Intro to hyperscanning with NIRx

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Scientific Consultants – NIRx
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SYNCC lectures and workshops - Warsaw

Hyperscanning with fNIRS

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Hyperscanning refers to neuroimaging two or more people at the same time to study the brain during interaction.

Application Examples:

- Social interaction
- Parent-child interactions
- Cooperation and competition
- Creative group tasks
- Social self-perception / disorders

Hyperscanning in Relational Neuroscience

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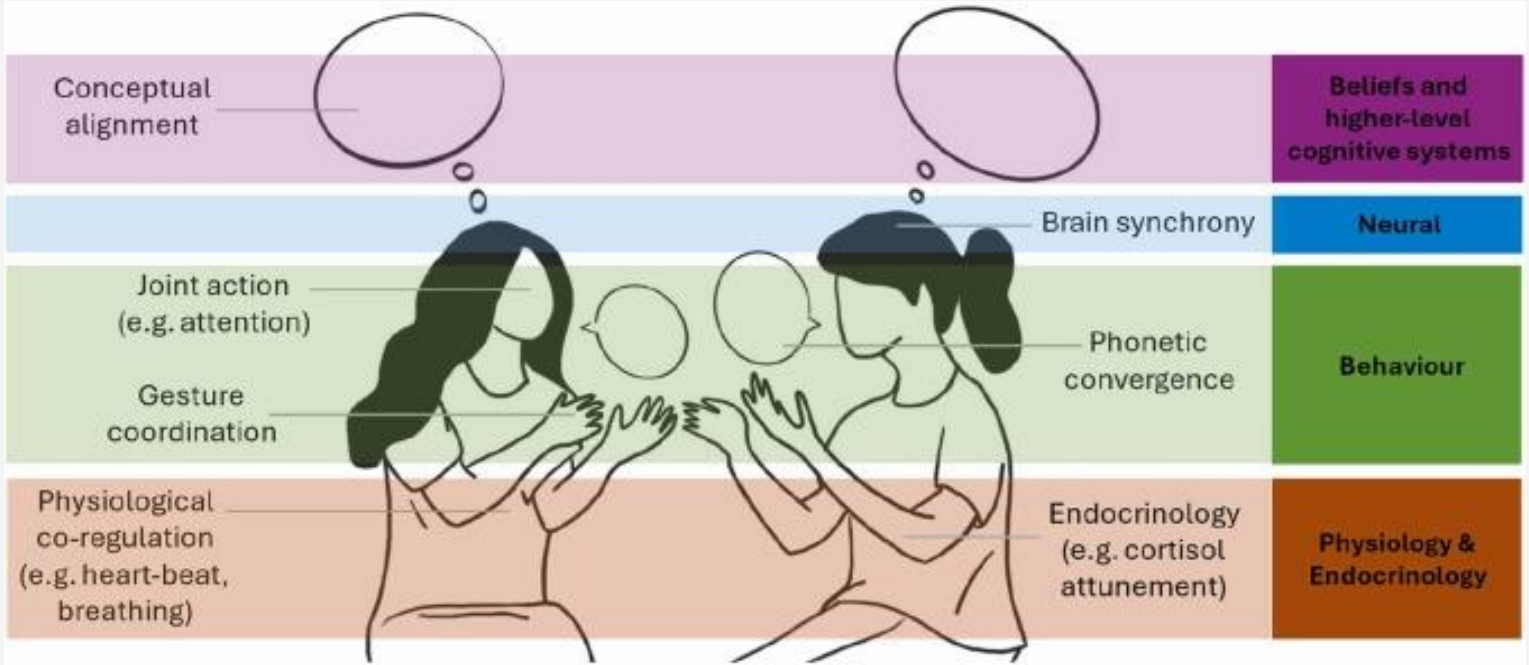
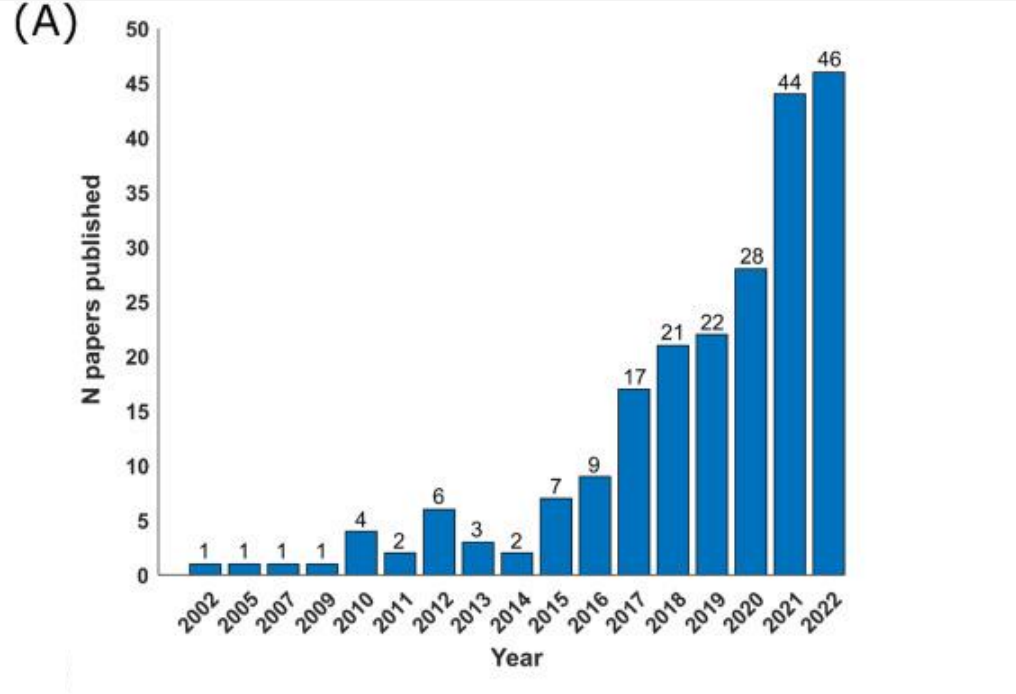
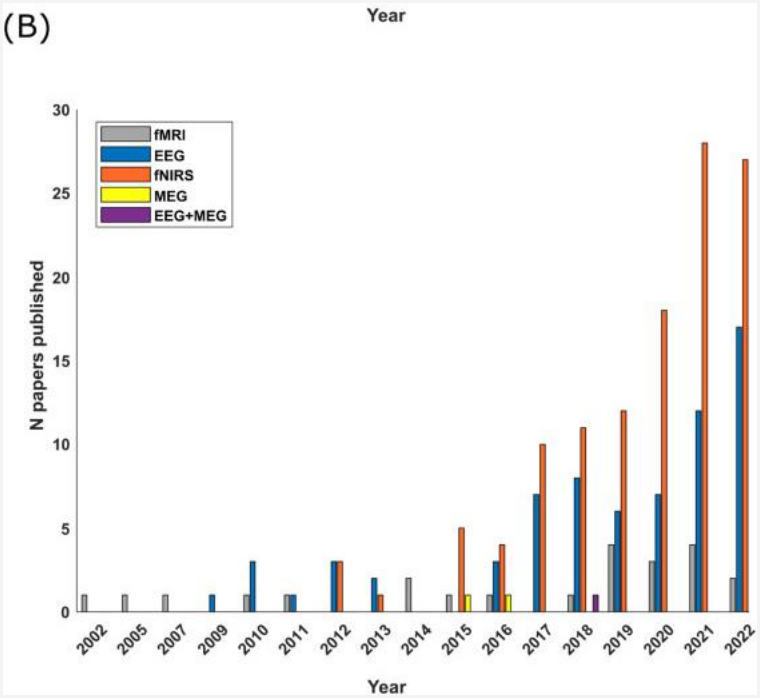


De Felice et al. (2025)

fNIRS hyperscanning: Motivation

fNIRS Hyperscanning is popular!





Hakim et al. (2023)

Hyperscanning with fNIRS

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Why use fNIRS for Hyperscanning?

- Comfortable and easy to apply
- Suitable for all age groups
- Wireless & mobile
- Robust to motion
- Naturalistic environments & Ecological validity
- Compatible with other modalities (EEG, physio measures, motion capture, etc.)

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NIRx hardware & software solutions

A brief overview of the NIRx portfolio:

Product launches from 2000 until today

2004
DYNOT 232

2012
NIRSport

2018
NIRSport2

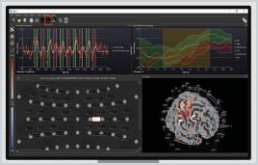
2020
Hyperscanning App

2022
Borealis

2000
DYNOT 936

2008
NIRScout

2019
Satori and Turbo-Satori



2021
NIRxWINGS1

2023
EFE and MLI in Aurora

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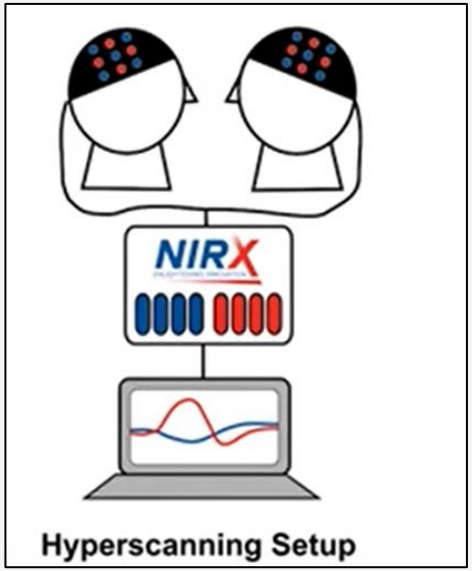
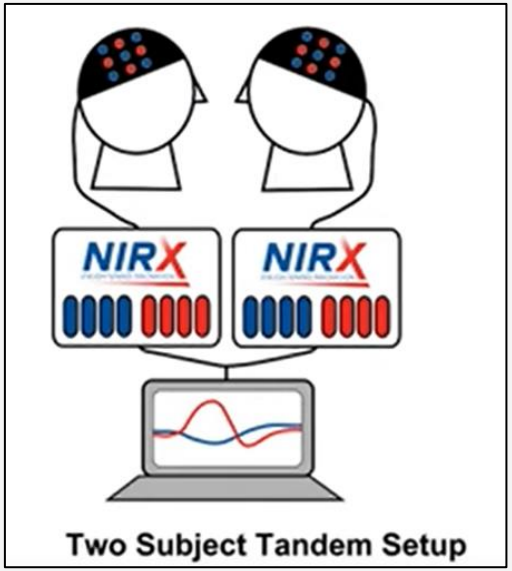
Hyperscanning configurations

Single Device



Hyperscanning Setup

Multiple Devices



Two Subject Tandem Setup

Currently tested for up to 10 NIRSport2 devices for concurrent hyperscanning

Single device hyperscanning: NIRSport2

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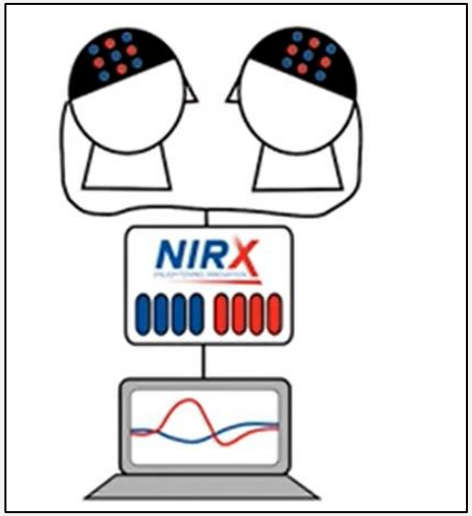
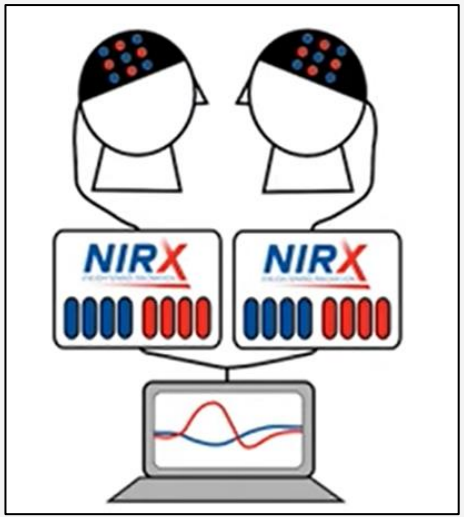
Single Device



Multiple device hyperscanning: NIRSport2

Multiple Devices



Acquisition PC

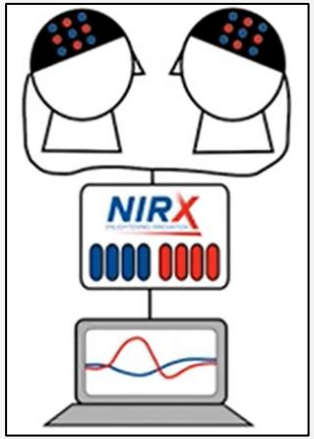
Access
Point WiFi

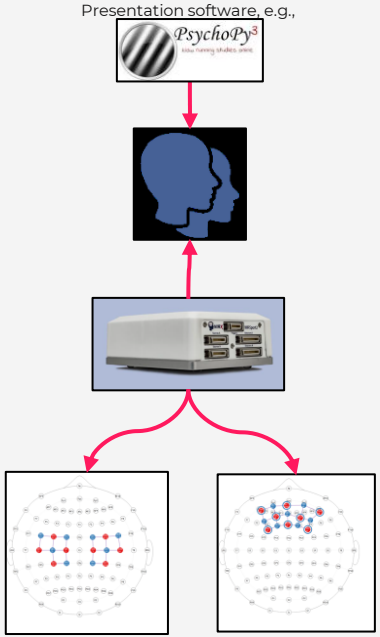
NIRSport2
WiFi

Solution for NSP2: The Hyperscan App

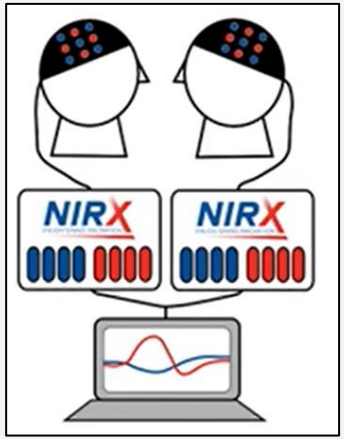
One interface for status and control

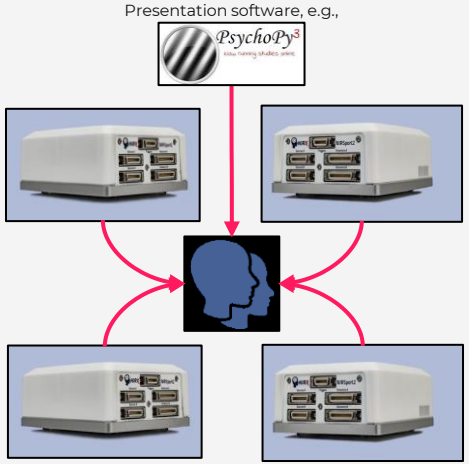
Single Device





Multiple Devices

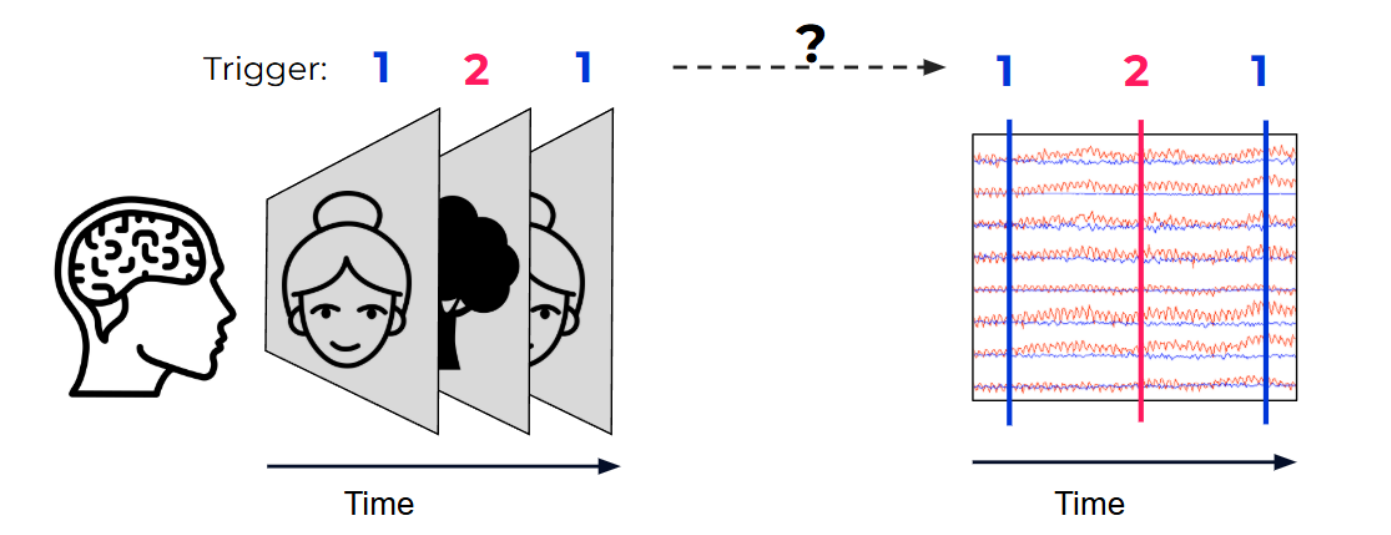




Other requirements?

Although the Hyperscan App allows you to control the different recording instances, it is recommended to send **shared triggers** to achieve accurate synchronization of the two data streams.

Detour: What is a trigger?



Summary: Hyperscan options with NIRSport2

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		Single device	Multiple Devices
Coverage	Max. configuration	8x8 for 2 subjects	32x32 for 4 subjects 16x16 for up to 10 subjects*
Triggering	Manual (button press)	Yes	No
	TTL	No**	Yes
	LSL	Yes	Yes
Add-ons	Accelerometer	Yes	Yes
	NIRxWINGS	No**	Yes

* Configurations listed were tested in a controlled environment; more might be possible with more powerful PC.
** Coming up in future Aurora versions.

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Hyperscanning application examples

Hyperscanning task types

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- **Imitation tasks**: One participant imitates the other's movements or behaviors;
- **Coordination/joint tasks:** Participants try to move as synchronized as possible;
- **Eye contact/gaze tasks:** Look in each other's eyes, or look towards the third object;
- **Economic games/exchanges:** One participant provides an economic offer while the counterpart need to make a decision on whether they wanted to take it or not;
- **Cooperation and competition tasks:** Participants need to achieve a goal cooperatively or competitively;
- **Interactions in natural scenario**: Escape the lab environment and measure under real world conditions;
- **Conversation:** fNIRS allows to measure subjects during free speech

MY Wang et al. 2018

Example 1: One of the first fNIRS hyperscanning studies

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NIRS–based hyperscanning reveals increased interpersonal coherence in superior frontal cortex during cooperation

Xu Cui [1], Daniel M Bryant, Allan L Reiss

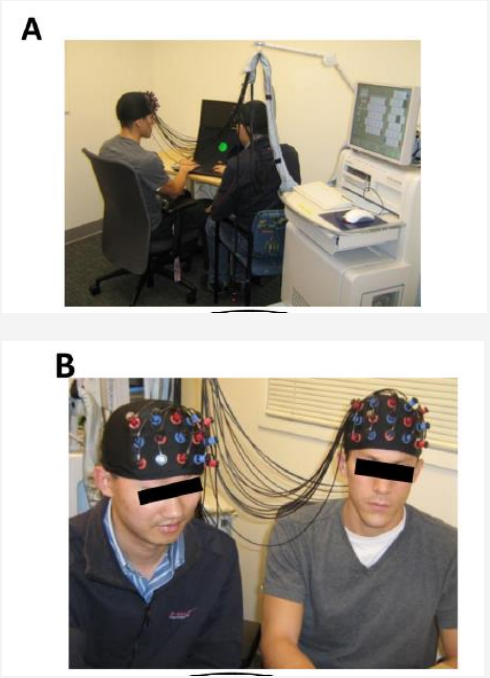
Affiliations + expand

PMID: 21933717 PMCID: PMC3254802 DOI: 10.1016/j.neuroimage.2011.09.003

Free PMC article

Abstract

We used Near-Infrared Spectroscopy (NIRS) to simultaneously measure brain activity in two people while they played a computer-based cooperation game side by side. Inter-brain activity coherence was calculated between the two participants. We found that the coherence between signals generated by participants' right superior frontal cortices increased during cooperation, but not during competition. Increased coherence was also associated with better cooperation performance. To our knowledge, this work represents the first use of a single NIRS instrument for simultaneous measurements of brain activity in two people. This study demonstrates the use of NIRS-based hyperscanning in studies of social interaction in a naturalistic environment.



Cui et al., 2012

Example 2: Synchrony during cooperation

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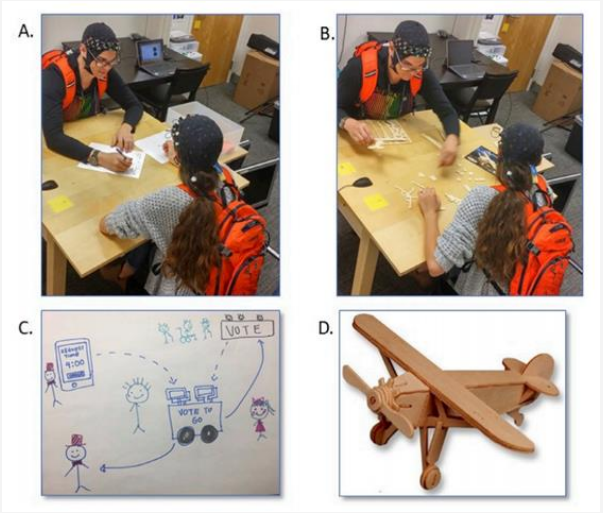
[Mayseless et al. 2019](#)

Real-life creative problem solving in teams: fNIRS based hyperscanning study

Naama Mayseless [a], Grace Hawthorne [b], Allan L. Reiss [a, c]



[Nguyen et al. 2020.](#)

Special Issue "Understanding Others": Research Report

The effects of interaction quality on neural synchrony during mother-child problem solving

Trinh Nguyen [a], Hanna Schleihauf [b, c, d], Ezgi Kayhan [e, f], Daniel Matthes [f], Pascal Vrtička [f], Stefanie Hoehl [a, f]

Example video

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Example 3: Hyperscanning during motion

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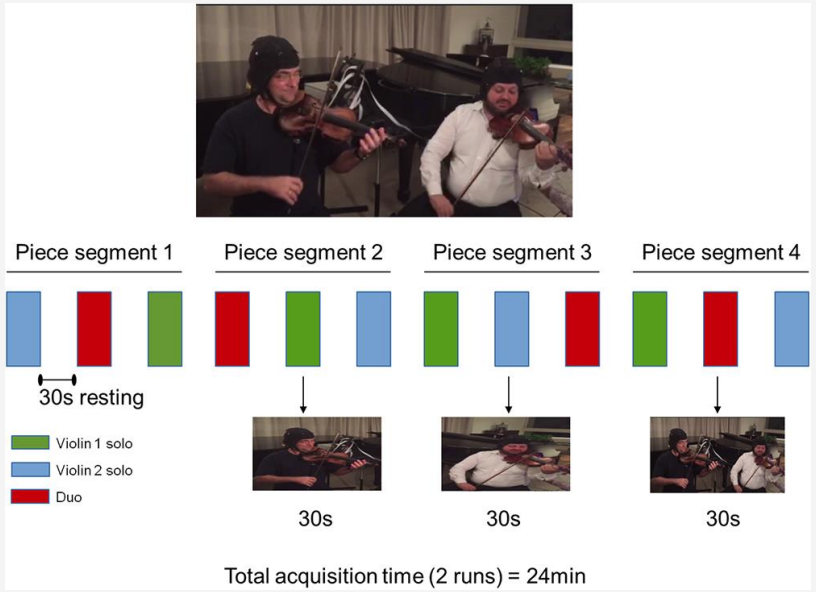
[Vanzella et al. (2019)]

fNIRS Responses in Professional Violinists While Playing Duets: Evidence for Distinct Leader and Follower Roles at the Brain Level

Patricia Vanzella[1,2*] Joana B. Balardin[3] Rogério A. Furucho[2]

Guilherme Augusto Zimeo Morais[4] Thenille Braun Janzen[5] Daniela Sammler[6*]

João R. Sato[1,2]



Example 4: Integrating brain and body synchrony

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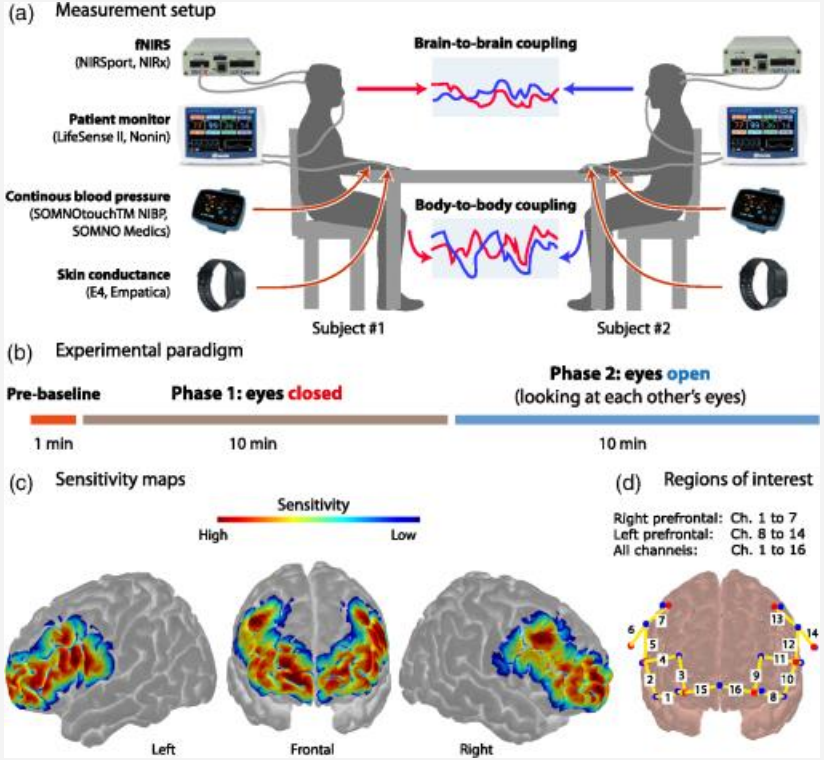
[Guglielmini et al. 2022.]

Open Access

18 April 2022

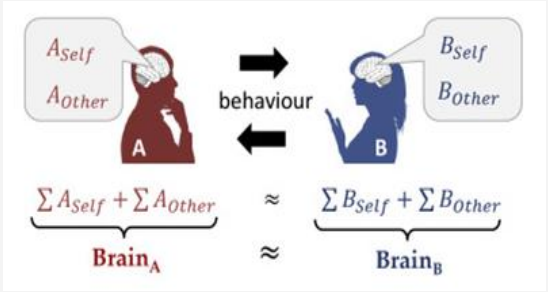
Systemic physiology augmented functional near-infrared spectroscopy hyperscanning: a first evaluation investigating entrainment of spontaneous activity of brain and body physiology between subjects

Sabino Guglielmini, Gino Bopp, Valentine L. Marcar, Felix Scholkmann, Martin Wolf



[Hamilton, A. F. C. 2020.]

Embodied mutual prediction theory:



A couple of NIRx features

NIRx

- ✓ Unmatched data quality through hair
- ✓ Modular and scalable
- ✓ Cap sizes for all age groups available
- ✓ Flexible montages
- ✓ Fully supported tools and tutorials
- ✓ Possibility to integrate physiological and other measures
- ✓ Strong track record in peer-reviewed (hyperscanning) research

Further resources

Hyperscanning resources

NIRx

Hyperscanning (fNIRS) reviews

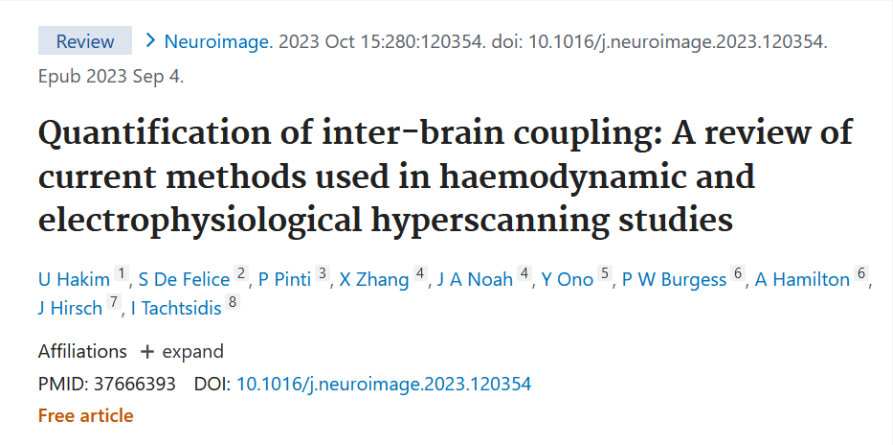
- Barde, A., Gumilar, I., Hayati, A. F., Dey, A., Lee, G., & Billinghurst, M. (2020). A review of hyperscanning and its use in virtual environments. *Informatics, 7*(4), Article 4. https://doi.org/10.3390/informatics7040055
- Czeszumski, A., Eustergerling, S., Lang, A., Menrath, D., Gerstenberger, M., Schuberth, S., Schreiber, F., Rendon, Z. Z., & König, P. (2020). Hyperscanning: A valid method to study neural inter-brain underpinnings of social interaction. *Frontiers in Human Neuroscience, 14*, Article 39. https://doi.org/10.3389/fnhum.2020.00039
- Czeszumski, A., Liang, S. H.-Y., Dikker, S., König, P., Lee, C.-P., Koole, S. L., & Kelsen, B. (2022). Cooperative behavior evokes interbrain synchrony in the prefrontal and temporoparietal cortex: A systematic review and meta-analysis of fNIRS hyperscanning studies. *eNeuro, 9*(2), ENEURO.0268-21.2022. https://doi.org/10.1523/ENEURO.0268-21.2022
- TenHouten, W., Schussel, L., Gritsch, M. F., & Kaplan, C. D. (2023). Hyperscanning and the future of neurosociology. *Sociological Methodology, 53*(1), 139–157. https://doi.org/10.1177/00811750221128790
- Wang, M.-Y., Luan, P., Zhang, J., Xiang, Y.-T., Niu, H., & Yuan, Z. (2018). Concurrent mapping of brain activation from multiple subjects during social interaction by hyperscanning: A mini-review. *Quantitative Imaging in Medicine and Surgery, 8*(8), 819–837. https://doi.org/10.21037/qims.2018.09.07
- De Felice, S., Chand, T., Croy, I., Engert, V., Goldstein, P., Holroyd, C. B., Kirsch, P., Krach, S., Ma, Y., Scheele, D., Schurz, M., Schweinberger, S. R., Hoehl, S., & Vrticka, P. (2025). Relational neuroscience: Insights from hyperscanning research. Neuroscience & Biobehavioral Reviews, 169, 105979. https://doi.org/10.1016/j.neubiorev.2024.105979

Analysis approaches

Most common analysis method: Wavelet transform coherence

- Zhang, X., J. A. Noah, S. Dravida, and J. Hirsch (2020). Optimization of wavelet coherence analysis as a measure of neural synchrony during hyperscanning using functional near-infrared spectroscopy. In: Neurophotonics 7.01, p. 1. DOI: 10. 1117/1.nph.7.1.015010

- Hakim, U., De Felice, S., Pinti, P., Zhang, X., Noah, J. A., Ono, Y., Burgess, P. W., Hamilton, A., Hirsch, J., and Tachtsidis, I. (2023). Quantification of inter-brain coupling: A review of current methods used in haemodynamic and electrophysiological hyperscanning studies. Neuroimage. 2023 Oct 15;280:120354. doi: 10.1016/j.neuroimage.2023.120354



Review > Neuroimage. 2023 Oct 15:280:120354. doi: 10.1016/j.neuroimage.2023.120354. Epub 2023 Sep 4.

Quantification of inter-brain coupling: A review of current methods used in haemodynamic and electrophysiological hyperscanning studies

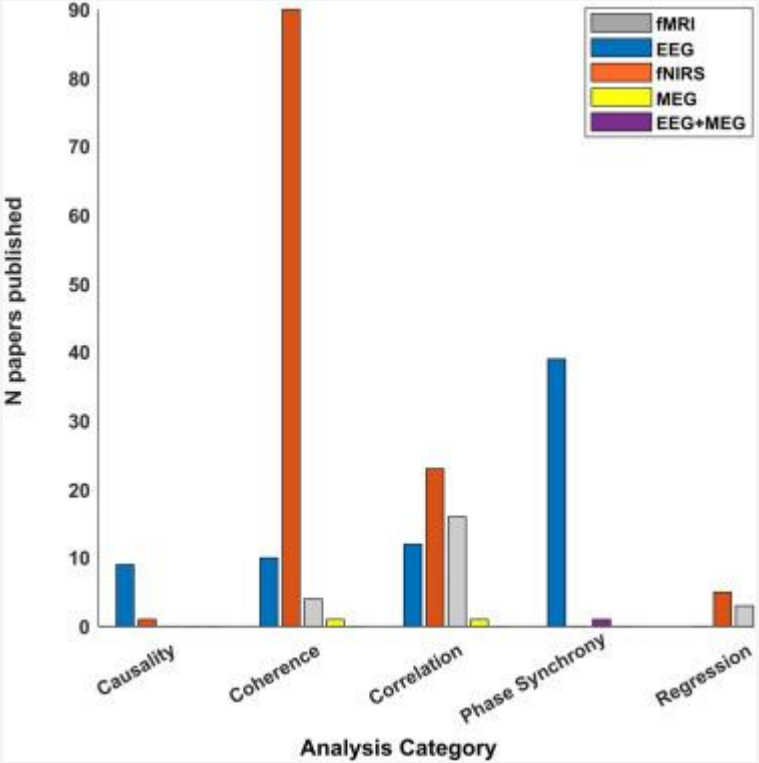
U Hakim [1], S De Felice [2], P Pinti [3], X Zhang [4], J A Noah [4], Y Ono [5], P W Burgess [6], A Hamilton [6], J Hirsch [7], I Tachtsidis [8]

Affiliations + expand

PMID: 37666393 DOI: 10.1016/j.neuroimage.2023.120354

Free article

Analysis approaches



If you are interested to learn more about fNIRS hyperscanning analysis, check out these webinars:

Part I - fNIRS Hyperscanning: Underlying Theory and Experimental Design

Part II - fNIRS Hyperscanning – Practical Considerations for Data Analysis

Hakim et al. (2023)

Questions?

For more information, contact us at consulting@nirx.net