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# Listening Effort and Cognitive Decline: An Exploratory Study Using Pupillometry

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PhD: Listen Care-fully: Healthcare Design on Listening Effort and Cognitive Function

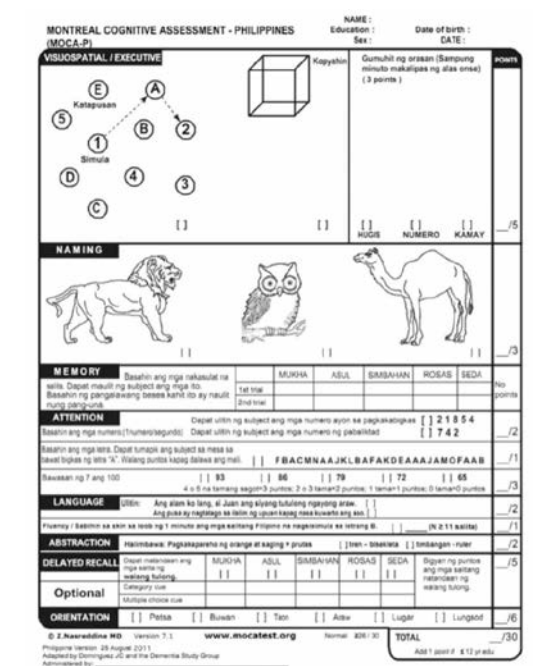
Project period: 2019 March – 2022 February

## Background

- Around **50 million people** have dementia worldwide with nearly **10 million new cases** every year<sup>1</sup>
- Hearing impairment accounts for **9% of the predictive power** of all risk factors associated with the development of dementia<sup>1</sup>
- Hearing loss is proposed as a **potentially modifiable risk factor** for dementia in midlife<sup>1</sup>
- Even **mild levels of hearing loss** increase the long-term risk of cognitive decline and dementia in individuals who are cognitively intact but hearing impaired at baseline.<sup>2</sup>
- The **mechanism underlying cognitive decline** associated with peripheral hearing loss is not fully clear<sup>1</sup>
- Research suggests a potential pathway between hearing and cognitive decline, with **listening effort, working memory and cognitive load** as principal mediators.<sup>3</sup>

## Research questions

- Is there an association between listening-effort, assessed by pupillometry, and cognitive function?
- Can the use of hearing aids reduce listening effort, and would this translate to improved performance on cognitive tests?
- Could cognitive health management practices be re-designed to account for audiology-related risks of cognitive decline?



## Why measure listening effort?

A growing amount of research is using pupillometry to examine listening effort and indicate the availability or demand on cognitive resources during processing.<sup>4-7</sup> Reports of effortful listening suggest that these difficulties are about more than sounds being too quiet or non-audible. These individuals may need to allocate more cognitive capacity to comprehend, remember and respond to auditory information.<sup>5</sup> The pupil diameter enlarges with this increased mental effort and reflects the processing demands associated with the task in relation to available cognitive resources.<sup>7</sup>

## What is the intervention?

### Subjects

- Two groups of healthy, middle-aged and older individuals (1: aged 60-80, 2: aged 40-60)
- One group of older individuals (aged 60-80) with Mild Cognitive Impairment (MCI)

### Eligibility

- Pure Tone Audiometry (PTA), age-matched, to rule out significant hearing loss
- Based on the broad Winblad criteria, control participants have a Mini-Mental State Examination (MMSE) score of 28 or higher

### Study 1: Clinical research

- Speech intelligibility and pupil dilation will be measured during a Hearing in Noise test (HINT).
- Cognitive function will be measured using a battery of attentional and memory-based cognitive tests.
- Those who demonstrate high levels of listening effort in noise will be fitted with hearing aids and re-tested on cognitive performance after 3 months of use

### Study 2: Integrative care research

- Could basic audiological testing be integrated in the management of cognitive impairment?
- Prototyping the integration of listening effort testing with dementia care professionals
- Investigating the impact on the patient journey, and factors such as training, costs and usability

## Objectives

- Determine whether increased listening effort is associated with cognitive function
- Investigate the feasibility of integrating listening effort technology as a predictive tool at point-of-care in dementia and hearing care settings

## Contact:

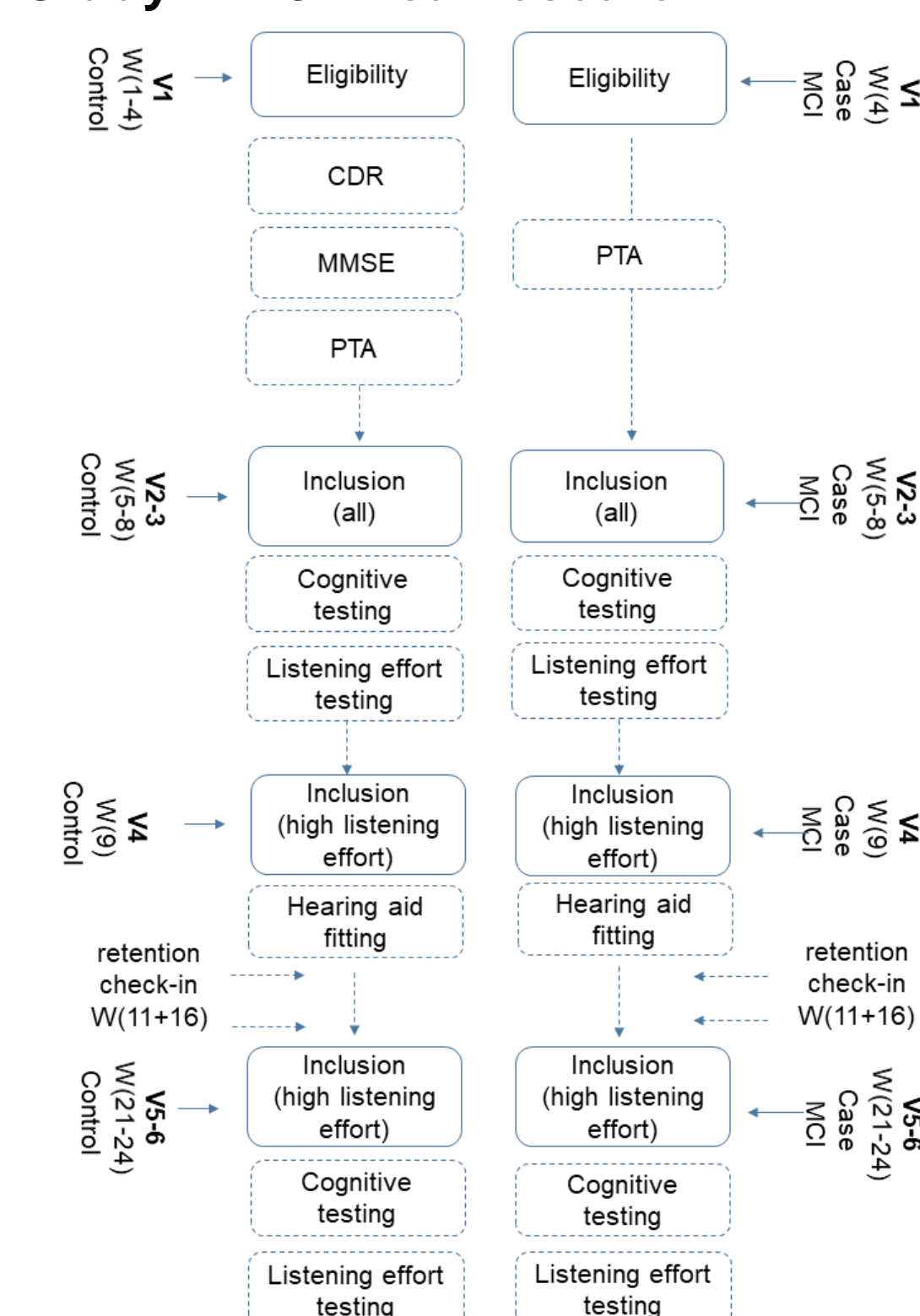


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Scan to learn more about the project



## Study 1 – Clinical research



## Collaborating partners



## References

- <sup>1</sup> World Health Organization. (14 May 2019) *Dementia fact sheet*. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/dementia>
- <sup>2</sup> Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, Ballard C, Banerjee S, Burns A, Cohen-Mansfield J, Cooper C. Dementia prevention, intervention, and care. *The Lancet*. 2017 Dec 16;390(10113):2673-734.
- <sup>3</sup> Leon M, Woo C. Environmental enrichment and successful aging. *Frontiers in behavioral neuroscience*. 2018;12:155.
- <sup>4</sup> Mc Garrigle, R., Munro, K.J., Dawes, P., Stewart, A.J., Moore, D.R., Barry, J.G., Amitay, S. 2014. Listening effort and fatigue: what exactly are we measuring? A British society of Audiology Cognition in Hearing Special Interest Group 'white paper'. *International Journal of Audiology*, 53(7): 433-440.
- <sup>5</sup> Pichora-Fuller, M.K., Kramer, S.E., Eckert, M.A., Edwards, B., Hornsby, B.W., Humes, L.E., et al. 2016. Hearing impairment and cognitive energy: The framework for understanding effortful listening (FUEL). *Ear and Hearing*, 37(Suppl 1): 5S-27S.
- <sup>6</sup> Alhanbali S, Dawes P, Lloyd S, Munro KJ. Self-Reported Listening-Related Effort and Fatigue in Hearing-Impaired Adults. *Ear Hear*. 2017 Jan/Feb; 38(1): e39-e48.
- <sup>7</sup> Zekveld AA, Kramer SE, Festen JM. Pupil response as an indication of effortful listening: The influence of sentence intelligibility. *Ear and hearing*. 2010 Aug 1;31(4):480-90.