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# Age-Related Changes in Selective Listening: Investigating Cognitive and Sensory Factors in Auditory Attention

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## Age-Related Changes in Selective Listening

In complex auditory environments, multiple sound sources generate interfering acoustic information.

Auditory attention allows to selectively listen and prioritize the relevant sensory input while filtering out competing information.

Selective listening depends both on:

- The quality of raw sensory inputs transmitted from the periphery
- The efficiency of top-down attentional processes

During healthy aging, a mixture of sensory and attentional factors can negatively affect listening performance (Russell, 2022)

**Our study investigates how sensory decline and cognitive aging contribute to age-related impairments in selective listening.**

## Sensory Decline

Age-related hearing loss (ARHL) is defined as a gradual decline in peripheral hearing abilities with advancing age (WHO,1991).

ARHL impairs the detection of sound frequencies, thereby affecting the processing of sensory input (Katz et al., 2015).

Even mild levels of ARHL can impair the ability to extract meaningful information from complex auditory environments (Russell, 2022).

## Cognitive Aging

The ability to inhibit irrelevant information is the primary cognitive function that declines with age (see Rey-Mermet & Gade, 2018, for a review).

Under flexible task requirements, older adults often show increased performance costs (e.g., switch cost), suggesting reduced cognitive control (Hirsch et al., 2016; Schils et al., 2024)

Theories of cognitive control in task switching suggest that inhibitory processes may be critical in determining switch costs:

- reducing the interference of the previously relevant task or attention set (Koch et al., 2010).

## Aim of the Present Study

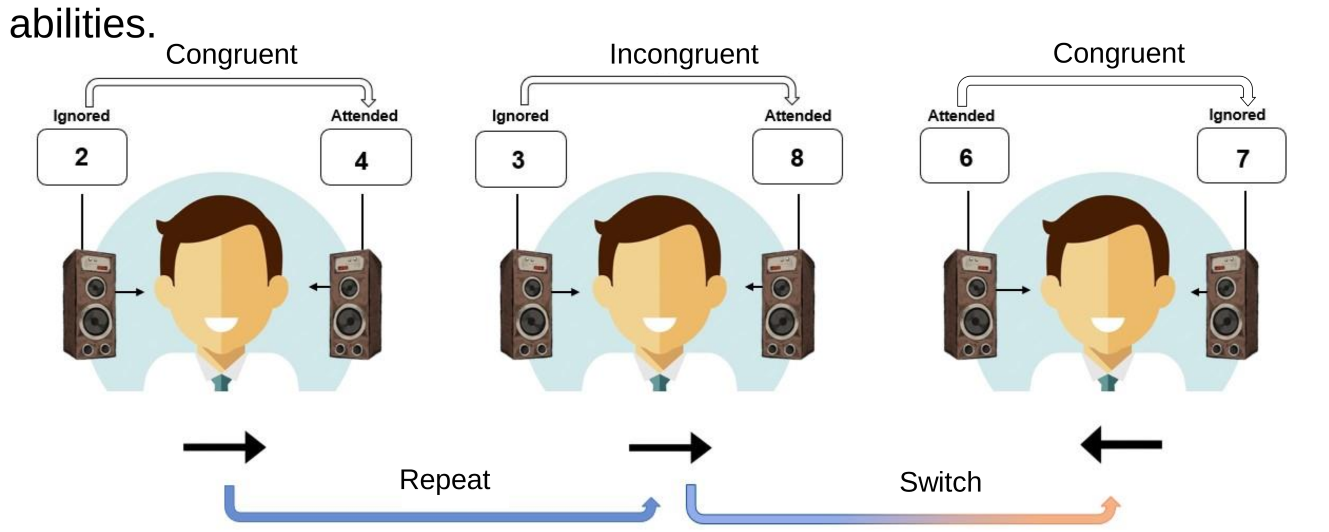
What explains age-related differences in attentional control during selective listening?

- Sensory decline
- Cognitive aging

Do auditory switch costs and congruency effect differ between age groups?

## The Present Study

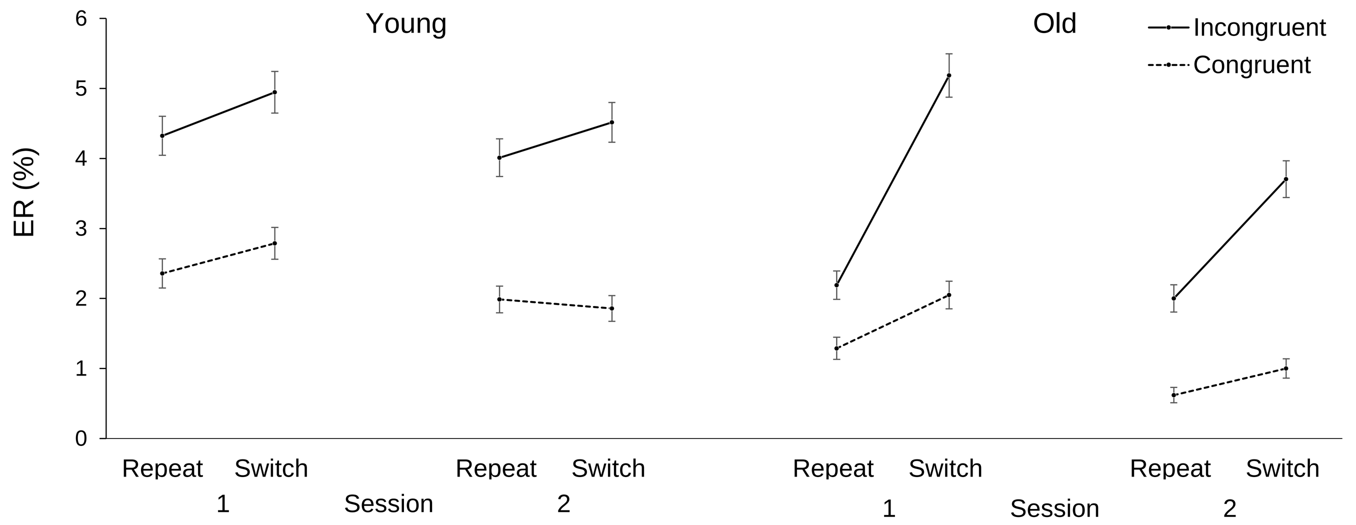
Using a cued selective listening task (Koch et al., 2011) and Pure Tone Audiometry, we assessed age-related differences during flexible auditory scene analysis and inter-individual differences in peripheral hearing abilities.




- Congruency (congruent vs. incongruent)
- Auditory attention switch (repeat vs. switch)
- Session (1 vs. 2)
- Age group (young vs. old)

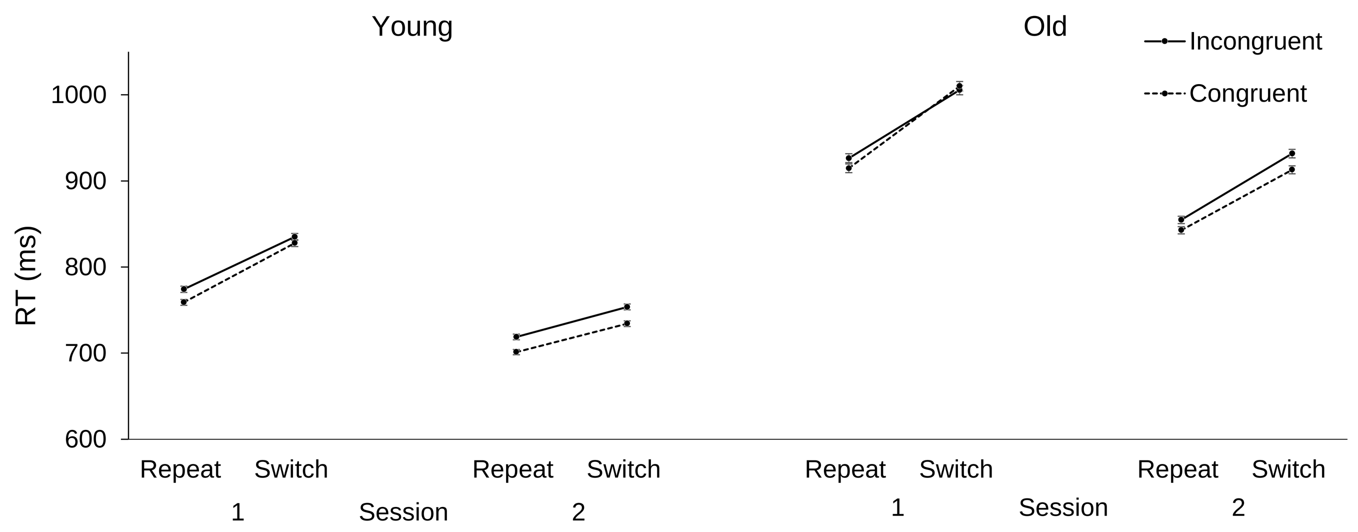
## Results

In Error Rate (ER), the old group showed larger switch costs (1.4%) relative to the younger one (0.3%), $F(1, 88) = 39.14$, $p < .001$, $\eta^2 p = .31$.




*Greater congruency effect during switch relative to repeat trials in the old (3.9% vs. 2.2%), but not in the young group (2.4% vs. 2.0%), $F(1,88) = 10.10$, $p = 0.02$, $\eta^2 p < .01$.*

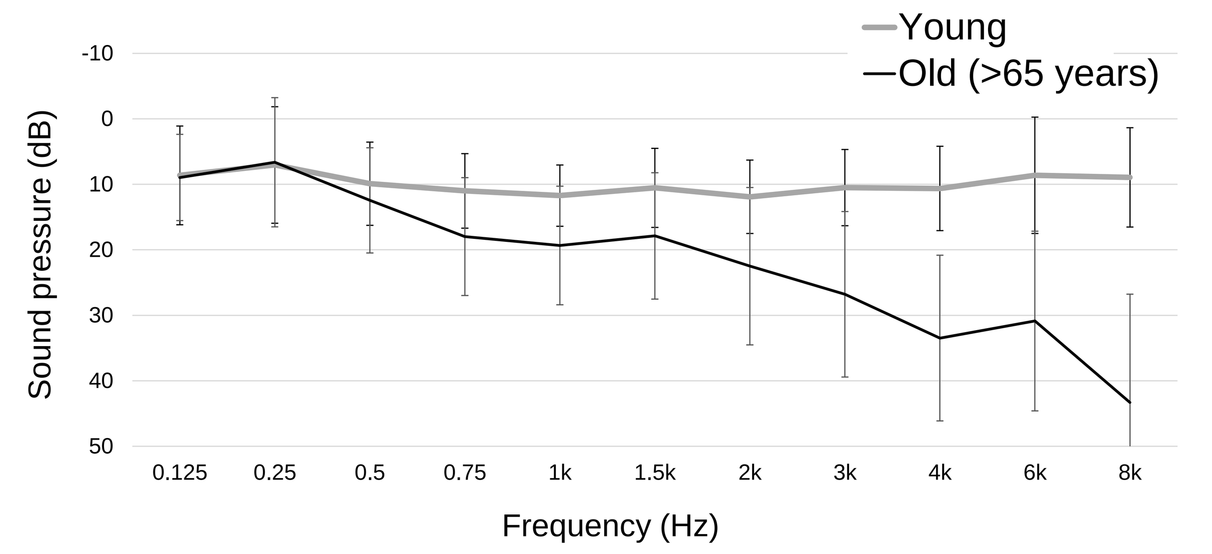
In Reaction Time (RT), the old group showed general slowing, $F(1,88) = 21.67$, $p < .001$, $\eta^2 p = .20$, and larger switch costs (79 ms) relative to the younger one (49 ms), $F(1, 88) = 15.92$, $p < .001$, $\eta^2 p = .15$




*Greater reduction of switch costs across sessions in the young group compared to older one (31 ms vs. 12 ms, respectively), $F(1, 88) = 3.77$, $p = .056$, $\eta^2 p = .04$. Log-transformed reaction time: $F(1, 88) = 4.98$, $p = .027$, $\eta^2 p = .05$.*

## Hearing Threshold: Pure Tone Audiometry (PTA)

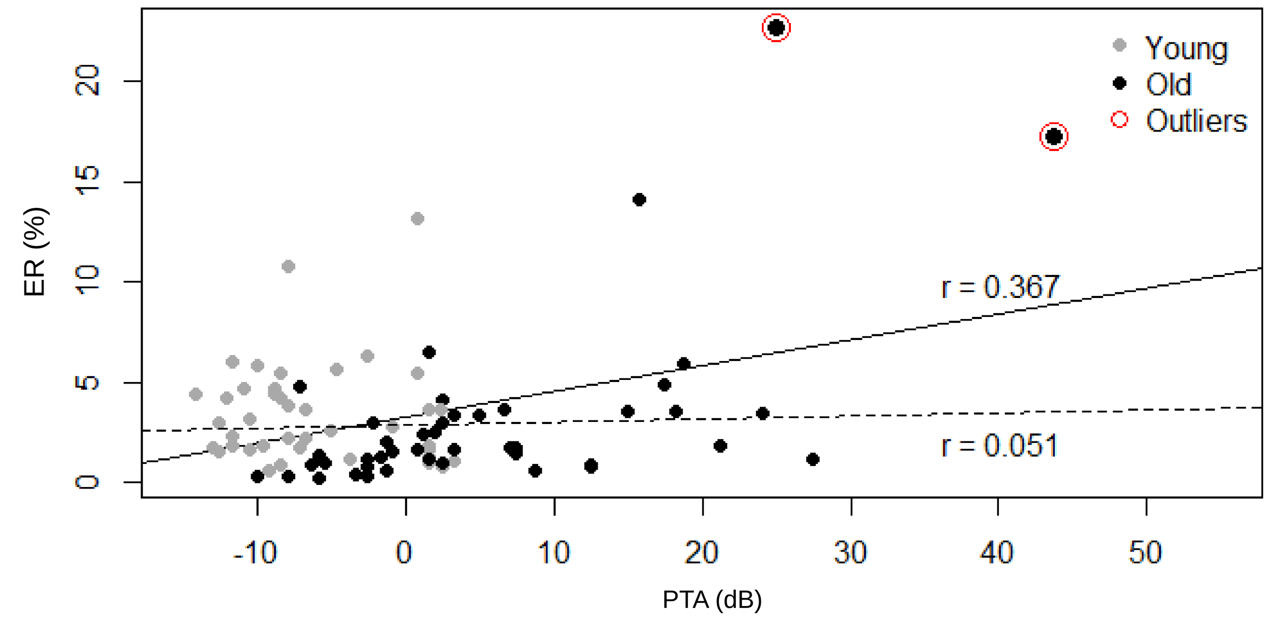
Participants' hearing abilities were assessed using Pure Tone Audiometry (young group: 8.93 dB; old group: 19.54 dB).



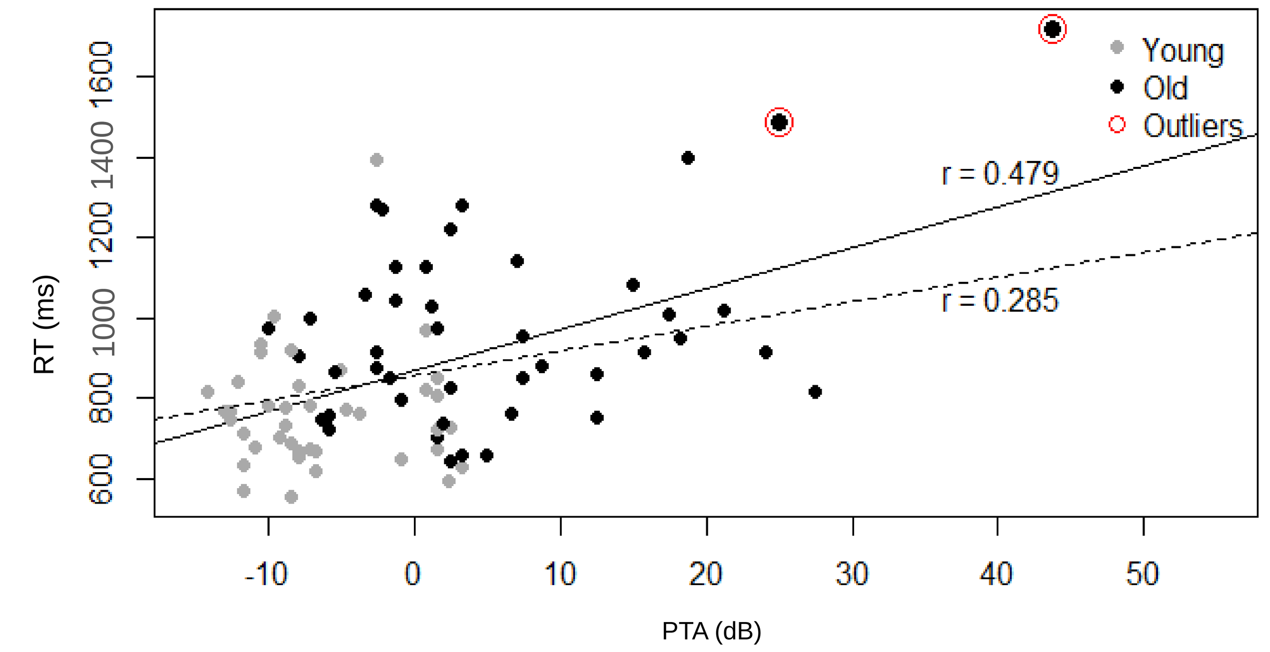

*Composite audiograms (young vs. old) indicating non-pathological ARHL (WHO, 1991). The old group showed a moderate sensory decline in higher frequencies.*

## Correlation Analysis

Hearing thresholds (PTA) were averaged across three frequencies: 500 Hz, 1000 Hz, and 2000 Hz (WHO, 1991).



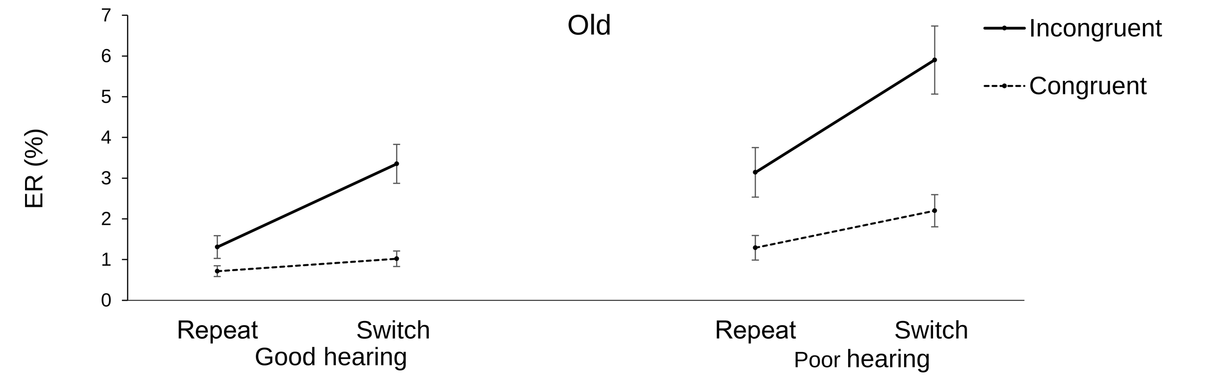

*The scatter plot shows a non significant relationship between hearing abilities (PTA) and ERs, $r = .05$, $t(90) = 0.48$, $p = .632$.*



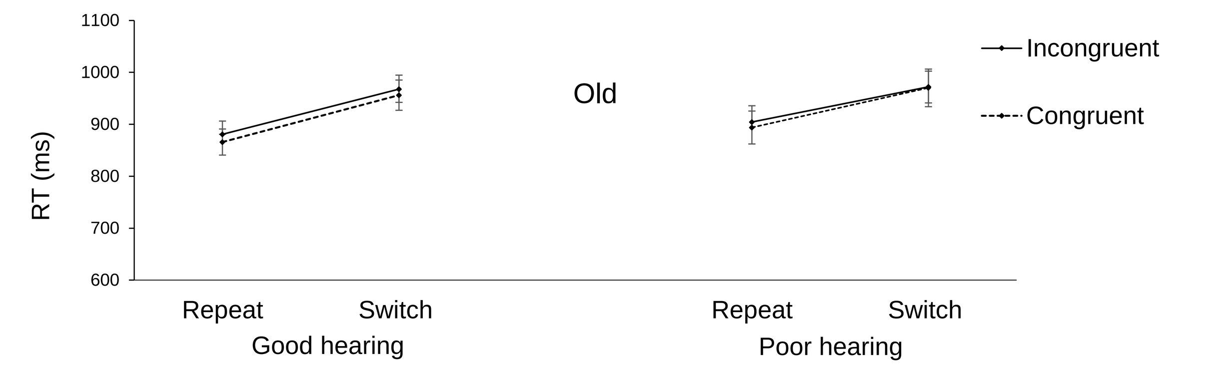

*The correlation between hearing abilities (PTA) and RTs was significant, $r = .28$, $t(90) = 2.82$, $p = .006$. The general slowing observed in the old group is influenced by their peripheral hearing abilities.*

## Median Split Analysis

PTA was a nonsignificant covariate in RT, $F < 1$, but was significant in ER analysis, $F(1, 89) = 3.84$, $p = .05$, $\eta^2 p = .04$. Old participants were divided based on the group's median hearing threshold (good vs. poor hearing)




*Old participants with poor hearing abilities were more error prone (3.1% vs.1.6%), $F(1, 43) = 5.21$, $p = .028$, $\eta^2 p = .108$.*




*No differences between old participants with good and poor hearing*

## Discussion

Poorer peripheral hearing abilities are associated with a general slowing of processing speed and, in the older group, are generally related to error rate (not specifically for incongruent trials). Our results suggest that, in the older group the performance impairment observed under adverse listening conditions, is not entirely due to sensory decline.

The greater switch cost observed in the old relative to younger group indicates that older adults experience greater difficulty in reconfiguring their attention set under flexible task demands (Hirsch et al., 2016).

Since, non-pathological sensory decline does not explain this performance cost, or the greater congruency effect observed during switch trials, the role of cognitive aging should be considered.

We propose that cognitive aging and deficit in inhibitory control processes, are critical in determining age-related impairments during flexible auditory scene analysis (Koch et al, 2010).

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