Effects of Sleep, Age, and Hearing on the Ease and Effectiveness of Communication, and the Role of Cognitive Resources

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Introduction

Older adults face a number of multifaceted challenges, such as:

- **Impaired hearing** with 40% of people over the age of 50, and 71% of people over the age of 70 having hearing impairment[1]
- **Cognitive decline** making an average older adult's cognitive performance similar to that of sleep-deprived younger adults[2][3][4]
- **Sleep-wake cycle disruption** affecting as many as 50% of them.[4]

Unexpected consequences may arise when such challenges occur together.

Cognitive resources may be influenced by factors such as **ageing**, **sleep deprivation**, and **hearing impairment**.

The availability of these resources has been linked to changes in *effort*, *fatigue*, *discourse comprehension*, and *overall wellbeing*.

Research Questions

I- How are wellbeing and the ease and effectiveness of communication affected by factors that contribute to cognitive depletion such as sleep deprivation, ageing, and hearing impairment, when present individually and in combination?

II- Is that effect mediated by cognitive resources?

Methods

Participants

The aim is to recruit a sample of 100 younger adults (aged 18 to 35) and a sample of 100 older adults (aged 60 and above).

So far, 52 younger adult participants, and 43 older adult participants have been recruited.

Participants are asked to have not consumed caffeine in the 2 hours prior to the data collection. Participants with known cognitive impairment or a disorder that affects their nervous system are excluded, including being on a medication that affects the nervous system. Participants who use hearing aids are excluded.

Data Collection

Data is being collected online using the Gorilla Experiment Builder platform, with participants recruited via Prolific. Participants complete an hour-long test battery once, made up of a listening component and a cognitive one, that are counter-balanced.

Task Protocol

The task protocol is designed induce listening-related effort and fatigue and measure them in real time.

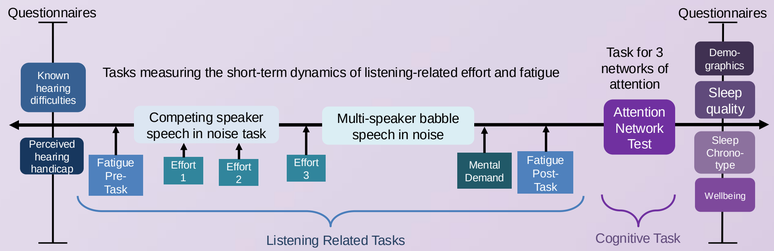

Fig. 1, The task protocol used in data collection, with a listening component and a cognitive component counterbalanced.

Measurements

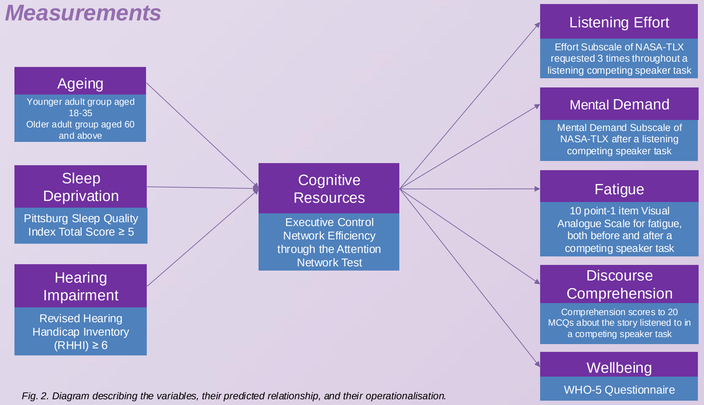

Fig. 2. Diagram describing the variables, their predicted relationship, and their operationalisation.

Preliminary Results

Descriptives

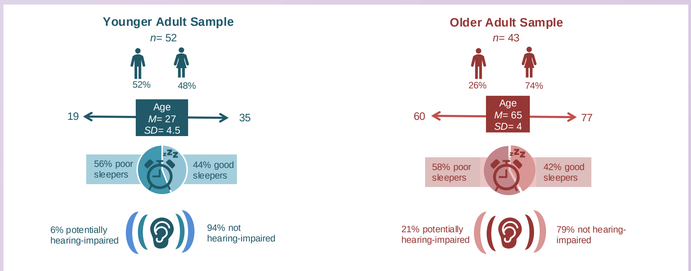

Fig. 3. The descriptive data of the samples that have been collected so far, describing gender, age, sleep quality, and hearing status of participants.

Outcome Variables

- **Fatigue** worsened significantly over time, for both younger $t(51) = -4.19$, $p < 0.001$ and older $t(42) = -3.98$, $p < 0.001$ groups.
- The younger group had marginally significantly higher ratings of **fatigue** than the older group at both timepoints $t(89.5) = -1.9497$, $p = 0.054$.
- **Effort** was influenced by **sleep deprivation** more so with ageing (marginally sig, Est= 0.0055, p= 0.051).

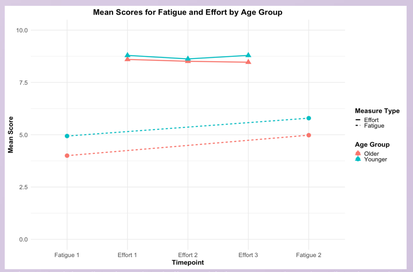

Fig. 4. Real-time listening-related effort and fatigue scores throughout listening tasks

Predictor Variables

- **Sleep deprivation** was associated with decreased efficiency of the Executive Attention Network (marginally sig., r= 0.2, p= 0.06), with increased fatigue (r= 0.24, p< 0.05), and with lower wellbeing scores (r= -0.33, p< 0.01).
- **Sleep deprivation** and **hearing handicap** are correlated even when controlling for age (*Est*= 0.41, p< 0.0001) & wellbeing (Est= 0.45, p< 0.0001).
- **Hearing handicap** was associated with decreased Alerting Network efficiency in the younger (r= 0.3, p= 0.03) and older (r= 0.29, p= 0.05) groups, and in **older adults** associated with decreased Orienting Network efficiency *(r= 0.33, p= 0.03)* and Executive Control accuracy (r= 0.42, p< 0.05).
- **Hearing handicap** was associated with alerting attention inefficiency even when controlling for age (r= 0.29, p= 0.004), and sleep (r= 0.29, p= 0.004).
- The less efficient the Alerting Attention Network, the worse the discourse comprehension, even when controlling for age and sleep (r= -0.29, p< 0.01).

Mediation Analyses

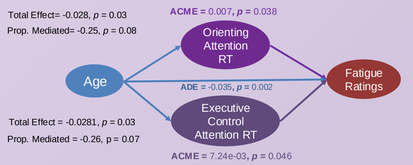

Fig. 5. Ageing leads to increased fatigue partially due to decreased attention efficiency.

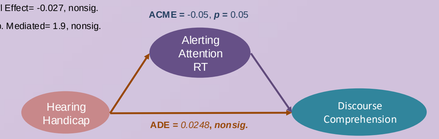

Fig. 6. Hearing handicap leads to poor comprehension only in case of decreased attention efficiency.

Regression Analyses

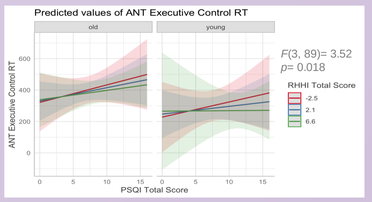

Fig. 7. Regression of Executive Control RT on hearing handicap, sleep deprivation, and age.

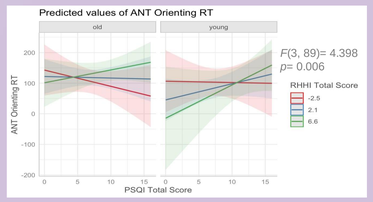

Fig. 8. Regression of Orienting RT on hearing handicap, sleep deprivation, and age.

Conclusions

- **Hearing handicap**, **sleep deprivation** and **ageing** can contribute to lowering attention efficiency.
- Older adults experiencing less efficient orienting and executive control attention networks are more likely to experience **fatigue** from listening.
- Listening related **fatigue** might worsen due to poor **sleep** and **ageing**.
- With **age**, the effect of **sleep deprivation** on **effort** increases.
- **Hearing handicap** could lead to a less efficient alerting network, and due to that, possibly lead to decreased discourse comprehension.

Summary

Older adults may be more vulnerable to the effects of poor sleep and hearing impairment, particularly in terms of maintaining attention, and experiencing effort and fatigue.

Listening related effort and fatigue may be impacted by ageing, sleep deprivation, and hearing impairment due to the depletion of cognitive resources.

Hearing adjustment protocols should account for sleep quality in preserving the attention needed for effective communication.

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