**Simultaneous detection of envelope frequency following responses and cortical responses to words using the Hotelling’s T2 Test**

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**Objectives:** Objective detection of responses to natural speech stimuli may have application to assess speech reception in people who are not able to respond reliably on behavioural tests (such as infants). Ideally, these tests would allow simultaneous measurement of speech processing by the auditory brainstem and cortex, such that audiologists can analyse the functionality of the auditory system at multiple levels. The use of natural speech could also be beneficial in optimising hearing aid fitting, as it would allow observation of the effect of the hearing aid settings to ecologically relevant stimuli. In the current work the feasibility of detecting objective brainstem and cortical responses to words using the electroencephalogram (EEG) was investigated.

**Design:** Four repeated words were presented sequentially at 70dBA through ER-2 insert earphones to 12 normal hearing adults. The stimuli consisted of a prolonged vowel in a /hVd/ structure (where V represents different vowel sounds). Each stimulus was presented over 440 sweeps (220 condensation, 220 rarefaction). Stimuli were presented at a rate of one per second. EEG data were collected from 12 normal hearing adult participants. After pre-processing and artefact removal, brainstem responses were analysed based on envelope frequency following response (eFFR) detection. Strength of the eFFR was assessed using the Hotelling’s T2 test (HT2) in the frequency domain. This test allows response detection at multiple frequencies simultaneously, including both spectral amplitude and phase characteristics of the response. In this study, eFFRs were detected based on characteristics at the glottal frequency and its first two harmonics. Cortical responses were analysed using HT2 in the time domain. For this purpose, evoked responses over the 1-second segment were divided into 100 millisecond segments. To test whether a response could be detected beyond the onset response, a further test was performed on the first 5 segments (including the onset) and the last 5 segments (excluding the onset).

**Results:** EFFRs could be detected for 83% of 48 tests (4 wordsx12 participants), with each participant showing a response for at least one of the stimuli. Median response detection time was 72s (interquartile range 50-121s). Detection success and time showed strong inter-individual variability. Cortical responses could be detected in 98% of tests when including the complete response, and 85% of tests when excluding the onset response, with at detection time of 53s (interquartile range 31-104s).

**Conclusion:** The study shows a paradigm for simultaneously analysing brainstem and cortical responses to ecologically relevant stimuli on subjects with normal hearing thresholds using the HT2 test. Responses can be detected within a time interval relevant for clinical environments. Inter-individual variability in eFFRs suggests the use of multiple stimuli would be beneficial for appropriate assessment of hearing function.