The role of the corpus callosum in dichotic listening: A combined morphometrical and diffusion-tensor MRI study

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**Introduction**

The commonly observed right-ear advantage (REA) in verbal dichotic listening (DL) can be modulated by instructing subjects to attend exclusively to one ear (forced attention) \([1, 2]\). Consequently, auditory laterality may be best understood as an interaction of two components: a bottom-up or stimulus-driven component, which favors processing of right-ear input, and a top-down component or process that allows for the attentional modulation of the laterality effect. Recent studies on patients with a severed Corpus callosum (CC) provide evidence that not only the bottom-up REA but also its top-down modulation are related to the functional integrity of the CC \([3]\).

**Objectives**

The following questions were addressed: (1) Is the auditory asymmetry related not only to macro- but also to microstructural variations of the CC, and (2) does attentional modulation affect this relationship?

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**Material and Methods**

**Participants**

40 right-handed males (mean age: 23.7 ± 4.1 years); normal hearing (threshold <20 dB); interaural threshold difference <15 dB.

**Bergen Dichotic Listening**

108 pairs of consonant-vowel (CV) syllables (e.g., /ba-da/, /ga-ta/), presented via headphones in 3 blocks differing in attentional instruction (NF: non-forced; FL: forced-left attention; FR: forced-right attention); order was interindividually balanced: NF/FR/FL or NF/FL/FR; parameters obtained:

- left (L\%) and right ear scores (R\%)
- auditory laterality: ALS = (R\%/L\%)/(R\%/L\%)
- attentional gain: e.g., LEG = (FL\%L%-NF\%L%)/NF\%L%
- “non-attentional” reduction: e.g., LER = (NF\%L%-FR\%L%)/NF\%L%

**Magnetic-Resonance Imaging**

Anatomical imaging: T1-weighted SE (TE=14msec, TR = 500 msec); 9 sagittal slices (3mm, no gap); 256 x 256 matrix within a FOV of 256 x 256 mm²

Diffusion-tensor imaging (DTI) in 6 non-collinear directions (b = 600 sec/mm²); multishot EPI (TE = 98 msec, EPI factor: 17); 3 sagittal slices (4 mm, NSA = 16); matrix: 96 x 96; FOV: 128 x 128mm²; reconstr. 128 x 128 matrix; cardiac triggering and navigator echo motion correction; Postprocessing: voxelwise estimation of the diffusion tensor and calculation of the two quantitative parameters fractional anisotropy (FA) and mean diffusion (MD) from the eigenvalues of the tensor (see Figure 1; for an introduction to DTI see Ref. \([4]\)).

**Measurements of the CC**

Cross-sectional area, FA and MD for the total CC and its three subregions: genu, trunclus, and posterior third

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**Results**

**DL performance:** As shown in Figure 2, a significant REA was found in the NF condition. Forced attention to the right ear further increases the REA while directing attention to the left results in a loss of the ear advantage.

**DL and CC microstructure:** In the NF condition, FA of the posterior callosal third was inversely related to L\% (r = -0.40, p < 0.001). With FL instruction, R\% was negatively related to MD (r = -0.36, p = 0.02) and RER was positively related to MD (r = 0.34, p = 0.02) in the posterior third.

**Discussion**

- **Substantial associations of CC with ALS:** R\%, and L\% in the NF condition indicate that a stronger interhemispheric connectivity allows increased left-ear and decreased right-ear performance, leading to a reduction in ALS.
- **In accordance with Kimura’s structural model of DL:** L\% was positively related to CC microstructural variability of the CC.
- **Recently studies on patients with a severed Corpus callosum (CC) provide evidence that not only the bottom-up REA but also its top-down modulation are related to the functional integrity of the CC** \([3]\).
- **Since DTI-derived measures offer indirect information about brain tissue properties:** the negative FA/L\% correlation in the posterior third indicates that NF performance is affected by microstructural variability of the CC.
- **Finding no correlation of any area or DTI measures with the REG under FR instruction seems to be only little direct involvement of the CC in this condition.**
- **Contrary, concerning the FL condition, R\% and REG were correlated to MD in the posterior third.** Thus, it seems likely that here microstructural variations are of particular importance, since under FL instruction the top-down modulation works against the built-in REA. However, under FR instruction a callosal involvement might be less important since both top-down and bottom-up component promote superior right-ear performance.

**Conclusion**

The results indicate a dual role of the CC: it not only subserves the bottom-up transfer of left-ear information to the left hemisphere, but it is also involved in the attentional modulation occurring in the FL condition. As recently proposed \([2]\), these functions may be supported by different callosal channels, one channel consisting of large-diameter axons responsible for rapid interhemispheric transfer of sensory information, and a second channel involving the small-diameter fibers that may mediate the allocation of attention to the left ear.

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**References**


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