

Neutral Entrainment to Speech Envelope in Response to Perceived Sound Quality

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Research Project Goals:

- ◆ To examine the neutral entrainment to continuous speech in an adverse environment and its relationship to perceived sound quality
- ◆ To determine if EEG reflects a neural activity that follows the speech envelope under a noisy environment.

Research Project Overview:

- ◆ **Subjects:** 8 native English speakers were recruited to participate in this experiment.
- ◆ **Stimuli:** The stimuli were adjusted to three sound pressure levels (75, 65, and 55 dB). The stimuli were mixed with the white babble noise generated at three SPL's (75, 65, and 55 dB) at different signal-to-noise ratios and speech levels.
- ◆ **Neural Responses:** Continuous EEG was pre-filtered in 0.3-50 Hz range, notch-filtered at 60 Hz, sampled at 1,024 Hz, and recorded from 32 electrodes positioned according to the extended International 10/20 placement map. EEG was fragmented into epochs synchronized with stimulation. Each epoch was baseline-corrected and filtered with a CAR spatial filter to reduce surface currents.
- ◆ **Procedure:**
 - ◆ Speech stimuli and EEGs were down-sampled to the same sampling rate 256 Hz. Time lags are from 0 to 500 milli-seconds. Multivariate Temporal Response Function (mTRF) was implemented to reconstruct EEGs and speech envelope.
 - ◆ EEG reconstruction uses every pair of a speech stimulus and corresponding EEGs.
 - ◆ Speech stimuli and EEGs were down-sampled to 64 Hz. Speech reconstruction from model re-generated
 - ◆ using all clean speech stimuli and corresponding EEGs; test against noisy speech
 - ◆ using all noisy speech stimuli and corresponding EEGs; test against clean speech.
 - ◆ The EEG and speech reconstruction were assessed based on Mean Squared Error (MSE) and Correlation (Rho).

Project Conclusions/Outcomes:

- ◆ Neural entrainment activities to speech are best observed at Front-Central electrodes.
- ◆ Noisy speech, where listeners have less difficulties to perceive, tends to be rated higher in perceived sound quality.
- ◆ Neural entrainment to speech occurs most within the first 50 milli-second window.

Research Project Results:

Subject	1	2	3	4	5	6	7	8
Speech at 75dB SPL								
MSE (10E-3)	171	413.72	484.04	565.76	160.93	270.04	207.66	344.9
Sound Quality	10	10	6	6	10	10	10	7
Speech at 75dB SPL + Babble noise at 55dB SPL								
MSE (10E-3)	160.02	400.57	508.9	563.46	232.41	272.65	213.80	341.1
Sound Quality	9	9	7	10	6	8	9	6
Speech at 65dB SPL								
MSE (10E-3)	184.39	488.74	499.24	589.07	313.11	275.21	246.43	262.2
Sound Quality	10	8	5	10	10	10	10	7
Speech at 65dB SPL + Babble noise at 75dB SPL								
MSE (10E-3)	161.45	404.91	491.09	556.91	208.95	271.08	210.32	345.5
Sound Quality	3	2	1	2	1	3	3	2

Table 1: Accuracy and sound quality of EEG prediction across participants for sentences at 65 & 75dB SPL and same sentences with babble noise at 55 & 75dB SL at Cz position

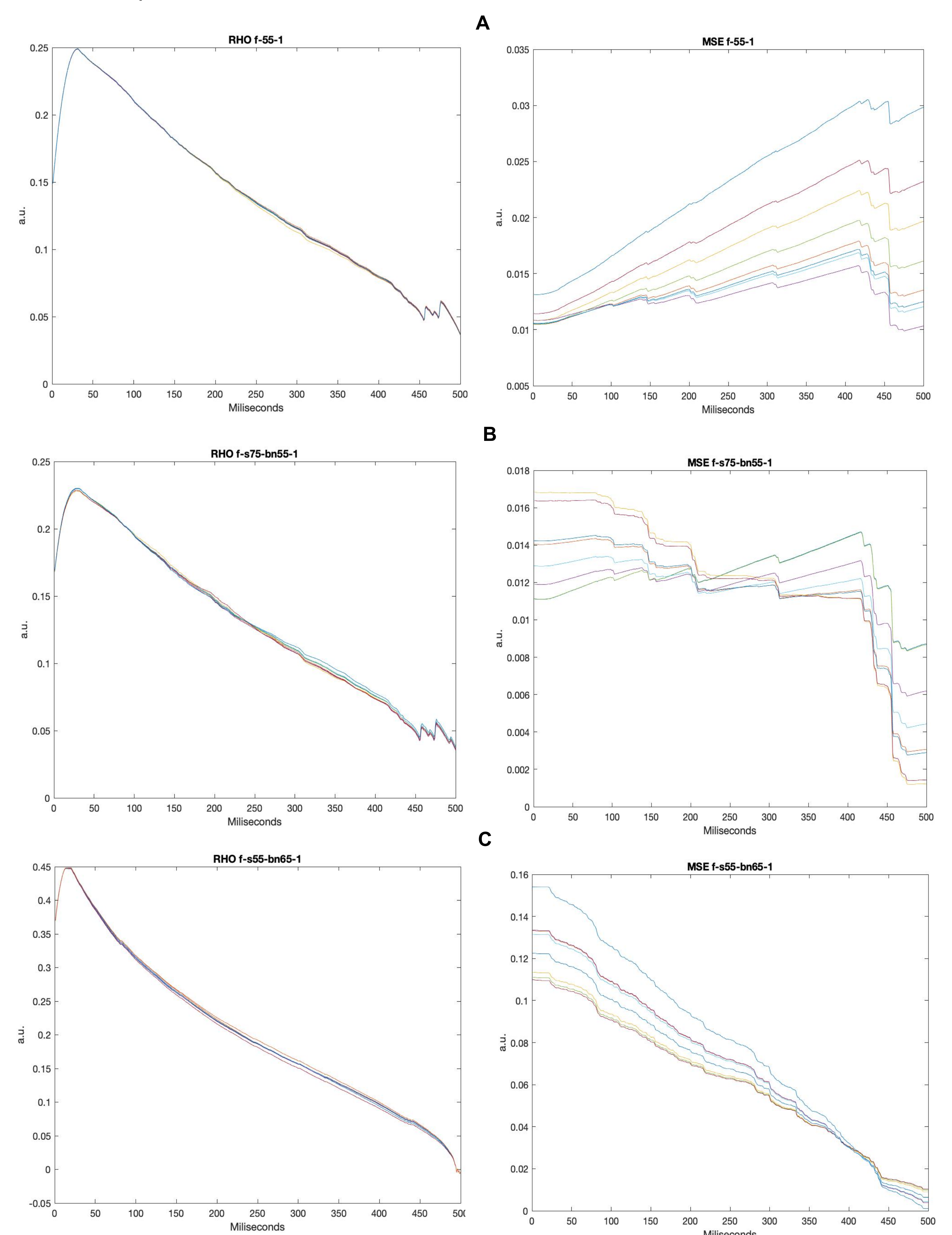


Figure 1: RHO and MSE between Original and Reconstructed Speech of (A) Speech at 55 SPL, (B) Speech at 75 SPL and Babble Noise at 55 SPL, (C) Speech at 55 SPL with Babble Noise at 65 SPL.