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Project Summaries

BrainsCAN

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Developing a mechanistic understanding of crossmodal reorganization following sensory loss

BrainsCAN, Western University

Blake E. Butler

Brian Allman

Ravi Menon

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Developing a mechanistic understanding of crossmodal reorganization following sensory loss

Background

Deafness dramatically alters brain structure and function. It has significant perceptual, social and economic impacts, much beyond just the loss of hearing. Social and cognitive development can be significantly impaired in children with hearing loss and age-related hearing loss has also been shown to accelerate cognitive decline in the elderly. It can result in social isolation and impairments to memory, attention and problem-solving.

Decades of research and development aimed at restoring sound sensation has allowed clinicians to recreate the sense of sound for both children and adults with profound hearing loss using cochlear implants. While a hearing aid typically amplifies sound so that it can be detected by damaged ears, a cochlear implant is an electronic device that picks up sound from the environment (with a microphone sitting behind the ear) and converts it to electrical impulses. These impulses are transmitted to an electrode array implanted in the ear that directly stimulates the auditory nerve. The cochlear implant is the most advanced prosthesis for restoring one of our senses and there are more than half a million devices implanted worldwide.

The Problem

While many children who receive an implant go on to acquire normal spoken language by school age, a subset of children never get the full benefit of restored sense of sound. We believe this difficulty reflects reorganization of neural circuits that would normally process sound to instead contribute to other senses (e.g. vision, touch). This phenomenon is known as plasticity; it's seen in normal brain development as we grow and learn, but it is also how the brain responds to damage or atypical experiences during development to find alternative ways to replicate important brain functions.

While plasticity leads to enhancements of the remaining senses that may help compensate for hearing loss, these changes may also prevent the brain from optimally processing sound once a cochlear implant has been provided.

Funding Program

BrainsCAN Accelerator Grant:
Full

Awarded: \$447,675 over 3 years

Additional BrainsCAN Support

Imaging Core
Rodent Cognition Core
Computational Core

Western Faculty, Group or Institution

Department of Psychology,
Faculty of Social Sciences

Keywords

Hearing & auditory perception,
neuroplasticity, fMRI

Related

[Project Summary: Imaging visually-evoked cortical activity](#)

The Project

Our long-term goal is to understand how plasticity reshapes circuits in the brain in response to atypical early experiences. This will allow us to better understand how the Deaf brain processes the world around us, and will make clear the challenges that must be overcome to optimize the function of cochlear implants and prostheses designed to restore sensory functions more broadly.

In this project, we will,

- * use whole-brain neuroimaging to determine which aspects of visual stimuli are processed in reorganized regions of the deaf 'auditory' cortex,
- * generate ultra-high resolution functional images of visual perception in these brain regions that will suggest from where these regions receive major inputs, and
- * probe these brain regions using advanced tools to manipulate the connections between brain regions in order to understand how visual stimuli drive activity in brain regions that would normally respond only to sound.

If successful, this project will radically transform our understanding of how plasticity can compensate for impairment of one of our senses. We hope it will inform the design of neural prostheses that can be tuned for individual patients. While this project focuses on deafness, we believe it will reveal underlying principles of plasticity that will apply to other senses.

Western Researchers

Blake E. Butler

Brian Allman

Ravi Menon

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