The TFS I-test reveals mild hearing loss

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Introduction
Growing evidence suggests that hearing-impaired listeners are much less able to extract information from the temporal fine structure (TFS) of a sound signal than normal hearing listeners (Hopkins et al., 2008; Santurette and Davi, 2006). This is in surprising contrast to the ability to make use of the temporal envelope of the sound, which seems to be relatively well preserved in hearing-impaired listeners. One way to better understand the TFS phenomenon would be to investigate possible correlations between individual variations in a clinical psychophysical TFS test and the real-world consequences that a hearing-impairment may cause. If such a correlation was found, an important link between TFS deficits and real-world problems would be established.

The current study investigates the usefulness of the TFS I-test (Moore and Sek, 2009) as a diagnostic tool by comparing the results from hearing-impaired (HI) and normal hearing (NH) listeners.

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Participants

Subjects included 19 listeners with mild to moderate hearing loss. Subjects ranged from 30 to 82 years, with a mean age of 62 years. Air-bone gaps were 15 dB or less and tympanograms were normal. The HI listeners showed no dead regions, as assessed using the ‘TEN HL test’ (Moore et al., 2004). Furthermore, 8 listeners with normal hearing were included, aged from 26 to 43 years, with a mean age of 36 years. The NH listeners had hearing thresholds of 20 dB or below and no history of hearing problems.

Experiment 1

Participants
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TFS test
Listeners discriminated harmonic and frequency shifted tones. The phases of the components were selected randomly for every stimulus. Both complexes had an envelope repition rate equal to F0, but differed in their TFS. To prevent discrimination based on spectral cues, all tones were passed through a fixed band pass filter. A background noise was used to mask combination tones (Moore & Sek, 2009). The stimuli were presented over headphones to the best ear.

Fig. 2. Reproduction of test stimuli. The left column shows conditions with F0 = Fc, the middle column shows harmonic and frequency shifted tones which have a similar envelope repetition rate but different TFS.

Results experiment 1
The task training conditions F0 and N5 showed that the test procedure was well understood by both NH and HI listeners, as reliable thresholds were obtained in most – if not all – cases. For the N11 test conditions, the TFS test measured the degree of sensitivity to TFS for NH listeners only; it was very difficult or impossible to get reliable TFS thresholds for any of the HI listeners in the test conditions (N11). This suggests that the HI listeners either had no TFS abilities left above 1 kHz or that the test was not sensitive enough. It was concluded that the test needed further development in order to measure the degree of remaining TFS-abilities among the HI listeners.

Discussion and conclusion
On both the TFS I-test and the TFS I.5 test, a rather binary result was found for most NH listeners, the test measured the degree of sensitivity to TFS. Most HI listeners, on the other hand, scored no better than chance. It seems that if a listener has a hearing impairment severe enough to benefit from a hearing aid – all subjects tested were hearing aid users - then a failure on the TFS I and TFS I.5 test is predicted. These findings are in line with other experiments showing that elevated audiometric thresholds have a severe impact on sensitivity to TFS as measured with similar stimuli (Anderson et al., 2010; Hopkins et al., 2010).

Further research is needed to establish whether the TFS I-test can distinguish between NH and even milder hearing loss than included in the current study.

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