Brain-to-Brain Communication
Enabled with Intracortical Microstimulation

ABSTRACT:

We proposed that direct communication between brains of rats would be studied in animals chronically implanted with multi-electrode arrays in multiple brain areas. The aims were: 1) Establish a Brain-to-Brain Interface (BtBI) using cortical correlates of motor performance; 2) Establish a BtBI using cortical correlates of active tactile performance; and 3) Demonstrate remapping of the primary somatosensory cortex (S1) in the decoder rat after successful BtBI interaction. We later tested the same principle in other species (monkeys). First, we proposed that extending this network of brains - a Brainet - processing information in real time could be the basis for a new type of organic computing architectures. We successfully demonstrated the Brainet principle in two studies where primates or rodents performed tasks that required cooperation between multiple interacting brains. Brainets of two or three monkeys, working in separate rooms, controlled a virtual arm using a brain-machine interface (BMI) with visual feedback. Groups of three monkeys working cooperatively were able to perform tasks that no monkey could complete alone (e.g. Brainet control of an avatar arm in three dimensions, each monkey could only control two dimensions). We found that as animals learned to control the BMI, their neural activity became more correlated and the performance in the task improved. We used brain-to-brain communication to transfer information between multiple interacting brains to solve a variety of fundamental computational problems. Using different Brainet architectures, we built a proof of concept for an organic computing device that could classify stimuli, store tactile memories, and perform sequential and parallel computations.

Keywords
Communication, Brain-to-Brain Interface, Multielectrode, Sensorimotor

Published Work:

Pais-Vieira, M., Chiuffa, G., Lebedev, M., Yadav, A., & Nicolelis, M. A. (2015). Building an organic computing device with multiple interconnected brains. *Scientific Reports, 5*: 11869. doi:10.1038/srep11869

Ramakrishnan, A., Ifft, P., Pais-Vieira, M., Byun, W., Zhuang, K., Lebedev, M., & Nicolelis, M. A. (2015). Computing Arm Movements with a Monkey Brainet. *Scientific Reports, 5*: 10767. doi:10.1038/srep10767

Pais-Vieira, M., Lebedev, M., Kunicki, C., Wang, J., & Nicolelis, M. A. (2013). A brain-to-brain interface for real-time sharing of sensorimotor information. *Scientific Reports, 3*: 1319. doi: 10.1038/srep01319

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