# Deep Learning in Mild Cognitive Impairment Diagnosis using Eye Movements and Image Content in Visual Memory Tasks

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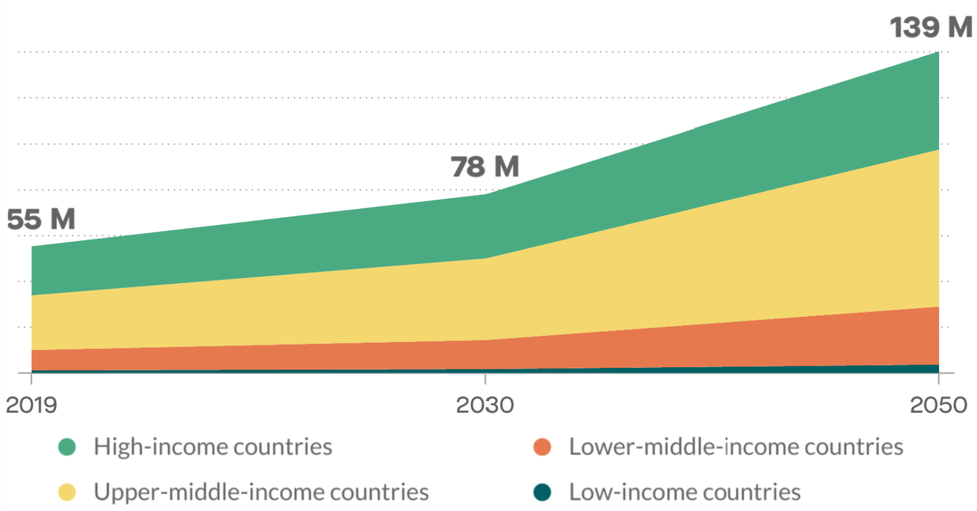
## Introduction

**"Dementia is an umbrella term for loss of memory and other thinking abilities severe enough to interfere with daily life"**, which includes conditions such as Alzheimer's Disease.

*Alzheimer's Association [1]*

**Number of people living with dementia in 2019, 2030 and 2050 (in million) by country income group**




*WHO [2]*

## What precedes Dementia? [3]

**Mild Cognitive Impairment (MCI)**

- Impairment of one or more cognitive domains
- Daily living activities are still preserved, contrary to dementia patients.

## How is MCI Diagnosed? [4]

**Pen and Paper tests and Neuroimaging**

- Require Specialized professional
- \+
- Delayed symptom recognition

→

- Not applicable at a large scale
- Late diagnosis

## How can we solve this problem?

**Digital Tests**
- Cost effective
- Pratical

\+

**Biometric Data**
- Extra relevant data
- No additional time cost

↓

**Deep Learning**
- Easier to analyse data

**Eye Movements**
- Early indicators of MCI

↓

**New diagnosis applicable at a large scale with comparable results?**

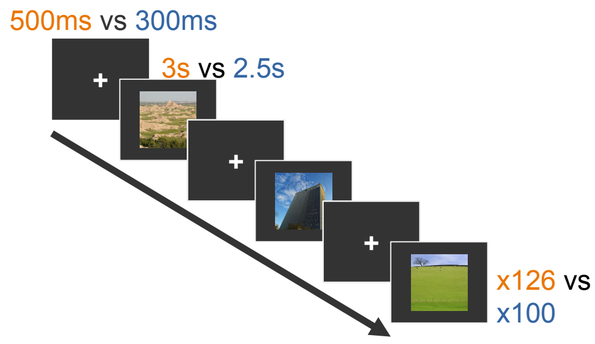
## Methodology

Data from ***Coco et al. [5]*** and data acquired by **us** in MCI patients and healthy controls (HCs) performing 2 similar tasks.

| ***Coco et al.*** | **Us** |
|---|---|
| 44 participants (30Hz)<br>• 24 MCI<br>• 20 HCs | 21 participants on going (150Hz)<br>• 12 MCI<br>• 9 HCs |

### Task

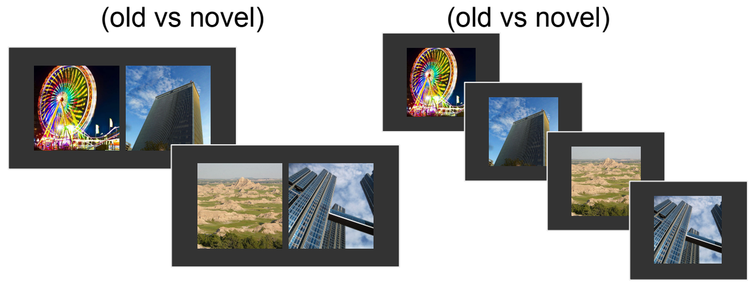
**Encoding Phase**




**Recognition Phase**

***Coco et al.***
Forced choice
(old vs novel)

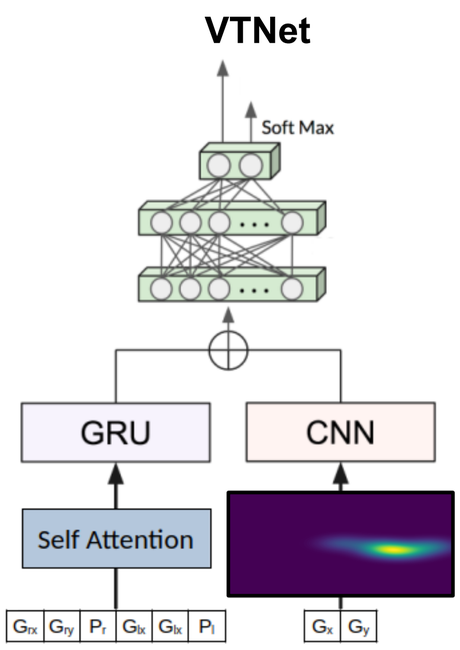
***Us***
Open choice
(old vs novel)



### Architecture [6]

- Low amount of data
- Hard to train data heavy architectures (*i.e.* transformers)

**VTNet**




*Sims et al., 2020*

## Results

**Tab. 1.** Models sensitivity and specificity (mean ± standard deviation) for Sririam et al., using Alzheimer's disease patients and Scanpaths, and our results using MCI patients and gaze heatmaps.

| | *Sririam et al. [7]* | Ours |
|---|---|---|
| **Sensitivity** | 70 ± 0.02 | 68.42 ± 27.26 |
| **Specificity** | 72 ± 0.02 | 76.47 ± 27.64 |

- Model trained only on *Coco et al.* data.
- Achieved comparable results in harsher conditions (Alzheimer's patients vs MCI patients)
- Hight standard deviation – small dataset

## Conclusion

- The initial results show promising results
- Tackling high standard deviation:
  - → Increase dataset
  - → Use methods such as Bootstrap aggregation [8]

**Future Possibilities**
- Use regular laptops and cameras – Increase scalability and reach of the diagnosis

## References

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This study is funded by Lisbon ELLIS Unit, the Center for Responsible AI (PRR), LARSyS FCT funding (DOI: 10.54499/LA/P/0083/2020, 10.54499/UIDP/50009/2020, and 10.54499/UIDB/50009/2020)