NIRX
OPTICAL NEUROIMAGING

fNIRS Publications

By Application

Contents

Auditory System

As fNIRS measurements are characterized by silent operations, innumerous possibilities of studies intended to explore cortical activation in the presence of controlled sounds can be achieved. Besides a better understanding of auditory processes in the brain, this may facilitate critical improvements on current solutions for cochlear implants.

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C. Olds *et al.*, "Cortical Activation Patterns Correlate with Speech Understanding After Cochlear Implantation," *Ear Hear*, vol. 37, no. 3, pp. e160-172, Jun. 2016.

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H. Santosa, M. J. Hong, and K.-S. Hong, “Lateralization of music processing with noises in the auditory cortex: an fNIRS study,” *Front Behav Neurosci*, vol. 8, p. 418, 2014.

L. Pollonini, C. Olds, H. Abaya, H. Bortfeld, M. S. Beauchamp, and J. S. Oghalai, “Auditory cortex activation to natural speech and simulated cochlear implant speech measured with functional near-infrared spectroscopy,” *Hear. Res.*, vol. 309, pp. 84–93, Mar. 2014.

T. T. Brink *et al.*, “The role of orbitofrontal cortex in processing empathy stories in 4- to 8-year-old children,” *Front Psychol*, vol. 2, p. 80, 2011.

For latest updates on health information pertaining to hearing, balance, taste, smell, and speech and language development, please visit:

http://www.nidcd.nih.gov/Pages/default.aspx

Brain-Computer Interface (BCI)

Given its great performance in the presence of muscle movements and the possibility of setting up measurements in realistic environments, fNIRS presents itself as an ideal candidate for the acquisition of cortical signals as reliable and representative inputs for Brain-Computer Interface investigations.

K. J. Verdière, R. N. Roy, and F. Dehais, “Detecting Pilot’s Engagement Using fNIRS Connectivity Features in an Automated vs. Manual Landing Scenario,” Frontiers in Human Neuroscience, vol. 12, Jan. 2018.

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K. Tumanov, R. Goebel, R. Möckel, B. Sorger, and G. Weiss, “fNIRS-based BCI for Robot Control,” in *Proceedings of the 2015 International Conference on Autonomous Agents and Multiagent Systems*, Richland, SC, 2015, pp. 1953–1954.

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For latest updates on NIH and DARPA funded efforts for BCI funded research, please visit:

http://www.nibib.nih.gov/news-events/newsroom/brain-computer-interfaces-come-home;

http://www.nidcd.nih.gov/funding/programs/npp/Pages/workshop_bci_summary.aspx;

Brain Perfusion

Brain perfusion assessment in clinical environments has mostly been performed by techniques that cannot accomplish constant monitoring of the brain. Due to its intrinsic capability of constant monitoring as well as the unique portability, fNIRS has clear potential for intensive care unit applications.

M. Tessari, A. M. Malagoni, M. E. Vannini, and P. Zamboni, "A novel device for non-invasive cerebral perfusion assessment," *Veins and Lymphatics*, vol. 4, no. 1, Mar. 2015.

J. Stojanovic-Radic, G. Wylie, G. Voelbel, N. Chiaravalloti, and J. DeLuca, "Neuroimaging and cognition using functional near infrared spectroscopy (fNIRS) in multiple sclerosis," *Brain Imaging Behav*, vol. 9, no. 2, pp. 302–311, Jun. 2015.

C. Habermehl, C. Schmitz, S. P. Koch, J. Mehnert, and J. Steinbrink, "Investigating hemodynamics in scalp and brain using high-resolution diffuse optical tomography in humans," 2012, p. BSu2A.2.

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For updates on the latest announcements on the NIH brain initiative: Brain Research through Advancing Innovative Neurotechnologies® (BRAIN), please visit:

http://braininitiative.nih.gov

Clinical Neurology

With the capabilities of constant monitoring of oxygenation, perfusion and autoregulation, fNIRS has a high potential for diagnoses of cerebrovascular disease and severe brain injury. Other clinical neurology methodologies, including epileptic disorders and central nervous system tumors, may benefit from the technique on the preoperative function localization.

T.-J. Kim et al., "The effect of dim light at night on cerebral hemodynamic oscillations during sleep: A near-infrared spectroscopy study," Chronobiology International, vol. 34, no. 10, pp. 1325–1338, Nov. 2017.

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A. M. Kempny *et al.*, "Functional near infrared spectroscopy as a probe of brain function in people with prolonged disorders of consciousness," *NeuroImage: Clinical*, vol. 12, pp. 312–319, Feb. 2016.

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H. Obrig, "NIRS in clinical neurology - a 'promising' tool?," *Neuroimage*, vol. 85 Pt 1, pp. 535–546, Jan. 2014.

For the latest listing of clinical trials involving brain disorders, please visit:

http://www.ninds.nih.gov/disorders/clinical_trials/index.htm

Cognitive States

fNIRS adds another dimension to studies investigating cognitive functions and mental states, since it is a portable technique not too sensitive to motion artifacts. Attention processes, inhibition mechanisms, and working memory, as well as other cognitive states, may be studied in natural environments with a fast setup preparation.

M. Balconi, L. Gatti, and M. E. Vanutelli, "When cooperation goes wrong: brain and behavioural correlates of ineffective joint strategies in dyads," *International Journal of Neuroscience*, vol. 128, no. 2, pp. 155–166, Feb. 2018.

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Z. Deng, Q. Huang, J. Huang, W. Zhang, C. Qi, and X. Xu, “Association between central obesity and executive function as assessed by Stroop task performance: A functional near-infrared spectroscopy study,” *Journal of Innovative Optical Health Sciences*, p. 1750010, Mar. 2017.

X. Xu, Z.-Y. Deng, Q. Huang, W.-X. Zhang, C. Qi, and J.-A. Huang, “Prefrontal cortex-mediated executive function as assessed by Stroop task performance associates with weight loss among overweight and obese adolescents and young adults,” *Behavioural Brain Research*, vol. 321, pp. 240–248, Mar. 2017.

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For the latest description on NIH's intramural efforts to explore cognition and its influences on mental health, please visit:

http://www.nimh.nih.gov/labs-at-nimh/research-areas/clinics-and-labs/lbc/index.shtml

Complementary and Integrative Medicine

Acupuncture, interactions of herbal medicines with conventional drugs, pain management, meditation, Yoga, Tai Chi and Qi Gong are among other alternative therapies whose serious inquiry is well supported by fNIRS. NIRx experts can help you plan experimental strategies best suited to explore nontraditional yet promising methods.

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For latest updates on complementary and integrative health strategies, please visit

https://nccih.nih.gov

Connectivity

fNIRS brings connectivity studies to a new level. The hyperscanning modality enables both online feedback as well as offline analysis regarding within- and between-subjects connectivity. In addition to that, fNIRS fast sampling rate for hemodynamic states allows for a quick update rate of connectivity feedback, resulting into enhanced subject engagement.

D. Farkas, S. L. Denham, and I. Winkler, “Functional brain networks underlying idiosyncratic switching patterns in multi-stable auditory perception,” *Neuropsychologia*, vol. 108, pp. 82–91, Jan. 2018.

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R. L. Barbour, H. L. Graber, Y. Xu, Y. Pei, C. H. Schmitz, D. S. Pfeil, A. Tyagi, R. Andronica, D. C. Lee, S.-L. S. Barbour, J. D. Nichols, and M. E. Pflieger, “A programmable laboratory testbed in support of evaluation of functional brain activation and connectivity,” *IEEE Trans Neural Syst Rehabil Eng*, vol. 20, no. 2, pp. 170–183, Mar. 2012.

H. Niu, S. Khadka, F. Tian, Z.-J. Lin, C. Lu, C. Zhu, and H. Liu, “Resting-state functional connectivity assessed with two diffuse optical tomographic systems,” *J Biomed Opt*, vol. 16, no. 4, p. 46006, Apr. 2011.

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For a description of the Human Connectome Project, please visit:

http://www.neuroscienceblueprint.nih.gov/connectome/

Developmental Changes

The portability of fNIRS, its performance in presence of general movements and the feasibility it offers in exploring cortical responses in social environments, represent the greatest advantages for studies on brain functional changes during development of infants and children.

C. Issard and J. Gervain, “Adult-like processing of time-compressed speech by newborns: A NIRS study,” *Developmental Cognitive Neuroscience*. Oct. 2017.

M. Mücke, C. Andrä, M. Gerber, U. Pühse, and S. Ludyga, “Moderate-to-vigorous physical activity, executive functions and prefrontal brain oxygenation in children: A functional near-infrared spectroscopy study,” *Journal of Sports Sciences*, pp. 1–7, May 2017.

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For updates from Dr. Catherine Spong, acting director of NICHD, on new program initiatives including Learning Disabilities Innovation Hubs, Precision Medicine Initiative, Intellectual and Developmental Disabilities Research Centers, please visit:

https://www.nichd.nih.gov/about/overview/directors_corner/Pages/default.aspx

Emotions

Near-infrared spectroscopy is non-invasive and particularly well suited for evaluating activity in the prefrontal cortex, one of the regions involved in emotional processing. More specific areas related to emotional processing, such as the frontopolar cortex, are easily accessible for measurements by NIRS, making the technique particularly suited to explore the emotional domain.

A. van der Kant, S. Biro, C. Levelt, and S. Huijbregts, “Negative affect is related to reduced differential neural responses to social and non-social stimuli in 5-to-8-month-old infants: A functional near-infrared spectroscopy-study,” *Developmental Cognitive Neuroscience*, vol. 30, pp. 23–30, Apr. 2018.

A. Landowska, S. Royle, P. Eachus, and D. Roberts, “Testing the Potential of Combining Functional Near-Infrared Spectroscopy with Different Virtual Reality Displays—Oculus Rift and oCtAVE,” in Augmented Reality and Virtual Reality, Springer, Cham, 2018, pp. 309–321.

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Motor Execution

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Multi-modal

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Neuroeconomics

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Pain Research

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Social Interaction

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NIRX is a world-leader in providing integrated solutions for fNIRS neuro-imaging. In 1988 we introduced the concept of tomographic imaging (i.e., multi-distance measurements) in dense scatted media base on diffusely scattered light. This approach has since been widely adapted and has served to launch the modern day field of fNIRS tomography.

Through our offices in Berlin, Minneapolis, Los Angeles and New York, our engineers and grant-funded investigators are providing a growing number of research teams world-wide with comprehensive technology solutions for the most demanding investigative applications.

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