Impact of Age and Hearing Loss on Sensori-motor Coupling During a Visual Attention Task

Maxime Perron[1,2], Susan Gillingham[1,2] & Claude Alain[1,2,3,4]

1. Department of Psychology, University of Toronto. 2. Rotman Research Institute, Baycrest.
3. Institute of Medical Sciences, University of Toronto. 4. Faculty of Music, University of Toronto.

Introduction

- Aging is associated with a decline in performance on tasks measuring executive function [1,2]; a decline that is amplified or accelerated by hearing loss [3,4].
- Selection and preparation of motor action constitute a subset of executive functions necessary for goal-directed behavior.
- Evidence indicates that sensory and motor changes may precede the cognitive symptoms of demantia and cognitive impairment [5].
- However, sensory and motor dysfunctions in cognitive aging have been studied separately.
- Modulations of EEG activity in sensori-motor tasks have been described primarily in the beta frequency ranges (12–30 Hz) [6], reflecting motor preparation.

Objective

- The purpose of this study was to examine the effects of age and hearing loss on the neurobiological mechanisms associated with pre- and and post-response processes during a visual attention task.

Method

Participants: 53 participants divided into three groups:
- 21 young adults (**YA**) (mean age = 23.3 ± 3.3);
- 17 older adults with normal hearing for their age (ONH) (mean age = 71.0 ± 3.2);
- 15 older adults with mild hearing loss (OHL) (mean age = 73.0 ± 3.8).

Hearing Evaluation: pure-tone audiometry (.25, .5, 1, 2, 3, 4 and 8 kHz).
- ONH: hearing thresholds below 20 dB for each frequency.
- OHL: hearing thresholds between 20 dB and 40 dB for all frequencies from 0.25 to 4 kHz.

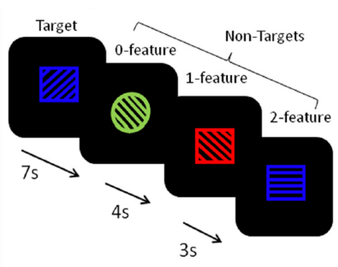
Neuropsychological Assessement: the tests included the Trail Making test (parts A and B), Digit Symbol Coding, Digit Span Foward and Backward, and Spatial Span Forward and Backward.

-> YA had better cognitive scores than both groups of older adults.

-> OHN and OHL groups did not differ in cognitive scores.

Visual RT Attention Task (Figure 1):

Figure 1. Paradigm [3]



Behavioural Analyses (Figure 2):
Two-way ANOVA with reaction time (RT) as dependent variable, Condition (Target, Non-target) as the within-subject variable, and Group (YA, ONH, OHL) as the between-subject variable.

EEG Processing: • EEG data was recorded using a 76-channel BioSemi Active Two system; • data was referrenced to the common average reference; • eye artefacts were corrected; • deffective electrodes were interpolated.

EEG Analyses: • Event-related potential (ERP): ERPs for target and non-target were extracted **(Figure 3)**. • Time-Frequency Analysis: temporal spectral evolution (TSE) for target and non-target **(Figure 4)**.

- ANOVAs with Group as between-subject variable was performed using BESA Statistics (cluster alpha of .01, 3000 permuations) for each condition.
- Correlations (cluster alpha of .01, 3000 permuations) between theta (4-7 Hz) and beta (12-30 Hz) power and RTs for each condition **(Figure 5)**.

Preliminary Results

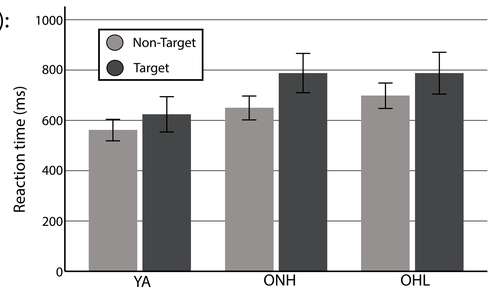
Behavioural

Condition Effect (F = 45.29, p < .001):
Non-Target < Target

Group Effect (F = 8.18, p = .001):
YA < ONH
YA < OHL
ONH = OHL

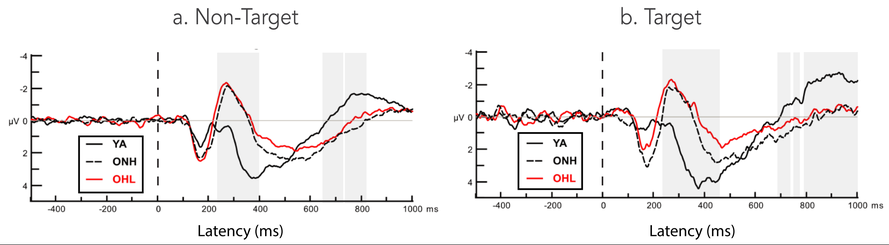
Group * Condition Interaction:
(F = 2.55, p = .09)

Figure 2. ANOVA results



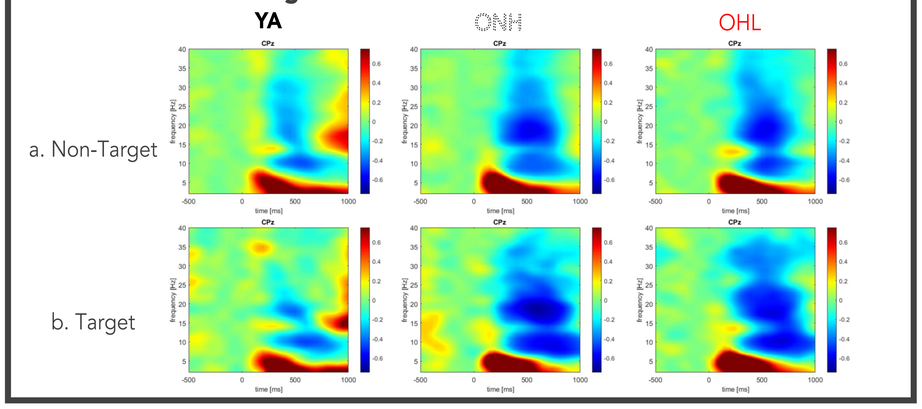
Event-Related Potential (ERP)

Figure 3. ERP at the CPz electrode



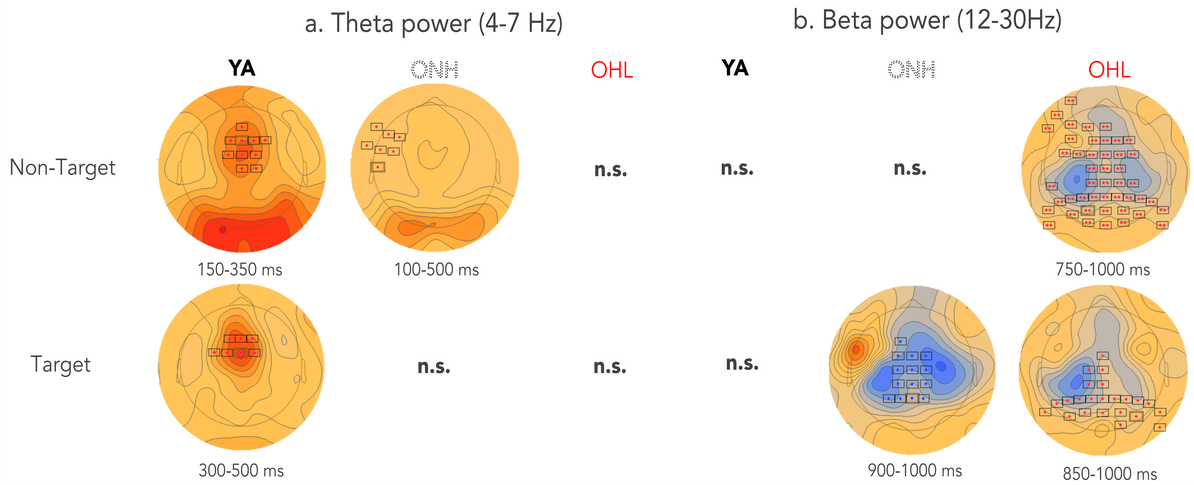
Time-Frequency Analysis

Figure 4. TSE at the CPz electrode



Brain-Behaviour Correlations

Figure 5. Correlations between power and RT



Discussion & Conclusion

Discussion

- Both older groups showed comparable performance, with expected age-related changes when compared to the YA group.
- Both older groups showed stronger beta desynchronisation pre-response, which may reflect greater effort or difficulty in selecting and preparing motor action.
- Although performance and neurobiological mechanisms appear similar between the two groups of older adults, performance does not correlate in the same way with brain activity.
- The rebound of beta activity post-response in frontal and occipital regions (i.e., > 750 ms) appears to be a better predictor of performance in OHL compared to ONH.
- This may reflect that people with hearing loss have the same brain function as those with normal hearing, but do not use the same resources to perform the task. This could indicate a compensation mechanism related to hearing loss.
- The strong correlations of RT with post-response beta activity in OHL could be indicative of a performance control mechanism in which they second-guess the response produced.

Conclusion

- Overall, preliminary analyses suggests that mild hearing loss does not appear to have a major impact on visual attention, but may change the relationship between behavior and the brain as a compensatory mechanism.
- Additional analyses are underway to replicate the results in similar paradigms evaluating different aspects of executive function.

References

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Acknowledgments

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