EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

Summer School:
Hands-on fNIRS data analysis for fundamental, applied and clinical research

2nd - 6th August 2021

Tuebingen, Germany

Funded by the Bundesministerium für Bildung und Forschung (BMBF) and the Wissenschaftsministerium Baden-Württemberg as part of the Excellence Strategy of the Government and the Länder.

Bundesministerium
für Bildung
und Forschung

Baden-Württemberg
MINISTERIUM FÜR WISSENSCHAFT, FORSCHUNG UND KUNST

Contents

1 Preface

Dear participant,

We are very pleased to welcome you to our Summer School about fNIRS data analysis. First of all, we are very happy that there was so much interest in the event, which shows us that fNIRS and especially the analysis of fNIRS data is a huge point in modern neuroscience. And secondly, we are very happy that the Summer School can take place with participation from all over the world, at least partly in-person, in the face of the worldwide corona pandemic which made organizing quite complicated some times. But now we're here – as well as you are, in-person or virtually.

To start, let's have a look back to the initial idea of this Summer School: What was our intention in organizing such a specific event about a topic only fNIRS-scientists themselves might understand – and maybe not even those?
Investigating how the brain works via (near-infrared) light seems quite fancy. Actually, it is, though – and therefore fNIRS has found plentiful adoption in fundamental and applied scientific paradigms in various neuroscientific disciplines over the last decades, with increasing numbers of publications every year. But although fNIRS research gets increasingly more attention, the analysis of fNIRS data is not yet standardized and also not always intuitively understandable – neither for beginners in this field of neuroscience nor for experienced scientists. Therefore, we thought about organizing this Summer School to introduce basic as well as advanced analysis methods for fNIRS data theoretically and to teach and practice these methods in hands-on sessions lead by experts. Furthermore, our Summer School can serve as a platform to address fNIRS-specific challenges and solutions, and to give early career researchers the opportunity for networking within the fNIRS community.

This fNIRS community itself is another alluring point about our Summer School, as on the one hand fNIRS is, however, still a quite specific neuroscientific method, but on the other hand it brings together scientists from different scientific disciplines with different focusses, ideas and applications of fNIRS from all over the world. Therefore, even if every single participant of our Summer School might be a geek somehow in his or her own field of research, we're all connected via the method we use for being geeks. In that sense, our Summer School might also establish the opportunity to connect and get in touch with, but also to get inspired as well as impressed by each other.

And we probably might have another point in common: even though all of us are interested in fNIRS, most of us, more or less, somehow struggle with the analysis of our data. Probably this might have been one reason for registration. Therefore, we hope that in our Summer School you can learn something new, get connections and more answers than new questions – we hope it will help you bringing light into the darkness. To support this, we are very grateful to have plenty of prestigious and experienced international speakers for lectures and hand-on sessions to learn from. We appreciate so much that they are willing to share their knowledge with us to improve our personal and thereby also the general understanding of and work on fNIRS data analysis.

But now, enough words are said by us until this point. We are very curious and full of pleasant anticipation to the upcoming five days. We are looking forward to an amazing time, to a positive and constructive atmosphere, to new connections and new ideas – in short to a brand new and surely successful fNIRS Summer School!
So, let's start! Let's get these fancy data understood! Let's get even bigger geeks!

The Organization Committee

2 Scientific Organization

General Chair

Dr. Christina Artemenko	*University of Tuebingen, Department of Psychology*
Dr. Philipp Alexander Schröder	*University of Tuebingen, Department of Psychology*
Dr. Thomas Dresler	*University Hospital of Tuebingen, Psychiatry*

Organization Team

Maryam Farshad Taghi Dizaj	*University of Tuebingen, Department of Psychology*
Yunfeng He	*University of Tuebingen, Department of Psychology*
Hendrik Laicher	*University Hospital of Tuebingen, Psychiatry*
Hannah Lönneker	*University of Tuebingen, Department of Psychology*
Lorenzo Semeia	*Institut for diabetes research and metabolic diseases (IDM), Helmholtz Center Munich at the University of Tuebingen, fMEG Center*

Student Assistants

Ronja Brandhorst
Alina Sabiha Senger

Contact

E-Mail: fnirs-summerschool@psycho.uni-tuebingen.de

3 General Information & Corona Management

Workshop Venue

Department of Psychology
University of Tuebingen
Schleichstraße 4
72076 Tuebingen (Germany)
Phone: +49 (0)7071 29-78345

Rooms:
Lecture hall: 4.329
Seminar rooms: 4.332 and 4.333

In the lecture hall, all talks and hands-on sessions are taking place. Due to the restricted places, we are assigning people into two groups (before vs. after lunch) so that everybody can attend half of the sessions live in the lecture hall and the other half via streaming in the seminar room nearby. You can see to which group you belong in the participants list (chapter 11 in this booklet). Since the sessions will be streamed for the online participants, all participants in the lecture hall need to agree for being recorded (by signing a document in the beginning) or can only attend in the seminar room.

WiFi

There is a free WiFi access at the venue:

SSID:	Guest
User name:	kppspg01
Password:	le5le4

SLACK

Since the Summer School is conducted as a hybrid event, we invite everybody to join our interactive platform on *slack*. You can register here: https://join.slack.com/t/fnirssummerschool2021/shared_invite/zt-tsgjlva8-Lr0UKtmY0nlJMg3pLBHKAQ
In the channels for each session on slack, you can leave comments and questions. We will moderate the questions for a best possible interaction between all participants and speakers.

HOMER3

Please install the program *Homer3* on your computer in order to follow the hands-on sessions on fNIRS data analysis [https://openfnirs.org/software/homer/]. You can also find a channel on slack with some explanations, links and the possibility to ask for help.

Best-Practice Paper

Please read the paper "*Best practices for fNIRS publications*" (authored by many of our speakers) [https://doi.org/10.1117/1.NPh.8.1.012101], to prepare yourself for the Summer School and for the panel discussion in particular.

Collaborative Paper

For documentation of the common knowledge about fNIRS we would like to combine all important topics during the Summer School into a collaborative hands-on fNIRS paper and everybody is invited to support by taking notes. More information on this you will get in the brainstorming sessions at the beginning and at the end of the Summer School.

Corona Management

In-person participation in the Summer School is regulated by the *Hygienic Concept of the University of Tuebingen* and the official *Corona-VO des Landes Baden-Württemberg (Corona Ordinance)*. An in-person event is thereby dependent on the current spread of Sars-COV-2 in Tübingen / Germany and may require continuous adherence to social distancing measures (e.g., wearing a medical or FFP-2 mask, keeping a distance of at least 1.5 meters to others, no symptoms of corona (fever, coughing, cold, loss of smell/taste) and no contact with a positively tested person in the past two weeks). Personal information will be collected for contact tracing. The organizers will inform all participants of the current regulation, but please be aware of possible travel restrictions and / or quarantine measures in your region of origin. Please find the official and continuously updated information from our University here: https://uni-tuebingen.de/en/171516

Masks:	medical or FFP-2 mask
Distance:	1.5 meters between each other
Air:	regular ventilation
Surfaces:	Please clean your place when entering!
Symptoms:	no symptoms of corona (fever, coughing, cold, loss of smell/taste)
Contact:	no contact with a positively tested person in the past two weeks
Sheet:	Please fill out the document for contact tracing.
Tests:	Rapid antigen tests can be conducted on an optional basis. They are available for free at different test stations in the center of Tuebingen. You can find all relevant information on this website: https://www.tuebingen.de/tuebinger-weg#/32271.

Please consider that the pandemic situation is a very dynamic one and could change rapidly and therefore also the regulations and protective measures might change and differ from those given here. We pleasantly ask you to keep yourself updated about the current situation and regulations and to always respect those for your own safety.

4 Acknowledgements

Our Summer School is part of the Excellence Strategy of the University of Tuebingen and therefore mainly sponsored and supported by this. The Excellence Strategy itself is a funding programme of the Federal Government and the Länder to strengthen cutting-edge research at universities in two funding lines: Clusters of Excellence and Universities of Excellence.

In that program the University of Tuebingen is one of Germany's excellent research locations since 2012. It holds his excellence status for his attempts *Research – Relevance – Responsibility* as well as *Open to New Challenges* and *a Global Scope of Action*. In the context of this excellence status the University of Tuebingen strives for five goals: strengthening research excellence, (further) developing a collaborative research environment, change ability, promoting global awareness in research and teaching, expanding social commitment.

Additionally, our Summer School gets funded as an early career researchers project, especially for the qualification of postdocs. The aim of this funding by the Graduate Academy of the University of Tuebingen is to expand the interdisciplinary and international networking of young researchers in addition to their scientific and methodological skills.

We are very thankful that our Summer School gets sponsored and realized as part of this as well as in the context of the Excellence Strategy by the University of Tuebingen.

You can find further information about the Excellence Strategy of the University of Tuebingen on https://uni-tuebingen.de/en/163957 and information about the Excellence Startegy funding programme of the Federal Government on https://www.bmbf.de/en/excellence-strategy-5425.html.

5 About Tuebingen

Small steps, narrow alleys, and pointed gables shape the silhouette of old Tuebingen on the way up to its castle. The Swabian university town of 87,000 inhabitants and about 28,000 students combines the flair of a lovingly restored medieval town centre with the colourful bustle and typical atmosphere of a young and cosmopolitan students' town. Tuebingen has witnessed almost a millennium of history. The area was likely first settled in the 12th millennium BC. Tuebingen itself dates to the 6th or 7th century AD. It was mentioned in writing for the first time in 1078, and achieved town status and civil liberty under the Palatine Counts of Tuebingen in the middle of the 13th century.

Many well-known personalities have resided in Tuebingen over the past few centuries. They came to teach, to study, or to find space for their artistic, scientific or political goals. The University became the cornerstone for numerous great careers, and has itself been moulded and enriched by the subsequent activities and events.

Discover the treasures of the historic old town: The Protestant seminary, in which Hölderlin, Schelling, and Hegel once shared a study; or the town hall in the marketplace, which is more than 500 years old. The Hölderlin Tower by the Neckar River invites you to linger with a line of "*Stocherkähne*", punting boats unique to Tuebingen ready for a ride. Numerous sidewalk cafes, wine taverns, restaurants, and boutiques invite visitors to stroll around and to pause here and there.

To learn more about what Tuebingen has to offer visit www.tuebingen.de/en.

Famous Personalities linked to Tuebingen

ALOIS ALZHEIMER (1864–1915), a German psychiatrist and neuropathologist who first identified Alzheimer's disease, studied medicine partially in Tuebingen.

GEORG WILHELM FRIEDRICH HEGEL (1770–1831), a German philosopher, studied theology at the Tübinger Stift.

HERMANN HESSE (1877–1962), a German-born Swiss poet, novelist, and painter, did an apprenticeship with a bookseller in Tuebingen, Nobel Prize in Literature in 1946.

JOHANN CHRISTIAN FRIEDRICH HÖLDERLIN (1770–1843), a German lyric poet, studied theology at the Tübinger Stift.

JOHANNES KEPLER (1571–1630), a German mathematician, astronomer, and astrologer, studied theology at the Tübinger Stift.

WOLFGANG KÖHLER (1887–1967), a German psychologist and phenomenologist, studied psychology partially in Tuebingen.

FRIEDRICH MIESCHER (1844–1895), a Swiss physician and biologist, the first to isolate the nucleic acid at the chemistry laboratory of Schloss Hohentuebingen.

EDUARD MÖRIKE (1804–1875), a German Romantic poet and writer of novellas and novels, studied theology at the Tübinger Stift, spent most of his life in Tuebingen.

POPE BENEDICT XVI (Joseph Aloisius Ratzinger, *1927), chair in dogmatic theology at the University of Tuebingen from 1966 to 1969.

JOHANN LUDWIG UHLAND (1787–1862), a German poet, philologist and literary historian, born and studied in Tuebingen.

WILHELM MAXIMILIAN WUNDT (1832–1920), a German psychologist, physiologist, and philosopher, studied medicine partially in Tuebingen.

Sightseeing walk through Tuebingen

(Numbers refer to the map of Tuebingen "Highlughts", see below)

House of the Nuns (Nonnenhaus) (1)

The House of the Nuns dates back to the second half of the 15th century and owes its name to the Beguine or hermit women who lived here in a fellowship similar to nuns and devoted their lives to charity. The stairs on the exterior of the building lead to the second floor, and to the left you will see to the so-called Speaking House, a medieval toilet directly over the Ammer Canal.
Leonhard Fuchs, professor of medicine in Tuebingen and the Father of Botany moved into the house in 1535 and planted an herb garden next to the building, which he used for his experiments on the medicinal use of plants. In the 18th century, a newly discovered plant family, Fuchsia was named after him. The stone book in front of the House of the Nuns commemorates his work.

Collegiate Church (Stiftskirche) (2)

In the context of the foundation of the University in 1477, the former parish church, which was mentioned for the first time in 1191, was transformed into a Gothic Collegiate Church. It was one of the first churches to convert to Martin Luther's protestant church after the reformation in 1534. The top of the tower was added only at the end of the 16th century. As one of the most important churches in Württemberg – and due to the support of the Duke Eberhard im Bart (the Bearded) of Württemberg – the Collegiate Church received an excellent décor.

Goethe (2)

Across from the *Stiftskirche* (Collegiate Church), number 15 in the Münzgasse lane, you will find the *Cotta-Haus* (House of Cotta), the former address of the famous publishing house that released the works of Schiller and Goethe. A plaque on the *Cotta-Haus* commemorates Goethe's stay of a few weeks while visiting his publisher (*Hier wohnte Goethe*). This is parodied on the building next door – once a dormitory, which features a plain sign with the words *Hier kotzte Goethe* (*"Goethe puked here"*).

Marketplace (Marktplatz) and City Hall (Rathaus) (4)

The Market place with City Hall and Neptune's Fountain, along with the Neckar waterfront, is one of the favorite photography locations.

The visually dominating City Hall – the oldest house at the marketplace – was built with three stories in 1435, in 1508 heightened by a fourth level, and in 1511 decorated with an artfully made astronomical clock by Johannes Stöffler. The clock, which still functions, shows the course of the stars, the phases of the moon, and even celestial events as eclipses of the sun and the moon.

The Renaissance Neptune's fountain gives a certain touch to the marketplace and dates back to the beginning of the 17th century. It is the work of the master builder Georg Müller based on the design by Heinrich Schickhardt, who was inspired by a Bolognese archetype.

Protestant Collegiate (Evangelisches Stift) (5)

The *Evangelisches Stift* was a former monastery of the Augustinians. In 1534, after the implementation of the reformation in Württemberg, it was reconstructed and enlarged in order to serve as a ducal stipend, a scholarship for students of Protestant Theology.

A great amount of European intellectual history has been written within its walls. Among the scholars who studied there were Johannes Kepler, Gustav Schwab, Eduard Mörike, Hermann Kurz as well as Hegel, Hölderlin, and Schelling, who occasionally lived and studied together in the collegiate at the end of the 18th century.

Today it serves as an accommodation and study space for about 120 students. Women have been admitted since 1969.

Burse (6)

The Burse was built from 1478 to 1482 as a students' home and study shortly after the founding of the University.
From 1803 to 1805, the building was transformed into the first medical clinic in Tuebingen. One of the first patients was the poet Friedrich Hölderlin, who was released as incurable after 231 days of therapy on May 3, 1807.
With the advancing medical development, the clinical center became too small. In 1972 – after a thorough reconstruction of the building – students and professors of philosophy and art history returned to this place of the "free arts."

Hölderlin Tower (Hölderlinturm) (7)

In the late 18th century, the *Hölderlinturm* was built on the pedestal of the inner ring wall. The wall dates back to the 13th century.
The poet Friedrich Hölderlin (born in 1770) lived here from 1807 until his death in 1843. The family of a carpenter Zimmer accommodated him in this building for the last 36 years of his life as he struggled with mental instability.
Today, the *Hölderlinturm* is a literary memorial place and museum.

Neckar Island (Neckarinsel) and Plane Tree Avenue (Platanenallee) (9)

In central Tuebingen, the Neckar River divides briefly into two streams, forming the elongated *Neckarinsel*, famous for its *Platanenallee* with high plane trees, some of which are more than 200 years old.
During the summer, the *Neckarinsel* is occasionally the venue for concerts, plays, and literary readings.
The row of historical houses across one side of the elongated *Neckarinsel* is called the *Neckarfront*. Houses were built even upon the city wall above the Neckar River during the Middle Ages, which created this distinctive waterfront, including the *Hölderlinturm*.

Additional stop: Hohentuebingen Castle (Schloss Hohentuebingen) (8)

In 1078, the castle of the Counts of Tuebingen was mentioned for the first time. The current castle, which hosts numerous institutes and collections of the University, derives mainly from the 16th century. The Hohentuebingen Castle is a mighty renaissance construction with four wings and a round tower. Its most beautiful decoration is the Renaissance portal built around 1606 in the style of a Roman triumphal arch, whose center shows the emblem of the Duchy of Württemberg.

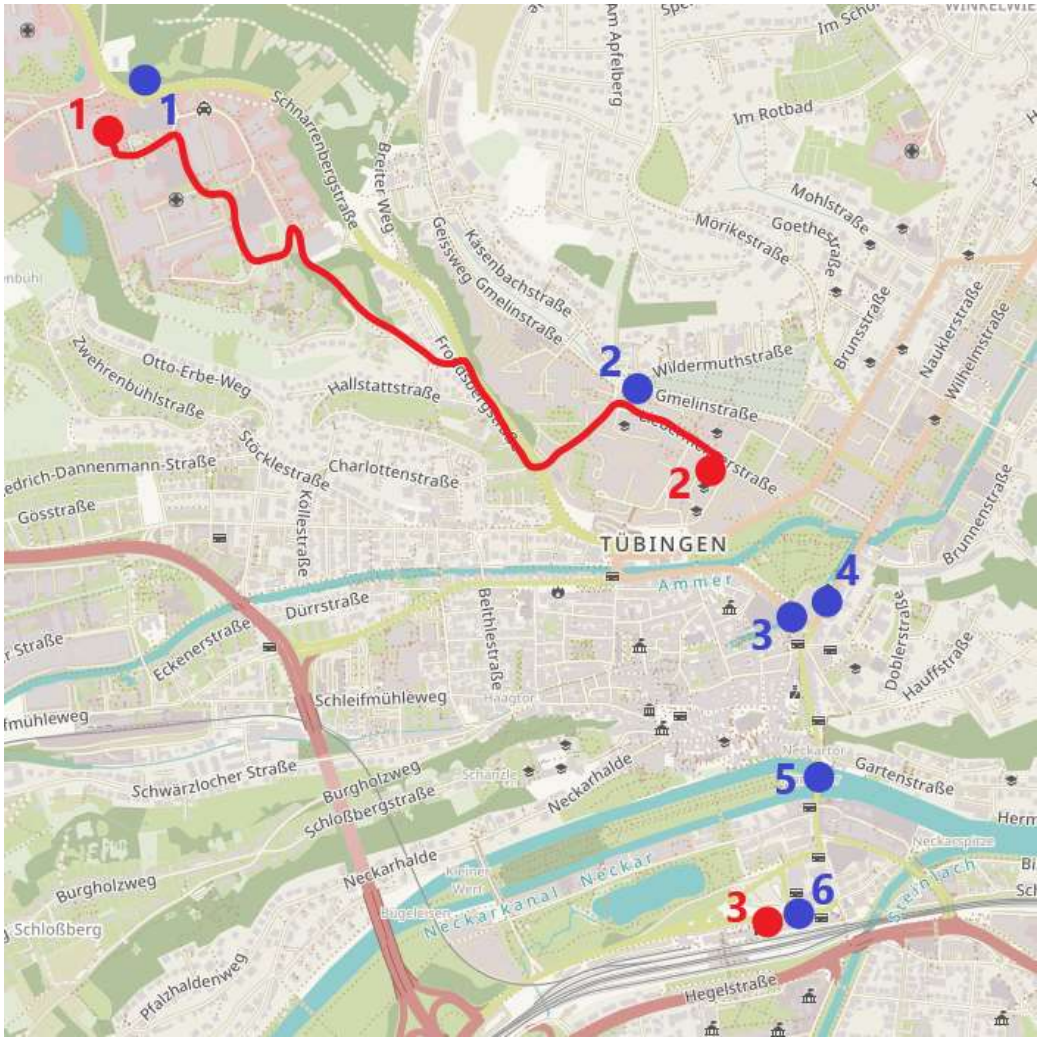
Beginning in the mid-18th century, the University acquired its first rooms in the castle, and in 1816, the King of Württemberg, Wilhelm I, transferred ownership of the castle to the University. The University library of nearly 60,000 volumes was temporarily housed in the hall of knights, an astronomical observatory was housed in the northeast tower, and a chemistry laboratory was set up in the kitchen. There, in 1869, Miescher was the first researcher to isolate various phosphate-rich chemicals, which he called nuclein (nucleic acid), in a laboratory, paving the way for the identification of DNA as the carrier of inheritance.

After the complex restoration of the castle from 1979 to 1994, some of the University's cultural and academic institutions were relocated there, the collections of which are open to the public. Parts of the highlights are numerous archeological findings and replicas, such as a complete ancient Egyptian burial chamber. Entrance to the cellar of the north wing, where the glorious 850 hl (22,455 gallons) wine barrel is located, dating back to 1546, is unfortunately not currently possible.

From the castle, the visitor has views to the city, as well as to the Neckar and Ammer valleys and the extended region up to the horizon of the Swabian Alb in the south.

6 Maps of Tuebingen

Important locations and relevant bus stops



From the Gästehaus (1, Hoppe-Seyler-Str. 6) to the Psychologisches Institut (2, Schleichstraße 4) you could either walk (~20 min) following the red path in the map, or take the bus number 5 from Uni-Kliniken Berg (1) to Uni-Kliniken Tal (2).
Important: suggested phone app for both local busses and regional trains: *DB Navigator*

Important places:

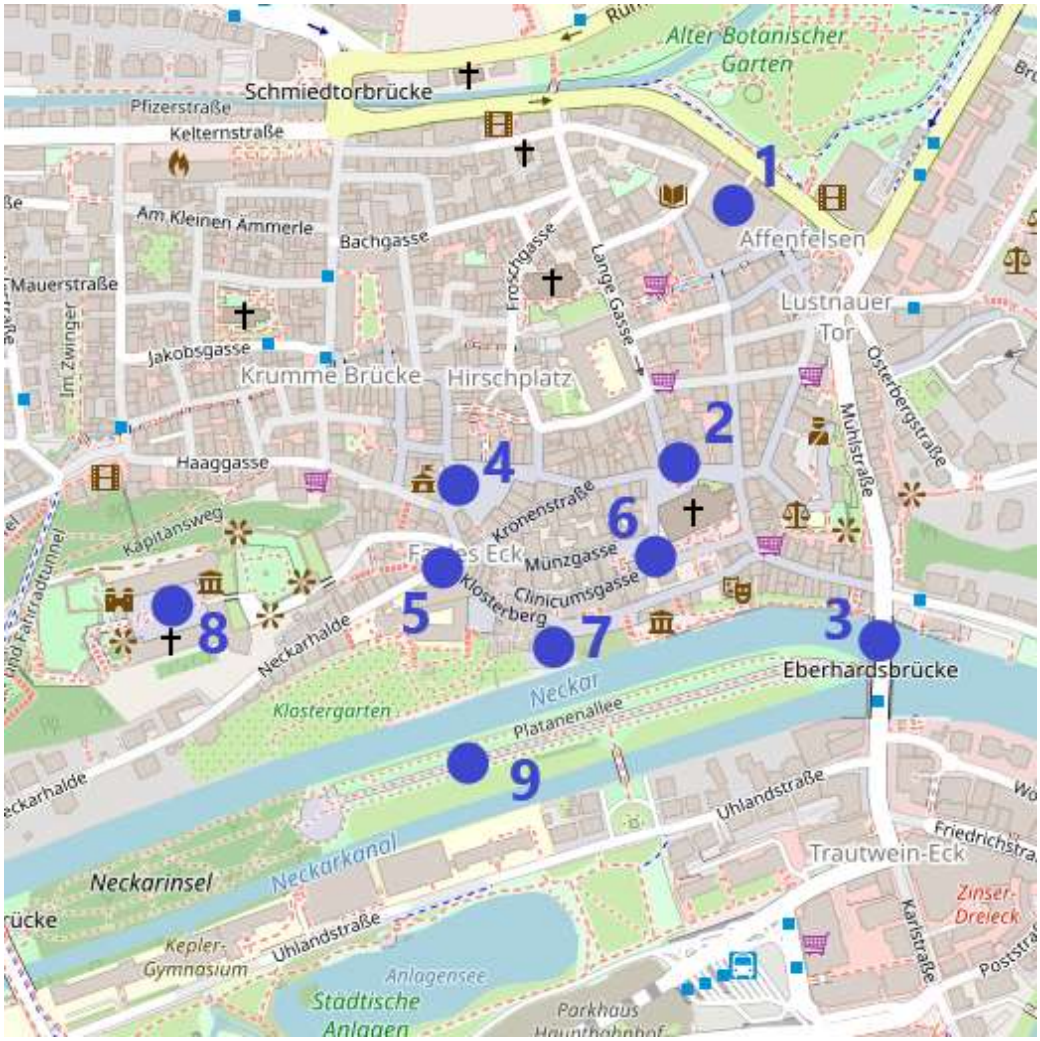
1. Gästehaus (Hotel) → Hoppe-Seyler-Str. 6
2. Psychologisches Institut (venue of the Summer School) → Schleichstr. 4
3. Tübingen Hbf (Main train/bus station).

Suggested bus stops:

1. Uni-Kliniken Berg
2. Uni-Kliniken Tal
3. Nonnenhaus
4. Wilhelmstraße
5. Neckarbruecke
6. Tübingen Hbf (Hauptbahnhof)

You will probably be moving between these stops most of the time. 1 and 2 allow to move between the Hotel and the Summer School lecture hall, while 3, 4 and 5 are suggested for reaching the old town (and back to the Hotel). Of course, there are more busses than only number **5** and surely more bus stops.

Highlights


Alter Botanischer Garten
Schmiedtorbrücke
Pfizerstraße
Kelternstraße
Am Kleinen Ämmerle
Bachgasse
Mauerstraße
Im Zwinger
Jakobsgasse
Krumme Brücke
Hirschplatz
Froschgasse
Lange Gasse
Lustnauer Tor
Osterbergstraße
Mühlstraße
Haaggasse
Kapitansweg
Kronenstraße
Münzgasse
Clinicumsgasse
Klosterberg
Neckarhalde
Klostergarten
Neckar
Platanenallee
Eberhardsbrücke
Uhlandstraße
Trautwein-Eck
Friedrichstra
Zinser-Dreieck
Karlstraße
Neckarinsel
Neckarkanal
Kepler-Gymnasium
Anlagensee
Städtische Anlagen
Parkhaus
1
2
3
4
5
6
7
8
9

Sightseeing walk through Tuebingen:

1. Nonnenhaus (House of the Nuns) → Beim Nonnehaus 12
2. Stiftskirche (Collegiate Church) and House of Cotta → Holzmarkt 1
3. Neckarbruecke (Neckar Bridge)
4. Marktplatz (Marketplace) and Rathaus (City Hall) → Am Markt 1
5. Evangelisches Stift (Protestant Collegiate) → Klosterberg 2
6. Burse → Bursagasse 1
7. Hölderlinturm (Hölderlin Tower) → Bursagasse 6
8. Schloss Hohentuebingen (Hohentuebingen Castle) → Burgsteige 11
9. Neckarinsel (Neckar Island) and Platanenallee (Plane Tree Avenue)

Ideas for hikes in the surroundings:

Heuberger Tor & pathway towards Hagelloch

Bebenhausen

Bad Urach Wasserfall

Burg Hohenzollern

7 About the University of Tuebingen

”Tuebingen does not have a university, it is a university.“, is a common expression for a good reason: With its palm tree symbol and Duke Eberhard’s motto “*Attempto*!” (“*Dare!*”), the university and its more than 26,000 students certainly shape the city image. Its 533 professors and 4,800 academics make it the second largest university in Baden-Württemberg, following Heidelberg. In total 330 courses are on offer. The seven institutes are spread throughout the city. In the old town, there is hardly a single building or location not associated with a famous scholar – Hegel, Hölderlin and Schelling, Mörike and Uhland, Kepler and Schickard among them. Furthermore, nine Nobel laureates are associated with the University of Tuebingen.

The Eberhard Karls University Tuebingen is one of Europe’s oldest universities. Several hundred years of history in the sciences and humanities have been written here. The University’s history began back in 1477, when Count Eberhard “the Bearded” of Württemberg founded the University. The latest chapter of the University’s history is marked by its success in the Excellence Initiative of the German federal and state governments. One Graduate School, one Excellence Cluster and the University’s Institutional Strategy were successful in the major funding program – also making Tuebingen one of Germany’s eleven universities in the top “Excellent” class. The University has partnerships with more than150 educational institutions in 45 countries, particularly in North America, Asia and Latin America as well as with all countries in Europe. Moreover, together with 6 partner institutions the University of Tuebingen promotes excellence in research-led education within the Matariki Network of Universities (MNU). Some 13 percent of students in Tuebingen come from abroad, and many of the University’s German students pursue part of their studies in other countries.

To learn more about the University of Tuebingen please visit the University’s Website www.uni-tuebingen.de/en.

8 Timetable

Monday, 2nd August 2021

14:00 - 14:30	Welcome
14:30 - 16:00	Why use light to assess brain function? Basics of the methodological approach and potential applications (Lecture by Hellmuth Obrig)
Coffee break	
16:30 - 17:15	Brainstorming for a collaborative hands-on paper (Moderation by Philipp Schroeder & Christina Artemenko)
17:15 - 18:30	Demonstration of fNIRS data collection (Hands-on session by Baris Yesilyurt)
20:00	*Online event*

Tuesday, 3rd August 2021

09:00 - 10:30	Analysis of fNIRS data: techniques, challenges and current trends (Lecture by Felix Scholkmann)
Coffee break	
11:00 - 13:00	My first fNIRS analysis (Hands-on session by Felix Scholkmann)
Lunch break	
14:30 - 16:00	Experimental Design (Online-Lecture by Simone Cutini)
Coffee break	
16:30 - 17:30	Historic developments of fNIRS (Lecture by Andreas J. Fallgatter)
18:00	*Event dinner*

Every in-person participant and lecturer are invited to join us at the restaurant *Neckarmüller* (Gartenstraße 4, Tuebingen). Participants need to pay the dinner for themselves. Furthermore, you need a negative corona antigen test of that day or a valid vaccination proof. Please have a look on the menu upon registration and let us know, if you want to join and what you'd like to order.

Wednesday, 4th August 2021

09:00 - 10:30 Motion artifact correction
(Online-Lecture by Sabrina Brigadoi)

Coffee break

11:00 - 1 3:00 Application of motion correction techniques to fNIRS signals
(Online Hands-on session by Sabrina Brigadoi)

Lunch break

14:30 - 16:00 Supervised and unsupervised decomposition of fNIRS data
(Lecture by Alexander von Lühmann & Meryem Yücel)

Coffee break

16:30 - 18:30 General Linear Model and Statistical Analysis
(Hands-on session by Alexander von Lühmann & Meryem Yücel)

Thursday, 5th August 2021

09:00 - 10:30 Hyperscanning with fNIRS
(Lecture by Vanessa Reindl)

Coffee break

11:00 - 13:00 Meet an expert

Lunch break

14:30 - 16:00 Multimodal Integration and Multivariate Data Analysis with fNIRS-EEG
(Lecture by Mathias Vukelic & Alexander von Lühmann)

Coffee break

16:30 - 18:00 fNIRS-based neurofeedback
(Lecture by Ann-Christine Ehlis)

Friday, 6th August 2021

09:00 - 11:00 Best practice on fNIRS publications
(Panel Discussion moderated by Meryem Yücel)

Coffee break

11:30 - 13:00 Data Blitz

13:00 - 14:00 Final Discussion on collaborative hands-on document
(Moderated by Philipp Schroeder & Christina Artemenko)

9 Lecturers

Sabrina Brigadoi
Developmental Psychology, University of Padova, Italy
sabrina.brigadoi@unipd.it

Sabrina Brigadoi is an assistant professor at the University of Padova. She uses fNIRS in her research and focuses on visual short-term memory, the analysis of signals and reconstruction of 3D images from data acquired with fNIRS, and on the impact of glycemic values on brain development in preterm newborns.

Simone Cutini
Department of General Psychology, University of Padova, Italy
simone.cutini@unipd.it

Simone Cutini is an associate professor at the University of Padova and the head of the functional Near-Infrared Spectroscopy Laboratory. He further develops the fNIRS methodology by focusing on probe placement and signal processing methods. In the field of cognitive neuroscience, he investigates cognitive control, visual short-term memory and numerical cognition by using fNIRS in addition to behavioral methods.

Ann-Christine Ehlis
Lab for Psychophysiology and Optical Imaging, Department of Psychiatry and Psychotherapy, University Hospital Tuebingen, Germany
ann-christine.ehlis@med.uni-tuebingen.de

Ann-Christine Ehlis is the head of the Psychophysiology & Optical Imaging Lab at the University Hospital of Tuebingen. Her major research interests are the application of fNIRS in psychological and neuropsychiatric research, neuromodulation by non-invasive neurostimulation and neurofeedback, executive functions and the prefrontal cortex, and the neurobiology of mental disorders.

Andreas J. Fallgatter

University Hospital of Tuebingen: Psychiatry, Germany
andreas.fallgatter@med.uni-tuebingen.de

Andreas J. Fallgatter is the medical director of the Department of Psychiatry and Psychotherapy at the University Hospital of Tuebingen. He focuses on neurophysiological methods and their application to mental disorders. His research is based on various methods, such as fNIRS, EEG, fMRI, and non-invasive brain stimulation methods (tDCS, rTMS, neuromodulation with neurofeedback).

Hellmuth Obrig

Clinic of Cognitive Neurology, University of Leipzig, Leipzig, Germany; Department of Neurology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany.
obrig@cbs.mpg.de

Hellmuth Obrig is a professor and deputy clinic director at the University of Leipzig and a group leader at the Max Planck Institute for Human Cognitive and Brain Sciences. His research focuses on language and plasticity and he combines neural and behavioral methods.

Vanessa Reindl

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Alexander von Lühmann is an associate researcher at the University of Boston and a scientific director at NIRx Medical Technologies. He is an expert for biomedical instrumentation and signal processing in neurotechnology, brain computer interfaces (BCI), diffuse optics and biopotentials (e.g., fNIRS and EEG, PPG, DCS, EOG, EMG, ECG).

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Mathias Vukelic is a research assistant at the Fraunhofer Institute for Industrial Engineering IAO. He aims to understand cognitive, emotional, and motivational processes and their underlying brain functions in complex real-world environments. In his research, he combines methods and knowledge from cognitive neuroscience with applied computer science to create intelligent technologies.

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Meryem Yücel is a research assistant professor at Boston University. Her aims to understand how the brain works in health and disease. She is an expert in functional brain imaging (fNIRS, fMRI, EEG) and mathematical modeling of biological systems. Currently, she focuses on fNIRS and uses it for clinical applications and basic neuroscience research.

10 Data Blitz

General Information for the Data Blitz

The live sessions will take place on the last day of the Summer School, Friday, 6th August, from 11:30 – 13:00. Every presenter will hold a short talk (5 minutes) about their project, followed by a discussion with the opportunity to ask questions (5 minutes).
There will be two sessions in parallel: one in-person (in the lecture hall) and one online (shown in the seminar room). As the sessions won't be streamed or recorded, you need to choose which sessions to attend in advance.
Here all abstracts are listed, sorted by the in-person sessions and online sessions.

Abstracts for in-person presentations

Zhizhao Jiang (Max-Planck-Institute for Human Cognitive and Brain Science, Leipzig, Germany)

The effects of a computer-based connected-text auditory training approach were evaluated in older adults. Training materials were phrases from connected text presented in noise. After each phrase, listeners selected target words in the phrases from amongst similar-sounding foil words. Training was carried out for 14 hours over four weeks. Assessments were made immediately after and four weeks post training. Whereas there was no difference between post-training and pre-training test, Speech Reception Threshold increased significantly by 0.7dB in the follow-up test. The neural sources of the improvements were investigated using fNIRS. The left angular gyrus and several other frontal and parietal regions were activated at the post-training and follow-up tests. This suggested that the training facilitated semantic processing and cognitive functions which support speech-in-noise perception. Functional connectivity between frontal and parietal lobes was also identified after training. Present data demonstrated that the training method has potential as a clinical intervention.

Iryna Schommartz (Goethe University Frankfurt, Germany)

Combining tDCS with functional near-infrared spectroscopy (fNIRS) we investigated potential tDCS-induced effects on sequential decision-making. Offline tDCS and sham-stimulation were applied over the left and right dorsolateral prefrontal cortex (dlPFC) in young male adults (N = 29, mean age = 23.4 years, SD = 3.2) in a double-blind between-subject design using a 3-state Markov decision task. The results showed (i) an enhanced dlPFC hemodynamic response during the acquisition of sequential state transitions that is consistent with findings from a previous functional magnetic resonance imaging (fMRI) study; (ii) a tDCS-induced increase of the hemodynamic response in the dlPFC; (iii) a greater tDCS-induced upregulation of hemodynamic responses in the delayed reward condition that seems to be associated with faster decision speed. Taken together, these findings provide empirical evidence for fNIRS as a suitable method for investigating hemodynamic correlates of sequential decision-making as well as functional brain correlates underlying tDCS-induced modulation.

Anne-Lisa Marais (University of Caen, Normandie, France)

We explore sensory learning and prediction as a screening tool for neurodevelopmental disorders. Using fNIRS (16 channels, Imagent®, ISS Inc.) and EEG (128 channels, MagstimEGI), we measure neuronal and neurovascular activities elicited by expected somatosensory stimuli in an oddball protocol combining trial-based (for EEG) and block-based (for fNIRS) analysis. The stimulation sequence is composed of vibrotactile stimuli, 10% of them being presented backward (deviant) and 10% being unexpectedly omitted (omissions). We aim at 160 children participants, from premature neonates at 35 weeks of corrected gestational age to six years old children, with various risk factors. We will measure the amplitude of neuronal and neurovascular responses to the three conditions, to assess sensory prediction and mismatch response as a function of age and risk factor (regression analysis). We will also compare fNIRS and EEG responses in each condition to evaluate their consistency and determine which is most reliable for screening purposes.

Monica Vanoncini (University of Potsdam, Germany)

The project examines whether and how neural synchrony between mothers and their 9-month-old infants predicts early speech segmentation, one important precursor of lexical acquisition. We hypothesize that more frequent episodes of mother-child neural synchrony will be associated with higher speech segmentation performance as assessed by eye-tracking. In order to quantify neural synchrony, the dyads perform a 5-minutes free play while we measure their brain activity using dual-fNIRS (frontal and temporo-parietal regions as regions of interest). We will calculate wavelet transform coherence (WTC) in oxygenated hemoglobin concentration changes to assess the cross correlation between fNIRS time series of mothers and their infants as an index of neural synchrony. In order to detect synchrony not related to the experimental interaction, we will conduct a validation by random pair analysis. Difference in looking time will be the response variable in the linear mixed model, whereas WTC and region of interest will enter as fixed and interaction effects.

Veerle de Rond (KU Leuven, Belgium)

So far, only one study investigated fNIRS test-retest reliability in young adults during turning and walking. Here, we investigated test-retest reliability in the PFC in healthy older adults during a postural weight-shifting task. Ten out of twenty participants were assessed on three time points on two consecutive days, representing pre, post and retention measurements. On day 1, fNIRS was assessed twice without cap removal and once on day 2 with cap removal. Multiple optode positions were marked on the head to assure similar cap placement on day 2. Results showed no difference in fNIRS measures (HbO2 and HHb) across time points ($p>0.05$). Intra-class correlation coefficients (ICC) were good for measurements without cap removal (pre-post) (HbO2: ICC=0.888, CI=0.608-0.971; HHb: ICC=0.568, CI=-0.030-0.871), and ranged from moderate to good for measurements with cap removal (HbO2: ICC=0.446, CI=-0.215-0.826; HHb: ICC=0.824, CI=0.468-0.952). Further validation of these findings is ongoing in a larger sample.

Sabrina von Au (Institute of Health Promotion and Clinical Movement Science, German Sport University Cologne, Germany)

In recent years, oxytocin has received increasing attention. Research has shown the influence of social and emotional well-being induced by oxytocin. A system of unmyelinated C-tactile afferents is postulated as a meditator of oxytocin. This C-tactile afferents innervating optimally to soft and slow interpersonal strokes on hairy skin. Up until now interpersonal gentle touch is most studied, but to date little is known about self-touch. Self-touch may be an important method for increasing oxytocin concentration and may offer several therapeutic benefits. The aim of the study is to measure brain responses to CT-targeted social- and self-touch. 60 healthy adults receive social-stroking and self-stroking to the right forearm separately, in a block design procedure. Oxytocin is measured centrally via fNIRS and peripherally via saliva sampling before und immediately after each block. Yet it is unknown, whether self-touches are linked to oxytocin. This research hypothezises that self-touch leads to release of oxytocin.

Renato Orti (University of Campania Luigi Vanvitelli, Italy)

Background: The coffee cup is next to me and next to my laptop indicates the switch between egocentric (subject-object) and allocentric (object-object) spatial representations. Although this fundamental visuospatial ability is necessary to perform our daily life activities, to date it is unclear which cortical regions are involved in switching processes. *Aims:* Investigating cortical activations on switching and non-switching between egocentric/allocentric encodings. *Method:* By means of fNIRS, changes in oxygenated and deoxygenated haemoglobin while performing an ad-hoc devised visuo-spatial memory switching task (Ego-Allo Switching Task) were recorded. *Results:* An involvement of frontal regions during switching vs. non-switching judgments appeared. In non-switching task, egocentric judgments showed activations in parietal regions; allocentric judgments in parieto-temporal regions. *Conclusions:* We showed for the first time the involvement of fronto-parietal regions in a visuo-spatial memory switching task, arguing for an involvement of such regions in the translational processes between spatial representations.

Helena Cockx (Radboud University & Donders Institute, Nijmegen, The Netherlands)

Imagine that you are chopping some carrots in the kitchen and suddenly the doorbell rings. You turn around to go open the door, but your feet are not moving. This symptom, called freezing of gait, is debilitating in three out of five persons with Parkinson's disease. Although fMRI studies have started to unravel its underlying neural mechanisms, these hypotheses have only scarcely been tested during over ground walking. fNIRS opens the possibility to study this mysterious phenomenon during real-life situations, but also comes with many challenges. In a first study in healthy controls, we try to identify the brain regions that correlate with automatic and non-automatic movements, since Parkinson's disease is marked by problems executing automatic movements, like walking. In a second study, we specifically trigger freezing of gait in people with Parkinson's disease to identify neural correlates of this symptom using fNIRS.

Yunfeng He (Department of Psychology, University of Tuebingen, Germany)

Domain-general or domain-specific? Cognitive control in two–digit number comparison

In a two-digit number comparison task, the comparison of unit-decade incompatible number pairs (e.g., 47_62) is more difficult than the comparison of compatible number pairs (e.g., 42_57). This unit-decade compatibility effect is further influenced by cognitive control, which decides how to allocate the attention when the task relevance of units and decades is altered. This preregistered fNIRS study aims to investigate the neural correlates of cognitive control during number comparison to identify whether it is domain-general processes, mainly localized in the frontal cortex, or has been domain-specific processes, mainly localized in the parietal cortex. 80 adults will complete the number comparison task in a 2 compatibility (compatible vs incompatible) × 2 cognitive control (low vs high) within-subject design. We expect a larger unit-decade compatibility effect in high cognitive control demands condition, associated with higher activation in the overlap between the number processing and cognitive control networks.

Abstracts for online presentations

Sarah Rösch (University of Leipzig, Germany)

While fNIRS has become a promising clinical neurofeedback (NF) tool, the underlying mechanisms remain unclear. In our feasibility study 'Near Infrared Spectroscopy Neurofeedback for Binge-Eating Disorder' (NIRSBED; DRKS00014752), n = 40 adults with binge-eating disorder, characterized by recurrent binge-eating episodes in the absence of regular weight control behaviours, underwent 12 fNIRS NF sessions over the prefrontal cortex. Participants performed passive viewing and regulation traks, during which they employed any mental strategy to modulate the online feedback (an individually appetitive food picture). The online and the offline (i.e., activity in regulation versus viewing) will be related to self-reported success, assuming a stronger correlation between the online and self-reported success. Psychopathological changes in self-reported food craving, urge to eat, and loss of control over eating will be investigated, hypothesizing significant decreases after versus before and with increasing sessions. The association between mental strategy use and brain-based and self-reported regulation is exploratively evaluated.

Hanna Schleihauf (University of California, Berkeley, USA; Max-Planck-Institute for Cognitive and Brain Science, Leipzig, Germany)

Understand each others' reasons?

While communicating, a speaker tries to transmit thoughts from their brain to the brain of the listener. Past research has shown, that during successful communication, the speaker's and listener's brains exhibit joint, temporally coupled, response patterns (Hasson, 2011). Such brain-to-brain coupling diminishes when the communication is unsuccessful. When engaging in discourse, we aim to gain a listener's understanding by using reasons to justify our actions and beliefs. We reach this goal using strong convincing reasons, and we likely fail if our reasons are weak. We plan to investigate the neural foundations of social reasoning in children by simultaneously measuring the brain activity of two communication partners exchanging arguments. We expect to find stronger brain-to-brain coherence if a speaker underpins their statements with reasons that the listener finds convincing, and lower brain-to-brain coherences if the listener is not convinced by the speaker's reasons.

Syed Hammad Nazeer Gilani (Air University, Pakistan)

A state-of-the-art brain-computer interface (BCI) system includes recording brain signals, noise reduction, channel selection, extracting features, classification, and application interface. Accuracy is one of the measures to evaluate the performance of the BCI system. fNIRS-BCI, cortical activity-based channel selection and intrinsic information features play a vital role in developing accurate BCI applications. In literature for fNIRS-BCI systems, statistical measures and t-value methods as channel section methods have been used and experimented with successfully. This research aims to enhance the fNIRS-BCI system's classification accuracy by proposing novel features and cortically active channels selecting method to enhance the system's accuracy. Proposed novel features are extracted using the vector-based phase analysis method. The proposed z-score method for channel selection is proposed to improve fNIRS-BCI performance. The results show 34.1- 53.5% and 12.1-25.7% improvement in classification accuracy using proposed novel features and a proposed channel selection method over conventional methods.

Jasmine Chan (Florida Atlantic University, United States of America)

This experiment predicts that a function of the left prefrontal cortex (PFC) is to process brand-name products for their attributes. Hemodynamic response was measured in bilateral PFC and anterior temporal lobe from 48 participants during a study task, where participants processed brand-name products using various types of attribute processing (i.e., once using one attribute, twice using the same attribute, and twice using two different attributes), and during a purchase intention test, where participants chose to purchase novel or previously processed brand-name products. Analysis of variance compared differences in hemodynamic response as a function of cortical structure, type of attribute processing, and task. Results from the purchase intention task showed repetition suppression in the left PFC for brand-name products that were previously processed for multiple attributes. Findings suggest processing different attributes of a brand-name product biases purchase intention, where participants were more likely to purchase brand-name products processed for multiple attributes.

Mariagrazia Ranzini (University of Padova, Italy)

The aim of my current fNIRS study is to explore the role of brain areas shared between number processes and hand actions. Previous studies have described interactions between number and hand action processes, but the brain network underlying these interactions remains largely unexplored. In this experiment, each participant will complete the following tasks: hand action (object grasping); object passive viewing (control task); number comparison; colour naming (control task). fNIRS source and detectors will be placed over frontoparietal cortex bilaterally to cover the grasping network. Modulations in the hemodynamic response will be analysed as a function of number-related variables (e.g., numerical magnitude), within brain areas active during hand action. The fNIRS lab in my institution is currently close due to anti-COVID-19 measures. Data collection will start asap. I will probably be able to collect some data in the next months.

Vera Mateus (Graduate Program on Developmental Disorders, Mackenzie Presbyterian University, São Paulo, Brazil)

We aimed to characterize the pattern of cortical activation to affective touch in 6-month-old infants, when they perceive the touch as being applied by their mothers versus an unfamiliar female. Participants were eight 6-month-old infants, born full-term and presenting typical development. Infant's neural processing of affective touch was assessed using fNIRS, specifically targeting the bilateral somatosensory and temporal areas of the brain. Tactile stimulation consisted of slow strokes (3 cm/s) applied by human hand on the infant's right shoulder blade, for 15 seconds periods followed by 12 to 15 seconds periods without touch, while the mother was seated next to the infant compared to an unfamiliar female tester. Results showed an activation in the somatosensory and temporal regions in response to affective touch when infants believed to be applied by their mother, but no significant cortical activation when the female tester was seated next to the infant during touch administration.

Franziska Albrecht (Karolinska Unstitute & Max-Planck-Institute for Cognitive and Human Brain Sciences, Sweden)

The Park-MOVE trial aims to reduce the disease burden and, particularly, risk of falls as well as increase health-related quality of life by tailored and personalized exercise protocols in elderly and people with Parkinson's disease (PwPD). We develop a protocol and explore brain activity in real time during rest and complex walking using gait analysis and fNIRS in healthy elderly and PwPD. Further we test resting-state fNIRS as a biomarker to distinguish between PwPD and healthy elderly. Thereafter, we investigate the heterogeneity of PD by characterizing subtypes using multimodal data (MRI/fNIRS, clinical, motor) in clustering analyses.

11 Preregistered Participants

In the following section, all participants are listed, ordered by their kind of participation (in-person vs. online) with their affiliation and e-mail address, so you can get in contact and stay in touch even after the Summer School.

To keep the prescribed distances, we are assigning in-person participants into two groups (before vs. after lunch) so that everybody can attend half of the sessions live in the lecture hall and the other half via streaming in the seminar room nearby. Therefore, in-person participants in the following section are listed in the groups *before lunch* and *after lunch*. Groups were assigned randomly.

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12 Notes