# Binaural temporal fine structure sensitivity in typically developing, normal hearing children.

S. A. Flanagan, B. C. J. Moore, A. M. Wilson, F. C. Gabrielczyk, A. MacFarlane, K. Mandke, and U. Goswami
Centre for Neuroscience in Education

**Speech in noise perception** has been shown to mature over the first 10 to 12 years of life (Corbin et al 2016). Research so far has been inconsistent regarding which aspects of hearing is limiting speech in noise perception in children.

**Speech can be modelled** as a rapidly oscillating carrier signal, called the Temporal Fine Structure (**TFS**), with a slower varying envelope (**ENV**), as shown in Fig. 1.

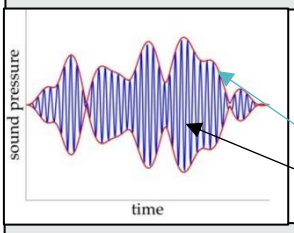


Figure 1. Simplified Speech ENV and TFS

ENV cues carry the speech information (Shannon et al., 1995) whereas TFS cues have been found to aid speech intelligibility in background sounds.

**Binaural hearing** makes use of the *differences* in *timing or phase* (ITD/IPD) and *level* (ILD) of the sound that arrives at the ears. This results in Spatial Release from Masking (**SRM**), the perceptual separation of signal from interfering sources. For adults this enhances speech intelligibility by 6 - 7 dB. (Hawley, 2004; Swaminathan et al., 2016).

**Methods**: 63 typically developing children (33 male, age approx. 5½ - 9 ½ years).

**Measuring Binaural TFS (bTFS).** Following the TFS-adaptive frequency paradigm developed by Fullgrabe et al. (2017), stimuli started at the lowest frequency (200 Hz) and used a two up one down method. This measured the highest frequency at which an interaural phase difference (IPD) of φ° can be distinguished from and IPD of 0°.

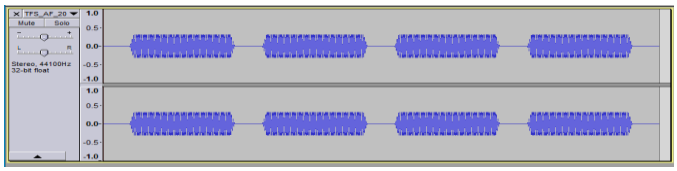

Figure 2. A stimulus consisted of 4 tones either all in phase, or alternately in phase and out of phase by φ = 180° or 30°. Sensitivity to the alternating phase gives a sense of a 'wobbling' tone.

**Results** show that the upper frequency limit for children was significantly lower than young normal hearing adults ($p<.001$), for both phase angles, with φ = 30° significantly harder than φ = 180°.

**Regression analysis** showed that age significantly predicted bTFS with adult thresholds estimated to be 10 years 2 months for a binaural phase shift of φ = 180°.

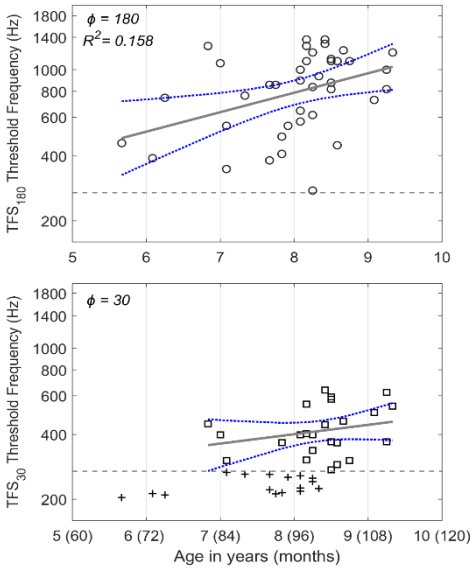


Fig.3. Chance performance threshold (dotted line) was exceeded by 40 of 63 children for φ = 180°

**Discussion**

- These findings are consistent with the current understanding that the auditory system continues to develop into the early teens (Litovsky, 2015).
- The relatively poor binaural TFS processing abilities of children may limit the SRM that occurs for them (especially at small angles) when listening to speech in the presence of spatially distributed interfering sounds.

For references and further details see:
Flanagan, S., Moore, B. C. J., Wilson, A. M., Gabrielczyk, F. C., Macfarlane, A., Mandke, K., Goswami, U. (2021). Development of binaural temporal fine structure sensitivity in children. *The Acoustical Society of America, 150, (4)*
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