Auditory alpha power differences in younger and older listeners during speech prosody processing

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1.Background
Older adults have been shown to exhibit more listening effort in adverse speech conditions compared to younger adults and this has been associated to working memory and decreased processing speed performance (e.g., 1). Furthermore, it has been suggested that power in the alpha band is related to quality of the speech signal [3] and acts as an inhibitory mechanism for task irrelevant brain areas [4]. Speech prosody can be described as the suprasegmental acoustic features of spoken language, such as speech melody or stress patterns. Usage of prosodic speech information for spoken language recognition remains relatively stable in older adults [5]. Here, we look at the neuronal mechanisms underlying speech prosody perception in normal hearing older adults in comparison to younger adults.

2. Goals
Investigation of elementary speech processing differences between age groups
Examination of the role of alpha band in task-free listening
Exploration of the relationship between alpha modulations and age differences

3. Methods
•Subjects: older adults (n = 17, mean age = 73.12, age range 68-84, 8 female) and younger adults (n = 26, mean age = 24.44, age range 20-29, 16 female) with no reported hearing or language deficits
•Mismatch negativity paradigm
  •Stimuli: three syllabic German word differing in stress pattern (Fig. 1)
  •Standard stimulus (75% of trials), deviant (12.5% of trials)
  •FFT recording (sampling rate = 512, 128 electrodes, BioSens ActiveTwo)
  •Preprocessing (Brain Vision Analyser, Filtering 1-20 Hz, ICA)
  •FFT-based power analysis over entire word, alpha band power (8-10 Hz)
•Forced-choice pitch-discrimination an word-discriminating task
•Stimuli: three syllabic German word differing in stress pattern
•Accuracy (percentage correct responses)

4. Results
•Higher accuracy of younger adults in forced choice task (Fig. 2)
•Inverse correlation between lower alpha power and performance in young adults (Table 1 & 2)
•Higher lower alpha power in the deviant condition relative to the standard condition in younger adults (Fig. 3)

Conclusion
Alpha modulations are largely seen as indication of top-down processes [e.g., 3, 4]. Lower remaining lower alpha band power in older adults in the deviant condition relative to the standard condition might imply a higher cognitive resource allocation in older adults in order to inhibit novel, irrelevant acoustic information [3]. This would further imply that older adults struggle more with the inhibition of acoustic material, already on a elementary, task-free speech processing level. Further, the missing association between performance and lower alpha power in older adults in contrast to younger adults might indicate that older listeners already exhibit high levels of cognitive resource allocation. Source localizations of differences between groups in the right auditory related cortex might be due to a preference of the right hemisphere in the processing of slowly changing information, such as speech prosody [7]. In summary, these results point towards a presumably greater resource allocation in older adults reflected in smaller lower alpha power when processing prosodic cues, which in turn might be associated with the grater listening effort seen in older adults. Further research is needed to determine the relationship between listening effort, alpha modulations and inhibition processes in speech perception in old age.

References

Fig 1: Three-syllabic German word with different stress: a) the standard stimulus in the upper panel is stressed on the first syllable (1), b) the deviant stimulus in the lower panel is stressed on the second syllable (2). Local stress is indicated by blue arrows, syllable locations are indicated by red numbers.

Fig 2: Group performance in forced-choice-task of older (OA) and younger (YA) adults (* p < .05, error bars represent standard errors.

Fig 3: sLORETA [6] Source localization of contrast between young and old adults of differences between standard and deviant in alpha band power band.

Table 1: Correlation of lower alpha power in right auditory related cortex with accuracy in forced choice task with similar stimuli in young adults (left) and older adults (right).

Table 2: Correlation of lower alpha power in right auditory related cortex with accuracy in forced choice task with similar stimuli in old adults.

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