Group-based four-dimensional brain mapping of executive control

Matthew T. Brennan
Wayne State University School of Medicine, Detroit, Michigan, 48201, USA, hj2255@wayne.edu

Kazuki Sakakura MD
Department of Pediatrics, Children's Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA., hg3544@wayne.edu

Masaki Sonoda MD, PhD
Department of Pediatrics, Children's Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA., msonoda@wayne.edu

Aimee Luat MD
Department of Pediatrics, Children's Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA., alua@med.wayne.edu

Neena Marupudi
Department of Neurosurgery, Children's Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA., neena.marupudi@wayne.edu

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Group-based four-dimensional brain mapping of executive control

Matthew Brennan$^{1,4}$; Kazuki Sakakura$^{1,5}$; Masaki Sonoda$^{1,6}$; Aimee F Luat$^{1,2,7}$; Neena I. Marupudi$^{3}$; Sandeep Sood$^{3}$; Eishi Asano$^{1,2,*}$

1: Department of Pediatrics, Children’s Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA.
2: Department of Neurology, Children’s Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA.
3: Department of Neurosurgery, Children’s Hospital of Michigan, Detroit Medical Center, Wayne State University, Detroit, Michigan, 48201, USA.
4: Department of Physiology, Wayne State University, Detroit, Michigan, 48201, USA.
5: Department of Neurosurgery, University of Tsukuba, Tsukuba, 3058575, Japan.
6: Department of Neurosurgery, Yokohama City University, Yokohama-shi, 2360004, Japan.
7: Department of Pediatrics, Central Michigan University, Mount Pleasant, MI, 48858, USA.

Corresponding Author:
Eishi Asano, MD, Ph.D., MS (CRDSA)
Address: Division of Pediatric Neurology, Children’s Hospital of Michigan, Wayne State University. 3901 Beaubien St., Detroit, MI, 48201, USA.
Phone: 313-745-5547; FAX: 313-745-9435; E-mail: easano@med.wayne.edu
Rationale: Humans utilize executive control processes to carry out non-automatic tasks. These tasks require coordination from higher brain centers to both suppress inappropriate behaviors and initiate correct responses. The goal of this study is to generate a novel, dynamic brain atlas to visualize and understand the network dynamics underlying executive control.

Methods: We studied 547 non-epileptic intracranial electrode sites sampled from seven patients with focal epilepsy. Each patient performed two types of verbal tasks: word-reading and Stroop color-naming. Mixed model analysis compared high-gamma cortical activation prior to response onset between the word-reading and Stroop color-naming tasks. Based on mixed model analysis, we visualized the white matter connectivity between the brain regions exhibiting simultaneous high-gamma augmentation.

Results: In the Stroop color-naming task, mixed model analysis showed more high-gamma augmentation 600 to 400 ms pre-response onset in the prefrontal region (e.g., left caudal middle-frontal gyrus; p = 0.0054; figure 1 arrowhead). Conversely, in the word-reading tasks, more high-gamma augmentation was seen in the occipitotemporal region (e.g., left posterior fusiform gyrus; p = 0.0002; figure 1 arrow). Dynamic tractography in the Stroop color-naming task showed functional connectivity enhancement between prefrontal regions 500 to 400 ms pre-response onset (figure 2 arrow). On the other hand, functional connectivity in the word-reading tasks was enhanced between occipitotemporal regions from 500 ms pre-response onset to 50 ms post-response (figure 2 arrowhead).

Conclusions: Prefrontal regions were activated during tasks requiring higher executive control, whereas occipitotemporal regions supported word reading.

Keywords (maximum of 10 keywords):
Intracranial electroencephalography (EEG) recording, executive control, physiological high-frequency oscillations (HFOs), neuroimaging, functional connectivity, diffusion tensor imaging (DTI), pediatric epilepsy surgery