

Using the NEF-SPA Approach to Build a Neurobiologically Plausible Large-Scale Brain Model for Speech Production and Perception

Bernd J. Kröger

Medical Faculty, RWTH Aachen University, Aachen, Germany

Kröger Lab Belgium, www.speechtrainer.eu

Abstract:

The NEF-SPA approach (Neural Engineering Framework combined with the Semantic Pointer Architecture; Eliasmith et al., *Science* 2012, 338, 1202–1205) enables the construction of neurobiologically plausible large-scale brain models that integrate cognitive, sensory, and motor functions. This framework has been successfully used to simulate various tasks, including copy drawing, digit recognition, reinforcement learning in a three-armed bandit task, and fluid reasoning.

In the present work, this approach is applied to model the central cognitive and sensorimotor components involved in speech processing—both production and perception. The model can incorporate neurofunctional deficits to simulate specific neurogenic speech and language disorders.

Our current implementation (Kröger & Bekolay, 2025, *Language, Cognition and Neuroscience*, 40, 616–639) allows the simulation of normal and impaired word production, word perception, and the generation of short sentences. Presently, the model is being used to simulate diagnostic scenarios such as question-answering tasks, as found in clinical speech-language screenings.

This poster presents the model's architecture and explores its potential for simulating speech acquisition, relearning, and rehabilitation.