT may be a useful diagnostic tool.

❑ The thinning of the superior temporal gyrus bilaterally predicted slower word recognition.

❑ The speed of healthy elderly's recognition of words was associated with brain regions related to visual/letter processing and identification of words. On the other hand, the speed of AD patients' recognition depended on regions associated with language and executive functions.

 Further analysis
 • Phonology vs. morphology in word recognition
 • Individual variance
 • Differences in word type (regular vs. irregular)