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Hidden hearing loss with envelope following responses (EFR): The off-frequency problem

Gerard Encina-Llamas¹, Aravindakshan Parthasarathy², James M. Harte³, Torsten Dau¹, Sharon G. Kujawa², Barbara Shinn-Cunningham⁴ and Bastian Epp¹

¹ Hearing Systems, Technical University of Denmark (DTU) - ² Harvard Medical School (MEEI-HMS) - ³ Interacoustics Research Unit (IRU) - ⁴ Boston University (BU)

Introduction

Recent animal studies have shown that noise over-exposure can cause the loss of auditory nerve (AN) fiber synapses without causing hair cell loss (see Kujawa and Liberman (2015) for a review). This AN fiber synapses loss has been termed “hidden hearing loss” or “synaptopathy”, since it is not reflected in the traditional pure-tone threshold. The envelope following response (EFR) has been proposed as a potential objective method to assess synaptopathy in humans (i.e., Bharadwaj et al., 2015). Encina-Llamas et al. (2016) reported different trends in EFR level-growth functions recorded using two modulation depths in normal-hearing (NH) and mild-hearing-impaired (HI) listeners. The EFR is a gross cephalographic potential that represents the encoding of the envelope of the stimulus, arising from synchronized neural activity from all excited frequencies and fibers. In this study, a computational model of the AN was used to investigate the effects of off-frequency contributions (i.e., away from the characteristic place of the stimulus) and the differential loss of different AN fiber types on EFR level-growth functions.