Phonemic effects on the Human Brain, as seen with EEG
A Pilot Study

A pilot study was undertaken by BSI, contracted by Dr Pillai, to evaluate the effect of the Phonemes used in his work on the human Brain. We utilized the EEG to see whether there were measurable systematic effects of the phonemes, as well as effects of the lateralization of the "focus" of the listener either to the right or to the left. A small pilot was proposed to look for initial findings, and allow an objective design of a more complete study.

Three healthy young individuals volunteered locally and agreed to listen to the recorded phonemic protocol and have their EEG recorded, with payment for their time at 50 dollars for the time used for the recording. Their EEGs were recorded, with 75 seconds of EEG recording during each of the conditions, from baseline, phonemes, and lateral focus all recorded in various segments of the EEG. One subject performed both the listening phonemic protocol and vocalizations of the phonemes.

The EEGs were recorded on Mitsar 201M amplifiers with 0.5-70 Hz bandpass, and a 60 Hz notch filter. Caps (ECI) were used for the electrode placement and impedances were all lowered to below 5K Ohms and above 1K Ohm. The EEGs were all of good technical quality, with residual eye movements de-artifacted using ICA software (WINEEG and Matlab). The remaining segments generally had 70 seconds of quality EEG data available for further analysis, allowing for a stable spectral profile to be acquired for each "state". The three subjects were summed and averaged, with the vocalization subject compared to the group norms.

The analysis was performed blinded to the intent of the study by the Chief Technologist at the Institute for the Human Brain in St. Petersburg, Russia, Sergey Evdokimov.

The initial processing with classical FFT summary spectra provided very subtle findings, as the phoneme's impact was lost within the summation of the brain's functional components seen as the raw spectral plot. The effects were masked, and a larger number of subjects would traditionally have been needed, but an additional analysis technique was applied: ICA analysis of the cleaned EEG. The ICA decomposed the raw EEG into the maximally independent generators of spatio-temporal patterns in the EEG of various spectral features.

These independent components are individually predictive of a smaller percentage of the total EEG power, and thus the phonemic sounds' impacts within these components allows a signal-to-noise ratio which permits the visualization of these subtle differences. These changes between phonemes, and also with respect to the lateralization of the perceptual focus were thus easily seen. These impacts of the focusing of perceptual intent is directed by the midbrain's sensory and processing relay and orchestration of these components.

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The images that follow illustrate lateralization of focus effects in components #3, 4, 5, 9, 16, with vocalizations seen in component 13 with no phonemic effects… and phonemes in component 11 with no vocalization effect. In many of these there is a shifting of prominence within the same spectral feature. In others there may be frequency-specific spectral responses. The components that show the differential effects of phonemes and vocalization are quite dramatic.

We cut down the analysis complexity by eliminating additional lateralization effects, limiting the processing to phonemes and simple lateralization effects. The additional data was all preserved for later analysis if desired.

The impact of these findings is that we have selected the analysis approach which is maximally sensitive to the impacts of the phonemes and focusing of perceptual intent, and can provide an estimation of effect size requirements for selecting an appropriate size for the final study. The additional sensitivity of the analysis approach to the effects of the phonemes allows a smaller N than if the effect was less easily differentiated.

View the following PPT by advancing and reversing the slides between pairs of component images, to see the difference in effects between slides in the spectral display below the map of each of the components as the focus is shifted right and left for these phonemes. The two last slides are vocalization and phoneme specific components.

Though more detail was seen in the recorded EEG data, the small number of subjects limits our focus to only the most striking effects seen in the recorded data.

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