Neural correlates of learning to encode language in music

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A musical speech surrogate encodes language into a non-speech modality for transmission. These include flutes, “talking drums”, and many others (see [1] for an overview). Neural processing of speech surrogates is almost entirely unstudied due to the rarity of their practice. An exception is an fMRI study on Silbo Gomero, a whistled speech surrogate from the Canary Islands that is non-musical and utilizes no instrument, which found that practitioners recruited left hemisphere temporal lobe regions associated with language processing while listening to whistled speech [2].

Seenku (a language of Burkina Faso) can be encoded and played on a balafon, a West African xylophone constructed of resonator gourds beneath wooden keys struck by a mallet. The current study presents results of an experiment with N=4 non-Seenku speaking university students in the United States who learned how to play the balafon – which included learning how to use it as a speech surrogate – from an expert practitioner.

Participants underwent two testing sessions: one at the beginning of their balafon learning, and one after approximately 6 weeks of lessons. Participants passively listened to stimuli while data were recorded on a 14 sensor EEG system (Emotiv Epoc X).

Four types of stimuli were compared: (1) Seenku speech (2) balafon playing devoid of any linguistic content (3) balafon “singing” (playing a melody with lyrics) (4) balafon speech surrogacy. The Seenku speech condition was the most acoustically distinct to the naïve ear as it was human speech, whereas the other conditions were produced by the balafon.

An ERP analysis revealed that the second session showed increased activity at several electrodes, including F7 which has been previously implicated in language learning [3]. Crucially, comparisons of topographic maps of the sessions show the most dramatic difference in the balafon speech surrogacy condition, suggesting students were not merely acquiring this form as a musical practice, though future work could examine band frequencies sensitive to musical training [4]. Overall, this study supports the notion that language processing is flexible enough to extend to other auditory domains beyond the speech modality, even with minimal training.

References

[1] McPherson, L., & Winter, Y. (2022). Surrogate languages and the grammar of language-based music. *Frontiers in Communication*, *7*, 838286.

[2] Carreiras, M., Lopez, J., Rivero, F., & Corina, D. (2005). Neural processing of a whistled language. *Nature*, *433*(7021), 31-32.

[3] Soman, A., Madhavan, C. R., Sarkar, K., & Ganapathy, S. (2019). An EEG study on the brain representations in language learning. *Biomedical Physics & Engineering Express*, *5*(2).

[4] Schalles, M. D., & Pineda, J. A. (2015). Musical sequence learning and EEG correlates of audiomotor processing. *Behavioural neurology*, *2015*(1), 638202.

Figures

Figure 1: EEG topography of students beginning Balafon training. Times from stimulus onset

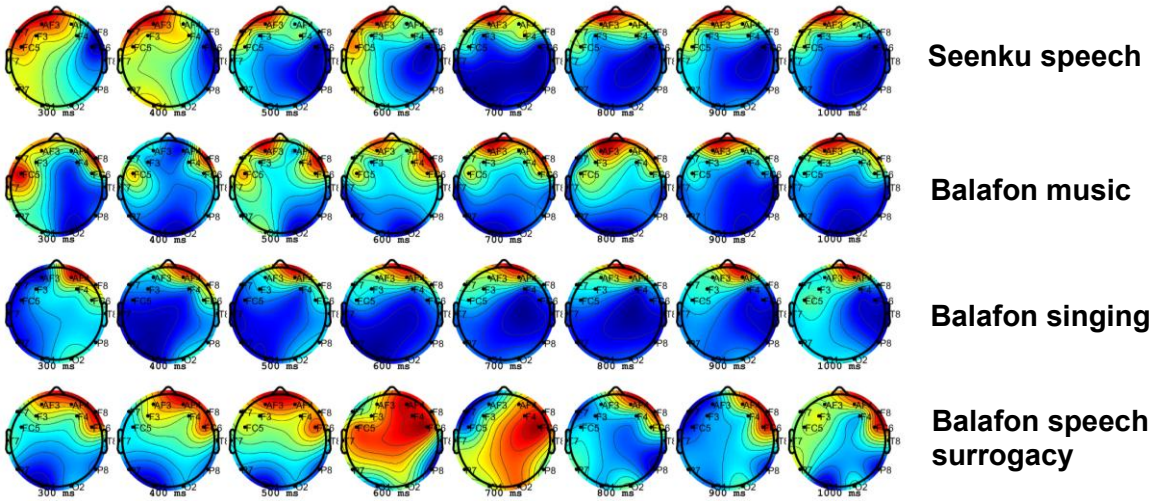

Figure 2: EEG topography of students with six weeks training. Times from stimulus onset