MP3 your A1! How frequent headphone-usage shapes your auditory cortex

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TARGET AUDIENCE: Neuroscientists, Neuroanatomists.

PURPOSE: It is well known that the brain is not anatomically static, but experiences plastic changes due to aging, learning, environmental influences, sleep, bodily injury, etc [1]. These neural changes are detectable using MRI in vivo [2-4]. For instance, the effect on the auditory cortex of the absence of auditory input in congenitally deaf people has been studied [4]. Usage of mobile phones and MP3 players continues to increase rapidly, leading to the question whether intense headphone usage might structurally influence primary auditory cortex A1 in humans. Myelination is efficiently indexed by measuring T1 relaxation [5,6], which enables the investigation of possible changes in cortical myelination.

METHODS: All experiments were performed on a 7 T whole-body MR scanner using a 24-channel phased array RF head coil. The study was carried out with ethical approval from the local university, and informed consent was obtained from the 12 subjects. The subjects completed a questionnaire regarding their usage of headphones (amount, subjective loudness, purpose, etc). To obtain the T1 maps, the MP2RAGE sequence was utilized [7]. The following parameters were used: TR = 5 s; TE = 2.62 ms; $T_{1/2}$ = 900 / 2750 ms; $FA_{1/2}$ = 5° / 3°; BW = 250 Hz/Px; $(0.5\ mm)^3$ isotropic voxel size. Both hemispheres were acquired separately and then merged. For analysis, ROIs spanning over 5 slices and containing 180 voxels were manually drawn in the core region of primary auditory cortex in each hemisphere. A1 was identified in two steps. First, a rough localization was performed using Heschl's gyrus as a landmark [8] as depicted in Fig. 1A (see yellow circle). Second, the ROIs (red box in Fig. 1B) were drawn in the area of locally decreased T1, which specifically identifies primary auditory cortex [9].

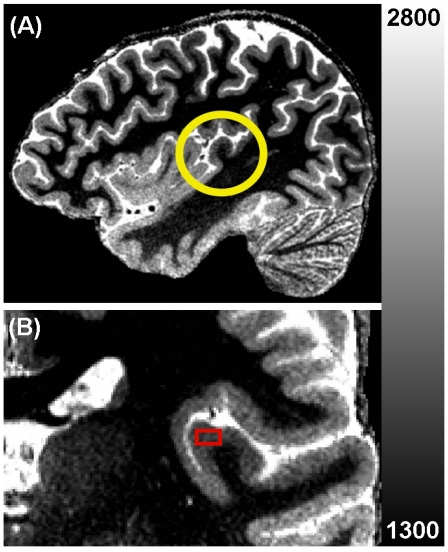

Fig. 1. (A) Sagittal view showing Heschl's gyrus. (B) Coronal view showing ROI used for analysis. Color bar represents T1 values in ms.

RESULTS: The relationship between T1 relaxation in primary auditory cortex and weekly headphone usage is shown in Fig. 2. A moderate correlation with an R^2 value of 0.52 was found. One subjects showed an outlier value of T1 in A1 of 1860 ms. Without this subject the correlation would reach significance ($R^2 > 0.6$).

DISCUSSION: Headphone usage was found to increase T1 relaxation rate in the primary auditory cortices A1 of adult human subjects, leading to the conclusion that it increases myelination in this cortical area. At first glance, such a result may be surprising as subjects who do not use headphones are also exposed to the daily auditory stimulation of normal life. However, almost all studies of brain plasticity use control subjects who also experience some stimulus to the area of interest, such as the "no-juggling" group in Draganski et al. [2], who certainly use their visual motion area V5 for normal purposes. We argue that it is the additional neuronal load on a highly specific brain area resulting from juggling training, or intense usage of headphones as in the present study, that leads to measurable effects such as the increased myelination that we have noted, and/or changes in cortical thickness or cortical folding [3].

CONCLUSION: Using T1 maps as a marker for myelin content we have shown a correlation between the frequency of headphone use and T1 relaxation in A1. This leads to the conclusion that frequent exposure to loud auditory stimuli increases myelination in primary auditory cortex.

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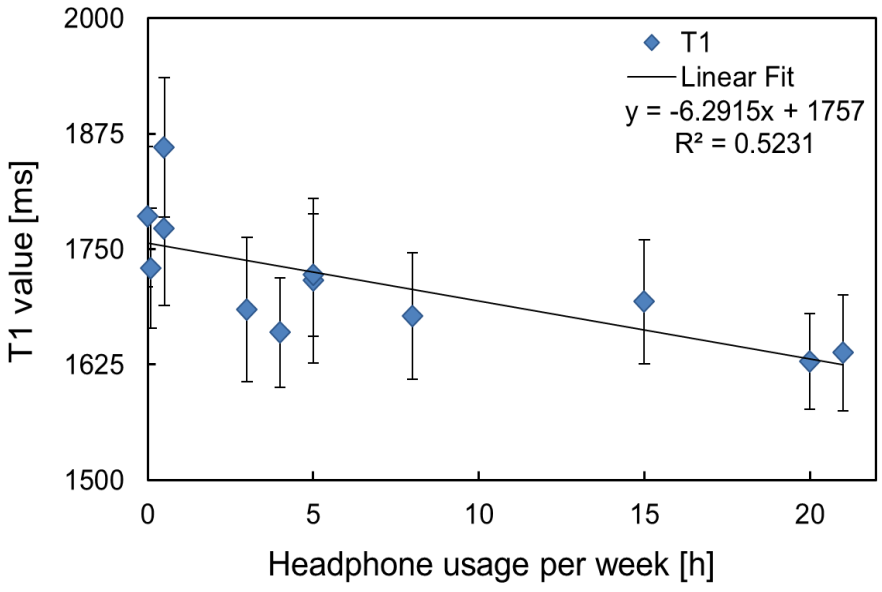

Fig. 2. T1 of A1 vs headphone use per week. Error bars show standard deviation.