Society for the Neural Control of Movement

NCM

33rd Annual Meeting

Dubrovnik, Croatia

Valamar Lacroma, Dubrovnik Hotel

2024

SATELLITE MEETING
April 15, 2024

ANNUAL MEETING
April 16 – 19, 2024

X @ncm-soc | #NCMDub24 | ncm-society.org

Program at a Glance

Schedule is subject to change

Time	Monday 15-Apr	Tuesday 16-Apr	Wednesday 17-Apr	Thursday 18-Apr	Friday 19-Apr
8:00	Registration /Information Desk Open	Registration / Information Desk Open Posters on Display Exhibits on Display ***Session 1*** ***Panel I*** *Lacal* (08:00 - 10:00)	Registration / Information Desk Open Posters on Display Exhibits on Display ***Session 5*** ***Panel III*** *Michaels* (08:00 - 10:00)	Registration / Information Desk Open Posters on Display Exhibits on Display ***Session 9*** ***Panel V*** *Crevecoeur* (08:00 - 10:00)	Registration / Information Desk Open Posters on Display ***Session 12*** ***Panel VII*** *Vahdat* (08:00 - 10:00)
8:15					
8:30	**Satellite Meeting**				
8:45					
9:00					
9:15					
9:30					
9:45					
10:00		**Break** (10:00 - 10:30)	**Break** (10:00 - 10:30)	**Break** (10:00 - 10:30)	**Break** (10:00 - 10:30)
10:15					
10:30		***Early Career Talk*** *Sam McDougle* (10:30 - 11:05)	***Session 6*** ***Individual II*** (10:30 - 12:30)	***Session 10*** ***Panel VI*** *Pirondini* (10:30 - 12:30)	***Session 13*** ***Individual III*** (10:30 - 12:30)
10:45					
11:00		***Session 2*** ***Panel II*** *Simha* (11:05 - 13:05)			
11:15					
11:30					
11:45					
12:00					
12:15					
12:30			***Session 7*** **Posters, Exhibitors & Lunch** (12:30 - 15:00)	***Session 11*** **Posters, Exhibitors & Lunch** (12:30 - 15:00)	***Session 14*** **Posters & Lunch** (12:30 - 15:00)
12:45					
13:00		***Session 3*** **Posters, Exhibitors & Lunch** (13:05 - 15:30)			
13:15					
13:30					
13:45					
14:00					
14:15					
14:30					
14:45					
15:00			***Session 8*** ***Panel IV*** *Shmuelof* (15:00 - 17:00)	**Free Time and/or Excursions**	***Session 15*** ***Panel VIII*** *Heed* (15:00 - 17:00)
15:15					
15:30		***Session 4*** ***Individual I*** (15:30 - 17:30)			
15:45					
16:00					
16:15					
16:30					
16:45					
17:00			**Members' Meeting** (17:00 - 17:30)		***Distinguished Career Award*** *Eberhard Fetz* (17:00 - 18:00)
17:15					
17:30		**NCM Board Meeting** (17:30 - 20:30) **Trainee Social** (17:30 - 18:30)			
17:45					
18:00					**Closing Drinks Reception** (18:00 - 19:00)
18:15					
18:30					
18:45					
19:00	**First Timer Social** (19:00 - 19:30)				
19:15					
19:30	**Opening Reception Valamar Lacroma** (19:30 - 21:30)				
19:45					
20:00		**Banje Beach (Old Town)**	**Hard Rock Café (Old Town)**		
20:15					
20:30					
20:45					
21:00					
21:15					
21:30					
21:45					
22:00					
22:15					
22:30					

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About NCM

The Society for the Neural Control of Movement (NCM) is an international community of scientists, clinician-investigators and students all engaged in research whose common goal is to understand how the brain controls movement.

NCM was conceived in 1990 by Barry Peterson. With an initial leadership team that also included Peter Strick and Marjorie Anderson, NCM was formally established to bring together scientists seeking to understand the neural mechanisms that guide meaningful activities of daily life, primarily through the brain's control of the eyes, head, trunk, and limbs. Early members consisted largely of systems neurophysiologists, behavioral, computational and theoretical neurobiologists, and clinician-investigators interested in disorders of motor function.

From the outset the goal of NCM was to provide a useful gathering of investigators in an informal and casual setting to present and discuss where we are in a diverse and complex field, where we should be going and how we might best proceed as a community with multiple perspectives and approaches. The meeting was to be unique in style, such that sessions were formulated and proposed by small groups of members, each and geared to inform the larger attending community through focused presentations and discussions integrated into themes reflecting the diversity of the membership. Sessions would change in content with each yearly meeting.

The inaugural NCM Conference took place in April 1991 on Marcos Island, Florida, with roughly 140 attendees. The success of the initial years promoted longevity and expansion of NCM and its conference, both in attendance (now over 250) and the breadth of scientific content. Sessions cover all levels of inquiry--from perception to genetic expression, and from whole organism to intracellular function, while also including computational and theoretical approaches. Sessions have expanded to include a variety of formats and durations to accommodate diverse needs and interests, while poster sessions have been augmented to yield highly popular, vibrant and flexible forums of scientific interchange. This highly regarded and robust conference continues to meet in desirable, family-friendly locations typically in late April/early May every year.

Letter from the President

Dear Colleagues,

As the new President, it is my pleasure to welcome you to the historic city of Dubrovnik, Croatia, for the 33rd Annual Meeting of the Society for the Neural Control of Movement!

We have an exciting program with a record number of submissions, including 24 team submissions, 146 individual oral submissions, and 272 poster submissions! This year's satellite meeting, "*Artificial sensorimotor control from restoration to augmentation*" promises to advance our understanding in exciting new directions. Organized by Tamar Makin from Cambridge University, Hayriye Cagnan of Imperial College, Sergey D. Stavisky from the University of California, Davis, and Silvestro Micera from EPFL. Our program further features two keynote addresses. On Thursday, we will hear from Sam McDougle of Yale University, winner of the Early Career Award, presenting on "*Cognitive Shaping of Motor Behavior*". We will also have the honor of hearing from our Distinguished Career Award Winner, Eb Fetz, of the University of Washington who will give our closing lecture aptly titled "*On the Neural Control of Movement*".

I am also pleased to announce that this year we have delegates attending from 31 countries and have maintained considerable diversity on our podium representative of the breadth of our scientific community. We have received substantial support from the NIH, in the form of a R13 Conference grant, from the National Institute of Neurological Disorders and Stroke (NINDS), with co-funding from NIA, NEI, NIDCD, NCMRR. As a result of this generous funding as well as that from all of our Industry sponsors, we have been able to offer support to trainees through a wide range of initiatives. Additionally, we have conducted outreach efforts to increase access for all members of our motor control community.

Finally, I would like to thank the NCM leadership, starting with our Officers Adrian Haith (Vice-President and Program Chair), Alaa Ahmed (Secretary/Treasurer), Kazuhiko Seki (Academic Development Chair) as well as the NCM board. All their efforts during the past year have been essential to making this meeting possible. Thank you to our outgoing board members who have supported the society over their terms. We have new and returning board members to welcome following a strong turnout for elections that included a full slate of eight candidates for four spots and two trainee candidates for one two-year term. Neeraj Ghandi will return for a second term, while David Franklin, Katja Kornysheva, and Lena Ting are all newly elected to the board, with terms to begin following this meeting. Our newly elected trainee member, Nina van Mastrigt will also begin her two-year term at the conclusion of the 2024 meeting. In addition, we now have three active working committees, a Diversity, Social Media, and Community Conduct committee, each composed of several society members with a board member liaison. Feel free to reach out to any board member if you are interested in participating.

I am looking forward to an extraordinary conference and to meeting each of you in Dubrovnik.

Be sure to immerse yourself in the full array of activities planned for this meeting. From engaging discussions in the meeting rooms to networking at the poster sessions, and eagerly anticipated evening meet up locations! We have a location on both Tuesday and Wednesday evenings for the nightly meet ups. They are both located within the city walls of Old Town and will be first come, first served for food and/or drinks. Tuesday night's meet up is scheduled for the Banje Bar where delegates who show their name badge prior to ordering will receive 10% off their bill. Wednesday night's location is the Hard Rock Café Dubrovnik. Both locations are large establishments so hopefully all who want to attend can!

Warm regards,

Kathy Cullen
President
Society for the Neural Control of Movement

Society Information

Elected members govern the Society for the Neural Control of Movement. These members comprise the Board of Directors who in turn elects Officers that comprise the Executive Committee. The Society's Bylaws govern how the Board manages the Society.

Officers and Board members are elected for three-year terms and may be re-elected to one additional contiguous term. The current Board comprises the following Officers and Directors:

OFFICERS EXECUTIVE COMMITTEE

President & Conference Chair
Kathleen Cullen

Vice President & Scientific Chair
Adrian Haith

Treasurer & Secretary
Alaa Ahmed

Development Officer
Kazuhiko Seki

BOARD MEMBERS

NAME	INSTITUTION	COUNTRY	TERM
Neeraj Gandhi[1]	*University of Pittsburgh*	USA	2021 - 2024
Wilsaan Joiner[1]	*University of California Davis*	USA	2021 - 2024
Jennifer Semrau[1]	*University of Delaware*	USA	2021 - 2024
Megan Carey[2]	*Champalimaud Center of the Unknown*	Portugal	2022 – 2025
Susan Coltman[*]	*University of Colorado, Denver*	USA	2022 - 2024
Freidl De Groote[1]	*KU Leuven*	Belgium	2022 – 2024
Sam McDougle[1]	*Yale University*	USA	2022 – 2025

Hans Scherberger[1]	*German Primate Center*	Germany	2022 – 2025
Aaron Wong[1]	*Moss Rehabilitation Research Institute*	USA	2022 – 2025
Joshua Cashaback[1]	*University of Delaware*	USA	2023 – 2026
Julie Duque[1]	*Université catholique Louvain*	BEL	2023 – 2026
Juan Gallego[2]	*Imperial College London*	GBR	2023 – 2026
Tarkeshwar Singh	*Pennsylvania State University*	USA	2023 - 2026

[1] Serving first 3 year term   [2] Serving second 3 year term   * Trainee Board Member

INCOMING BOARD MEMBERS

The following members will begin their term at the conclusion of the 2024 Annual Meeting:

NAME	INSTITUTION	COUNTRY
David Franklin	*Technical University of Munich*	Germany
Neeraj Ghandi	*University of Pittsburgh*	USA
Katya Kornysheva	*University of Birmingham*	GBR
Lena Ting	*Emory University & Georgia Tech*	USA
Nina van Mastrigt*	*Justus-Liebig-Universität Gießen*	Germany

NCM ADMINISTRATION

Association Secretariat & Conference Management *management@ncm-society.org*

Podium Conference Services

- Michelle Smith
- Marischal De Armond
- Rachel Waller

BOARD SERVICE

Nominations for NCM Board service open in January. Nominations must come from members in good standing, and only members are invited to stand for election. To learn more about Board service or if you are interested in serving on the NCM Board, please discuss your interest with one of NCM's Board members or Officers, or send an email to *management@NCM-Society.org*.

MEMBERSHIP INFORMATION

NCM membership is open to all scientists, principal investigators and students from around the world, pursuing research whose goal is to understand how the brain controls movement. Memberships are valid September 1 through August 31 each year.

BENEFITS

NCM membership includes the following benefits:

- Opportunity to submit proposals and abstracts for sessions at the Annual Conference
- Opportunity to submit proposals for satellite meetings
- Opportunity to register for Annual NCM Conferences at reduced registration rates
- Access to the member resource database and other members' web services
- Professional development and networking
- Access and ability to respond directly to job opportunity postings
- Ability to post job opportunities
- Access to online NCM resources and Annual Conference proceedings
- Access to scholarships (Grad Students and Post Docs)
- Opportunity to vote in Annual Elections of NCM Board members
- Opportunity to stand for election to, and serve on, the NCM Board of Directors
- Regular email updates and notices

To become an NCM Member please visit us at the registration desk today

NCM HISTORY

Since 1991 NCM's annual conferences have provided a forum for leading edge research, scholarly debate, the interchange of ideas, and a platform for many exceptional established and emerging researchers in the field of Neural Science. We are proud that this has all been accomplished in some of the nicest destinations in the world. Our history is strong, and our future is bright.

CONFERENCE	DATES	CITY	COUNTRY	HOTEL
32nd Annual Meeting*	April 17 – 21, 2023	Victoria	Canada	Victoria Conference Centre
31st Annual Meeting*	July 25 – 29, 2022	Dublin	Ireland	The Clayton Hotel Burlington Road
30th Annual Meeting	April 20 – 22, 2021	Virtual		
29th Annual Meeting*	April 23 – 27, 2019	Toyama	Japan	Toyama International Conference Center
28th Annual Meeting*	April 30 – May 4, 2018	Santa Fe	USA	Hilton Buffalo Thunder
27th Annual Meeting*	May 1 – 5, 2017	Dublin	Ireland	The Clayton Hotel Burlington Road
26th Annual Meeting	April 24 – 29, 2016	Montego Bay	Jamaica	Hilton Rose Hall Resort
25th Annual Meeting*	April 20 – 24, 2015	Charleston, SC	USA	Francis Marion Hotel
24th Annual Meeting*	April 21 – 25, 2014	Amsterdam	Netherlands	Grand Hotel Krasnapolsky
23rd Annual Meeting*	April 16 – 20, 2013	San Juan, Puerto Rico	USA	El San Juan Hotel & Casino

22nd Annual Meeting*	April 23 – 28, 2012	Venice	Italy	Hilton Molino Stucky
21st Annual Meeting*	April 26 – 30, 2011	San Juan, Puerto Rico	USA	El San Juan Hotel & Casino
20th Annual Meeting*	April 20 – 25, 2010	Naples, Florida	USA	Naples Beach Hotel & Golf Club
19th Annual Meeting*	April 28 – May 3, 2009	Waikoloa, Hawaii	USA	Waikoloa Beach Marriott Resort & Spa
18th Annual Meeting	April 29 – May 4, 2008	Naples, FLA	USA	Naples Beach Hotel & Golf Club
17th Annual Meeting*	March 25 – April 1, 2007	Seville	Spain	Melia Sevilla
16th Annual Meeting*	April 30 – May 7, 2006	Key Biscayne, FLA	USA	Sonesta Beach Resort
15th Annual Meeting	April 12 – 17, 2005	Key Biscayne, FLA	USA	Sonesta Beach Resort
14th Annual Meeting*	March 25 – April 3, 2004	Sitges	Spain	Melia Sitges
13th Annual Meeting	April 22 – 27, 2003	Santa Barbara, CA	USA	Fess Parker's Doubletree Resort
12th Annual Meeting*	April 14 – 21, 2002	Naples, FLA	USA	Naples Beach Hotel & Golf Club
11th Annual Meeting	March 25 – 30, 2001	Seville	Spain	Melia Sevilla
10th Annual Meeting	April 9 – 17, 2000	Key West, FLA	USA	Wyndham Casa Marina Resort
9th Annual Meeting*	April 11 – 19, 1999	Kauai, Hawaii	USA	Princeville Resort
8th Annual Meeting	April 14 – 22, 1998	Key West, FLA	USA	Marriott Casa Marina Resort
7th Annual Meeting*	April 8 – 16, 1997	Cozumel	Mexico	Presidente Intercontinental
6th Annual Meeting	April 16 – 21, 1996	Marco Island, FLA	USA	Radisson Suite Beach Resort
5th Annual Meeting	April 18 – 25, 1995	Key West, FLA	USA	Marriott Casa Marina Resort
4th Annual Meeting*	April 13 – 22, 1994	Maui, Hawaii	USA	Maui Marriott Resort (Lahaina)
3rd Annual Meeting	April 13 – 18, 1993	Marco Island, FLA	USA	Radisson Suite Beach Resort
2nd Annual Meeting	April 21 – 26, 1992	Marco Island, FLA	USA	Radisson Suite Beach Resort
1st Annual Meeting	April 6 – 11, 1991	Marco Island, FLA	USA	Radisson Suite Beach Resort

*indicates a Satellite Meeting was held in conjunction with the Annual Conference

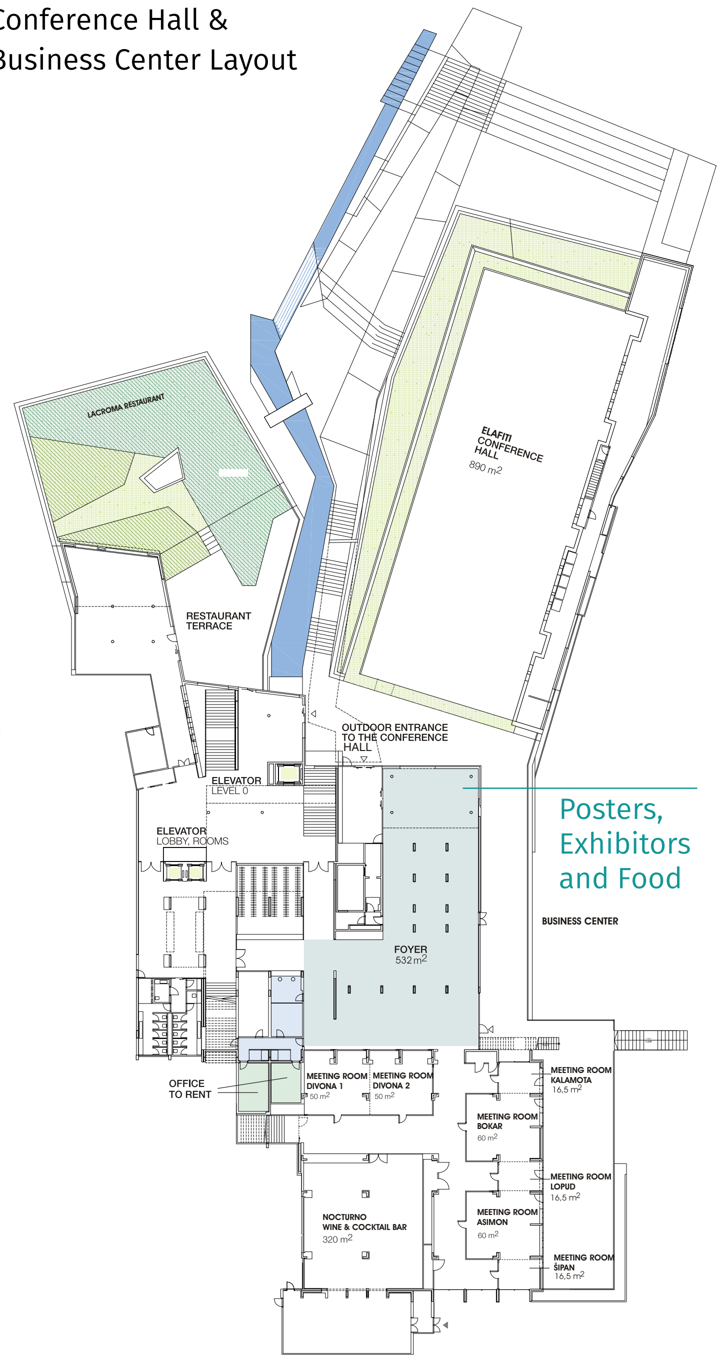
CONFERENCE VENUE

Valamar Lacroma Dubrovnik
Iva Dulčića 34
20000, Dubrovnik, Croatia

All conference sessions will take place in this location, including the Opening Reception.

Level 0
Elafiti Conference Hall

Conference Hall & Business Center Layout



REGISTRATION

SATELLITE MEETING

Satellite Meeting registration fees include access to the full day meeting with refreshment breaks and a buffet lunch on Monday April 15th.

ANNUAL CONFERENCE

Annual Conference registration fees include access to all sessions including panel, individual, and poster sessions. Registration also includes daily refreshment breaks, buffet lunches, the Opening Reception on Monday evening, and the Closing Drinks Reception.

ADDITIONAL TICKETS

Tickets can be purchased separately for your guests and/or children for the Opening Reception, Closing Drinks Reception and excursions. These additional tickets can be purchased from the staff at NCM's Registration Desk.

NAME BADGES

Your name badge is your admission ticket to the conference sessions, coffee breaks, meals, and receptions. Please always wear it. At the end of the Conference we ask that you recycle your name badge in one of the name badge recycling stations that will be set out or leave it at the Registration Desk.

To help identify and mentor our future investigators, student delegates have green edged badges. All other delegates have clear badges. NCM Officers and Board Members, Exhibitors and Staff will be identified by appropriate ribbons. The scholarship winners and the Early Career Award winner will be identified by award winner ribbons.

DRESS CODE

Dress is casual for all NCM meetings and social events.

REGISTRATION AND INFORMATION DESK HOURS

The NCM Registration and Information Desk, located in the foyer of the Elafiti Conference Hall, will be open during the following dates and times:

Monday, April 15	08:00 – 18:00
Tuesday, April 16	07:30 – 17:30
Wednesday, April 17	07:30 – 17:30
Thursday, April 18	07:30 – 15:00
Friday, April 19	07:30 – 18:00

If you need assistance during the conference, please visit the Registration Desk.

POSTER INFORMATION

ANNUAL MEETING

There are four Poster Sessions during the Meeting and posters have been allocated to one of the sessions based on poster themes. Poster presenters must set-up and remove their posters during the following times.

POSTER SESSION 1

Set-up:
Tuesday, April 16, between 07:30 and 10:00
Remove:
Tuesday, April 16, no later than 17:30

POSTER SESSION 2

Set-up:
Wednesday, April 17, between 07:30 and 10:00
Remove:
Wednesday, April 17, no later than 17:30

POSTER SESSION 3

Set-up:
Thursday, April 18, between 07:30 and 10:00
Remove:
Thursday, April 18, no later than 15:15

POSTER SESSION 4

Set-up:
Friday, April 19, between 07:30 and 10:00
Remove:
Friday, April 19, immediately following the poster session conclusion.

Any posters that are not taken down by the removal deadline will be held at the registration desk until the end of the Meeting. Any posters that remain unclaimed by the end of the Meeting will be disposed of.

Information on Poster Authors (Lead), Poster Numbers and Poster Titles begins on page 55. For a complete copy of all the poster abstracts, a digital abstract booklet can be downloaded from the Member Only section of the NCM Website.

STAFF

NCM staff from Podium Conference Specialists can be identified by orange ribbons on their name badges. Feel free to ask anyone of our staff for assistance. For immediate assistance please visit us at the Registration Desk.

INTERNET SERVICES

Wireless Internet is available to Annual Meeting delegates for no charge. Simply choose the **Valamar Guest WiFi network**, and enter the password: **v@lamAr135**
Kindly note, the WiFi strength is ideal for checking emails and websites but is not strong enough for streaming videos or heavy social media use.

If you are active on social media, make sure to hashtag *#NCMDub24 @ncm_soc* when referring to the meeting. We ask all NCM delegates to respect no live tweeting of presentations without prior approval from the speakers/authors. Poster authors may choose to allow photography of their poster. Please check with poster presenters before taking a photo of their poster.
We encourage social tweets about the conference and look forward to growing our online community.

If you require assistance, please visit the registration desk and we will endeavour to assist you.

NO SMOKING POLICY

The Valamar Lacroma is a completely non-smoking facility indoors. Smoking is allowed on the terraces, including the Elafiti Terrace in front of the meeting rooms.

CODE OF CONDUCT

As a representative of your institution the professional standards and code of conduct of your institution are in effect while at the NCM Annual Meeting, Satellite Meeting and all social events.

The Society for the Neural Control of Movement (NCM) encourages open and honest intellectual debate within a welcoming and inclusive atmosphere at the Annual Meeting and through official NCM social media channels. To help maintain an open and respectful community of scientists, NCM does not tolerate illegal or inappropriate behavior at any annual meeting, including violations of applicable laws of the country in which the meeting is taking place. NCM condemns inappropriate or suggestive acts or comments that demean or harass another person by reason of gender, gender identity or expression, sexual orientation, physical appearance, ethnicity/race, religion (or lack thereof), or that are generally unwelcome or offensive to other members of the community. Sexual language and imagery, unless related to specific scientific discussions, is not appropriate for any conference venue, including talks, workshops, parties, Twitter and other online media. As the NCM Annual Meeting is attended by a wide spectrum of delegates, please be aware of the power dynamic between PIs, post doctoral fellows and students and how that dynamic may affect interactions amongst delegates.

Special Meetings & Events

GENERAL INFO

Monday, April 15 17:30 – 18:15

SATELLITE ARTISTIC PRESENTATION

Location: **Elafiti Conference Hall**

Monday, April 15 19:00 – 19:30

FIRST TIMER RECEPTION

Location: **Nocturno Bar**

Monday, April 15 19:30 – 21:30

OPENING RECEPTION

Location: **Lobby Bar Terrace at the Valamar Lacroma Dubrovnik Hotel**

Tuesday, April 16 17:30 – 18:30

TRAINEE RECEPTION

Location: **Nocturno Bar**

Wednesday, April 17 17:00 – 17:30

NCM MEMBERS MEETING

Location: **Elafiti Conference Hall**

Friday, April 19 18:00 – 19:00

CLOSING DRINKS RECEPTION

Location: **Foyer outside the Elafiti Conference Hall**

NCM Excursions

NCM invites you to take advantage of your visit to Dubrovnik by exploring this wonderful and historical city and its surroundings! You can sign up for the below excursions when you register for the meeting or add them on to your existing registration. *Please note, minimum numbers are required to run all three tours. Should the minimum numbers not be reached, individuals will be contacted.*

THURSDAY, APRIL 18, 2024

OLD TOWN SIGHTSEEING TOUR

15:30 – 18:30 (approximately)

Cost: $50 per person USD

Includes coach transportation, licensed guide, and water

Interested in seeking a cultural experience in Dubrovnik? After a short transfer from the hotel to the Old Town, discover the Old Town in a small group accompanied by licensed guides.

There are many beautiful cities in the world, however the people of Dubrovnik claim their city to be the most beautiful. Famous English poet Bernard Shaw spent some time in Dubrovnik in 1929 and after that he wrote *“Those who seek paradise on Earth should come to Dubrovnik."*

Dubrovnik is on UNESCO’s list of cultural heritages and is regarded as one of the most beautiful cities in the Mediterranean. Surrounded by ramparts and fortresses, it is a treasure of architectural and cultural masterpieces, well preserved over centuries.

The tour includes some free time to explore Old Town before returning to the hotel via coach bus.

GAME OF THRONES TOUR

15:30 – 18:30 (approximately)

Cost: $65 per person USD

Includes coach transportation, licensed guide, bottle of water, and entrance fees/tourism tax

When the US production company behind the Game of Thrones series picked Dubrovnik as the setting for the capital city of Westeros, King's Landing, they could not have chosen better. The Old Town in so stunningly striking that it seems to have leapt directly from the pages of George R.R Martin's addictive series of novels and it is no coincidence that Dubrovnik was also a capital city in its own right – of the now extinct Republic of Ragusa.

On this tour, guests will be taken through all the parts of the Old City where some of the most memorable scenes from the ongoing cultural phenomenon were filmed, including: The Pile Gate where King Joffrey was faced with a citizens' riot and pelted with dung. The Lovrijenac fortress where the unsuccessful attack on King's Landing, known as the Battle of Blackwater, took place.

The seemingly endless fortified walls will be seen from Lovrijenac fortress where Tyrion Lannister and Varys took a stroll, with Tyrion uttering the immortal phrase that will be shared during the tour.

The tour includes some free time to explore Old Town before returning to the hotel via coach bus.

KONAVLE TOUR AND TASTINGS

15:30 – 19:00 (approximately)

Cost: $80 per person USD

Includes coach transportation, licensed guide, entry fees to various locations, snacks/treats, and wine tasting with cheese and liqueur

Except for the crystal-clear sea and beautiful coast which are well known in the world, Croatia also offers a beautiful countryside where many traditions are still alive and where wine cultivation is one of the oldest and most developed way of life. This tour will take place through Konavle, the most southern region of Croatia, which has always been closely connected with Dubrovnik through its history of commerce and way of life. During this tour, the group will stop at different locations for special tastings and experiences during which guests can meet the locals who are keeping the traditions of the region alive.

The tour will include a visit to an authentic water mill where guests are welcomed by staff in national costumes offering small refreshments including typical liquors, figs, and almonds. In addition to the possible demonstration of the water mill, guests will also see a fully reconstructed fulling mill, demonstrating the process of pounding textiles, a crucial step in making the national costumes and other clothes over the past 500 years.

The second stop will include a visit to the family run winery Brajkovic surrounded by green slopes and vineyards. The Brajkovic family traditionally cultivates indigenous varieties of grapes and produces high quality red and white wines. Guests will have the option to taste the variety of wines and learn about the traditional way of wine growing in the region. Croatia is well known as one of the 10 best wine regions in the world with much of the production being white wines. The Konavle region is home to the Dubrovnik Malvasija, a well-known dry white wine that guests will have the option to taste.

Satellite Meeting

Lead Sponsor:

Artificial sensorimotor control from restoration to augmentation

NCM SATELLITE MEETING, DUBROVNIK, CROATIA

MONDAY, APRIL 15, 2024

Sessions held at the Valamar Lacroma Dubrovnik Hotel

The focal point of this meeting is the confluence of cutting-edge neurotechnologies designed to improve motor control, encompassing Deep Brain Stimulation, Brain-Computer Interfaces, Peripheral Nervous Stimulation, as well as non-invasive counterparts such as prosthetics and exoskeletons. We will explore the spectrum from the restoration of impaired motor functions to the augmentation of existing capabilities and consider the myriad of motor control mechanisms harnessed by neurotechnologies, as well as their potential implications and applications. We will provide an overview of the current state of artificial sensorimotor control and also provide insight into how these technologies can evolve to address future challenges when technological advancement and user-driven brain plasticity meet. The proposed satellite meeting thus represents a unique opportunity to navigate and chart the future of this rapidly evolving landscape in neural control of movement.

The satellite is organized by
Tamar Makin, *Cambridge University*
Hayriye Cagnan, *Imperial College*
Sergey D. Stavisky, *University of California, Davis*
Silvestro Micera, *EPFL*

IN MEMORIAM

This year's NCM's satellite meeting will be dedicated to honouring the extraordinary impact of **Sliman Bensmaia**, a titan in the realm of artificial sensorimotor control. In the intricate symphony of neuroscience, Sliman Bensmaia was both a maestro and a rockstar. Sliman's pioneering work, from mapping the brain's tactile blueprint to creating a prosthetic arm that fist-bumped a President, was underscored by his indomitable spirit and unyielding curiosity. With the roaring spirit of a Harley rider and the uncompromising meticulousness of an artist tuning a grand piano to the perfect pitch, it's not just the man of science we remember but the unforgettable man behind the science – the jazz enthusiast, the candid orator, the larger-than-life personality and the life of every party, who could out-drink the lot of us, leaving laughter and legendary tales in his wake at every NCM.

MONDAY, APRIL 15

08:00 – 08:30 **REGISTRATION**

08:30 – 08:45 **OPENING REMARKS**

08:45 – 09:30 **SCIENTIFIC KEYNOTE**

Next generation neural interfaces at Neuralink

Joseph O'Doherty, *Neuralink*

09:30 – 11:00 **SESSION 1: RESTORATION**

Potentiation of cortico-spinal output via targeted electrical stimulation of the motor thalamus

Elvira Pirondini, *University of Pittsburgh*

Restoring touch through a brain interface: Local geometric features encoded via patterned microstimulation of human somatosensory cortex

Giacomo Valle, *University of Chicago*

Therapies orchestrated by patients' own rhythms

Hayriye Cagnon, *Imperial College London*

11:00 – 11:30 COFFEE BREAK

11:30 – 13:00 **SESSION 2: AUGMENTATION**

Assistive, augmentative, and adaptive: Considerations for designing the future body

Dani Clode, *Cambridge University*

Augmenting mobility and motor performance: Soft wearable exosuits in wellness, rehabilitation and the workplace

Lorenzo Masia, *Heidelberg*

A wrist-based surface EMG neuromotor interface for human computer interaction that works across a population

Abby Russo, *Meta Reality Labs*

13:00 – 14:00 LUNCH AND SATELLITE MEETING POSTER SESSION

14:00 – 15:30 **SESSION 3: FUTURE HORIZONS**

Biomagnetic sensing: A high-performance approach to building non-invasive neural interfaces

Nishita Deka, *Sonera*

Next-generation neurotechnology for decoding and regulation of brain states - *Presenting virtually*

Maryam Shanechi, *University of Southern California*

Towards a clinically viable speech neuroprosthesis

Francis Willett, *Stanford University*

15:30 – 16:30 POSTERS AND COFFEE BREAK

16:30 – 17:10 **NON-TECHNICAL KEYNOTE**

The training-technology nexus for neurorestoration and neuroprosthetics

John Krakauer, *Johns Hopkins University*

17:10 – 17:30 **TRIBUTE TO SLIMAN**

17:30 – 18:15 **MOTOR AUGMENTATION AND ART: STELARC**

Stelarc's projects explore alternative anatomical architectures. He has performed and exhibited in Japan, Korea, China, Europe, the USA, South America and Australia. He is acknowledged internationally as a pioneer in Performance, Media Arts, and by the Augmented Humans research community. He has used interactive media, prosthetics, robotics, virtual systems and the internet to actualise his ideas.

19:30 – 21:30 **OPENING RECEPTION FOR ANNUAL MEETING**

Please Note: *If you registered to attend the Satellite Meeting ONLY and want to attend the dinner, tickets can be purchased at the registration desk.*

PS - 1 ***Virtual and physical active tool-use training do not change time perception in peripersonal or far space***

Jahanian Najafabadi Amir [1], Christoph Kayser [1]

[1] *Bielefeld University*

PS - 2 ***Neural mechanisms underlying self-regulation of corticospinal excitability; a transcranial magnetic stimulation - evoked potential (TEP) pilot study***

Helene Arnold [1], Kathy Ruddy [2], Colin Simon [1]

[1] *Trinity College Dublin,* [2] *Queen's University Belfast*

PS - 3 ***Top-down processing activates deprived sensory brainstem nuclei following tetraplegia***

Paige Howell [1], Finn Rabe [1], Simon Schading-Sassenhausen [2], Sarah Meissner [1], Patrick Freund [2], Nicole Wenderoth [1], Sanne Kikkert [1]

[1] *ETH Zürich,* [2] *University Hospital Zürich*

PS - 4 ***Motor learning mechanisms are not modified by feedback manipulations in a real-world task***

Federico Nardi [1], Shlomi Haar [1], Aldo Faisal [1]

[1] *Imperial College London*

PS - 5 ***Neuroplasticity of finger representations induced by a TMS-based BCI-neurofeedback approach***

Ingrid Odermatt [1], Sanne Kikkert [1], Manuel Schulthess-Lutz [1], Ernest Mihelj [1], Paige Howell [1], Caroline Heimhofer [1], Roisin McMackin [2], Patrick Freund [3], Nicole Wenderoth [1]

[1] *ETH Zürich,* [2] *Trinity College Dublin,* [3] *University Hospital Zürich*

PS - 6 ***Task-related changes in connectivity between parietal and parieto-occipital areas in chronic left hemisphere stroke***

Elisabeth Rounis [1]

[1] *University of Cambridge*

PS - 7 ***EMG control of a hand augmentation technology***

Julien Russ [1], Kitty Goodridge [1], Francesco Cenciarelli [1], Hristo Dimitrov [1], Dani Clode [1], Tamar Makin [1]

[1] *University of Cambridge*

PS - 8 ***The developing homunculus: sensory body maps in children with and without upper limb differences***

Raffaele Tucciarelli [1], Laura-Ashleigh Bird [2], Malgorzata Szymanska [1], Mathew Kollamkulam [3], Harshal Arun Sonar [4], Jamie Paik [4], Tessa Dekker [5], Dani Clode [1], Dorothy Cowie [6], Tamar Makin [1]

[1] *University of Cambridge,* [2] *Durham University,* [3] *University of Oxford,* [4] *École Polytechnique Fédérale de Lausanne,* [5] *UCL Institute of Ophthalmology,* [6] *University of Durham*

PS - 9 ***Spatial transformations underlying saccadic eye movements to tactile and visual target stimuli***

Celia Foster [1], Maxime Gaudet-Trafit [2], Valentin Marcon [2], Franck Lamberton [3], Wei-An Sheng [2], Suliann Ben Hamed [4], Tobias Heed [5]

[1] *University of Cambridge,* [2] *University of Lyon,* [3] *CERMEP-Imagerie du Vivant,* [4] *Institut des Sciences Cognitives Marc Jeannerod,* [5] *University of Salzburg*

PS - 10 ***Explainable deep learning for localizing cortical physiomarkers from deep brain stimulation***

Nicolas Calvo Peiro [1], Mathias Haugland [1], Yen Foung Tai [1], Anastasia Borovykh [1], Shlomi Haar [1]

[1] *Imperial College London*

PS - 11 ***Investigating the propagation of beta bursts across the corticospinal tract in Parkinson's disease***

Cosima Graef [1], Alejandro Pascual Valdunciel [1], Dario Farina [1], Ravi Vaidyanathan [1], Yen Foung Tai [1], Shlomi Haar [1]

[1] *Imperial College London*

PS - 12 ***Neurophysiology vs Neuroanatomy of deep brain stimulation in Parkinson's disease***

Alena Kutuzova [1], Cosima Graef [1], Bradley Lonergan [1], Yen Tai [1], Shlomi Haar [1]

[1] *Imperial College London*

PS - 13 ***Intracortical local field potentials as stable signals for across-user brain-computer interface control***

Cecilia Gallego-Carracedo [1], Matthew Perich [2], Raeed Chowdhury [3], Lee Miller [4], Juan Gallego [1]

[1] *Imperial College London,* [2] *Université de Montréal,* [3] *University of Pittsburgh,* [4] *Northwestern University*

PS - 14 ***Stochastic Dynamic Operator (SDO) descriptions of neurons can flexibly scale from single-unit to population-level analysis***

Trevor Smith [1], Terence Sanger [2], Simon Giszter [1]

[1] *Drexel University,* [2] *University of California, Irvine*

PS - 1 Yoga as a natural model for motor learning in a null space

Alexandra Williams [1], Hristo Dimitrov [1], Julien Russ [1], Tamar Makin [1]

[1] *University of Cambridge*

PS - 17 Multifunctional, adaptive and interactive AI system for acting in multiple contexts

Annalisa Bosco [1], Stefano Ellero [2], Patrizia Fattori [1], Markus Lappe [3], Joseph Mcintyre [4], Ivilin Stoianov [5]

[1] *University of Bologna,* [2] *STAM - Genova,* [3] *University of Muenster,* [4] *Tecnalia Research & Innovation,* [5] *National Research Council*

PS - 18 Ventral motor cortex activity supports neural cursor control by a person with paralysis

Tyler Singer-Clark [1], Carrina Lacobacci [1], Maitreyee Wairagkar [1], Nicholas Card [1], Xianda Hou [1], David Brandman [1], Sergey Stavisky [1]

[1] *University of California, Davis*

PS - 19 Anisotropy of temporal resolution on the hand dorsum

Jumpei Mizuno [1], Matthew Longo [2], Nobuhiro Hagura [1]

[1] *National Institute of Information and Communications Technology,* [2] *Birkbeck, University of London*

PS - 20 Precise cortical contributions to sensorimotor feedback control during reactive balance in aging and Parkinson's disease

Scott Boebinger [1], Aiden Payne [2], Giovanni Martino [3], Kennedy Kerr [1], Jasmine Mirdamadi [4], Michael Borich [4], Lena Ting [1]

[1] *Georgia Institute of Technology & Emory University,* [2] *Department of Psychology, Florida State University, Tallahassee, FL, USA,* [3] *University of Padova,* [4] *Emory University*

PS - 21 Open-source solutions for accurate hand markerless kinematics measurement using web cameras

Hristo Dimitrov [1], Giulia Dominijanni [2], Tamar Makin [1]

[1] *University of Cambridge,* [2] *École Polytechnique Fédérale de Lausanne*

PS - 22 Enhancing balance in the older adults: a tailored approach integrating postural training and proprioceptive stimulation

Thomas Lapole [1], Marie Fabre [1], Anastasia Theodosiadou [2], Anastasia Papavasileou [3], Chrystostomos Sahinis [3], Ioannis Amiridis [3], Dimitris Patikas [3], Stéphane Baudry [2]

[1] *Université Jean Monnet Saint-Etienne,* [2] *Université Libre de Bruxelles,* [3] *Aristotle University of Thessaloniki*

PS - 23 Generalisation of motor skill learning with a hand augmentation device

Giulia Dominijanni [1], María Molina [2], Lucy Dowdall [2], Dani Clode [2], Tamar Makin [2]

[1] *École Polytechnique Fédérale de Lausanne,* [2] *University of Cambridge*

PS - 24 Comparison of pathways for sensory feedback for wearable devices

Lucy Dowdall [1], Edmund Da Silva [1], Matteo Bianchi [2], Fumiya Iida [1], Dani Clode [1], Tamar Makin [1]

[1] *University of Cambridge,* [2] *University of Pisa*

PS - 25 Can the somatosensory cortex integrate a tactile representation of an extra robotic body part?

Lucy Dowdall [1], Giulia Dominijanni [2], Maria Molina [1], Dani Clode [1], Tamar Makin [1]

[1] *University of Cambridge,* [2] *École Polytechnique Fédérale de Lausanne*

PS - 26 Decoding hand movements with optomyography

Roman Khalikov [1], Gurgen Soghoyan [1], Mikhail Sintsov [2], Mikhail Lebedev [3]

[1] *Skolkovo Institute of Science and Technology,* [2] *Research Center of Motorica LLC,* [3] *Lomonosov Moscow State University*

PS - 27 Enhanced prosthetic hand control through AI and VR integration for intuitive and natural finger movements

Anna Makarova [1], Aleksandr Kovalev [1], Petr Chizhov [1], Matvey Antonov [1], Vladislav Lomtev [1], Gleb Duplin [1], Andrey Tsurkan [1], Viacheslav Gostevskii [1], Vladimir Bessonov [1], Mikhail Korobok [1], Alexei Timcenko [1]

[1] *ALVI Labs*

PS - 29 Auditory noise improves postural control in children with and without autism spectrum disorder: A pilot study

Se-Woong Park [1], Jesus Siqueiros [1], Sakiko Oyama [1]

[1] *University of Texas at San Antonio*

PS - 30 Investigating the modulation of muscular null space for the control of supernumerary degrees of freedom

Julien Rossato [1], Daniele Borzelli [2], Denise Berger [3], Sergio Gurgone [4], Andrea D'avella [5]

[1] *IRCCS Fondazione Santa Lucia,* [2] *University of Messina,* [3] *Fondazione Santa Lucia,* [4] *National Institute of Information and Communications Technology,* [5] *University of Rome Tor Vergata*

PS - 31 *Integrating visual perception in assistive robotics for human augmentation*

Enrica Tricomi [1], Lorenzo Masia [1]

[1] *Heidelberg University*

PS - 32 *Epidural stimulation with viral BDNF therapy improves recovery of function after SCI, delays onset of viral side effects, and maintains observed hindlimb muscle synergies and motor modularity*

Andrey Borisyuk [1], Trevor Smith [1], Kim Dougherty [1], Simon Giszter [1]

[1] *Drexel University*

PS - 33 *An accurate and rapidly calibrating speech neuroprosthesis*

Nicholas Card [1], Maitreyee Wairagkar [1], Carrina Lacobacci [1], Xianda Hou [1], Tyler Singer-Clark [1], Francis Willett [2], Erin Kunz [2], Chaofei Fan [2], Maryam Vahdati Nia [1], Darrell Deo [2], Eun Young Choi [2], Matthew Glasser [3], Leigh Hochberg [4], Jaimie Henderson [2], Kiarash Shahlaie [1], David Brandman [1], Sergey Stavisky [1]

[1] *University of California, Davis,* [2] *Stanford University,* [3] *Washington University,* [4] *Brown University*

PS - 34 *Human subjects can utilize tactile feedback delivered via contactors sliding on their forearm skin to detect finger postures with a task-dependent feedback channel dominance*

Ismail Devecioglu [1], Ertuğrul Karakulak [1]

[1] *Tekirdağ Namık Kemal University*

PS - 35 *Similar oscillatory mechanisms map touch on hands and tools*

Cécile Fabio [1], Romeo Salemme [2], Alessandro Farne [3], Luke Miller [4]

[1] *Bielefeld University,* [2] *Integrative Multisensory Perception Action & Cognition Team,* [3] *INSERM,* [4] *Radboud University Nijmegen*

PS - 36 *Sensory peripheral electrical stimulation decreases intermuscular coherence and phase difference between the wrist flexors and extensors in essential tremor patients*

Nish Mohith Kurukuti [1], Hamidollah Hassanlouei [2], Xin Yu [3], Grace Hoo [3], Jose Pons [1]

[1] *Northwestern University,* [2] *Marquette University,* [3] *Shirley Ryan AbilityLab*

PS - 37 *The myokinetic control and stimulation interface: a robotic platform to study kinesthesia in humans*

Federico Masiero [1]

[1] *University of Heidelberg*

PS - 38 *Using multimodal neuroimaging to guide implantation of brain-computer interfaces*

Hunter Schone [1], John Downey [2], Stephen Foldes [3], Charles Greenspon [2], Fang Liu [1], Nicolas Kunigk [1], Ceci Verbaarschot [1], Robert Gaunt [1], Jennifer Collinger [1]

[1] *University of Pittsburgh,* [2] *University of Chicago,* [3] *Phoenix Children's Hospital*

PS - 39 *Examining asymmetric activation of mirror neuron networks in stroke EEG during motor imagery*

Parikshat Sirpal [1], Parikshat Sirpal [1]

[1] *University of Oklahoma*

PS - 40 *Wearable myoelectric interface for neurorehabilitation (MINT) conditioning reduces abnormal co-activation and improves arm function in chronic stroke*

Marc Slutzky [1], Abed Khorasani [1], Cynthia Gorski [1], Joel Hulsizer [1], Na Teng Hung [1], Vivek Paul [1], Prashanth Prakash [1], Jinsook Roh [2]

[1] *Northwestern University,* [2] *University of Houston*

PS - 41 *Limits of neural stimulation for prosthetic control: tactile afferents cannot follow high rates of electrical stimulation*

Alwin So [1], Tom Su [1], Felix Aplin [1], Richard Vickery [2], Ingvars Birznieks [1]

[1] *University of New South Wales,* [2] *University of New South Wales Sydney*

PS - 42 *Neural basis of manual coordination in human motor cortex*

Anton Sobinov [1], Alexandriya Emonds [1], Elizaveta Okorokova [1], Lee Miller [2], Sliman Bensmaia [1]

[1] *University of Chicago,* [2] *Northwestern University*

PS - 43 *Combined neurostimulation for multimodal somatosensory feedback*

Gurgen Soghoyan [1], Nikita Piliugin [2], Artur Biktimirov [3], Yury Matvienko [4], Alexander Kaplan [5], Mikhail Sintsov [4], Mikhail Lebedev [5]

[1] *Skolkovo Institute of Science and Technology,* [2] *The Skolkovo Institute of Science and Technology,* [3] *Far Eastern Federal University,* [4] *Research Center of Motorica LLC,* [5] *Lomonosov Moscow State University*

PS - 44 *Manipulating task-relevant artificially evoked somatosensory feedback in a bidirectional brain-controlled guitar playing game*

Ceci Verbaarschot [1], Albert Monscheuer [1], Brian Dekleva [1], Jennifer Collinger [1], Robert Gaunt [1]

[1] *University of Pittsburgh*

PS - 45 *Neural Data Transformer 3: a foundation model for motor decoding*

Joel Ye [1], J. Patrick Mayo [2], Adam Smoulder [1], Adam Rouse [3], Hongwei Mao [2], Xuan Ma [4], Aaron Batista [2], Steven Chase [1], Charles Greenspon [5], Lee Miller [4], Nicholas Hatsopoulos [5], Andrew Schwartz [2], Jennifer Collinger [2], Leila Wehbe [1], Robert Gaunt [2]

[1] *Carnegie Mellon University,* [2] *University of Pittsburgh,* [3] *University of Kansas Medical Center,* [4] *Northwestern University,* [5] *University of Chicago*

PS - 46 *A modular architecture for trial-by-trial learning of redundant motor commands*

Lucas Dal'bello [1], Denise Berger [1], Daniele Borzelli [2], Andrea D'avella [3]

[1] *Fondazione Santa Lucia,* [2] *University of Messina,* [3] *University of Rome Tor Vergata*

PS - 47 *Neural avalanches to design innovative sensorimotor-based brain-computer interface*

Camilla Mannino [1], Pierpaolo Sorrentino [2], Mario Chavez [3], Marie-Constance Corsi [1]

[1] INRIA, [2] INSERM, [3] Centre National de la Recherche Scientifique

NOTES

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Annual Conference Schedule

All sessions will be held in the Valamar Lacroma Dubrovnik Hotel. Presentations will be in the Elafiti Conference Hall with the posters in the Business Centre Exhibition Area

DAY 1 MONDAY, APRIL 15, 2024

19:00 – 19:30 **FIRST TIMER SOCIAL**

Nocturno Bar (Level 1)

Attending NCM for the first time? Join other first time attendees prior to the opening reception. Key members of the NCM community, and members of the DEI committee, will be in attendance to welcome you to the meeting.

19:30 – 21:30 **OPENING RECEPTION**

Lobby Bar Terrace

Join us to meet up with old colleagues and meet new ones at the opening reception. A full meal will be provided in an informal networking event with food stations and passed and plated appetizers. Join us at the Valamar Lacroma outdoor patio to kick off the annual conference!

DAY 2 TUESDAY, APRIL 16, 2024

08:00 - 10:00 **SESSION 1, PANEL I**

Neural dynamics of sensorimotor decision making: The role of basal ganglia, motor cortex and prefrontal cortex

Organizer: **Irene Lacal**
Discussant: **Juan Gallego**

Irene Lacal [1], Pierre Boucher [2], David Thura [3], Manuel Molano [4]

[1]German Primate Center, [2] Boston University, [3] INSERM, U1028, CNRS UMR5292, Lyon Neuroscience Research Center, [4] IDIBAPS

10:00 – 10:30 BREAK

10:30 – 11:05 **EARLY CAREER AWARD PRESENTATION AND TALK**

Cognitive shaping of motor behavior

Sam McDougle, *Yale University*

11:05 – 13:05 **SESSION 2, PANEL II**

Why and how does active control of muscle spindles shape movement?

Organizer: **Surabhi Simha**
Discussant: **David Franklin**

Surabhi Simha [1], Alessandro Santuz [2], Lena Ting [1], Michael Dimitriou [3]

[1] Emory University and Georgia Institute of Technology, [2] Max Delbrück Center for Molecular Medicine, [3] Umeå University

13:05 – 15:30 SESSION 3, POSTER 1, EXHIBITORS, & LUNCH

15:30 – 17:30 SESSION 4, INDIVIDUAL I

O1.1 - *A differential influence of the pathophysiology of Parkinson's Disease on distinct phases of muscle recruitment during visually-guided reaching*

Madeline Gilchrist [1], Rebecca Kozak [1], Margaret Prenger [2], Kathryne (Kasey) Van Hedger [2], Penny Macdonald [3], Brian Corneil [1], Mimma Anello [3]

[1] Western University, [2] University of Western Ontario, [3] Clinical Neurological Science, Western University

Presenting Author: **Madeline Gilchrist**

O1.2 - *Sound activates a dormant visual-motor pathway bypassing primary visual cortex*

Tatiana Malevich [1], Ziad Hafed [2], Yue Yu [3], Matthias Baumann [3], Tong Zhang [3]

[1] University of Tuebingen, [2] Centre for Integrative Neuroscience, [3] Hertie Institute for Clinical Brain Research

Presenting Author: **Tatiana Malevich**

O1.3 - *Cerebellar encoding of prior knowledge in sensorimotor timing*

Julius Koppen [1], Ilse Klinkhamer [1], Marit Runge [1], Devika Narain [1]

[1] Erasmus Medical Center

Presenting Author: **Julius Koppen**

O1.4 - *Is there more to sequence learning than better anticipation?*

Mehrdad Kashefi [1], Joern Diedrichsen [1], J. Andrew Pruszynski [1]

[1] Western University

Presenting Author: **Mehrdad Kashefi**

O1.5 - *Evidence against replay-mediated offline learning during the first minutes of motor skill acquisition*

Anwesha Das [1], Alexandros Karagiorgis [1], Joern Diedrichsen [2], Max-Philipp Stenner [3], Elena Azanon [1]

[1] University of Magdeburg, [2] Western University, [3] Otto-von-Guericke University Magdeburg and Leibniz Institute for Neurobiology Magdeburg

Presenting Author: **Anwesha Das**

O1.6 - *Balancing demands for stability and flexibility in the motor system of rats performing multiple motor sequences*

Naama Kadmon Harpaz [1], Steffen B. E. Wolff [2], Kiah Hardcastle [1], Rudy Gelb-Bicknell [3], Theodore J. Zwang [3], Bence Olveczky [1]

[1] Harvard University, [2] University of Maryland School of Medicine, [3] Mass General Institute for Neurodegenerative Disease, Massachusetts General Hospital

Presenting Author: **Naama Kadmon Harpaz**

17:30 – 18:30 **TRAINEE SOCIAL**

Nocturno Bar
(Level 1)

Sponsored by: REALITY LABS

All trainees (students, post doctoral fellows, and research lab technicians) welcome to join us for a casual, networking social following the conclusion of the day. Network in a relaxed environment, get to know new people, and enjoy this trainee focused event.

20:00 – onwards **NIGHTLY PUB MEET UP**

Banje Beach Club
Ul. Frana Supila 10/B, 20000, Dubrovnik

Join us nightly to network outside of the meeting and enjoy some of Dubrovnik! Please note, the location is open to the public and will not be exclusive to NCM delegates with first come, first served for seating and access.

DAY 3 WEDNESDAY, APRIL 17, 2024

08:00 – 10:00 **SESSION 5, PANEL III**

Closing the loop: The role of feedback in neural population dynamics

Organizer: **Jonathan Michaels**
Discussant: **Mark Churchland**

Jonathan Michaels [1], Britton Sauerbrei [2], Amy Orsborn [3], Laureline Logiaco [4]

[1] Western University, [2] Case Western Reserve University School of Medicine, [3] University of Washington, [4] Massachusetts Institute of Technology

10:00 – 10:30 BREAK

10:30 - 12:30 **SESSION 6, INDIVIDUAL II**

O2.1 - *Using a stochastic optimal control framework to model the control of complex human movement: Application to an aerial acrobatics*

Eve Charbonneau [2], Friedl De Groote [1], Mickaël Begon [2]

[1] KU Leuven, [2] Université de Montréal

Presenting Author: **Eve Charbonneau**

O2.2 - *Spinal reflex representation in the primary motor cortex*

Tatsuya Umeda [1], Osamu Yokoyama [2], Michiaki Suzuki [2], Miki Kaneshige [2], Tadashi Isa [1], Yukio Nishimura [2]

[1] Kyoto University, [2] Tokyo Metropolitan Institute of Medical Science

Presenting Author: **Tatsuya Umeda**

O2.3 - *Spinal networks act as a continuous attractor during pause of movement*

Salif Komi [1], Jaspreet Kaur [1], Madelaine Bonfils [1], Jakob Sørensen [1], Nicolas Bertram [1], Rune Berg [1]

[1] *University of Copenhagen*

Presenting Author: **Salif Komi**

O2.4 - *Distinct contributions of feedback and feedforward control during longitudinal de novo learning*

Chen Avraham [1], Firas Mawase [1]

[1] *Technion - Israel Institute of Technology*

Presenting Author: **Firas Mawase**

O2.5 - *Decision uncertainty as a context for motor memory*

Nobuhiro Hagura [1], Kisho Ogasa [1], Atsushi Yokoi [2], Gouki Okazawa [3], Masaya Hirashima [4]

[1] *NICT,* [2] *National Institute of Information and Communications Technology,* [3] *Institute of Neuroscience, Chinese Academy of Sciences,* [4] *Center for Information and Neural Networks, National Institute of Information and Communications Technology*

Presenting Author: **Nobuhiro Hagura**

O2.6 - *Striatal and cerebellar involvement in reinforcement learning in the human infant brain*

Juliana Trach [1], Tristan Yates [1], Sheri Dawoon Choi [1], Lillian Behm [1], Cameron Ellis [2], Samuel McDougle [1], Nicholas Turk-Browne [1]

[1] *Yale University,* [2] *Stanford University*

Presenting Author: **Juliana Trach**

12:30 – 15:00 **SESSION 7, POSTER 2, EXHIBITORS, & LUNCH**

15:00 - 17:00 **SESSION 8, PANEL IV**

The underlying mechanisms of motor impairments after stroke

Organizer: **Lior Shmuelof**

Lior Shmuelof [1], Inbar Avni [1], Stuart Baker [2], Alkis Hadjiosif [3], Jennifer Mak [4]

[1] *Ben Gurion University of the Negev,* [2] *Newcastle University,* [3] *Harvard University,* [4] *Bioengineering Department, University of Pittsburgh*

17:00 – 17:30 **NCM MEMBERS MEETING**

All members of the Society for the Neural Control of Movement are invited to attend

20:00 – onwards **NIGHTLY PUB MEET UP**

Hard Rock Cafe Dubrovnik
Poljana Paska Milicevica 4
Dubrovnik

Join us nightly to network outside of the meeting and enjoy some of Dubrovnik! Please note, the location is open to the public and will not be exclusive to NCM delegates with first come, first served for seating and access.

DAY 4 THURSDAY, APRIL 18, 2024

8:00 – 10:00 **SESSION 9, PANEL V**

Feedforward and feedback mechanisms of neural control: Theory and applications

Organizer: **Frederic Crevecoeur**
Discussant: **Friedl de Groote**

Frederic Crevecoeur [1], Friedl De Groote [2], Etienne Burdet [3], David Franklin [4], Janneke Schwaner [5]

[1] University of Louvain, [2] KU Leuven, [3] Imperial College London, [4] Technical University of Munich, [5] University of California, Irvine

10:00 – 10:30 BREAK

10:30 - 12:30 **SESSION 10, PANEL VI**

Neural control of speech: What did we miss in the last 20 years?

Organizer: **Elvira Pirondini**
Discussant: **Sergey Stavisky**

Elvira Pirondini [1], Sergey Stavisky [2], Ludo Max [3], Marc Slutzky [4], Nicholas Card [2]

[1] University of Pittsburgh, [2] University of California, Davis, [3] University of Washington, [4] Northwestern University

12:30 – 15:00 **SESSION 11, POSTER 3, EXHIBITORS, & LUNCH**

15:00 – onwards **FREE TIME AND TICKETED EXCURSIONS**

DAY 5 FRIDAY, APRIL 19, 2024

8:00 – 10:00 **SESSION 12, PANEL VII**

Spinal cord and brainstem control of upper limb movements. Is it time to revisit our cortically-centered view of hand motor control and learning?

Organizer: **Shahab Vahdat**
Discussant: **Leonardo Cohen**

Shahab Vahdat [1], Julien Doyon [2], Sho Sugawara [3], Veronique Marchand-Pauvert [4]

[1] University of Florida, [2] McGill University, [3] Tokyo Metropolitan Institute of Medical Science, [4] Inserm, Sorbonne Université

10:00 – 10:30 BREAK

10:30 - 12:30 **SESSION 13, INDIVIDUAL III**

O3.1 - *Differential roles of the cerebellum and basal ganglia in decision making*

Sabrina Abram [1], Jonathan Tsay [2], Tianhe Wang [1], Samuel McDougle [3], Richard Ivry [4]

[1] University of California, Berkeley, [2] University of Cambridge, [3] Yale University, [4] University of California

Presenting Author: **Sabrina Abram**

O3.2 - *The hand outperforms the eyes at localizing somatosensory targets*

Marion Naffrechoux [1], Eric Koun [2], Alessandro Farnè [2], Alice Catherine Roy [3], Denis Pélisson [2]

[1] Lyon Neuroscience Research Center (IMPACT Team), [2] Lyon Neuroscience Research Center (CRNL), IMPACT Team, [3] Dynamique Du Langage Laboratory

Presenting Author: **Marion Naffrechoux**

O3.3 - *Cerebellar input and output circuits for dexterous movement*

Eiman Azim [1], Ayesha Thanawalla [1], Oren Wilcox [1], Kee Wui Huang [1], Elischa Sanders [1]

[1] Salk Institute for Biological Studies

Presenting Author: **Eiman Azim**

O3.4 - *Kinematic and kinetic signals in monkey and human motor cortex*

Elizaveta Okorokova [1], John Downey [1], Charles Greenspon [1], Sliman Bensmaia [1], Anton Sobinov [1]

[1] University of Chicago

Presenting Author: **Elizaveta Okorokova**

O3.5 - ***Leveraging preparatory activity from the human motor cortex for high performance brain-computer interface control***

Mattia Rigotti-Thompson [1], Yahia Ali [1], Samuel Nason-Tomaszewski [1], Claire Nicolas [2], Nick Hahn [3], Donald Avansino [3], Domenick Mifsud [1], Kaitlyn Tung [4], Shane Allcroft [5], Jaimie Henderson [3], Leigh Hochberg [6], Nicholas Au Yong [1], Chethan Pandarinath [1]

[1] Emory University and Georgia Institute of Technology, [2] Massachusetts General Hospital, [3] Stanford University, [4] Georgia Institute of Technology, [5] Brown University, [6] Brown University & Massachusetts General Hospital

Presenting Author: **Mattia Rigotti-Thompson**

O3.6 - ***Vestibular stabilization drives gaze control strategies in primate locomotion***

Oliver Stanley [1], Ruihan Wei [1], Kathleen Cullen [1]

[1] Johns Hopkins University

Presenting Author: **Oliver Stanley**

12:30 – 15:00 SESSION 14, POSTER 4 & LUNCH

15:00 - 17:00 SESSION 15, PANEL VIII

Current debates on the integration of touch and movement

Organizer: **Tobias Heed**
Discussant: **Kathleen Cullen**

Tobias Heed [1], Konstantina Kilteni [2], Matej Hoffmann [3], Katja Fiehler [4]

[1] University of Salzburg, [2] Donders Institute for Brain, Cognition and Behaviour, Radboud University, [3] Czech Technical University in Prague, [4] University of Giessen

17:00 – 18:00 SESSION 16, DISTINGUISHED CAREER AWARD PRESENTATION AND TALK

On the "Neural control of movement"

Eberhard Fetz, *University of Washington*

18:00 – 19:00 CLOSING DRINKS RECEPTION

Foyer

Team & Individual Oral Abstracts

TUESDAY, APRIL 16, 2024

08:00 – 10:00 SESSION 1, PANEL I

Neural dynamics of sensorimotor decision making: the role of basal ganglia, motor cortex and prefrontal cortex

Irene Lacal [1], Pierre Boucher [2], David Thura [3], Manuel Molano [4]

[1]German Primate Center, [2] Boston University, [3] INSERM, U1028, CNRS UMR5292, Lyon Neuroscience Research Center, [4] IDIBAPS

Discussant: **Juan Gallego**

Sensorimotor decision-making is a complex process that requires the integration of cognitive, motivational, and kinematic features for the translation of sensory information into motor output. This concept aligns with the observation of widespread decision signals in the brain, particularly in subcortical and frontal cortical areas known for their involvement in action selection and execution, such as the basal ganglia, the primary motor cortex (M1), the dorsal premotor cortex (PMd), and the dorsolateral prefrontal cortex (dlPFC).

What roles do the different brain regions play in the functional continuum from sensory evidence-based decision formation to the kinematics of the response movement? In this panel, we will address this question by focusing on neurophysiological evidence collected from these cortical and subcortical brain areas across multiple model organisms (rats, rhesus macaques and humans).

First, Manuel Molano will talk about how the accumulation of decision evidence shapes response trajectories in rats and humans performing an auditory discrimination task. He will show how prior expectations influence response behavior and vigor in both species and demonstrates that this dynamic can be modelled computationally. Single neuron activity in rat dorso-medial striatum is shown to closely track slow fluctuations of vigor across trials.

David Thura will then discuss the role of the basal ganglia and sensorimotor cortex in action selection and movement vigor. By testing monkeys performing visually-guided choices between reaching movements and a reaching-based foraging task, he demonstrates that basal ganglia are responsible for coordinating and invigorating decisions and actions, leaving the task of selection to the sensorimotor cortex.

To follow, Irene Lacal will talk about the role of M1, PMd and dlPFC in action selection and execution in unconstrained rhesus macaques engaging in a task that requires to choose one of two alternative targets while or before walking towards them. Population dynamics suggest that, when choosing while walking, M1 is engaged primarily in the stepping behavior, leaving the task of selecting between action goals to PMd and dlPFC.

Lastly, Pierre Boucher will discuss the differential role of PMd and dlPFC in decision making. By testing rhesus macaques on a visual discrimination task that decouples perceptual decisions from action choices, he shows that neural population dynamics suggests that dlPFC main task is to solve the perceptual decision, while PMd is mainly involved in action selection.

Taken together, these results suggest the basal ganglia to be involved in action vigor and urgency, dlPFC in solving the perceptual aspects of decisions and M1 and PMd in selecting and executing the behavioral response. This functional specialization and its implications for our understanding of the neural basis of sensorimotor decision-making will be addressed in the final discussion.

10:30 - 11:05 EARLY CAREER AWARD PRESENTATION AND TALK

Cognitive shaping of motor behavior

Sam McDougle, *Yale University*

The fields of motor neuroscience and cognitive psychology are too often siloed. But cognitive processes affect motor behavior in a range of ways, influencing the selection, planning, and learning of movements. In turn, how we move affects what we perceive, closing the loop between cognitive and motor systems. In this talk, I will discuss some recent projects from my lab that highlight the intersection of cognition and motor behavior. I will feature work on how cognitive stages of action planning shape implicit forms of motor learning, the dynamic flow of information from decision-making to movement selection systems, and neural computations that cut across action and visual cognition. Overall, I will try to make the case that studying motor behavior in a vacuum risks missing key stops along the road from thought to action.

11:05 – 13:05 SESSION 2, PANEL II

Why and how does active control of muscle spindles shape movement?

Surabhi Simha [1], Alessandro Santuz [2], Lena Ting [1], Michael Dimitriou [3]

[1] *Emory University and Georgia Institute of Technology,* [2] *Max Delbrück Center for Molecular Medicine,* [3] *Umeå University*

Discussant: **David Franklin**

Understanding how higher-level control mechanisms integrate with our peripheral sensory systems is necessary to understand how we move. Muscle spindles are sensory organs integral to proprioception and equipped with their own neural drive from the gamma motor neurons that receive descending cortical input. However, due to experimental limitations, little is known about how neural drive to muscle spindles is modulated in movement. In this panel, we will present recent advances in theory, modeling, and experimental approaches to better understand proprioception, particularly muscle spindles. We will articulate a compelling argument that active tuning of the neural drive to muscle spindles alters sensory feedback that shapes the nervous system's ability to predict and adapt to a dynamic environment. We will use evidence from recent developments in in vivo and genetic manipulations in animals, predictive computational models, and microneurography studies in humans. We hope to promote further research into gamma motor neurons and their control of sensory feedback in adaptive proprioception and action.

Lena Ting will discuss different physiological structures of muscle spindle Ia, II, and Golgi tendon organ Ib proprioceptors, highlighting that they may together encode muscle state. She will discuss how the muscle spindle outputs can be modulated by neural control and the role of supraspinal systems in shaping muscle spindles output in humans, which in turn shapes cortical and subcortical control of balance.

Alessandro Santuz will discuss the current state of the field in quantifying the role of proprioceptive feedback during dynamic motor tasks in vertebrates. He will present data from in vivo behavioral experiments in humans and mice using a mixture of electrophysiology, computational neuroscience and mouse genetics. Such multidisciplinary frameworks can be used to dissect the contributions of neural pathways for proprioception in the generation of robust locomotor output.

Surabhi Simha will present a neuromechanical framework to understand how biophysical properties of muscles and muscle receptors shape muscle spindle output. Using predictions from a biophysical computational model that simulates the effect of gamma motor drive on muscle spindle output, she will show how gamma drive can sculpt the spindle output in a task-appropriate manner (e.g. posture vs locomotion) as well as dissociate self-generated and imposed forces.

Michael Dimitriou will argue that muscle spindles under fusimotor control are best thought of as signal-processing devices rather than stretch receptors, giving rise to flexible coordinate representations according to task characteristics and goals. He will present data from human microneurography experiments showing that spindle tuning enables the independent preparatory control of reflex muscle stiffness, selective extraction of information during motor adaptation, and segmental stretch reflexes to operate in joint space.

15:30 – 17:30 SESSION 4, INDIVIDUAL I

O1.1 - *A differential influence of the pathophysiology of Parkinson's Disease on distinct phases of muscle recruitment during visually-guided reaching*

Madeline Gilchrist [1], Rebecca Kozak [1], Margaret Prenger [2], Kathryne (Kasey) Van Hedger [2], Penny Macdonald [3], Brian Corneil [1], Mimma Anello [3]

[1] Western University, [2] University of Western Ontario, [3] Clinical Neurological Science, Western University

Presenting Author: **Madeline Gilchrist**

Parkinson's Disease (PD) is characterized by slowed and reduced voluntary movements caused by dopamine depletion in the dorsal striatum. However, recent evidence suggests that PD leaves reflexive, visually-guided movements intact. Such selective sparing in PD is seen in the persistence of express saccades mediated by the midbrain superior colliculus (SC) well into disease progression. PD patients mistakenly generate more express saccades in an anti-saccade task, indicating deficient contextual control. Recent work measuring upper limb muscle recruitment during visually-guided reaching has implicated the SC via the tecto-reticulo-spinal pathway in the earliest phase of upper limb muscle recruitment following visual stimulus onset. Like express saccades, such express visuomotor responses (EVRs) are extremely short-latency (80-120 ms in human) and tied to the time and location of visual stimulus onset. Unlike express saccades, muscle recruitment during visually-guided reaches plays out over hundreds of milliseconds and includes both rapid, stimulus-driven recruitment followed by later, volitional recruitment. Could the pathophysiology of PD selectively influence these different phases of recruitment? To address this we recorded upper-limb muscle activity in two experiments with patients with PD (n = 16, n = 18) and age-matched healthy controls (HC; n = 18, n = 17). Both experiments required participants to consolidate an instruction to reach either toward (pro-reach) or away from (anti-reach) a visual stimulus. Task difficulty was increased in Exp 2 by reducing the duration of the instruction so that it appeared only 1000 or 500 ms before stimulus presentation. In both experiments, we found that EVRs on pro-reaches were spared and of similar magnitude in patients with PD compared to HC. However, the ensuing phases of muscle recruitment, including the phase aligned to reach onset, were significantly reduced in patients with PD ($p = 0.049$), which related to the expected lower peak reach velocities ($p = 0.035$). We also examined the magnitude of EVRs on anti-reach trials and found that when compared to the magnitude of EVRs on pro-reach trials, patients with PD were less able to contextually dampen EVRs, particularly when the instruction time was shortened to 500 ms ($p = 0.045$). Our results are consistent with parallel-but-interacting subcortical and cortical pathways converging onto a common reticulospinal pathway. In PD, the earliest recruitment phase mediated by the subcortical SC is spared, but contextual control is compromised. This finding mirrors the hyper-reflexive eye movements in PD and is consistent with the role of the dorsal striatum in modulating habitual movement. Following this initial phase, subsequent phases of muscle recruitment are dampened, producing the expected bradykinesia. Thus, signatures of a differential influence of PD on stimulus- versus movement-aligned recruitment are observable even within a single trial.

O1.2 - *Sound activates a dormant visual-motor pathway bypassing primary visual cortex*

Tatiana Malevich [1], Ziad Hafed [2], Yue Yu [3], Matthias Baumann [3], Tong Zhang [3]

[1] *University of Tuebingen,* [2] *Centre for Integrative Neuroscience,* [3] *Hertie Institute for Clinical Brain Research*

Presenting Author: **Tatiana Malevich**

Like in other species, the primate visual system contains an anatomical retinal projection bypassing the geniculostriate pathway and innervating the midbrain (Cowey, 2010). However, unlike in some of these species, such as the mouse, the functional significance of this alternative visual pathway remains unknown: in fact, increasing evidence suggests that it may be completely dormant in primates. We first tested this idea by performing focal, reversible inactivation of the primary visual cortex (V1) and investigating a robust oculomotor phenomenon, called saccadic inhibition. This phenomenon, which is believed to rely on subcortical eye-movement control circuits, such as the superior colliculus (SC) and downstream pre-motor neurons (Buonocore and Hafed, 2023), is characterized by a short-latency cessation of saccade generation after visual stimulus onset, as well as by a concomitant saccade direction biasing, first towards and then away from stimulus location. We reversibly inactivated V1 via muscimol microinjection (1.5"2.5 Î¼L; 10 mg/mL), rendering two rhesus macaque monkeys cortically blind to a specific region of the visual field. When we then presented a visual stimulus within this localized cortical scotoma, saccadic inhibition was completely abolished, confirming a dominance of the geniculostriate pathway, even for such a reflex-like oculomotor phenomenon. Simultaneously recorded SC visual responses were also eliminated. However, why does the alternative visual pathway, directly targeting oculomotor control circuits, exist at all? We hypothesized that this pathway might still be functional, albeit in a gated manner. During V1 inactivation, we paired a visual onset in the blind field with a sound pulse (50 ms; 1 KHz; suprathreshold) that was presented binaurally and was completely uninformative about the visual stimulus location. Saccadic inhibition was now partially restored, and it was stronger and earlier than when the sound pulse occurred alone. Most importantly, there was a re-emergence of saccade direction biasing towards the visual stimulus location, even though the sound was not spatially informative. Guessed visually-guided, foveating saccades towards a target presented in the blind field were also mildly more accurate when visual stimuli were paired with the uninformative sound. These results demonstrate that multi-sensory information can activate an otherwise dormant visual-motor pathway bypassing V1, for example, by gating readout of retinotectal visual signals arriving at the SC. Given the large differences in dominance of geniculostriate versus retinotectal visual pathways in different animal models used to study the neural control of movement, our findings underscore the importance of multi-species comparisons in understanding hierarchical sensorimotor processes, and they inform models of active visually-guided behavior invoking parallel sensory streams.

O1.3 - *Cerebellar encoding of prior knowledge in sensorimotor timing*

Julius Koppen [1], Ilse Klinkhamer [1], Marit Runge [1], Devika Narain [1]

[1] *Erasmus Medical Center*

Presenting Author: **Julius Koppen**

Behavior in the natural world is rife with feats of temporal precision but laboratory measurements of such behaviors reveal surprising biases in sensorimotor timing. Previous theoretical work attributes some of these biases to Bayesian inference processes that increase their reliance on prior knowledge of well-timed movements under uncertainty. We, however, know little about how neural circuits utilize prior knowledge required for precise temporal control of movements. Here we use theory, large-scale electrophysiology, machine learning, and optogenetics to investigate whether cerebellar circuits could provide a substrate for encoding prior knowledge of temporal statistics to generate precise movements. We train mice on a modified eyeblink conditioning task, where they learn associations between a visual cue (conditioned stimulus CS) and a periocular airpuff (unconditioned stimulus US). Unlike conventional eyeblink conditioning, the time intervals between the CS and US are drawn from discrete uniform probability distributions of different statistics, i.e., very narrow, narrow, and wide. After several pairings, the eyelid learns to close predictively and on test trials where the airpuff is omitted, we evaluate the statistics of the predictive (conditioned) eyelid closure for different prior distributions. We found that kinematic and temporal properties of the eyelid movement adapted to changes in the statistics of the stimuli. Neural activity profiles of cerebellar Purkinje cells and putative molecular layer interneurons recorded during behavior in lobules IV/V and Simplex of the cerebellar cortex concomitantly changed their statistics to accommodate the changing prior distributions. We used a recent deep learning technique, known as LFADS, to decode trial-by-trial activity from cerebellar cortical neurons and decode behavioral metrics to establish changing statistics. We also analyzed latent population dynamics for different prior distributions to conclude that neural population tuning changes its statistics when the prior distribution switches from narrow to wide. Calibrated optogenetic perturbations to cerebellar Purkinje cells within the duration of the temporal distribution caused a complete suppression of the prior-related response. Furthermore, we found prior-related signaling in cerebellar Purkinje cell complex spike activity that was time-locked to the onset of prior distributions. Finally, we propose a computational model of the cerebellar-olivary circuit that uses juxtaposed plasticity principles to explain how the cerebellar cortex encodes and leverages prior knowledge to generate precise eyelid control.

O1.4 - *Is there more to sequence learning than better anticipation?*

Mehrdad Kashefi [1], Joern Diedrichsen [1], J. Andrew Pruszynski [1]

[1] *Western University*

Presenting Author: **Mehrdad Kashefi**

For nearly fifty years, motor sequence learning has been studied using the Serial Reaction Time (SRT) paradigm. However, the utility of the SRT for motor sequence learning has been severely criticized: it is suggested that in SRT, the majority of the learned improvement is due to either implicit or explicit prediction of the upcoming actions in the sequence.

We addressed this pitfall of the SRT with a novel continuous-reaching task that manipulates how many future reach targets are shown on the screen (Horizon). In Experiment 1, participants (N=14, 6F) performed sequences of 14 reaches in a robotic exoskeleton. Within a session, 80% of trials were repetitions of a fixed sequence and 20% were random sequences to assess sequence-specific learning and general learning, respectively. Critically, we manipulated how many future targets participants could see at any given time. In the Horizon 1 case, we replicated the classic SRT results. With practice, subjects became faster due to anticipation of the next movement. Importantly, in the Horizon 4 condition, we still observed a robust speed-up, even though full explicit knowledge of the upcoming targets was provided.

We conducted a second experiment to rule out the possibility that faster movement was just a result of more vigor due to familiarity with the learned sequence. In the first block, participants (N=15, 4F) learned one sequence with the right hand and another sequence with the left hand simultaneously. Then, we instructed them to execute the sequence initially learned with their right hand with their left hand, and vice versa. We observed no transfer of learning between hands in the first few trials of the second block, suggesting that the original learning was effector-specific and unrelated to motivational factors.

In a third experiment, we asked what is the minimum fragment of the practiced sequence that can evoke the learned speed-up. Each participant (N=28, 12F) extensively practiced a sequence then they executed random sequences which shared one, two, and up to five consecutive targets of the practiced sequence. We observed a speed-up for reaches connecting the practiced targets, but not in the reaches entering or exiting the practiced set of targets. Our results show that any given reach will speed up if the start, end, and previous targets are part of a previously practiced sequence.

We simulated the same task in a modular recurrent neural network (RNN) that controlled an arm model. The network was first trained on random point-to-point reaches and then over-trained on one sequence. In many networks, we saw that learning-related changes mostly occurred in modules connected to task and vision, not in motor-related modules. Together, with the behavioral results and RNN simulations, we propose a model for sequence learning that relies on optimizing individual movement for the sequence, rather than generating a dedicated sequence representation at the motor level.

O1.5 - *Evidence against replay-mediated offline learning during the first minutes of motor skill acquisition*

Anwesha Das [1], Alexandros Karagiorgis [1], Joern Diedrichsen [2], Max-Philipp Stenner [3], Elena Azanon [1]

[1] University of Magdeburg, [2] Western University, [3] Otto-von-Guericke University Magdeburg and Leibniz Institute for Neurobiology Magdeburg

Presenting Author: **Anwesha Das**

How can humans learn motor skills efficiently? Learning of a novel motor skill is typically exhibited by fast improvements in performance during practice (online learning). Boenstrup et al. 2019 have suggested a rapid form of offline learning during the first few minutes of skill acquisition, evident in performance gains across periods of rest interspersed between practice periods (micro-offline gains, MOG). Buch et al. 2021 suggested that these gains were potentially driven by temporally compressed neural replay of the practised sequence. We trained healthy human participants to produce a sequence of five key presses as often as possible in 10s practice periods interleaved with 10s rest periods. We replicated MOGs across 10s rests, in a total of 6 experiments. We found similar performance improvements across rest periods whether subjects were truly resting (N=34), engaged in motor imagery (N=34), or distracted by a demanding cognitive task (N=33). We also ran a between-subject study (N=79) wherein one group of participants performed a fixed sequence in every practice period whereas another group performed sequences of finger movements which never repeated, neither within a given practice period, nor across the entire experiment. If the MOG is driven by replay, it should vanish when sequences are never repeated. Unexpectedly, we found similar performance improvements when subjects trained on sequences that never repeated, questioning a role of replay for the observed performance gains. Furthermore, if MOG indeed corresponds to an offline gain, i.e., additional learning, then training with 10s rest periods (spaced training) should result in overall more skill compared to training without rest periods (massed training). Our 2 in-lab (N=62 and N=85) and 1 online (N=358) experiments, tested whether interspersed rest periods result in a true learning benefit. One group was trained via interleaved practice and rest periods of 10s each, whereas the other group was trained in a single, continuous practice period without breaks, matched in training duration. We intended to disentangle true, offline learning from other potential mechanisms that might be at play during breaks, so both groups were allowed to rest for a longer break of 5 minutes, enabling washout of accumulated fatigue and unmasking of true, latent learning. We compared performance between groups across 20s test periods at different points throughout the experiment. Despite significant MOG in the spaced training group, we observed that both resulted in a similar number of correct keypresses after washout. Across 3 experiments, we found no overall learning benefit when humans trained with vs. without 10s breaks. Taken together, our data indicate that the interpretation of MOG should cautiously differentiate between apparent learning and true, offline consolidation. Our findings will help understand early skill acquisition and strategies to benefit skill learning in humans.

O1.6 - *Balancing demands for stability and flexibility in the motor system of rats performing multiple motor sequences*

Naama Kadmon Harpaz [1], Steffen B. E. Wolff [2], Kiah Hardcastle [1], Rudy Gelb-Bicknell [3], Theodore J. Zwang [3], Bence Olveczky [1]

[1] Harvard University, [2] University of Maryland School of Medicine, [3] Mass General Institute for Neurodegenerative Disease, Massachusetts General Hospital

Presenting Author: **Naama Kadmon Harpaz**

The mammalian brain can learn to generate a near infinite number of actions by sequencing movements in new and adaptive ways. While we rely on such behavioral flexibility to interact with an unpredictable world, some behaviors, such as our signature, are performed repeatedly in the same way, making their execution reliable and robust to demands for continual learning. How the brain manages the tradeoff between flexibility and robustness is a key question not only for neuroscience, but also for AI systems that struggle in this domain.

One way to manage this tradeoff is to use the high dimensionality of neural circuits and assign each skilled behavior a dedicated manifold in neural state-space, allowing learning to continue along other dimensions while keeping the dedicated sub-circuit stable. To examine this hypothesis, we studied the acquisition of multiple motor sequences in freely behaving rats, and probed the activity of the sensorimotor striatum the main input region to the basal ganglia that has been implicated in the learning and execution of skilled behavior. Specifically, animals were trained in a continual manner on two different lever-tap sequences that shared the first element, allowing us to compare the behavior and neural activity associated with the same action embedded in different sequences. With practice, animals mastered both sequences, developing smooth and stereotypical movement trajectories. Following previous findings that have demonstrated the necessity of the sensorimotor striatum in the execution of a single learned motor skill, we hypothesized that lesions to this region in expert animals would affect the ability to perform the learned sequences. Indeed, learned kinematics were impaired following lesions of the sensorimotor striatum, showing a revert to a variable halting behavior. When examining the neural activity of single units in the sensorimotor striatum of expert animals we found that the two motor sequences were associated with stable yet distinct neural activity patterns, implying that learning leads to dedicated and unique task-specific activations in neural state-space, possibly minimizing interference and allowing each behavior to remain stable and robust to new learning.

In current ongoing work, we study how repeated practice leads to the engagement of the sensorimotor striatum and the separation of neural activity patterns. To that end, we have been developing a new flexible probe for electrophysiology recordings that can be used to record the activity of multiple single neurons continuously over months in freely behaving animals. This new method will allow us to study how neural circuits evolve over training to support motor sequence learning in the mammalian general-purpose learner.

08:00 – 10:00 SESSION 5, PANEL III

Closing the loop: the role of feedback in neural population dynamics

Jonathan Michaels [1], Britton Sauerbrei [2], Amy Orsborn [3], Laureline Logiaco [4]

[1] *Western University,* [2] *Case Western Reserve University School of Medicine,* [3] *University of Washington,*

[4] *Massachusetts Institute of Technology*

Discussant: **Mark Churchland**

The dynamical systems view of neural population activity, in which populations of neurons interact over time to produce coordinated patterns of activity, has been very influential in motor control - notably for characterizing cortical activity. This framework has typically been used to understand how goals are represented in motor planning and how this activity is translated into the muscle patterns required for movement, with less emphasis on the online control of movement. In parallel, decades of research have characterized the online, closed-loop control of movement through the lens of feedback control. While these efforts have led to successes in modeling motor behavior and have inspired analyses of neural data, this approach has not converged on a cohesive explanation of neural implementation. In this panel, we will bridge this gap by presenting and discussing evidence from rodents, primates, and computational models detailing how elements of feedback control can be integrated into the dynamical systems framework to provide a cohesive model of closed-loop motor control.

First, Britton Sauerbrei will discuss the complementary role of spinal circuits, the cerebellum, and motor cortex in locomotion when mice need to adapt to changes in limb properties, specifically showing that while motor cortex is not necessary when adaptation is required, activity shifts dramatically, potentially supporting future changes in voluntary control exerted by motor cortex.

Laureline Logiaco will discuss how different regions of the mammalian brain (cerebellum, M1, integrative sensorimotor cortices) can synergize to tackle learned closed-loop sensorimotor tasks, using a modeling approach. Specifically, this framework explains several experimental results in a single working model and makes predictions about task contingencies that require the synergy of many regions or instead mostly rely on a sub-part of the circuit.

Jonathan Michaels will discuss how we can integrate information related to expected future sensory input into frameworks of motor control, specifically showing that sensory expectation signals are present in many cortical areas of macaques, allowing the motor system to react flexibly to unexpected external perturbations.

Finally, Amy Orsborn will discuss how sensory feedback contributes to motor learning in interfaces like brain-computer interfaces, specifically showing that differences in the dimensionality of sensory feedback and movement control space may shape learning dynamics.

The panel concludes with a discussion focused on integrating the results of the talks into a common framework for understanding how different brain regions participate in incorporating sensory feedback in motor commands.

10:30 – 12:30 SESSION 6, INDIVIDUAL II

O2.1 - *Using a stochastic optimal control framework to model the control of complex human movement: Application to an aerial acrobatics*

Eve Charbonneau [2], Friedl De Groote [1], Mickaël Begon [2]

[1] *KU Leuven,* [2] *Université de Montréal*

Presenting Author: **Eve Charbonneau**

Optimal control theory has been used by biomechanists for decades to generate human movement. Resulting optimal kinematics closely reproduce human movements but lack the motor variability presented by humans and neglect the perception-action coupling needed to execute complex motion. Optimal feedback control theory has been proposed to overcome these issues [1]. It was brilliantly introduced in a computational method allowing for solving biomechanical stochastic optimal control problems (SOCP) involving more complex musculoskeletal models. It was done by including Gaussian motor noise, a Gaussian distribution of states, and a feedback loop based on deviations from the motor plan grasped by noised sensory input [2]. The SOCP optimal control policies better reproduced some key characteristics of human motion like stabilization through muscle co-contraction, realistic kinematic response to perturbations, and task-dependant modulations of feedback. This implementation considers sensory noise to be constant, whereas the acuity of our senses is state-dependent and lacks online prospective adaptations of the motor plan. These assumptions are not met during complex human motion involving multiple sensory inputs such as aerial acrobatics. Indeed, it was shown that athletes make prospective adaptations of their ongoing acrobatics in a feedforward manner [3] and our vestibular acuity depends on the head velocity. Thus, to model the gymnasts' behavior, we introduce in the current study state-dependent motor and sensory noise (e.g. vestibular noise is smaller if the head velocity is reduced) and feedforward adaptation to the nominal motor plan based on the somersault angular velocity to the dynamics equation. Optimal control policies for executing a backward somersault were generated with a full-body torque-driven skeletal model composed of seven degrees of freedom. The objective was to reach the landing position as consistently as possible and to minimize the expected efforts (including feedback and feedforward components) required. For comparison, three types of problems were solved: i) a deterministic optimal control problem (DOCP), ii) a constant noise SOCP, and iii) our new approach involving noise modulation and feedforward adaptations (SOCP+). The optimal kinematics generated through the three methods differed from one another. The SOCP control policy leads to smoother kinematics than the DOCP policy; this more conservative technique would require less precision during execution. The addition of noise modulations introduced modifications of the neck kinematics between the SOCP and SOCP+ policies. The SOCP+ reproduced the sensory acquisition strategies used by gymnasts to reduce landing variability. The appearance of these sensory strategies highlights the potential of this SOCP+ framework. As it is generic, it could help us better understand the organization of other complex human movements.

[1] **Todorov**, 2004
[2] **Van Wouwe**, 2022
[3] **Bardy, J.**, 1998

O2.2 - *Spinal reflex representation in the primary motor cortex*

Tatsuya Umeda [1], Osamu Yokoyama [2], Michiaki Suzuki [2], Miki Kaneshige [2], Tadashi Isa [1], Yukio Nishimura [2]

[1] *Kyoto University,* [2] *Tokyo Metropolitan Institute of Medical Science*

Presenting Author: **Tatsuya Umeda**

How supraspinal and spinal structures in the nested hierarchy control limb muscles is a fundamental question in the neural control of limb movements. Various theories, including the servo control hypothesis and internal model for motor control, have historically been proposed to incorporate the role of spinal reflexes into cortical control of limb movements. More recently, optimal feedback control theory and active inference have been developed further to deepen our understanding of neural control of limb movements. Despite these theoretical advancements, the precise neural mechanism by which the central nervous system, in concert with spinal reflexes, orchestrates motor control signals, especially concerning the flow of information coded in neural activities across sensorimotor circuits, remains elusive.

Here, we simultaneously recorded activities in motor-related cortical areas (MCx), afferent neurons, and forelimb muscles of monkeys performing reaching movements. We developed a linear model to explain the instantaneous muscle activity based on the activity of MCx and peripheral afferents. Decomposing the reconstructed muscle activity into subcomponents explained by MCx and afferents activity, we found that initial muscle activation for forelimb movement is driven by MCx output, followed by the activation of peripheral afferents through limb movement, which in turn modulates muscle activity via spinal reflex pathways. Based on the information flow, we found that MCx, primarily the primary motor cortex (M1), encodes subsequent afferent activities attributed to forelimb movements. M1 also encodes a subcomponent of muscle activity evoked by these afferent activities, corresponding to spinal reflexes. Furthermore, selective disruption of the afferent pathway specifically reduced this subcomponent of muscle activity, suggesting that M1 output drives muscle activity not only through direct descending pathways but also through the transafferent pathway composed of descending plus subsequent spinal reflex pathways. These findings suggest that M1 generates optimal motor output by employing an internal forward model, which prospectively computes future spinal reflexes.

O2.3 - *Spinal networks act as a continuous attractor during pause of movement*

Salif Komi [1], Jaspreet Kaur [1], Madelaine Bonfils [1], Jakob Sørensen [1], Nicolas Bertram [1], Rune Berg [1]

[1] *University of Copenhagen*

Presenting Author: **Salif Komi**

How does a cat gracefully walk and suddenly freeze its ongoing movement when spotting a mouse? The common wisdom attributes this ability to neural circuits within the spinal cord that are well-known for their ability to generate rhythmic movements, doing so in symphony with the brain. However, the mechanisms behind this generation remain unclear. While the prevailing view suggests the existence of specialized modules for distinct functions, recent observations, including rotational neural activity during rhythmic limb movement (Lind 2022), challenge this perspective. Furthermore, the precise means by which the neural circuitry achieves a pause in ongoing movement across any posture remains elusive.

To investigate how spinal neural networks execute locomotion that can be paused at any point, we utilized high-density electrophysiology in rat spinal cords during voluntary locomotion, coupled with optogenetic perturbation of the pedunculo-pontine nucleus, a known regulator of movement arrest (Goni-Erro 2023). We present compelling evidence supporting the existence of continuous network attractor properties within the spinal network. We find that during volitional locomotion, the neuronal manifold activity exhibits robust rotational patterns, whose topology is invariant at various speeds and across animals. Furthermore, this trajectory converges to a stable point-attractor precisely at the moment of motor arrest, and it persists in this specific configuration until the movement is continued on the initial trajectory. Through computational modeling, we argue that the network is analogous to a Continuous Attractor Network (CAN), which has been demonstrated in grid cells of the entorhinal cortex associated with memory storage and retrieval (Gardner 2022). We finally suggest specific structural mechanisms by which the network is physically implemented and controlled to transition between locomotion and pause.

In light of these observations, we propose the presence of a CAN-analogous spinal network with rotational properties as the mechanism behind generation as well as the arrest of ongoing movement.

O2.4 - *Distinct contributions of feedback and feedforward control during longitudinal de novo learning*

Chen Avraham [1], Firas Mawase [1]

[1] *Technion - Israel Institute of Technology*

Presenting Author: **Firas Mawase**

Learning a motor skill from scratch, known as de novo learning, involves establishing a new control system. Typically, real-world motor tasks, like bicycle riding, require using a combination of feedback and predictive control systems to produce smooth and accurate movements. Due to the inherent time delay of feedback control and its inability to reflect the body's current state, employing a feedforward model is crucial to produce quick and precise actions. The development of feedback and feedforward control systems during the acquisition of new motor skills is not yet fully understood.

In our study, ten right-handed participants (6 females, age 24.7±2.0 years) practiced a mirror reversal continuous tracking task during 5 consecutive days. The target moved in a pseudo-random trajectory, shaped by a sum-of-sinusoids, across a frequency range of 0.1 to 2.15 Hz. We aimed to discern whether participants learned this task primarily through feedforward control, feedback control, or a combination of both. We assessed this by (1) checking for the presence of after-effects, which are indicative of feedforward control, and (2) introducing probe trials where the cursor made unpredictable translocations, prompting a feedback response.

Our findings showed a gradual learning, with participants achieving an average learning level of 54.37±0.08% by Day 5 (100% representing complete learning). Analysis of responses to cursor jumps on day 5 revealed a close alignment with ideal feedback responses (regression slope of 0.87±0.03), suggesting that continuous learning was mostly achieved using feedback control. Intriguingly, a small yet significant after-effect (15.29±0.11%) was also observed post-learning ($t(9)=3.47$, $p=0.0032$), indicating a contribution of feedforward control to the overall learning process.

However, the predominance of slower frequencies in overall learning could inadvertently obscure the actual impact of the feedforward controller. To verify this, we conducted a linear systems analysis, using the discrete Fourier transform, offering a more granular view than trajectory-alignment analysis. This analysis revealed rapid learning at lower frequencies and slower learning at higher frequencies. Interestingly, higher frequencies were associated with greater after-effects, suggesting a more pronounced role of feedforward control at these frequencies ($t(9)=2.55$, $p=0.031$).

These results provide new insights into how humans acquire de novo motor skills. The properties of de novo learning can potentially be explained by the existence of two distinct control pathways: Firstly, corrective feedback responses operate at low frequencies, acting early on learning and improve with practice. Secondly, at high frequencies, the target's speed may surpass the capacity for feedback control, resulting in predominantly inadequate feedforward responses during early learning. However, this feedforward controller is flexible and develops gradually with practice.

O2.5 - *Decision uncertainty as a context for motor memory*

Nobuhiro Hagura [1], Kisho Ogasa [1], Atsushi Yokoi [2], Gouki Okazawa [3], Masaya Hirashima [4]

[1] NICT, [2] National Institute of Information and Communications Technology, [3] Institute of Neuroscience, Chinese Academy of Sciences, [4] Center for Information and Neural Networks, National Institute of Information and Communications Technology

Presenting Author: **Nobuhiro Hagura**

In a penalty shoot-out of a football (soccer) game, one may decide to kick the ball to the right corner confidently, seeing that the goalkeeper is moving to the other side, or decide to make the same kick while being unsure about the goalkeeper's movement. Because both actions are apparently identical, we tend to believe that the same motor memory (i.e., a motor program for kicking the ball to the right) is retrieved and executed for both cases regardless of the quality of the preceding decision.

Indeed, previous perceptual decision-making studies have treated uncertainty as a factor for modulating the evidence accumulation process for decisions, implicitly assuming that an identical motor program is triggered once the evidence level reaches a bound (Ratcliff & MacKoon, 2008, Gold & Shadlen, 2007). The current theory of motor learning posits that the brain flexibly forms and switches between multiple motor memories through contextual inference process, relying on external sensory cues linked to action (Heald et al., 2021). In this framework, again, uncertainty of cues is treated as a variable which leads to uncertainty of the associated contexts, not the cue to directly specify the context for the motor memory.

Opposing to the dominant views in both decision-making and motor learning literatures, we show that uncertainty of the decision cues for action execution, by itself, acts as a significant contextual cue for motor memory. Participants judged the direction (left or right) of a visual motion (random-dot motion) presented on the screen. They were asked to reach towards the target of the perceived motion direction by moving a manipulandum with their right hand. The reaching movement following the decision was performed under a velocity-dependent force-field. We manipulated the uncertainty level of the decision by changing the coherence level of dots motion.

We showed that actions learned following certain (uncertain) decisions only partially transfer to actions following uncertain (certain) decisions. Participants were able to learn two different force-fields if each perturbation was preceded by a different decision uncertainty level. Crucially, such contextual effect generalized to novel stimuli with matched uncertainty levels. Finally, we demonstrated that participants could differentiate the force-field contexts based on the decision uncertainty at the deliberation/planning stage of action, before performing the decided action.

Taken all together, our findings broaden our understanding of contextual inference for motor memory, emphasizing that it extends beyond physical stimuli to encompass the internal inferential state of the environment.

O2.6 - *Striatal and cerebellar involvement in reinforcement learning in the human infant brain*

Juliana Trach [1], Tristan Yates [1], Sheri Dawoon Choi [1], Lillian Behm [1], Cameron Ellis [2], Samuel McDougle [1], Nicholas Turk-Browne [1]

[1] *Yale University,* [2] *Stanford University*

Presenting Author: **Juliana Trach**

The ability to learn from positive and negative feedback is an essential cognitive capacity throughout life but perhaps especially when first learning to make sense of and interact with the world during early development. Behavioral work suggests that even very young human infants can use reward feedback to guide their actions toward maximizing rewards they receive from their environment. However, it is unknown how the infant brain learns from and processes rewards, nor what the time course of maturation is for the relevant neural systems. Prior work with adults and adolescents has highlighted canonical regions of the striatum in reinforcement learning (RL; Bartra et al., 2013; Fouragnan et al., 2018). More recently, there has been growing interest in the role that the cerebellum might play in this crucial learning capacity (e.g., Wagner & Luo, 2020). While the cerebellum has historically been associated with motor control and error-based motor learning, work with nonhuman primates and rodents has yielded evidence of neural processing of rewards and reward predictions in the cerebellum, providing one example of a nonmotor function of the region (Heffley & Hull, 2019; Kostadinov & Hausser, 2022; Sendhilnathan et al., 2020; Wagner et al., 2017). Still, it is unclear whether part or all of this RL system is mature in infancy or whether cerebellar processing changes as infants gain more motor capacities. Furthermore, methodological challenges have limited the study of subcortical structures - like the cerebellum - in infants, which cannot be easily studied with traditional infant neuroimaging techniques such as EEG and NIRS. Recent advances have made it possible to conduct fMRI studies in awake and behaving infants (Ellis et al., 2020). We used fMRI to measure whole-brain activity during an infant-friendly Pavlovian RL paradigm. Infants were presented with two shapes, one associated with a high reward probability (80%) and the other with a low reward probability (20%). One shape was randomly selected on each trial, and then it revealed either a rewarding stimulus (a dynamic smiley face) or no outcome. Our model-based fMRI analyses focused on core components of RL: reward prediction (i.e., Q-value), reward feedback, and both signed and unsigned reward prediction error. Our results revealed widespread processing of all of these signals, including the striatum, insula, anterior cingulate cortex, and thalamus. Moreover, we found evidence for infant cerebellar responses that correlated with both reward prediction and reward feedback. Overall, this work marks a promising step in our understanding of RL in the infant brain and the role of the cerebellum in cognitive functions.

15:00 – 17:00 SESSION 8, PANEL IV

The underlying mechanisms of motor impairments after stroke

Lior Shmuelof [1], Inbar Avni [1], Stuart Baker [2], Alkis Hadjiosif [3], Jennifer Mak [4]

[1] Ben Gurion University of the Negev, [2] Newcastle University, [3] Harvard University, [4] Bioengineering Department, University of Pittsburgh

Stroke is the leading cause of long-term disability in the western world. Disability after stroke can be driven by a combination of underlying impairments, such as control deficits, loss of dexterity, weakness, spasticity, and pathological synergies. The extent and time-course of recovery may differ across impairments, highlighting the importance of phenotyping for the prognosis of stroke recovery.

The overarching goal of this panel is to review recent approaches towards phenotyping motor impairments after stroke and their underlying mechanisms. A suggested conceptual approach to phenotyping motor impairments is through the direct and indirect effects of the lesion on motor pathways. Negative signs, such as loss of control and weakness are proposed to be associated with damage to the corticospinal tract (CST), whereas positive signs, such as spasticity and pathological synergies, are suggested to be driven by hyper-activation of the reticulospinal tract (RST).

Avni et al. will present a longitudinal kinematic study of subjects with stroke that shows that weakness and pathological synergies appear together in the early sub-acute stage but show a differential recovery time course, pointing to their dissociable origin. Baker et al., will present a lesion study in monkeys that aims to characterize the origin of positive signs in the primary motor cortex, concluding that positive signs may be associated with a significant loss of CST input to sub-cortical circuits. To further characterize the contribution of cortical areas to motor impairments, Mak et al. will present the results of an rTMS stimulation study in stroke subjects, showing indications of altered non-primary motor area involvement in the control of movement after small, subcortical strokes. Finally, Hadjiosif et al. will take a different approach by studying the consistency between deficits during holding still, hypothesized to reflect RST function, and reaching, which is thought to be dominated by CST function. The reported lack of interaction between holding deficits and reaching deficits provides further support for the dissociable origin of negative and positive signs.

We show that disability after stroke can be conceived as an outcome of a combination of negative and positive signs that may be associated with distinct motor pathways. Moreover, some of the results highlight a causal association between loss of CST input and the hyper-activation of RST and call for a systematic examination of the causes of emergence and recovery of positive signs. The motor pathway account for motor deficits after stroke and the potential dependence between CST and RST may be fundamental for the understanding of general principles in motor control.

08:00 – 10:00 SESSION 9, PANEL V

Feedforward and feedback mechanisms of neural control: theory and applications

Frederic Crevecoeur [1], Friedl De Groote [2], Etienne Burdet [3], David Franklin [4], Janneke Schwaner [5]

[1] *University of Louvain,* [2] *KU Leuven,* [3] *Imperial College London,* [4] *Technical University of Munich,* [5] *University of California, Irvine*

Discussant: **Friedl de Groote**

The principles of control theory have advanced but also shaped our understanding of how the brain controls movements, while the combination of computational and experimental results has guided research into the neural correlates of sensorimotor functions. For example, the early introduction of optimal control assumed an open-loop controller capable of selecting efficient trajectories and mapping them to motor commands. Subsequent studies have highlighted the importance of feedback control, which has challenged the nature of trajectory representation in the brain by showing that for some tasks, goal-directed control does not necessarily require a feedforward controller. More recently, feedforward and feedback control mechanisms have been associated with different time frames, the former referring to the gradual acquisition of motor patterns through development and learning, while the latter was prevalent for execution of movement and responses to disturbances. At the interface between these time frames, several studies have demonstrated behavioral and neurophysiological correlations between adaptive motor patterns and responses to perturbations when humans are exposed to changes in limb dynamics. This research required dissecting the neuroanatomy of feedback pathways, leading to a precise description of how the visual and proprioceptive systems engage various feedback loops. The current observations concluded that feedforward and feedback pathways may not be completely separable from functional and behavioral perspectives. The impact of interpreting neural data associated with movement control is enormous, since the sensorimotor pathways involved in feedback control and adaptation must therefore overlap.

In this session, we propose to present recent advances based on similar principles, applied to a wide variety of systems, tasks and populations. More precisely, the success of theoretical control models quickly comes up against the complexity of the human body, which is particularly challenging to describe for locomotion tasks. Modeling the physics of locomotion to understand and evaluate the neural control of gait is a subject that will be addressed (J. Schwaner). The interaction between feedforward and feedback control mechanisms has been exploited to study the multimodal properties of neural control in adaptation tasks including multiple effectors, goals and environments (D. Franklin), interactions between individuals, including typically developing children (E. Burdet), and in response to dynamic changes in the environment (F. Crevecoeur).

As these contributions highlight, we are currently witnessing a paradigmatic shift towards complex tasks, more representative of daily activities. We will discuss how interpreting behavioral data through the lens of a control theoretical approach can shed light on the nature of the underlying neural controller, potential dysfunctions, as well as the limits of our current understanding.

10:30 – 12:30 SESSION 10, PANEL VI

Neural control of speech: What did we miss in the last 20 years?

Elvira Pirondini [1], Sergey Stavisky [2], Ludo Max [3], Marc Slutzky [4], Nicholas Card [2]

[1] University of Pittsburgh, [2] University of California, Davis, [3] University of Washington, [4] Northwestern University

Planning and executing motor behaviors requires orchestrating neural activity among multiple cortical and subcortical regions. Interestingly, the coordination between these brain areas underlying movement and speech generation appear to share similarities. The field of speech neural control has recognized this affinity by leveraging knowledge and technologies developed for limb movements to investigate speech production and promote functional recovery in patients with neurological injury. However, these explorations have so far remained marginal in the community of Neural Control of Movement. We believe that sharing recent progress in studying the neural control of speech could now close the loop by benefiting researchers working on upper and lower-limb motor control. For this, Dr. Ludo Max will open the panel by discussing recent behavioral studies that focus on sensorimotor interactions in the context of orofacial speech movements in neurologically healthy individuals with an emphasis on similarities and differences with paradigms for limb sensorimotor learning. Dr. Marc Slutzky will then continue along this line showing how the cortical encoding of speech production has homologous hierarchical organization with that of upper-limb movements and how non-frontal cortices may contribute to speech production. Dr. Nicholas Card will then steer the panel towards novel advances in neurotechnology for speech motor deficits. He will show that brain-computer interfaces (BCIs), which have until recently been primarily developed for limb restoration applications, have now reached a level of performance in the speech BCI domain suitable for clinical deployment for restoring rapid communication to people living with severe dysarthria. In particular, he will show a novel accurate and rapidly-calibrating method that could benefit other BCI applications. Dr. Elvira Pirondini will continue in this direction showing her recent results on the use of deep brain stimulation to improve hand motor control and how these results translate to restore natural speech. Finally, Dr. Sergey Stavisky will drive the discussion around an important question: what did we miss in the last 20 years in the field of speech neural control that could now be leveraged for advancing our knowledge in speech and limb motor control and restoration of volitional functions?

08:00 – 10:00 SESSION 12, PANEL VII

Spinal cord and brainstem control of upper limb movements. Is it time to revisit our cortically-centered view of hand motor control and learning?

Shahab Vahdat [1], Julien Doyon [2], Sho Sugawara [3], Veronique Marchand-Pauvert [4]

[1] University of Florida, [2] McGill University, [3] Tokyo Metropolitan Institute of Medical Science, [4] Inserm, Sorbonne Université

Our classical view of neural control of movement states that the execution of goal-directed upper limb movements mainly relies on the activation of cortical motor areas, such as primary motor and premotor cortices. On the other hand, postural and balance control heavily relies on the activation of brainstem motor nuclei, such as the reticular formation. Growing evidence from animal work is starting to challenge this view by demonstrating active involvement of multiple brainstem and intersegmental spinal cord circuits in the execution of goal-directed forelimb movements, including the medullary reticular formation and the propriospinal neurons at C3-C4 cervical levels. What is the relationship between the activities of brainstem and intersegmental spinal cord centers and cortical motor areas in upper limb motor control? Do these findings extend to humans with a more developed corticospinal pathway? Are they also involved in motor planning and motor learning? In this panel, we will explore these questions across multiple levels of the central nervous system (cortical, brainstem, spinal cord), in various behavioral paradigms and processes involving upper limb movements (planning, execution, learning), and across multiple model organisms (humans, mice). First, Shahab Vahdat will discuss the contribution of brainstem and spinal cord activity in hand/forepaw force control, using innovative fMRI protocols enabling assessment of task-related brain and spinal cord connectivity in humans and mice. Shahab will discuss the modular organization of functional connectivity between medullary reticular formation, C3-C4 propriospinal system, and cortical motor areas involved in hand force control. Second, Sho Sugawara will detail the structural features of brain-spinal cord pathways to clarify the anatomical basis for voluntary motor control. Sho will further discuss premovement activity in brain-spinal cord pathways using simultaneous brain-spinal cord fMRI. Sho's work delineates how premovement spinal cord activation may contribute to motor planning in humans. Third, Veronique Marchand-Pauvert will discuss the functional role of propriospinal neurons in hand motor control. Veronique will discuss the origins of cortical inputs to the C3-C4 propriospinal neurons using a combination of TMS and peripheral nerve stimulation. Her work suggests a direct descending control of propriospinal transmission from premotor cortex in humans. Lastly, Julien Doyon will discuss a comprehensive view on neural substrates of motor sequence learning in humans, in which spinal cord local circuits play an active role in this process. Using simultaneous spinal cord-brain fMRI, Julien will discuss several lines of evidence showing learning-induced changes in the spinal cord circuits across various stages of learning, and how they relate to cortical and subcortical activations. The panel will conclude with a discussion focusing on the themes emerging across the talks led by Leonardo Cohen.

10:30 – 12:30 SESSION 13, INDIVIDUAL III

O3.1 - *Differential roles of the cerebellum and basal ganglia in decision making*

Sabrina Abram [1], Jonathan Tsay [2], Tianhe Wang [1], Samuel McDougle [3], Richard Ivry [4]

[1] *University of California, Berkeley,* [2] *University of Cambridge,* [3] *Yale University,* [4] *University of California*

Presenting Author: **Sabrina Abram**

The outcome of a choice depends on which action we select as well as how we execute this action. Consider playing the slot machines in a casino versus a claw machine in an arcade. In the casino, we need to select which slot machine to play, hoping to have chosen the one ready to pay off a jackpot. In contrast, with a claw machine, we not only need to select our desired toy but also maneuver the claw to successfully grasp it. The latter affords a sense of agency. Decisions made with a sense of agency (action selection with action execution) involve different strategies than those made without a sense of agency (action selection alone).

Do these two scenarios also differentially engage neural systems associated with decision making and motor control? Dopaminergic circuits within the basal ganglia are central to models of reward learning and motor control, and recent studies involving rodents and non-human primates have also implicated the cerebellum in reward processing and learning. Here, we tested individuals with neurodegenerative disorders affecting the basal ganglia (Parkinson's disease, PD) or cerebellum (cerebellar degeneration, CD) on decision-making tasks, comparing their performance to older controls (OC). We used a 2x2x3 design, manipulating the learning environment (model-free vs model-based), sense of agency (without-agency vs with-agency), and group (CD, PD, OC). In the model-free condition, participants selected and reached to one of two targets, each associated with reward probabilities that varied over time. In the model-based condition, they selected one of two options, each associated with transition probabilities that caused a specific target to appear, and then reached to this target to earn rewards. In the without-agency condition, we told participants that the outcome was determined by a lottery. In the with-agency condition, we told them that they were rewarded if they accurately reached to the target, giving the illusion of control.

Performance in the without-agency condition was strikingly similar for CD participants and controls (CD n=21, OC n=15). In contrast, CD participants performed worse than controls in the with-agency condition (CD n=16, OC n=15). We observed this same pattern for both model-free and model-based learning. We fit a reinforcement learning model to choice behavior and found that, for the with-agency CD group, differences in performance could be explained by deficits in decision noise for model-free learning and deficits in learning rate for model-based learning. Our preliminary results for the PD group point towards the opposite pattern: trending deficits without-agency (n=8) while intact performance with-agency (n=8) for model-free and model-based learning.

In summary, these results provide evidence for the differential involvement of the cerebellum and basal ganglia in decision making, with the cerebellar contribution limited to situations where the outcomes of our decisions depend on action execution.

O3.2 - *The hand outperforms the eyes at localizing somatosensory targets*

Marion Naffrechoux [1], Eric Koun [2], Alessandro Farnè [2], Alice Catherine Roy [3], Denis Pélisson [2]

[1] Lyon Neuroscience Research Center (IMPACT Team), [2] Lyon Neuroscience Research Center (CRNL), IMPACT Team, [3] Dynamique Du Langage Laboratory

Presenting Author: **Marion Naffrechoux**

Neural representations of our body state are critical to generate and monitor our interactions with the environment. Among such body representations (BR), the body state estimate is necessary to plan, execute and correct on-line the motor command of goal-directed movements. Despite their crucial contribution to motor behavior, BR are nonetheless distorted even in healthy participants according to several studies testing the localization performance of unseen body parts (proprioceptive or proprio-tactile targets). However, these BR distortions were mostly studied with the contralateral upper limb as a probe. Thus, to determine whether the observed mislocalizations result from a true representational distortion, comparison with another effector, such as the eyes, is required. Such comparison is particularly interesting because the eye and hand motor control systems have distinct properties and rely on partly separate neural substrates.

In the present study, we aimed to assess the accuracy of two effectors (eye and hand) to localize somatosensory targets. Twenty-six healthy participants performed two localization tasks. For the proprioceptive task, they had to localize the index fingertip of their unseen dominant hand positioned passively, at random, at one of two possible forearm positions (10° and 30° of elbow flexion from the initial -horizontal- position). For the tactile task, they localized the vibrotactile stimulus applied to the index finger or to the thumb of their unseen dominant hand (fixed forearm position at 30° of elbow flexion from horizontal). In each task, the localization response consisted of an ocular saccade or a manual pointing with the opposite hand, each response type alternating between saccade and manual blocks of trials. Linear mixed models were applied separately to the horizontal and vertical localization errors to analyse the effect of effector (eye vs hand) and target position (10° vs 30° or finger vs thumb).

Target position affected the localization performance, which generally was more accurate for the 30° proprioceptive target and for the thumb tactile target. Note that, in agreement with previous work, localization responses to proprioceptive targets erred toward the body, as if arm length was underestimated. Also confirming previous studies is the finding that the thumb was less affected by distortions than the index finger. Moreover, the effector affected the localization performance in both tasks: horizontal errors were larger for the ocular responses than for the manual responses. Noteworthy, despite this difference in accuracy, eye and hand effectors led to positively correlated errors, suggesting that they similarly track somatosensory defined positions on one's arm. This last observation opens the possibility to use the eyes as probes to assess body distortions in populations with upper limb motor disorder (such as Developmental Coordination Disorder or after stroke).

O3.3 - *Cerebellar input and output circuits for dexterous movement*

Eiman Azim [1], Ayesha Thanawalla [1], Oren Wilcox [1], Kee Wui Huang [1], Elischa Sanders [1]

[1] *Salk Institute for Biological Studies*

Presenting Author: **Eiman Azim**

A critical challenge for the sensorimotor system is managing the intricate coordination of dozens of limb muscles to interact with the world with speed and dexterity. Despite the importance of sensory feedback, delays in the transmission of peripheral signals imply an additional more rapid internal feedback mechanism. A prominent theory posits that outgoing motor commands are copied to the cerebellum, where they are used to generate predictions of impending movement outcomes that can be used to compensate for sensory delays and rapidly update motor output. Yet how putative copy signals are functionally organized as they enter the cerebellum and how cerebellar output rapidly refines motor output remain poorly understood.

In a first project, we explore the lateral reticular nucleus (LRN), a brainstem structure that conveys copy signals from the spinal cord to the cerebellum. We find diverse molecular, anatomical, and electrophysiological properties of LRN neurons, suggesting distinct subclasses process different movement related features. Perturbation of LRN neurons disrupts forelimb movements, as revealed by machine learning-based approaches designed to identify kinematic phenotypes. In a second complementary project, we focus on output pathways in the cerebellar nuclei (CN) that impact limb movement through diverse motor targets. We show that anatomically distinct subsets of CN neurons have discrete contributions to forelimb motor control, with separate subclasses capable of eliciting rapid changes in motor neuron activity, muscle recruitment, and movement kinematics. Together, these findings reveal a functional logic to cerebellar input and output pathways that facilitate rapid refinement to enable dexterity.

O3.4 - *Kinematic and kinetic signals in monkey and human motor cortex*

Elizaveta Okorokova [1], John Downey [1], Charles Greenspon [1], Sliman Bensmaia [1], Anton Sobinov [1]

[1] *University of Chicago*

Presenting Author: **Elizaveta Okorokova**

Object manipulation requires control over various behavioral variables: kinematic, describing posture and movement of the hand, and kinetic, describing forces. Humans excel at this behavior - the hand conforms to the object's shape and size during reaching, and fingers apply precise forces to hold and move the object after grasping. Previous studies have suggested a more robust encoding of hand postures compared to grasp force in the motor cortical responses of both humans and non-human primates. However, those conclusions were drawn based on the classification of a low number of grasping postures and discreet forces, neglecting the continuous nature of hand movements and changes in applied force. To understand the interaction between posture and force signals in the motor cortex during naturalistic behaviors, we conducted a parallel set of experiments with healthy non-human primates and humans with tetraplegia. In the first set of experiments, we trained non-human primates to grasp sensorized objects with an instructed force level. The object changed size and orientation to evoke different movements. Throughout the experiment, we recorded hand kinematics across 28 degrees of freedom together with the manual forces applied to the object. In the second set of experiments, a human participant was instructed to attempt grasping objects of varied sizes and orientations in a virtual environment with different levels of force. In both experiments, we recorded corresponding neural responses from the motor cortex using chronically implanted Utah electrode arrays. We first characterized the tuning of individual neurons in monkey and human motor cortices to object shape and target force. We have found that individual neurons were modulated to the time course of the task and that the representations of object and force were intermixed. We then built linear and non-linear decoders of continuous kinematic and kinetic traces. Surprisingly, our findings demonstrated that the motor cortex exhibits a robust representation of grasp force, comparable to the representation of the individual components of movement, such as hand orientation, or aperture. Moreover, our investigation into the relationship between neural representations of force and kinematics revealed only weak linear dependence between grasp force and hand posture. These results carry significant implications for our understanding of manual motor control and the creation of the next generation of decoders for brain-controlled bionic hands that can permit dexterous object manipulation.

O3.5 - *Leveraging preparatory activity from the human motor cortex for high performance brain-computer interface control*

Mattia Rigotti-Thompson [1], Yahia Ali [1], Samuel Nason-Tomaszewski [1], Claire Nicolas [2], Nick Hahn [3], Donald Avansino [3], Domenick Mifsud [1], Kaitlyn Tung [4], Shane Allcroft [5], Jaimie Henderson [3], Leigh Hochberg [6], Nicholas Au Yong [1], Chethan Pandarinath [1]

[1] Emory University and Georgia Institute of Technology, [2] Massachusetts General Hospital, [3] Stanford University, [4] Georgia Institute of Technology, [5] Brown University, [6] Brown University & Massachusetts General Hospital

Presenting Author: **Mattia Rigotti-Thompson**

Preparatory activity that precedes movement execution is a well-known property of neural activity within the motor cortex. Non-human primate studies have demonstrated that preparatory activity encodes several properties of upcoming movements, such as direction, distance, and speed. However, this wealth of information is usually ignored in intracortical brain-computer interface (iBCI) applications, where control is driven by instantaneous readouts from neural activity during intended movement. In this work, we studied preparatory activity from the motor cortex of human participants with the goal of harnessing it to improve BCI control. We recorded intracortical spiking activity from the precentral gyrus of participants T11 and T5 enrolled in the BrainGate2 clinical trial while they performed 2D cursor control tasks. We first designed a cursor following task where participants were instructed to prepare and attempt movements to a randomly cued peripheral target following a variable but known delay. Consistent with previous studies, we identified a neural trigger signal aligned to the cued movement initiation time at the end of the delay (T11: $r = 0.81$, 147 trials; T5: $r = 0.89$, 167 trials). We also identified preparatory activity that preceded this signal, which showed tuning to the direction of the upcoming movement (decoding $R2 > 0.40$ for over 250 ms before trigger when delay ≥ 0.6 s, for both participants). As a proof of concept for iBCI use, T11 performed a variant of the task where both movement initiation and intended direction were decoded online from preparatory activity. This allowed T11 to achieve self-paced, rapid control of an on-screen cursor to fixed-distance targets (400 ms movement time, median angular error < 18 degrees, 91 trials). We next characterized preparatory activity for attempted movements that were less-constrained to better resemble practical iBCI control. Participants used an iBCI-controlled cursor to acquire targets in a 2D spatial grid (19 targets) without enforced delays or a fixed start position. We evaluated the decoding accuracy of the intended movement endpoint from neural activity, and found that both endpoint direction and distance could be decoded during the first 400 ms after target presentation (T11: dir. $R2 > 0.85$, dist. $R2 > 0.20$, 554 trials, 5-fold cross-val.; T5: dir. $R2 > 0.80$, dist. $R2 > 0.30$, 788 trials, 5-fold cross-val.). This demonstrates that neural trajectories are tuned to the direction and distance of the endpoint around the time of movement initiation. Overall, this work is one of the first to characterize the encoding properties of preparatory activity recorded from the human motor cortex and shows the potential of leveraging this activity for high performance brain-computer interface control.

O3.6 - *Vestibular stabilization drives gaze control strategies in primate locomotion*

Oliver Stanley [1], Ruihan Wei [1], Kathleen Cullen [1]

[1] *Johns Hopkins University*

Presenting Author: **Oliver Stanley**

Stable and accurate control of gaze - the sum of the head's position and orientation in space with the eyes' orientation in the head - is integral to activities of daily living, particularly for guiding locomotion. The vestibular system makes critical contributions to both components of gaze control (i.e., head stabilization and visual stabilization). Specifically, the vestibulo-collic and vestibulo-spinal reflexes help keep the head steady in space during locomotion and to counteract unexpected postural perturbations, while the vestibulo-ocular reflex keeps the retinas on-target by driving eye movements to counteract head movement. To better understand the contributions of the vestibular system to behavioral stabilization during locomotion, we assessed gait and the gaze control of two normal rhesus macaques and one with long-term complete bilateral vestibular loss during walking both on a treadmill at varied speeds and during repeated passages of a linear walkway.

We recorded single-eye video-oculography using a head-mounted camera and used a head-mounted 6D inertial measurement unit and retroreflective markers to capture head movement & orientation. Animals' gait was captured in 3D via markerless feature tracking using synchronized cameras set around the behavioral apparatus. As expected, we identified systematic differences in gait and head movement kinematics between normal and vestibular-loss animals.

The macaque with chronic vestibular loss exhibited lower gaze stability and higher variability in limb and head movements, a trend which was exacerbated at higher locomotion speeds. In all animals, gaze shift occupied approximately one quarter of each step cycle on average, and showed modulation with the step cycle during treadmill locomotion. The strength of this modulation was reduced during overground walking. In comparing the frequency and magnitude of gaze shifts during treadmill versus overground locomotion, we found that healthy animals increased the frequency of gaze shifts while the vestibular-loss animal increased the magnitude of those shifts. We speculate that, for animals with vestibular loss, a gaze control strategy using a smaller number of large gaze-correcting shifts may be more efficient than making many small shifts that would be quickly washed out by the gaze instability resulting from the absence of vestibular reflexes. Taken together, these findings establish that the vestibular system provides a foundation of postural and gaze stability that enables more effective motor control strategies during locomotion.

15:00 – 17:00 SESSION 15, PANEL VIII

Current debates on the integration of touch and movement

Tobias Heed [1], Konstantina Kilteni [2], Matej Hoffmann [3], Katja Fiehler [4]

[1] *University of Salzburg,* [2] *Donders Institute for Brain, Cognition and Behaviour, Radboud University,* [3] *Czech Technical University in Prague,* [4] *University of Giessen*

Discussant: **Kathleen Cullen**

Sensorimotor research has had a strong focus on visual and proprioceptive information for movement planning and execution. Touch has received much less attention in motor control research, even though movements are often directed towards tactile events, such as an itch or a tap on the shoulder, and every movement evokes tactile sensory input, such as contact with an object (hands) or the ground (feet), hitting an obstacle, or movement of clothing on the skin.

Tactile processing has received more attention in other areas of (cognitive) neuroscience, for instance in the domain of multisensory processing, in which movement is, however, often not taken into account. Yet, research has begun to grow together across domains over the last decade, and there are now a number of ongoing debates on the processing of touch in the context of movement. Our symposium turns to two such debated tactile-motor topics: (1) the attenuation, or suppression, of tactile input when movement is planned or executed; and (2) the spatial coding of tactile events. Our aim is to show how seemingly "clear and logical" ideas have turned out to be incorrect, and to give an outlook on the currently debated, possible alternative explanations.

Regarding (1), human participants are often less sensitive to tactile input when they plan or perform a movement than in non-movement contexts. Current debates revolve around the question whether tactile sensitivity reduction involves predictions of forward models, or whether touch is generally reduced by default during movement. Our talks will highlight different approaches to this question, both in the context of movement towards the own body “ that is, sensitivity reduction for the touch one produces oneself as opposed to the touch one receives without planning “ and movement to other objects “ that is, when touch is "collateral", rather than related to the movement goal per se.

Regarding (2), the focus on visuo-motor paradigms in motor research has stimulated theories about visuo-motor and tactile-motor processing as being analogous. A key tenet of tactile-spatial processing emerging from this approach has been that touch is transformed into a "3D-like, visual" spatial code, and that this 3D spatial code is the basis for planning movement towards touch. On the one hand, findings from neuroimaging seem to fit well with this idea. On the other hand, recent findings from both multisensory decision making and infant tactile-motor development call this idea into question, suggesting that tactile processing may not involve recoding into 3D space and, thus, refuting the idea that visuo- and tactile-motor processing are analogous.

In sum, our symposium focuses on two areas of tactile-motor processing to sketch out the positions of the respective debates, highlight emerging theories and approaches, and point out potential (non-) analogies to visuo-motor theories.

17:00 – 18:00 DISTINGUISHED CAREER AWARD PRESENTATION AND TALK

On the "Neural Control of Movement"

Eberhard Fetz, *University of Washington*

Assuming that the neural control of movement poses answerable questions, we have investigated the relations between primate motor cortex cells and muscles using diverse approaches. First, we trained monkeys to activate motor cortex cells, hoping to reveal their "muscle fields"; this quickly proved to be untenable because monkeys could make many different movements (or none) to fire any cell. Moreover, even consistently correlated cells and muscles could be readily dissociated by operant conditioning. Focusing next on those cells whose spikes causally facilitate muscles (probably via monosynaptic corticomotoneuronal connections) we discovered a variety of relationships in their relative firing patterns. Remarkably, monkeys could even dissociate the activity of CM cells from their target muscles, in both directions (still unpublished), showing that the relative activation of these directly connected elements is surprisingly flexible. The explicit coding of movement parameters by populations of cortical cells turns out to be slippery as well: many different parameters can be extracted from the same population of cells with simple linear decoders. Trajectories of population activity in multidimensional neural space have led to the concept of lower-dimensional manifolds constraining dynamics, suggesting that explanations of movement control are better sought in the properties of manifolds than the roles of individual neurons. Such descriptive exercises are conceptually seductive but evade the harder details about how neural computation in the brain causally generates volitional movements. Toward that end, experiments combining operant conditioning with multiunit recording and neural network modeling could provide further insights.

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NOTES

Poster Sessions

The Society for the Neural Control of Movement is pleased to present a wide range of current research through the poster sessions. The posters have been divided over four sessions, each on display for one day.

SESSION 1
Tuesday, April 16, 2024 08:00 – 17:30

SESSION 2
Wednesday, April 17, 2024 08:00 – 17:30

SESSION 3
Thursday, April 18, 2024 08:00 – 15:00

SESSION 4
Friday, April 19, 2024 08:00 – 15:00

The poster numbers are divided first by session, then by theme, and finally with a unique number.

Session – Theme – Board Number (ex. 1-A-1)

THEMES

A – Adaptation & Plasticity in Motor Control
B – Control of Eye & Head Movement
C – Disorders of Motor Control
D – Fundamentals of Motor Control
E – Integrative Control of Movement
F – Posture and Gait
G – Theoretical & Computational Motor Control

POSTER SESSION 1

TUESDAY, APRIL 16, 2024

A – ADAPTATION & PLASTICITY IN MOTOR CONTROL

1-A-1 ***Role of contextual cues on the expression of competing motor memories***

Adarsh Kumar [1], Neeraj Kumar [2]

[1] Queen's University, [2] McGill University

1-A-2 ***Neck muscle vibration in SCNP leads to differential changes in neurophysiological measures in response to visuomotor tracing task***

Alexandre Kalogerakis [1], Paul Yielder [1], Hailey Tabbert [1], Ushani Ambalavanar [1], Bernadette Murphy [1]

[1] Ontario Tech University

1-A-3 ***Long-term development of a motor memory***

David Franklin [1], Pascal Nietschmann [1], Thalia Papadopoulou [1], Sae Franklin [1]

[1] Technical University of Munich

1-A-4 ***A novel robotic thumb proprioception assessment reveals surprising aspects of proprioceptive adaptation in unimpaired and stroke participants***

David Reinkensmeyer [1], Luis Garcia-Fernandez [1], Andria Farrens [1], Chris Johnson [1], Vicky Chan [1], Joel Perry [2], Erich Wolbrecht [2]

[1] University of California, Irvine, [2] University of Idaho

1-A-5 ***Optimization of modularity during development to simplify walking control across multiple steps***

Elodie Hinnekens [1], Bastien Berret [2], Estelle Morard [2], Manh-Cuong Do [2], Marianne Barbu-Roth [3], Caroline Teulier [2]

[1] Fondazione Santa Lucia, [2] Université Paris-Saclay, [3] Université Paris Cité

1-A-6 ***Evoked motor responses induced by subdural stimulation of motor, premotor, and parietal cortex using novel conducting polymer electrodes in a non-human primate stroke model***

Ian Moreau-Debord [1], Alwin Wan [1], Douglas Cook [2], Stephane Quessy [3], Numa Dancause [3]

[1] Panaxium, [2] Queen's University, [3] Université de Montréal

1-A-7 ***Online interference of declarative memory in force field adaptation***

Judith Rudolph [1], Luc Selen [1], W. Pieter Medendorp [2]

[1] Radboud University, [2] Radboud University Nijmegen

1-A-8 ***Dissolving the barrier between mental rehearsal and physical execution: Imagined prior movements enhance adaptation performance***

Magdalena Gippert [1], Pei-Cheng Shih [2], Tobias Heed [3], Ian Howard [4], Mina Jamshidi [5], Arno Villringer [1], Bernhard Sehm [1], Vadim V. Nikulin [1]

[1] Max Planck Institute for Human Cognitive and Brain Sciences, [2] Sony Computer Science Laboratories, Inc., [3] University of Salzburg, [4] University of Plymouth, [5] Technical University Berlin

1-A-9 *How are three tactile acuity tasks modulated by electrical repetitive tactile stimulation: evaluation of the remote effect on the unstimulated hand*

Malika Azaroual-Sentucq [1], Frédéric Volland [2], Alessandro Farne [3], Dollyane Muret [4]

[1] *INSERM Lyon Neuroscience Research Center CRNL ImpAct,* [2] *INSERM Lyon Neuroscience Research Centre CRNL ImpAct,* [3] *INSERM,* [4] *Paris Saclay University*

1-A-10 *Visual error-induced motor memory in targeted walking*

Kenta Yamamoto [1], Tsuyoshi Ikegami [2], Masaya Hirashima [2]

[1] *Osaka University,* [2] *National Institute of Information and Communications Technology*

1-A-11 *Autonomic responses to visual and proprioceptive errors during motor learning*

Motoko Nogami [1], Nobuhiro Hagura [2], Atsushi Yokoi [2]

[1] *Osaka University,* [2] *National Institute of Information and Communications Technology*

1-A-12 *Revisiting cortical face-to-hand area remapping after cervical spinal cord injury*

Paige Howell [1], Finn Rabe [1], Simon Schading-Sassenhausen [2], Harshal Arun Sonar [3], Jamie Paik [3], Patrick Freund [2], Nicole Wenderoth [1], Sanne Kikkert [1]

[1] *ETH Zürich,* [2] *University Hospital Zürich,* [3] *École Polytechnique Fédérale de Lausanne*

1-A-13 *Repetition- but not learning-related corticospinal plasticity is enhanced during sensorimotor mu rhythm trough phases*

Tharan Suresh [1], Fumiaki Iwane [1], Minsu Zhang [1], Margaret Mcelmurry [1], Muskan Manesiya [1], Michael Freedberg [1], Sara Hussain [1]

[1] *The University of Texas at Austin*

1-A-14 *The cerebellum acts as the analog to the medial temporal lobe for sensorimotor memory*

Alkis Hadjiosif [1], Tricia Gibo [2], Maurice Smith [1]

[1] *Harvard University,* [2] *Johns Hopkins University*

1-A-15 *Combining proprioceptive stimulation and action observation to evoke plasticity in primary motor cortex: a TMS-fNIRS pilot study*

Ambra Bisio [1], Monica Biggio [1], Costanza Iester [1], Laura Bonzano [1], Marco Bove [1]

[1] *University of Genoa*

1-A-16 *Motor learning mechanisms are not modified by feedback manipulations in a real-world task*

Federico Nardi [1], Shlomi Haar [1], Aldo Faisal [1]

[1] *Imperial College London*

1-A-17 *Can the somatosensory cortex integrate a tactile representation of an extra robotic body part?*

Lucy Dowdall [1], Giulia Dominijanni [2], María Molina [1], Dani Clode [1], Tamar Makin [1]

[1] *University of Cambridge,* [2] *École Polytechnique Fédérale de Lausanne*

1-A-18 *Human-machine interaction: inferring cognitive state from motor control*

Axel Roques [1], Pierre-Paul Vidal [2], Yannick James [3], Dimitri Keriven Serpollet [4]

[1] *Centre Borelli (UMR9010),* [2] *CNRS,* [3] *Thales AVS France,* [4] *Université Paris Cité*

1-A-19 *Real-time personalized brain state-dependent TMS: a novel neurostimulation technique to improve poststroke corticospinal tract activation*

Uttara Khatri [1], Sara Hussain [1]

[1] *University of Texas at Austin*

1-A-20 *Changes in kinematic variability in the very early stages of motor learning*

Se-Woong Park [1], Jesus Siqueiros [1], Mary Carroll [1]

[1] *University of Texas at San Antonio*

B – CONTROL OF EYE & HEAD MOVEMENT

1-B-21 *Saccade kinematics and post-saccadic oscillations in retinitis pigmentosa and age-related macular degeneration*

Jeroen Goossens [1], Leslie Guadron [1], Samuel Titchener [2], Carla Abbott [2], Lauren Ayton [2], John van Opstal [1], Matthew Petoe [2]

[1] *Radboud University,* [2] *University of Melbourne*

1-B-22 *Development of a system to study visuomotor control of bicycling in a complex urban environment*

Ningtao Lu [1]

[1] *University of Birmingham*

C – DISORDERS OF MOTOR CONTROL

1-C-23 *Testing a novel paradigm to compare Decision-making in cognitive and motor domains*

Ksenia Germanova [1], Ksenia Panidi [2], Maria Nazarova [3]

[1] *HSE University,* [2] *Higher School of Economics,* [3] *Aalto University*

1-C-24 *Impaired impulse control and reduced corticomotor excitability in medicated Parkinson's disease*

Aliya Warden [1], Craig Mcallister [1], Damian Cruse [1], Hayley Macdonald [2]

[1] *University of Birmingham,* [2] *University of Bergen*

1-C-25 *Exercise priming modulates intracortical inhibition to improve cognitive-motor interactions in Parkinson's disease*

Anjali Sivaramakrishnan [1], Alyssa Baeza [1], Michelle Aguirre [1], Okeanis Vaou [1], Daniel Corcos [2]

[1] *University of Texas Health Science Center at San Antonio,* [2] *Northwestern University*

1-C-26 *Investigating the effects of aging on sensorimotor performance*

Laura Alvarez Hidalgo [1], Ellie Edlmann [1], Gunnar Schmidtmann [1], Ian Howard [1]

[1] *University of Plymouth*

1-C-27 *The effects of central sensitization on motor unit properties in the upper limb*

Nicholas Antony [1], Hailey Tabbert [1], Imran Khan Niazi [2], John Srbely [3], Fredy Rojas [2], Bernadette Murphy [1], Paul Yielder [1]

[1] *Ontario Tech Univeristy,* [2] *New Zealand College of Chiropractic,* [3] *University of Guelph*

1-C-28 *Hemisphere-specific virtual reality training of the ipsilesional arm in chronic, severely impaired stroke survivors with right-hemisphere damage*

Nick Kitchen [1], Candice Maenza [1], Terrence Murphy [1], Carolee Winstein [2], Robert Sainburg [1]

[1] *Pennsylvania State University,* [2] *University of Southern California*

1-C-29 *Altered Lateralized Readiness Potentials in hemiplegic patients following stroke reveal interhemispheric dynamics in motor recovery*

Nikolay Syrov [1], Yana Alieva [2], Alexandra Medvedeva [3], Lev Yakovlev [1]

[1] *Skolkovo Institute of Science and Technology,* [2] *Federal Center of Brain Research and Neurotechnologies,* [3] *Vladimir Zelman Center for Neurobiology and Brain Rehabilitation, Skolkovo Institute of Science and Technology*

1-C-30 *Electrophysiology confirmation of quantified anatomy connectivity by individual dystonia patient*

Sumiko Abe [1], Jessica Vidmark [2], Maral Kasiri [3], Rahil Soroushmojdehi [3], Alireza Mousavi [3], Terence Sanger [3]

[1] *Children's Hospital of Orange County,* [2] *University of California,* [3] *University of California, Irvine*

1-C-31 *Cortico-cortical connectivity is modulated during healthy ageing and by levodopa in tremor-dominant Parkinson's disease*

Ann-Maree Vallence [1], Brittany Rurak [1], Jane Tan [1], Peter Drummond [1], Julian Rodrigues [2], Brian Power[2]

[1] *Murdoch University,* [2] *Hollywood Private Hospital*

1-C-32 *Investigating sleep-dependent consolidation of motor learning in the context of sub-acute recovery after stroke*

Matthew Weightman [1], Barbara Robinson [1], Morgan Mitchell [1], Emma Garratt [2], Rachel Teal [3], Nele Demeyere [1], Melanie Fleming [1], Heidi Johansen-Berg [1]

[1] *University of Oxford,* [2] *Buckinghamshire, Oxfordshire and Berkshire West Integrated Care Board,* [3] *Oxford University Hospitals*

1-C-33 *Epidural spinal cord stimulation facilitates motor-unit activity and restores arm motor function after post-stroke paralysis*

Nikhil Verma [1], Erick Carranza [2], Erynn Sorensen [2], Luigi Borda [1], Marc Powell [3], Roberto M. De Freitas [2], Peter Gerszten [2], George Wittenberg [2], Lee Fisher [2], Elvira Pirondini [2], Marco Capogrosso [2], Douglas Weber [1]

[1] *Carnegie Mellon University,* [2] *University of Pittsburgh,* [3] *Reach Neuro Inc.*

D – FUNDAMENTALS OF MOTOR CONTROL

Poster Cluster (1-A-34 to 1-D-38)
Motor Control and Skill Learning with Wearable Myoelectric Interfaces

1-A-34 *Towards human motor augmentation by learning to control novel wrist muscle co-contractions*

Josh Chartier [1], Calvin Kao [1], Rishi Rajalingham [1], Claire Warriner [1], Dano Morrison [1], Emanuele Formento [1], Mario Bräcklein [1], Codie Mcconkey [1], Deren Y. Barsakcioglu [2], Agnese Grison [2], Bruno Grandi Sgambato [2], Christopher Collins [1], Michael Glueck [1], David Sussillo [1]

[1] *Meta Platforms, Inc.,* [2] *Imperial College London*

1-D-35 *Motor unit activation states: Extracting a high-dimensional control signal from a single muscle for novel human machine interactions*

Mario Bräcklein [1], Jorge Menendez [1], Najja Marshall [1], Emanuele Formento [1], Vinay Jayaram [1], Niru Maheswaranathan [1], Diego Adrian Gutnisky [1]

[1] *Meta Platforms, Inc.*

1-D-36 *Reliable motor unit tracking across sessions for probing the flexibility of motor unit control*

Emanuele Formento [1], Najja Marshall [1], Mario Bräcklein [1], Peter Lee [1], Jun Ye [1], Dano Morrison [1], Renxiong Wang [1], David Sussillo [1], Diego Adrian Gutnisky [1]

[1] *Meta Platforms, Inc.*

1-D-37 *Fine firing rate control of isolated motor units with a noninvasive sEMG device*

Najja Marshall [1], Emanuele Formento [1], Elom Amematsro [2], Mario Bräcklein [1], Peter Lee [1], Jun Ye [1], N. Rao [1], P. Bard [1], N. Siddiqi [1], David Sussillo [1], Diego Gutnisky [1]

[1] *Meta Platforms, Inc.,* [2] *Columbia University*

1-D-38 *Multisensory feedback training improves the precision control and learning of targeted muscle activation states*

Purnima Padmanabhan [1], Parastoo Abtahi [1], Viswanathan Ayyappan [1], Chad Yu [1], Alexander Bakogeorge [1], Hemant Surale [1], Shanaathanan Motchalingam [1], Christopher Collins [1]

[1] *Meta Platforms, Inc.*

1-D-39 *Preliminary kinematic analysis of the use of a Taichi sword: the working point moves along the length of the tool according to the task intention*

Agnes Roby-Brami [1], Océane Dubois [1], Emmanuel Guigon [1]

[1] *Sorbonne Université*

1-D-40 *Exploring physical resilience during healthy aging: insights from an inter-joint coordination task*

Anouck Matthijs [1], Anda de Witte [1], Dante Mantini [1], Jolien Gooijers [1], Jean-Jacques Orban De Xivry [1]

[1] *Katholieke Universiteit Leuven*

1-D-41 *PCA does not allow an assessment of dimensionality and mixes population dimensions*

Benjamin Dann [1], Andrej Filippow [1], Hans Scherberger [1]

[1] *German Primate Center*

1-D-42 *Spatial microstructure of motor cortical neural dynamics*

Daniel O'shea [1], Eric Trautmann [2], Xulu Sun [1], Saurabh Vyas [2], Krishna Shenoy [1]

[1] *Stanford University,* [2] *Columbia University*

1-D-43 *Combining MEG with real-time measures of articulation during speech*

Douglas Cheyne [1], Ioanna Anastasopoulou [2], Cecilia Jobst [1], Narges Moein [1], Gloria Lai [1], Blake Johnson[2]

[1] *Hospital for Sick Children Research Institute,* [2] *Macquarie University*

1-D-44 *Mapping lower-limb muscle synergies encoded in the human brain through transcranial magnetic stimulation of the motor cortex and functional magnetic resonance imaging*

Jodie Jingping Xie [1], Richard Liu [2], Idy Chou [1], Kelvin Lau [1], Roy T. H. Cheung [3], Arthur Mak [1], Vincent Chi Kwan Cheung [1]

[1] *The Chinese University of Hong Kong,* [2] *City University of Hong Kong,* [3] *Western Sydney University*

1-D-45 *The role of supplementary motor area in motor imagery: a transcranial direct current stimulation study*

Judith Bek [1], Xiaoye Michael Wang [2], Timothy Welsh [2]

[1] *University College Dublin,* [2] *University of Toronto*

1-D-46 *Hardware powered ultra low latency (HarPULL) brain-state dependent TMS technology*

Nikita Fedosov [1], Julia Nekrasova [1], Milana Makarova [1], Alexei Ossadtchi [1]

[1] *HSE University*

1-D-47 *Thalamic interaction of basal ganglia and cerebellar circuits during motor learning*

Jun Ding [1]

[1] *Stanford University*

1-D-48 *Effects of 6 months of endurance exercise and chronotropic status on VO2peak, motor signs, and peak heart rate in individuals with drug naïve Parkinson's disease*

Garett Griffith [1], Niyati Mehta [1], Guillaume Lamotte [2], Erin Suttman [2], Jacob Haus [3], Elizabeth Joslin [1], Katherine Balfany [4], Wendy Kohrt [4], Cory Christiansen [4], Edward Melanson [4], Lana Chahine [5], Charity Patterson [5], Daniel Corcos [1]

[1] *Northwestern University,* [2] *University of Utah,* [3] *University of Michigan,* [4] *University of Colorado Anschutz Medical Campus,* [5] *University of Pittsburgh*

1-D-49 *Non-invasively-recorded spinal cord responses to median nerve stimulation demonstrate stronger high-frequency oscillations in anterior versus posterior electrode locations*

Prabhav Mehra [1], Helene Arnold [1], Saroj Bista [1], Marjorie Metzger [1], Leah Nash [1], Eileen Giglia [1], Serena Plaitano [1], Peter Bede [1], Madeleine Lowery [2], Muthuraman Muthuraman [3], Lara Mcmanus [1], Orla Hardiman [1], Bahman Nasseroleslami [1]

[1] *Trinity College Dublin,* [2] *University College Dublin,* [3] *Universitätsklinikum Würzburg*

1-D-50 *Co-activation and co-variation of muscles jointly evolve during learning a new redundant isometric myocontrol task*

Raoul Bongers [1], Iris Slooter [1], Morten Kristoffersen [2]

[1] *University Medical Center Groningen,* [2] *Center for Bionics & Pain Research*

1-D-51 ***Gaze direction influences the generalization of visuomotor memory***

Sergio Gurgone [1], Ryosuke Murai [2], Tsuyoshi Ikegami [1]

[1] National Institute of Information and Communications Technology, [2] The University of Tokyo

1-D-52 ***Serial dependence reveals an active suppression in the sequential motor planning***

Tianhe Wang [1]

[1] University of California, Berkeley

1-D-53 ***Stochastic Dynamic Operator (SDO) descriptions of neurons can flexibly scale from single-unit to population-level analysis***

Trevor Smith [1], Terence Sanger [2], Simon Giszter [1]

[1] Drexel University, [2] University of California, Irvine

1-D-54 ***Switching motor cortex dynamical rules influenced by distinct cortical and subcortical regions during skilled movements***

Sanjay Shukla [1], Erica Nagase [1], Alan Yao [1], Kate Santoso [1], Emily Stenzler [1], David Lipkin [1], Angela Kan [1], Ahmet Arac [1]

[1] University of California, Los Angeles

1-D-55 ***Shared neural states, but dissimilar information encoded for motor control in medial parietal areas***

Francesco Vaccari [1], Stefano Diomedi [1], Marina De Vitis [1], Konstantinos Hadjidimitrakis [1], Matteo Filippini [1], Patrizia Fattori [1]

[1] University of Bologna

1-D-56 ***The secret of tiny hand movements to feel and manipulate objects***

Naqash Afzal [1], Alastair Loutit [2], Ismail Devecioglu [3], Sophie Du Bois De Dunilac [4], Helen O'shea [4], Pablo Martinez Ulloa [4], Richard Vickery [5], Heba Khamis [6], Stephen Redmond [4], Michaël Wiertlewski [7], Ingvars Birznieks [8]

[1] Neuroscience Research Australia, [2] Université de Genève, [3] Tekirdağ Namık Kemal University, [4] University College Dublin, [5] University of New South Wales Sydney, [6] Contactile Ltd, [7] Delft University of Technology, [8] University of New South Wales

1-D-57 ***Space across the motor cortical sheet as a coding dimension***

Nicholas Hatsopoulos [1], Milan Rybar [1], Wei Liang [1], Karthikeyan Balasubramanian [1]

[1] University of Chicago

1-D-58 ***The contribution of brainstem and intersegmental spinal cord networks to upper limb force control in mice and humans***

Shahab Vahdat [1], Matteo Grudny [1], Vishwas Jindal [1]

[1] University of Florida

1-D-59 ***Mitigating disruption to voluntary movement caused by velocity-dependent stretch reflex via α-MN collateral projection to γ-MN: A simulation study***

Grace Niyo [1], Lama Almofeez [1], Andrew Erwin [2], Francisco Valero-Cuevas [1]

[1] University of Southern California, [2] University of Cincinnati

E – INTEGRATIVE CONTROL OF MOVEMENT

1-E-60 ***Evidence for planning ahead in the whole-body kinematics of climbing routes execution***

Antonella Maselli [1], Lisa Musculus [2], Riccardo Moretti [3], Andrea D'Avella [4], Markus Raab [2], Giovanni Pezzulo [3]

[1] National Research Council of Italy, [2] German Sport University Cologne, [3] National Research Council, [4] University of Rome, Tor Vergata

1-E-61 ***A preliminary investigation into the efficacy of training soccer heading in immersive virtual reality***

Ben Marshall [1], Liis Uiga [1], Johnny Parr [1], Greg Wood [1]

[1] Manchester Metropolitan University

1-E-62 ***Vestibulo-spinal pathway contributes to alpha- band Intermuscular Coherence during rest, but not during voluntary reaching movements***

Angelo Bartsch [1], Francisco Valero-Cuevas [1]

[1] University of Southern California

1-E-63 ***EEG brain generators during speech production in breathing constraint***

Guy Cheron [1], Ana Maria Cebolla Alvarez [1], Didier Demolin [2], Said-Iraj Hashemi [3], Dominique Ristori [4]

[1] Université Libre de Bruxelles, [2] CNRS-UMR 7018, [3] Laboratory of Neurophysiology and Movement Biomechanics, [4] Laboratory of Neurophysiology and Movement Biomechanics (LNMB)

1-E-64 ***Decoding action and observation of hand gestures in the human brain***

Hunter Schone [1], Tamar Makin [2], Chris Baker [3]

[1] University of Pittsburgh, [2] University of Cambridge, [3] National Institutes of Health

1-E-65 ***tDCS applied to M1 influences temporal and amplitude performance on different time scales across training and retention in a bimanual task***

John Buchanan [1], Austin McCulloch [2]

[1] Texas A&M University, [2] McPherson College

1-E-66 *What's touch got to do with musicians' motor performance? The interaction between expertise and tactile perception in a piano key press*

Julia Tom [1], Joseph X Manzone [1], Joyce L Chen [1]

[1] *University of Toronto*

1-E-67 *Neuronal population coding in the cervical spinal cord for voluntary reaching movements*

Kazutaka Maeda [1], Shiro Egawa [1], Akito Kosugi [1], Amit Yaron [1], Kazuhiko Seki [1]

[1] *National Center of Neurology and Psychiatry*

1-E-68 *Exploring the neural correlates of tactile imagery: significance for non-invasive brain computer interfaces applications*

Lev Yakovlev [1], Marina Morozova [1], Andrei Miroshnikov [2], Aigul Nasibullina [1], Artemiy Berkmush-Antipova [3], Nikolay Syrov [1], Mikhail Lebedev [2], Alexander Kaplan [2]

[1] *Skolkovo Institute of Science and Technology,* [2] *Lomonosov Moscow State University,* [3] *Immanuel Kant Baltic Federal University*

1-E-69 *Error monitoring in basketball free-throw shooting – An EEG study*

Britta Hinneberg [1], Kristina Bohn [2], Lea Junge-Bornholt [2], Heiko Maurer [2], Hermann Müller [2], Mathias Hegele [3], Lisa Maurer [2]

[1] *University of Giessen,* [2] *Justus Liebig Universität Giessen,* [3] *Center for Mind, Brain & Behavior*

1-E-70 *Anterior cingulate cortex is involved with proactive control through modulation of contingent negative variation*

Archana Mysore [1], Christopher Blais [1], William J. Tyler [2], Marco Santello [1]

[1] *Arizona State University,* [2] *University of Alabama at Birmingham*

1-E-71 *Somatosensory compensation is faster than auditory compensation in speech motor control*

Morgane Bourhis [1], Yosra Jelassi [2], Pascal Perrier [3], Takayuki Ito [3]

[1] *GIPSA-Lab,* [2] *Instituto Politécnico Nacional de Grenoble,* [3] *GIPSA-lab*

1-E-72 *The middle ear muscles control eye movement-related eardrum oscillations (EMREOs) and implicate an eye-centered reference frame in the ear for localizing sound*

Stephanie Lovich [1], David Kaylie [1], Cynthia King [1], Christopher Shera [2], Jennifer Groh [1]

[1] *Duke University,* [2] *University of Southern California*

1-E-73 *Sensorimotor prediction facilitates task-relevant visual information uptake in a goal-oriented throwing task*

Theresa Brand [1], Alexander Schütz [2], Hermann Müller [1], Mathias Hegele [3], Heiko Maurer [1], Lisa Maurer[1]

[1] *Justus-Liebig-University Giessen,* [2] *Philipps-University Marburg,* [3] *Center for Mind, Brain & Behavior*

F – POSTURE & GAIT

1-F-74 *Muscular work feedback during assisted treadmill training to improve engagement and motor learning*

Julia Manczurowsky [1], Blake Karavas [1], Charles Hillman [1], Christopher Hasson [1]

[1] *Northeastern University*

1-F-75 *Machine learning-based reconstruction of missing kinematic and electromyographic data for electrical stimulation therapy assessment*

Chiara Ciucci [1], Simone Romeni [2], Daniele Emedoli [3], Sandro Iannaccone [3], Silvestro Micera [4]

[1] *Scuola Superiore Sant'Anna,* [2] *EPFL,* [3] *Università Vita-Salute San Raffaele,* [4] *The BioRobotics Institute and Department of Excellence in Robotics and AI*

1-F-76 *Reinforcement differently changes locomotor learning and retention in older adults*

Christopher Hill [1]

[1] *Northern Illinois University*

1-F-77 *The human voice aligns with whole-body kinetics*

Wim Pouw [1], Raphael Werner [1], Lara Burchardt [1], Luc Selen [2]

[1] *Radboud University Nijmegen,* [2] *Radboud University*

1-F-78 *Validation of the Equidyn protocol for evaluation of dynamic balance in older adults through a smartphone application*

Luis Teixeira [1], Paola Valenciano [1], Pedro Monteiro [1]

[1] *University of São Paulo*

1-F-80 *Distinct cortical dynamics during stepping responses for recovering balance between people with stroke, healthy older and healthy young individuals*

Joris Van Der Cruijsen [1], Wouter Staring [1], Digna de Kam [1], Lotte van de Venis [1], Teodoro Solis-Escalante [1], Vivian Weerdesteyn [2]

[1] *Radboud University Medical Center,* [2] *Radboud University*

1-F-81 *The cortical dynamics underlying contextual (Dis-)Inhibition of anticipatory postural responses during step initiation*

Lucas Billen [1], Ilse Giesbers [1], Brian Corneil [2], Vivian Weerdesteyn [3]

[1] *Radboud University Medical Center,* [2] *Western University,* [3] *Radboud University*

1-F-82 *Cortical neuroprosthesis for the recovery of gait control after spinal cord injury*

Marco Bonizzato [1], Maude Duguay [2], Elena Massai [2], Marina Martinez [2]

[1] *Polytechnique Montréal,* [2] *Université de Montréal*

G – THEORETICAL & COMPUTATIONAL MOTOR CONTROL

1-G-83 *Using joint action parameters as biomarkers for theory of mind*

Cecilia De Vicariis [1], Alessandro Provaggi [1], Laura Bandini [1], Matteo Pardini [2], Vittorio Sanguineti [1]

[1] *University of Genoa,* [2] *IRCCS Ospedale Policlinico San Martino*

1-G-84 *Learning coordinated gaits on complex surfaces*

Heike Stein [1], Andry Andrianarivelo [2], Jeremy Gabillet [2], Clarisse Batifol [2], Ali Jalil [2], Michael Graupner [2], N Alex Cayco Gajic [1]

[1] *ENS,* [2] *Université Paris Cité*

1-G-85 *Reward feedback enhances sustained attention on short timescales*

Juliana Trach [1], Megan T. Debettencourt [2], Angela Radulescu [3], Samuel Mcdougle [1]

[1] *Yale University,* [2] *Ruby NeuroTech,* [3] *Icahn School of Medicine at Mount Sinai*

1-G-86 *Sensorimotor games to study emergent coordination.*

Laura Bandini [1], Giada Ierardi [1], Cecilia De Vicariis [1], Vittorio Sanguineti [1]

[1] *University of Genoa*

1-G-87 *A modular architecture for trial-by-trial learning of redundant motor commands*

Lucas Dal'bello [1], Denise Berger [1], Daniele Borzelli [2], Andrea D'Avella [3]

[1] *Fondazione Santa Lucia,* [2] *University of Messina,* [3] *University of Rome Tor Vergata*

1-G-88 *Bayesian inference in arm posture perception*

Valeria Peviani [1], Manon Joosten [2], Luke Miller [2], W. Pieter Medendorp [1]

[1] *Radboud University Nijmegen,* [2] *Radboud University*

1-G-89 *Dopamine modulator shapes locomotor patterns through ion channel conductance within central pattern generators*

Atiyeh Nezhadebrahim [1], Slivia Tolu [1]

[1] *Denmark Technological University*

1-G-90 *Motor skills assessment of microsurgical anastomosis*

Soheil Gholami [1], Kunpeng Yao [2], Torstein R. Meling [3], Aude Billard [1]

[1] *École Polytechnique Fédérale de Lausanne,* [2] *Swiss Federal Institute of Technology Lausanne,* [3] *The National Hospital of Denmark*

1-G-91 *Energy and time minimization predicts real-world reaching movements with objects*

Surabhi Simha [1], Jeremy Wong [2]

[1] *Georgia Institute of Technology & Emory University,* [2] *University of Calgary*

POSTER SESSION 2

WEDNESDAY, APRIL 17, 2024

A – ADAPTATION & PLASTICITY IN MOTOR CONTROL

Poster Cluster (2-A-1 to 2-A-4)

2-A-1 *Similar oscillatory mechanisms map touch on hands and tools*

Cécile Fabio [1], Romeo Salemme [2], Alessandro Farne [3], Luke Miller [4]

[1] *Bielefeld University,* [2] *Integrative Multisensory Perception Action & Cognition Team,* [3] *INSERM,* [4] *Radboud University Nijmegen*

2-A-2 *Active tool-use training does not change time perception in peripersonal or far space*

Jahanian Najafabadi Amir [1], Christoph Kayser [1]

[1] *Bielefeld University*

2-A-3 *Changes of sensorimotor representation of the forearm in peripersonal and far space during active tool-use training through life span*

Jahanian Najafabadi Amir [1], Nakisa Nourzadegan [2], Sara Mohammdi [3], Alireza Rastegari [4], Hadis Imani [5]

[1] *Bielefeld University,* [2] *Iran University of Science and Technology,* [3] *Islamic Azad University,* [4] *University of Padova,* [5] *Constructor University Bremen*

2-A-4 *Changes in body ownership and agency associated to body schema modifications across the lifespan in active tool-use training*

Jahanian Najafabadi Amir [1], Sara Mohammdi [2], Nakisa Nourzadegan [3], Alireza Rastegari [4], Hadis Imani [5]

[1] Bielefeld University, [2] Islamic Azad University, [3] Iran University of Science and Technology, [4] University of Padova, [5] Constructor University Bremen

2-A-5 *Sleep consolidation potentiates skill maintenance*

Agustin Solano [1], Gonzalo Lerner [1], Guillermina Griffa [1], Alvaro Deleglise [1], Pedro Caffaro [1], Luis Riquelme [1], Daniel Perez-Chada [2], Valeria Della-Maggiore [1]

[1] University of Buenos Aires, [2] Austral University Hospital

2-A-6 *Reaching and speech adaptation in healthy young, old and older old adults*

Anda de Witte [1], Anouck Matthijs [1], Jolien Gooijers [1], Dante Mantini [1], Jean-Jacques Orban De Xivry [1]

[1] Katholieke Universiteit Leuven

2-A-7 *Paired associative stimulation in elbow flexor muscles in humans with spinal cord injury*

Carley Butler [1], Monica Perez [2]

[1] Northwestern University, [2] Shirley Ryan AbilityLab

2-A-8 *Implicit adaptation is fast and independent from explicit adaptation*

Denise Henriques [1], Bernard 't Hart [1], Sebastian D'amario [2]

[1] York University, [2] Queen's University

2-A-9 *The viscoelastic properties of the legs can enable a wide range of gait initiation dynamics when coupled to a CPG in a simulated quadruped insect*

Kaitlyn Kumar [1], Xiaosi (Horace) Zhang [1], Lawrence Bowens [1], Francisco Valero-Cuevas [1]

[1] University of Southern California

2-A-10 *Comparison of pathways for sensory feedback for wearable devices*

Lucy Dowdall [1], Edmund Da Silva [1], Matteo Bianchi [2], Fumiya Iida [1], Dani Clode [1], Tamar Makin [1]

[1] University of Cambridge, [2] University of Pisa

2-A-11 *Burst-modulated nerve stimulation increases the estimates of persistent inward currents for distal muscles*

Nish Mohith Kurukuti [1], Xin Yu [2], Hamidollah Hassanlouei [3], Grace Hoo [2], Jose Pons [1]

[1] Northwestern University, [2] Shirley Ryan AbilityLab, [3] Marquette University

2-A-12 *Eye movements may reflect the computed component of strategic re-aiming*

Yixin Wan [2], Jana Maresch [1], Opher Donchin [1]

[1] Ben-Gurion University of the Nagev, [2] Changzhou University

2-A-13 *Feedback control mechanism in redundant bimanual stick-manipulating task*

Toshiki Kobayashi [1], Daichi Nozaki [1]

[1] The University of Tokyo

2-A-14 *The human hippocampus supports implicit motor learning*

Guillermina Griffa [1], Valeria Della-Maggiore [1]

[1] University of Buenos Aires

2-A-15 *Short visual feedback latencies impair implicit sensorimotor learning*

Alkis Hadjiosif [1], George Abraham [1], Tanvi Ranjan [1], Maurice Smith [1]

[1] Harvard University

2-A-16 *Assessing the stability of hamstring and quadricep corticomuscular coherence over time: a 3-month test-retest study*

Callum Jarvis [1]

[1] Manchester Metropolitan University

2-A-17 *Predicting sequences of upcoming sensorimotor events after a brachial plexus injury*

Jesus E. Garcia [1], Paulo Roberto Cabral-Passos [2], Noslen Hernández [3], Bia Ramalho [2], Maria Luisa Salles Rangel [4], Pedro R Pinheiro [5], Antonio Galves [2], Claudia D. Vargas [6]

[1] Campinas State University, [2] University of São Paulo, [3] INRA French National Institute for Agricultural Research, [4] Universidade São José, [5] Universidade Federal do Rio de Janeiro, [6] Federal University of Rio de Janeiro

2-A-18 *Movement smoothness decreases with increasing loads during squats and is higher in the eccentric than concentric phase: a novel framework on inter-joint movement fusion*

Paul Kaufmann [1], Alexander Pürzel [1], Willi Koller [1], David Deimel [1], Juliana Exel [1], Arnold Baca [1], Hans Kainz [1]

[1] University of Vienna

2-A-19 *A gain field adaptation model explains distributive learning across movement and corollary discharge fields*

Jana Masselink [1], Markus Lappe [1]

[1] University of Muenster

2-A-20 ***Effects of direct experience with unfamiliar tools on white matter pathways as evidenced by connectometry analysis***

Jamie Scholl [1], Taylor Bosch [1], Lee Baugh [1]

[1] *University of South Dakota*

2-A-21 ***Mechanisms underlying acquisition and durability of newly learned speech-acoustical mapping***

Nishant Rao [1], Yiyun Hua [2], David Ostry [2]

[1] *Yale University,* [2] *McGill University*

B – CONTROL OF EYE & HEAD MOVEMENT

2-B-22 ***Oculomotor behavior during unimanual vs. bimanual tasks: Comparison between typically-developing children vs. children with cerebral palsy***

Isabelle Poitras [1], Manel Abid [1], Carole Rigourd [2], Catherine Mercier [1]

[1] *Université Laval,* [2] *Centre for Interdisciplinary Research in Rehabilitation and Social Integration*

2-B-23 ***Probing correlates of saccadic suppression in the primate superior colliculus and primary visual cortex***

Matthias Baumann [1], Ziad Hafed [2]

[1] *Hertie Institute for Clinical Brain Research,* [2] *Centre for Integrative Neuroscience*

2-B-24 ***Vestibular reflexes drive neck muscles to ensure head stabilizations during locomotion***

Ruihan Wei [1], Oliver Stanley [1], Kathleen Cullen [1]

[1] *Johns Hopkins University*

C – DISORDERS OF MOTOR CONTROL

2-C-25 ***Age-specific distortion of neocortical motor outputs in 5XFAD mice***

Cassandra Wolsh [1], Rogers Brown [1], Anna Sagui [1], Elizabeth Ochoa [1], Andrew Brown [1], Jeffery Boychuk [2]

[1] *University of Texas Health Science Center at San Antonio,* [2] *University of Missouri*

2-C-26 ***Brain-computer interface mediated contingent functional electrical stimulation of stroke impaired upper extremity enhances recovery of motor function in the brain and body***

Alexander Remsik [1], Klevest Gjini [2], Brayden Fry [3], Jack Stange [3], Heidi Anderson [3], Lindsay Burrowes [3], Peter Van Kan [4], Veena Nair [3], Vivek Prabhakaran [1]

[1] *University of Wisconsin, Madison,* [2] *Department of Neurology,* [3] *Department of Radiology,* [4] *Department of Kinesiology*

2-C-27 ***Investigating the propagation of beta bursts across the corticospinal tract in Parkinson's disease***

Cosima Graef [1], Alejandro Pascual Valdunciel [1], Dario Farina [1], Ravi Vaidyanathan [1], Yen Foung Tai [1], Shlomi Haar [1]

[1] *Imperial College London*

2-C-28 ***Deficits in motor cortex function during speech production in childhood apraxia of speech***

Ioanna Anastasopoulou [1], Kirrie Ballard [2], Peter Wilson [3], Douglas Cheyne [4], Pascal Van Lieshout [5], Blake Johnson [1]

[1] *Macquarie University,* [2] *University of Sydney,* [3] *Australian Catholic University,* [4] *Hospital for Sick Children Research Institute,* [5] *University of Toronto*

2-C-29 ***Characterizing motor unit activity during a standing balance task before and after one week of subacute stroke rehabilitation***

Jackson Levine [1], Alyssa Jones [2], Rebecca Schwanemann [3], Xin Yu [3], Jose Pons [4]

[1] *Northwestern University, Shirley Ryan AbilityLab,* [2] *University of Illinois Chicago,* [3] *Shirley Ryan AbilityLab,* [4] *Northwestern University*

2-C-30 ***Force-dependent dissimilarity of finger patterns in sub-acute stroke as revealed by fPCA***

Ori Rajchert [1], Shay Ofir [2], Firas Mawase [1]

[1] *Technion Israel Institute of Technology,* [2] *Loewenstein Rehabilitation Medical Center*

2-C-31 ***Ultrasound imaging can track joint kinematics in the presence of functional electrical stimulation***

Shriniwas Patwardhan [1], Katharine Alter [1], Jared Stowers [1], Diane Damiano [2], Thomas Bulea [1]

[1] *National institutes of Health, Clinical Center,* [2] *National Institutes of Health*

2-C-32 ***Neuronal signatures of pallidal activity in Parkinson's disease and dystonia***

Alexey Sedov [1], Veronika Filiushkina [2], Philip Pavlovsky [3], Indiko Dzhalagoniia [3], Ulia Semenova [1], Anna Gamaleya [4], Alexey Tomskiy [4]

[1] *Semenov Institute of Chemical Physics,* [2] *N.N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences,* [3] *N.N. Semenov Federal Research Center for Chemical Physics Russian Academy of Sciences,* [4] *Burdenko National Scientific and Practical Center for Neurosurgery*

2-C-33 ***Explainable deep learning for localizing cortical physiomarkers from deep brain stimulation***

Nicolas Calvo Peiro [1], Mathias Haugland [1], Yen Foung Tai [1], Anastasia Borovykh [1], Shlomi Haar [1]

[1] *Imperial College London*

D – FUNDAMENTALS OF MOTOR CONTROL

Poster Cluster (2-D-34 and 2-D-35)

2-D-34 *String-pulling behavior in the aging marmoset*

Mathilde Bertrand [1], Michael Karkuszewski [1], Jean-Jacques Orban De Xivry [2], J. Andrew Pruszynski [1]

[1] *University of Western Ontario,* [2] *Katholieke Universiteit Leuven*

2-D-35 *Characterizing marmoset forelimb coordination in string-pulling*

Michael Karkuszewski [1], Mathilde Bertrand [1], Jean-Jacques Orban De Xivry [2], J. Andrew Pruszynski [1]

[1] *University of Western Ontario,* [2] *Katholieke Universiteit Leuven*

2-D-36 *Cortical beta oscillations help synchronise muscles during static postural holding in healthy motor control*

Thomas Simpson [1], William Godfrey [1], Flavie Torrecillos [1], Shenghong He [1], Damian Herz [2], Ashwini Oswal [1], Muthuraman Muthuraman [3], Alek Pogosyan [1], Huiling Tan [1]

[1] *University of Oxford,* [2] *Johannes Gutenberg-University,* [3] *Universitätsklinikum Würzburg*

2-D-37 *Biological stimuli are processed differently from non-biological stimuli and are more influenced by spatial congruence than by perspective*

Baptiste Waltzing [1], Marcos Moreno-Verdú [1], Siobhan McAteer [1], Elise Van Caenegem [1], Gautier Hamoline [1], Robert Hardwick [1]

[1] *Université Catholique de Louvain*

2-D-38 *Frequency-dependent responses reveal distinct contribution of feedback and feedforward control during longitudinal de novo learning*

Chen Avraham [1], Firas Mawase [1]

[1] *Technion Israel Institute of Technology*

2-D-39 *Is motor imagery more like movement execution or working memory? A meta-analytic comparison*

Elise Van Caenegem [1]

[1] *Université Catholique de Louvain*

2-D-40 *Accelerometry as new measurement technique for mapping cortical motor representations – preliminary data*

Gautier Hamoline [1]

[1] *Université Catholique de Louvain*

2-D-41 *Yoga as a natural model for motor learning in a null space*

Hristo Dimitrov [1], Alexandra Williams [1], Julien Russ [1], Tamar Makin [1]

[1] *University of Cambridge*

2-D-42 *Effect of GABA on brain-spine interactions for motor control during cervical spinal cord stimulation in monkeys*

Josep-Maria Balaguer [1], Lucy Liang [2], Amr Mahrous [3], Jonathan Ho [2], Erinn Grigsby [1], Arianna Damiani [2], Jorge Gonzalez-Martinez [4], Peter Gerszten [4], David Bennett [5], CJ Heckman [3], Elvira Pirondini [1], Marco Capogrosso [1]

[1] *University of Pittsburgh,* [2] *Reliance Naval and Engineering Limited,* [3] *Northwestern University,* [4] *University of Pittsburgh Medical Center,* [5] *Neuroscience and Mental Health Institute*

2-D-43 *Reaching movements reflect ongoing deliberation that involves evidence integration and urgency*

Jan Calalo [1], Truc Ngo [1], Seth Sullivan [1], Adam Roth [1], Rakshith Lokesh [2], John Buggeln [1], Kathryn Strand [1], Vanessa Marchhart [1], Michael Carter [3], Isaac Kurtzer [4], Joshua Cashaback [1]

[1] *University of Delaware,* [2] *Northeastern University,* [3] *McMaster University,* [4] *New York Institute of Technology*

2-D-44 *Reward-based motor learning: the direction of exploration deviates from random behavior*

Jeroen B.J. Smeets [1], Nina Van Mastrigt [2], Katinka Van Der Kooij [1], Bernadette Van Wijk [1]

[1] *Vrije Universiteit Amsterdam,* [2] *Justus Liebig Universität Giessen*

2-D-45 *The temporal organization of descending activations and their interaction with spinal reflexes in the generation of arm movements*

Lei Zhang [1]

[1] *Ruhr University Bochum*

2-D-46 *Somatotopy of the interhemispheric interactions reflected in physiological mirror activity*

Milana Makarova [1], Ksenia Kozlova [1], Gleb Perevoznyuk [1], Pavel Novikov [1], Vadim Nikulin [2], Mikhail Baklushev [1], Mikhail Ivanov [1], Maria Nazarova [3]

[1] *HSE University,* [2] *Max Planck Institute for Human Cognitive and Brain Sciences,* [3] *Aalto University*

2-D-47 *Small scale heterogeneity of high frequency LFP aids movement decoding*

Michael Depass [1], Ali Falaki [2], Stephane Quessy [2], Numa Dancause [2], Ignasi Cos [3]

[1] *Universitat Pompeu Fabra,* [2] *Université de Montréal,* [3] *University of Barcelona*

2-D-48 ***Pre-movement activity in rostral and caudal cervical segment represent a different types of force productions: A simultaneous brain-spinal cord fMRI study***

Noboru Usuda [1], Sho Sugawara [1], Yukio Nishimura [1]

[1] *Tokyo Metropolitan Institute of Medical Science*

2-D-49 ***Online navigation in a virtual 3D environment based on primary motor and premotor activity in macaques***

Ophelie Saussus [1], Sofie De Schrijver [1], Jesus Garcia Ramirez [2], Thomas Decramer [2], Peter Janssen [1]

[1] *Katholieke Universiteit Leuven,* [2] *Universitair Ziekenhuis Leuven*

2-D-50 ***Individual differences in motor variability in relation to thalamic and M1 GABA content***

Rubi Ruopp [1], Mary Gach [1], Ian Greenhouse [1]

[1] *University of Oregon*

2-D-51 ***Subcortical control of human reaching?***

Samuele Contemori [1], Gerald Loeb [2], Timothy Carroll [1], Guy Wallis [3], Brian D. Corneil [2]

[1] *The University of Queensland,* [2] *University of Southern California,* [3]*Western University*

2-D-53 ***Differences in perception and reproduction of a kinesthetic illusion of movement evoked with different frequencies of vibration: a comparison between healthy young and older adults using motion analysis***

Francesco Mirabelli [1], Andrea Albergoni [2], Emanuela Faelli [3], Piero Ruggeri [3], Laura Avanzino [3], Marco Bove [1], Ambra Bisio [1]

[1] *University of Genoa,* [2] *Free University of Bozen,* [3] *Department of Experimental Medicine, Section of Human Physiology, Università degli Studi di Genova,*

2-D-54 ***Grip-to-load force adjustments observed during initial grip might be partially attributed to the passive mechanical behavior of finger pad tissues***

Ismail Devecioglu [1], Naqash Afzal [2], Raiyaan Ruhi [3], Alastair Loutit [4], Richard Vickery [3], Ingvars Birznieks [5]

[1] *Tekirdağ Namık Kemal University,* [2] *Neuroscience Research Australia,* [3] *University of New South Wales Sydney,* [4] *Université de Genève,* [5] *University of New South Wales*

2-D-56 ***Characterizing somatotopy and stability of human motor cortical activity recorded with a Stentrode***

Nikole Chetty [1]

[1] *Carnegie Mellon University*

2-D-57 ***Error prediction determines the coordinate system used for novel dynamics representation***

Raz Leib [1], David Franklin [1]

[1] *Technical University of Munich*

2-D-58 ***Can I catch this ball and do I know if I can? — Examining the interceptability of a ball for oneself***

Samruddhi Damle [1], Reinoud J. Bootsma [2], Frank T. J. M. Zaal [1]

[1] *University Medical Center Groningen,* [2] *Aix Marseille Université*

E – INTEGRATIVE CONTROL OF MOVEMENT

2-E-59 ***Role of variability in exploration for new coordination patterns during de novo learning***

Anadi Mehta [1], Joanne Smith [1], David Travieso [2], Raoul Bongers [1]

[1] *University Medical Center Groningen,* [2] *Autonomous University of Madrid*

2-E-60 ***Feeding mental imagery with our own self-generated touch feedback alleviates sensory gating***

Chloe Sutter [1], Livia Felicetti [2], Julie Torres [3], Etienne Louyot [4], Jenny Faucheu [5], Arnaud Witt [3], Pierre Henri Cornuault [6], Luc Carpentier [6], Eric Chatelet [4], Jean Blouin [7], Francesco Massi [8], Laurence Mouchnino [7]

[1] *Centre National de la Recherche Scientifique,* [2] *Sapienza University,* [3] *Université de Bourgogne,* [4] *INSA Lyon, CNRS, LaMCoS, UMR5259,* [5] *École des Mines de Saint-Étienne,* [6] *Université de Franche-Comté,* [7] *Aix-Marseille University,* [8] *Sapienza University*

2-E-61 ***Local muscle pressure stimulates the principal receptors for proprioception***

Frida Torell [1], Michael Dimitriou [1]

[1] *Umeå Universitet*

2-E-62 ***Cross-area sensorimotor subspace contains distinct prehension features***

Ian Heimbuch [1], Preeya Khanna [2], Lisa Novik [3], Karunesh Ganguly [1], Robert Morecraft [4]

[1] *University of California, San Francisco,* [2] *University of California, Berkeley,* [3] *University of California, Davis,* [4] *University of South Dakota*

2-E-63 ***Generating realistic arm movements in reinforcement learning: a quantitative comparison of reward terms and task requirements***

Jhon Paul Feliciano Charaja [1], Isabell Wochner [2], Daniel Haüfle [1]

[1] *Hertie Institute for Clinical Brain Research,* [2] *Heidelberg University*

2-E-64 ***Neural representation of mechanical reasoning while using novel tools***

Joachim Hermsdörfer [1], Thabea Kampe [1], Clara Seifert [1], Cilia Jäger [1], Afra Wohlschläger [1]

[1] *Technical University of Munich*

2-E-65 ***Anisotropy of temporal resolution on the hand dorsum***

Jumpei Mizuno [1], Matthew Longo [2], Nobuhiro Hagura [1]

[1] *National Institute of Information and Communications Technology,* [2] *Birkbeck, University of London*

2-E-66 ***Involvement of aIPS and PMv in online adjustments to object size and distance perturbations during reach-to-grasp movements in virtual reality***

Luis Schettino [1], Mariusz Furmanek [2], Madhur Mangalam [3], Kyle Lockwood [4], Serge Adamovich [5], Mathew Yarossi [4], Eugene Tunik [4]

[1] *Lafayette College,* [2] *University of Rhode Island,* [3] *University of Nebraska Omaha,* [4] *Northeastern University,* [5] *New Jersey Institute of Technology*

2-E-67 ***Differential sensitivity of manipulation and grasp forces to task requirements***

William Noll [1], Yen-Hsun Wu [1], Marco Santello [1]

[1] *Arizona State University*

2-E-68 ***Information processing during the hand laterality judgement task is primarily driven by rotational angle: insights from a 'forced response' paradigm***

Marcos Moreno-Verdú [1], Siobhan McAteer [1], Baptiste Waltzing [1], Elise Van Caenegem [1], Gautier Hamoline [1], Robert Hardwick [1]

[1] *Université Catholique de Louvain*

2-E-69 ***Career development support from NIH***

Maria Nurminskaya [1]

[1] *National Institute of Child Health and Human Development*

2-E-70 ***Non-invasive OPM evidence for rhythmic interactions between the human brain, spinal cord, and muscle***

Meaghan Spedden [1], George O'neill [2], Ryan Timms [1], Timothy West [3], Stephanie Mellor [1], Tim Tierney [1], Nicholas Alexander [1], Robert Seymour [1], Simon Farmer [4], Sven Bestmann [1], Gareth Barnes [1]

[1] *UCL Queen Square Institute of Neurology,* [2] *University College London,* [3] *Imperial College London,* [4] *The National Hospital for Neurology and Neurosurgery*

2-E-71 ***Bilateral tDCS protocols improved ankle-dorsiflexion force control capabilities between feet***

Nyeonju Kang [1]

[1] *Incheon National University*

2-E-72 ***Smooth pursuit eye movements contribute to anticipatory limb force stabilization during contact with moving objects***

Oindrila Sinha [1], Tarkeshwar Singh [1]

[1] *Pennsylvania State University*

2-E-73 ***Robust neuroprosthetic control using cerebellar activity in the stroke brain***

Daniel Bowen [1], Aamir Abbasi [1], Tanuj Gulati [2], Rohit Rangwani [2]

[1] *Center for Neural Science and Medicine,* [2] *University of California, Los Angeles*

2-E-92 ***Principles of reinforcement learning during continuous motor control***

Pierre Vassiliadis [1]

[1] *Swiss Federal Institute of Technology Lausanne*

F – POSTURE AND GAIT

2-F-74 ***Assessing corticoreticular tract integrity in multiple sclerosis: implications for postural and gait deficits***

Christopher Patrick [1], Sutton Richmond [2], Clayton Swanson [3], Brett Fling [1]

[1] *Colorado State University,* [2] *University of Florida,* [3] *Malcom Randall VA Medical Center*

2-F-75 ***Flexible and rapid modulation of gait control assessed by long-range autocorrelation***

Clémence Vandamme [1], Virginie Otlet [1], Renaud Ronsse [1], Frederic Crevecoeur [1]

[1] *Université Catholique de Louvain*

2-F-76 ***Stepping through fear: analysing postural adaptations in elderly women during transitional locomotor tasks***

Justyna Michalska [1], Anna Kamieniarz-Olczak [1], Anna Brachman [1], Kajetan J. Słomka [1], Grzegorz Juras [1]

[1] *Academy of Physical Education in Katowice*

2-F-77 ***Dopamine intake improves cortico-muscular connectivity and gait coordination in Parkinson's disease***

Paulo Cezar Santos [1], Benedetta Heimler [2], Or Koren [3], Tamar Flash [1], Meir Plotnik [3]

[1] *Weizmann Institute of Science,* [2] *Sheba Medical Center*

2-F-78 Enhancing balance in the older adults: a tailored approach integrating postural training and proprioceptive stimulation

Thomas Lapole [1], Marie Fabre [1], Anastasia Theodosiadou [2], Anastasia Papavasileou [3], Chrystostomos Sahinis [3], Ioannis Amiridis [3], Dimitris Patikas [3], Stéphane Baudry [2]

[1] Université Jean Monnet Saint-Etienne, [2] Université Libre de Bruxelles, [3] Aristotle University of Thessaloniki

2-F-79 Real-time analysis of gait through inertial sensors for optimization of epidural electrical stimulation

Veronica Fossati [1], Simone Romeni [2], Ilaria Ciampa [3], Daniele Emedoli [4], Sandro Iannaccone [4], Silvestro Micera [5]

[1] Scuola Superiore Sant'Anna, [2] EPFL, [3] Scuola Superiore Sant'Anna Pisa, [4] Università Vita-Salute San Raffaele, [5] The BioRobotics Institute and Department of Excellence in Robotics and AI

2-F-80 Cortical activity during reactive balance reflects perceptual-motor and cognitive-motor interactions

Jasmine Mirdamadi [1], Scott Boebinger [2], Lena Ting [2], Kennedy Kerr [1], Michael Borich [1]

[1] Emory University, [2] Georgia Institute of Technology & Emory University

2-F-81 Human foot force reveals different balance control strategies between healthy younger and older adults

Kaymie Shiozawa [1], Rika Sugimoto Dimitrova [1], Kreg Gruben [2], Neville Hogan [1]

[1] Massachusetts Institute of Technology, [2] University of Wisconsin-Madison

2-F-82 Vestibular contributions to dynamic postural control in nonhuman primates

Olivia Leavitt [1], Kathleen Cullen [1]

[1] Johns Hopkins University

G – THEORETICAL & COMPUTATIONAL MOTOR CONTROL

2-G-83 Modeling proprioception with physics-informed neural networks

Adriana Perez Rotondo [1], Michael Dimitriou [2], Alexander Mathis [1]

[1] École Polytechnique Fédérale de Lausanne, [2] Umeå Universitet

2-G-84 The potential of neural avalanches to design innovative sensorimotor-based brain-computer interface

Camilla Mannino [1], Pierpaolo Sorrentino [2], Mario Chavez [3], Marie-Constance Corsi [1]

[1] INRIA, [2] INSERM, [3] Centre National de la Recherche Scientifique

2-G-85 Modelling bilateral hemispheric control using neural networks

Jarrad Rinaldo [1], Levin Kuhlmann [1], Jason Friedman [2], Gideon Kowadlo [3]

[1] Monash University, [2] Tel Aviv University, [3] Cerenaut

2-G-86 Investigating the modulation of muscular null space for the control of supernumerary degrees of freedom

Julien Rossato [1], Daniele Borzelli [2], Denise Berger [3], Sergio Gurgone [4], Andrea D'Avella [5]

[1] IRCCS Fondazione Santa Lucia, [2] University of Messina, [3] Fondazione Santa Lucia, [4] National Institute of Information and Communications Technology, [5] University of Rome Tor Vergata

2-G-87 Using artificial neural networks to identify a neural basis of savings in motor learning

Mahdiyar Shahbazi [1], Mehrdad Kashefi [1], Olivier Codol [2], Jonathan Michaels[1], Paul Gribble [1]

[1] University of Western Ontario, [2] Université de Montréal

2-G-88 Identifying Essential Components of Proprioceptive Feedback with Task-Driven Deep Learning

Max Grogan [1], Aldo Faisal [1]

[1] Imperial College London

2-G-89 Motor units recruitment and modulation patterns in variable-force single digit tasks

Renato Mio Zaldivar [1], Jyotindra Narayan [1], Aldo Faisal [2]

[1] University of Bayreuth, [2] Imperial College London

2-G-90 A model of cerebellum contribution to visuomotor adaptation

Emmanuel Guigon [1], Tianhe Wang [2], Jonathan Tsay [3], Guy Avraham [4], Richard Ivry [4]

[1] Sorbonne Université, [2] University of California, Berkeley, [3] University of Cambridge, [4] University of California

2-G-91 Biologically plausible neural dynamics for reaching emerge in reinforcement—not supervised—learning

Olivier Codol [1], Guillaume Lajoie [1], Matthew Perich [1]

[1] Université de Montréal

POSTER SESSION 3

THURSDAY, APRIL 18, 2024

A – ADAPTATION & PLASTICITY IN MOTOR CONTROL

3-A-1 ***Investigating view direction and perspective cues with varying perturbation profiles in dual visuomotor adaptations***

Adrien Verhulst [1], Yasuko Namikawa [1], Shunichi Kasahara [1]

[1] *Sony Computer Science Laboratories, Inc.*

3-A-2 ***The high visibility of human locus coeruleus at ultra-high field MRI***

Atsushi Yokoi [1], Ikuhiro Kida [1]

[1] *National Institute of Information and Communications Technology*

3-A-3 ***Impact of targets by human and object on accuracy in motor task***

Ayane Kusafuka [1], Rintaro Yamamoto [2], Taishi Okegawa [2], Daiki Yamasaki [2], Saki Takao [2], Kazutoshi Kudo [2], Katsumi Watanabe [1]

[1] *Waseda University,* [2] *The University of Tokyo*

3-A-4 ***Cerebellar function in motor adaptation beyond spatial control: individuals with cerebellar ataxia exhibit impaired adaptation to perturbations of time and pitch in speech***

Robin Karlin [1], Anneke Slis [2], Ben Parrell [2]

[1] *University of Missouri,* [2] *University of Wisconsin, Madison*

3-A-5 ***Benefits of attentional focus on visuomotor adaptation are observed when paired with a perceptual pre-planned aiming task***

Darrin Wijeyaratnam [1], Erin Cressman [1]

[1] *University of Ottawa*

3-A-6 ***Explicit sensorimotor strategies fail to launch in response to small perturbations***

Elizabeth Cisneros [1], Richard Ivry [2], Jonathan Tsay [3]

[1] *University of California, Berkeley,* [2] *University of California,* [3] *University of Cambridge*

3-A-7 ***Generalisation of motor skill learning with a hand augmentation device***

Giulia Dominijanni [1], María Molina [2], Lucy Dowdall [2], Dani Clode [2], Tamar Makin [2]

[1] *École Polytechnique Fédérale de Lausanne,* [2] *University of Cambridge*

3-A-8 ***Motor adaptation as an associative learning process***

Guy Avraham [1], Samuel McDougle [2], Jordan Taylor [3], Richard Ivry [1]

[1] *University of California,* [2] *Yale University,* [3] *Princeton University*

3-A-9 ***TMS-based neurofeedback facilitates motor imagery of different hand actions***

Hsiao-Ju Cheng [1], Niccolò Voster [1], Chantal Wunderlin [1], Daryl Chong [1], Ingrid Odermatt [2], Nicole Wenderoth [2]

[1] *Singapore-ETH Centre,* [2] *ETH Zürich*

3-A-10 ***Differential contributions of model-based and model-free learning to visuomotor adaptation***

Jinsung Wang [1]

[1] *University of Wisconsin, Milwaukee*

3-A-11 ***EMG control of a hand augmentation technology***

Julien Russ [1], Kitty Goodridge [1], Francesco Cenciarelli [1], Hristo Dimitrov [1], Dani Clode [1], Tamar Makin [1]

[1] *University of Cambridge*

3-A-12 ***Correcting cortical output: a distributed learning framework for motor adaptation***

Leonardo Agueci [1], N Alex Cayco Gajic [1]

[1] *École Normale Supérieure*

3-A-13 ***The developing homunculus: sensory body maps in children with and without upper limb differences***

Raffaele Tucciarelli [1], Laura-Ashleigh Bird [2], Malgorzata Szymanska [1], Mathew Kollamkulam [3], Harshal Arun Sonar [4], Jamie Paik [4], Tessa Dekker [5], Dani Clode [1], Dorothy Cowie [6], Tamar Makin [1]

[1] *University of Cambridge,* [2] *Durham University,* [3] *University of Oxford,* [4] *École Polytechnique Fédérale de Lausanne,* [5] *UCL Institute of Ophthalmology,* [6] *University of Durham*

3-A-14 ***Plasticity of sensorimotor confidence during motor adaptation***

Marissa Fassold [1], Michael S. Landy [1]

[1] *New York University*

3-A-15 ***Validating a low-density EEG device for Targeted Memory Reactivation (TMR) during sleep for stroke rehabilitation***

Morgan Mitchell [1]

[1] *University of Oxford*

3-A-16 ***Delivering information to the cortical reach-to-grasp network with low-amplitude intracortical microstimulation***

Brandon Ruszala [1], Marc Schieber [1]

[1] *University of Rochester*

3-A-17 *Finger-specific representations are sharpened during a fatiguing motor task*

Caroline Heimhofer [1], Susanne Koblitz [2], Marc Bächinger [2], Nicole Wenderoth [1]

[1] ETH Zürich, [2] Neural Control of Movement Lab

3-A-18 *External feedback signals in oculomotor learning*

Frauke Heins [1], Markus Lappe [1]

[1] University of Muenster

3-A-19 *Unveiling the gradual formation of stable functional representation of muscle synergies during infant locomotor development through kinematic-muscular synergies and personalized neuromusculoskeletal modeling*

Jiayin Lin [1], Sophia C.W. Ha [12], Janet Zhang [2], Zoe Chan [3], Xiaoyu Guo [4], Rosa Chan [4], Roy Cheung [5], Chao-Ying Chen [6], Vincent Chi Kwan Cheung [1]

[1] Chinese University of Hong Kong, [2] The Hong Kong Polytechnic University, [3] University of Calgary, [4] City University of Hong Kong, [5] Western Sydney University, [6] Chang Gung University

3-A-20 *Rapid implicit learning of temporal context in a cerebellar task*

Luca Mangili [1], Charlotte Wissing [1], Devika Narain [1]

[1] Erasmus University Medical Center

3-A-21 *Unravelling motor adaptation: insights from EEG and post-movement beta rebound*

Matthias Will [1], Betina Korka [1], Max-Philipp Stenner [2]

[1] University Magdeburg, [2] Otto-von-Guericke University Magdeburg

3-A-22 *The error signals for sensorimotor adaptation with visuomotor rotation perturbations*

Xiaoyue Zhang [1], Kunlin Wei [1]

[1] Peking University

B – CONTROL OF EYE & HEAD MOVEMENT

3-B-23 *Extraretinal information contributes to manual tracking*

Adrien Coudiere [1], Frederic Danion [2]

[1] Université de Poitiers, [2] Centre National de la Recherche Scientifique

3-B-24 *Spatial transformations underlying saccadic eye movements to tactile and visual target stimuli*

Celia Foster [1], Maxime Gaudet-Trafit [2], Valentin Marcon [2], Franck Lamberton [3], Wei-An Sheng [2], Suliann Ben Hamed [4], Tobias Heed [5]

[1] University of Cambridge, [2] University of Lyon, [3] CERMEP-Imagerie du Vivant, [4] Institut des Sciences Cognitives Marc Jeannerod, [5] University of Salzburg

3-B-25 *Failure of reafference: movement induced visual loss secondary to infantile nystagmus. It is not just the VOR*

James Phillips [1], John Kelly [1], Avery Weiss [1], Leo Ling [1]

[1] University of Washington

3-B-26 *Dissociation of smooth and saccadic pursuit while tracking moving motion patterns*

Krischan Koerfer [1], Markus Lappe [1]

[1] University of Muenster

C – DISORDERS OF MOTOR CONTROL

3-C-27 *Does postural training combined with proprioceptive stimulation modulate further muscle spindles pathway in old adults?*

Marie Fabre [1], Anastasia Theodosiadou [2], Anastasia Papavasileiou [3], Chrysostomos Sahinnis [3], Ioannis Amiridis [3], Dimitris Patikas [3], Stéphane Baudry [2], Thomas Lapole [1]

[1] Université Jean Monnet Saint-Etienne, [2] Université Libre de Bruxelles, [3] Aristotle University of Thessaloniki

3-C-28 *Quantitative assessments of reaching after focal ischaemic lesions in non-human primates*

Anna Baines [1], Stuart Baker [1], John Krakauer [2]

[1] Newcastle University, [2] Johns Hopkins University

3-C-29 *Pathogenesis of freezing of gait in a neuromusculoskeletal model*

Daisuke Ichimura [1], Makoto Sawada [2]

[1] National Institute of Advanced Industrial Science and Technology (AIST), [2] Reiwa Health Sciences University

3-C-30 *The neural basis of motor sequence control in individuals with Developmental coordination disorder (DCD)*

Helena Wright [1], Rhys Yewbrey [2], Katja Kornysheva [1]

[1] University of Birmingham, [2] Bangor University

3-C-31 *Does imagery influence movement during dance in people with Parkinson's disease?*

Judith Bek [1], Laurel Trainor [2], Joseph DeSouza [3]

[1] University College Dublin, [2] McMaster University, [3] Centre for Vision Research

3-C-32 *Ventral motor cortex activity supports neural cursor control by a person with paralysis*

Tyler Singer-Clark [1], Carrina Lacobacci [1], Maitreyee Wairagkar [1], Nicholas Card [1], Xianda Hou [1], David Brandman [1], Sergey Stavisky [1]

[1] *University of California, Davis*

3-C-33 *Subthalamic neurons of patients with early onset Parkinson's disease are more sensitive to voluntary movements*

Veronika Filiushkina [1], Elena Belova [1], Anna Gamaleya [2], Alexey Tomskiy [3], Alexey Sedov [1]

[1] *N.N. Semenov Federal Research Center for Chemical Physics, Russian Academy of Sciences,* [2] *Burdenko National Scientific and Practical Center for Neurosurgery, Moscow, Russia,* [3] *Burdenko National Scientific and Practical Center for Neurosurgery*

3-C-34 *Epidural stimulation with viral BDNF therapy and robot training after SCI improves recovery of function, delays the onset of viral side effects, and maintains observed hindlimb muscle synergies and motor modularity*

Andrey Borisyuk [1], Trevor Smith [1], Kim Dougherty [1], Simon Giszter [1]

[1] *Drexel University*

D – FUNDAMENTALS OF MOTOR CONTROL

Poster Cluster (3-D-35 to 3-G-37)

3-D-35 *Targeting a specific motor control process reveals an age-related compensation that adapts movement to gravity environment*

Robin Mathieu [1], Florian Chambellant [2], Elizabeth Thomas [3], Charalampos Papaxanthis [3], Pauline Hilt [4], Patrick Manckoundia [1], France Mourey [2], Gaveau Jeremie [4]

[1] *INSERM U1093 CAPS,* [2] *INSERM CAPS U1093,* [3] *Université de Bourgogne,* [4] *University of Burgundy*

3-D-36 *Metabolic cost demonstrates gravity-related effort minimisation*

Robin Mathieu [1], Denis Barbusse [2], Augustine Levi-Chebat [1], Hervé Assadi [1], Charalampos Papaxanthis [3], Gaveau Jeremie [2]

[1] *INSERM U1093 CAPS,* [2] *University of Burgundy,* [3] *Université de Bourgogne*

3-G-37 *Deactivation and collective phasic muscular tuning for pointing direction: insights from machine learning*

Florian Chambellant [1], Gaveau Jeremie [2], Charalampos Papaxanthis [3], Elizabeth Thomas [3]

[1] *INSERM CAPS U1093,* [2] *University of Burgundy,* [3] *Université de Bourgogne*

3-D-38 *Deepening understanding and practical application of neural control with high-density electromyography*

Dailyn Despradel Rumaldo [1], Luigi Borda [1], Nikhil Verma [1], Prakarsh Yadav [2], Jennifer Collinger [3], Douglas Weber [1]

[1] *Carnegie Mellon University,* [2] *PhD student,* [3] *University of Pittsburgh*

3-D-39 *Differential roles of low- and high-beta band cortico-subcortical coherence in movement inhibition and expectation*

Bernadette Van Wijk [1], Vladimir Litvak [2], Chunyan Cao [3]

[1] *Vrije Universiteit Amsterdam,* [2] *University College London,* [3] *Shanghai JiaoTong University*

3-D-40 *Discerning state estimation and sensory gating, two presumptive predictive signals in mouse barrel cortex*

Cornelius Schwarz [1], Kalpana Gupta [1], Ritu Roy Chowdhury [1], Shubhodeep Chakrabarti [1]

[1] *Eberhard Karls University of Tübingen*

3-D-41 *The effects of inherent and incidental constraints on bimanual force control in parabolic flight*

Deanna Kennedy [1], Osmar Pinto Neto [2], Madison Weinrich [1], Renee Abbott [1], Nathan Keller [3], Traver Wright [4], Bonnie Dunbar [1], Ana Diaz Artiles [1]

[1] *Texas A&M University,* [2] *Anhembi Morumbi University,* [3] *NASA Johnson Space Center,* [4] *University of Texas Medical Branch*

3-D-42 *Deliberative processes within the sensorimotor cortex: the effect of choice uncertainty on beta-band activity in a free-choice task*

Dominique Delisle-Godin [1], Pierre-Michel Bernier [1]

[1] *Université de Sherbrooke*

3-D-43 *The cellular encoding of passive forelimb movement in mouse forelimb primary somatosensory and motor cortex*

Ian Stewart [1], Clarissa J Whitmire [2], James Fa Poulet [3]

[1] *Max Delbrück Center for Molecular Medicine,* [2] *Queensland Brain Institute,* [3] *Charité Medical University*

3-D-44 *Does arm performance under different visual conditions explain related arm selection?*

Ioanna Giannakou [1], David Punt [1]

[1] *University of Birmingham*

3-D-45 *Emergence of crystallized neural patterns during vocal learning*

Leila May Pascual [1], Michael Pasek [1], Ilya Nemenman [1], Samuel Sober [1]

[1] *Emory University*

3-D-46 *Force matching: motor effects that are not perceived by the actor*

Michal Pawlowski [1], Joseph Ricotta [2], Sayan De [2], Mark Latash [2]

[1] *Academy of Physical Education in Katowice,* [2] *Pennsylvania State University*

3-D-47 *Volitional control of movement interacts with proprioceptive feedback in motor cortex during brain-computer interface control in humans*

Monica Liu [1], Robert Gaunt [2], Jennifer Collinger [2], John Downey [3], Aaron Batista [2], Michael Boninger [4], Douglas Weber [5]

[1] *University of Washington,* [2] *University of Pittsburgh,* [3] *University of Chicago,* [4] *University of Pittsburgh Medical Center,* [5] *Carnegie Mellon University*

3-D-48 *Grasp posture in ambiguous settings is sensitive to prior object motion*

Natalie Maffitt [1], Demetris Soteropoulos [1], Alexander Kraskov [1]

[1] *Newcastle University*

3-D-49 *Visual activity modulates population dynamics during the initiation of identical grasp movements*

Nicolas Zdun [1], Jonathan Michaels [2], Hans Scherberger [1], Benjamin Dann [1]

[1] *German Primate Center,* [2] *Western University*

3-D-50 *Combining visual and proprioceptive information in fast motor decisions*

Gul Duygun [1], Nina Van Mastrigt [2], Jeroen B.J. Smeets [1]

[1] *Vrije Universiteit Amsterdam,* [2] *Justus Liebig Universität Giessen*

3-D-51 *Effects of tool use on differences between dominant and non-dominant hands in right-handed and left-handed individuals*

Tomoko Aoki [1], Marc Schieber [2]

[1] *Prefectural University of Kumamoto,* [2] *University of Rochester*

3-D-52 *Jaw muscle spindle afferents as multiplexed channels for sensing and guiding orofacial movement*

William Olson [1], Varun Chokshi [1], Jeong Jun Kim [1], Noah Cowan [1], Daniel O'Connor [1]

[1] *Johns Hopkins University*

3-D-53 *Neural dynamics of macaque motor cortex during flexible manual interception*

Yiheng Zhang [1], Qifan Wang [2], Yun Chen [2], Tianwei Wang [3], He Cui [2]

[1] *Center for Excellence in Brain Science and Intelligence Technology,* [2] *Chinese Institute for Brain Research,* [3] *German Primate Center*

3-D-54 *Clustering patterns in multiunit LFP recordings in the monkey motor cortex during a reach and grasp task*

Elizabeth Thomas [1], Florian Chambellant [1], Ali Falaki [2], Ian Moreau-Debord [3], Stephane Quessy [2], Robert French [1], Numa Dancause [2]

[1] *Université de Bourgogne,* [2] *Université de Montréal,* [3] *Panaxium*

3-D-55 *Neural dynamics of sensorimotor decision-making in freely walking rhesus macaques*

Irene Lacal [1], Zurna Ahmed [1], Alexander Gail [1]

[1] *German Primate Center*

3-D-56 *The influence of object weight on handover actions in young and old adults*

Lena Kopnarski [1], Claudia Voelcker-Rehage [1], Julian Rudisch [1]

[1] *University of Münster*

3-D-57 *The interaction between visual position and visual motion for moving targets and self-controlled cursors explained through a multisensory LQG model*

Loes Van Dam [1]

[1] *Technical University of Darmstadt*

3-D-58 *Inter-participant similarity of muscle synergies is not increasing with external constraints during walking but is influenced by extraction algorithms and the chosen number of synergies*

Paul Kaufmann [1], July Seidl [1], Hans Kainz [1], Arnold Baca [1]

[1] *University of Vienna*

3-D-59 *Muscle dynamics follow typical movement trajectories in persons with limb amputation*

Shriniwas Patwardhan [1], Wilsaan Joiner [2], Jonathon Schofield [2], Siddhartha Sikdar [3]

[1] *National institutes of Health, Clinical Center,* [2] *University of California, Davis,* [3] *George Mason University*

3-D-92 *Motivation upregulates the adaptive response in sensorimotor learning*

Salma Khateeb [1], Yara Abu-Hana [1], Vikram Chib [2], Firas Mawase [1]

[1] *Technion Israel Institute of Technology,* [2] *Johns Hopkins University*

E – INTEGRATIVE CONTROL OF MOVEMENT

Poster Cluster (3-E-60 and 3-E-61)

3-E-60 *Central projection to the hand region of primate cuneate nuclei*

Moeko Kudo [1], Shinji Kubota [2], Satomi Kikuta [1], Junichiro Yoshida [1], Saeka Tomatsu [3], Tatsuya Umeda [4], Kazuhiko Seki [1]

[1] *National Center of Neurology and Psychiatry,* [2] *National Institute of Neuroscience,* [3] *National Institute for Physiological Sciences,* [4] *Kyoto University*

3-E-61 *Projections from the primary motor and sensory cortex to the subcortical somatosensory relay neurons in non-human primates*

Shinji Kubota [1], Moeko Kudo [2], Satomi Kikuta [2], Junichiro Yoshida [2], Shun Nakamura [2], Akiya Watakabe [3], Ken-Ichi Inoue [4], Masahiko Takada [4], Kazuhiko Seki [2]

[1] *National Institute of Neuroscience,* [2] *National Center of Neurology and Psychiatry,* [3] *RIKEN Center for Brain Science, Saitama, Japan,* [4] *Kyoto University*

3-E-62 *The role of visuomotor experience in attenuation of visual evoked responses*

Batel Buaron [1], Roy Mukamel [1]

[1] *Tel Aviv University*

3-E-63 *Repetition of coordinated digit force control disrupts switching between motor plans*

Catherine Sager [1], Ian Greenhouse [1], Michelle Marneweck [1]

[1] *University of Oregon*

3-E-64 *Corticospinal excitability reflects unfolding decisions during ongoing actions*

Cesar Canaveral [1], Louis-Phillipe Tremblay [1], Andrea Green [1], Paul Cisek [1]

[1] *Université de Montréal*

3-E-65 *Neural activity in the cortico-basal ganglia network of non-human primates: integration of context information and coordination of behavior during foraging*

Clara Saleri [1], David Thura [1]

[1] *INSERM*

3-E-66 *Unveiling the role of cutaneous feedback in voluntary movement control: Insights from conflicting visual-somatosensory inputs*

Maria Evangelia Vlachou [2], Juliette Legros [2], Cécile Sellin [2], Dany Paleressompoulle [2], Francesco Massi [3], Martin Simoneau [4], Laurence Mouchnino [5], Jean Blouin [5]

[2] *Centre de Recherche en Psychologie et Neurosciences, Aix-Marseille Université/CNRS, Marseille,* [3] *Sapienza University,* [4] *Université Laval,* [5] *Aix Marseille Université*

3-E-67 *Active movement encoding in motor working memory*

Hanna Hillman [1], Alexander D. Forrence [1], Samuel Mcdougle [1]

[1] *Yale University*

3-E-68 *Impact of EMG signal processing on accuracy and latency of motor intention prediction*

Lucas Quesada [1], Dorian Verdel [2], Olivier Bruneau [3], Bastien Berret [1], Michel-Ange Amorim [1], Nicolas Vignais [4]

[1] *Université Paris-Saclay,* [2] *Imperial College of Science, Technology and Medicine,* [3] *ENS Paris-Saclay Laboratoire LURPA,* [4] *Université de Rennes*

3-E-69 *Decoding hand movements with optomyography*

Roman Khalikov [1], Gurgen Soghoyan [1], Mikhail Sintsov [2], Mikhail Lebedev [3]

[1] *Skolkovo Institute of Science and Technology,* [2] *Research Center of Motorica LLC,* [3] *Lomonosov Moscow State University*

3-E-70 *The effect of cortical inhibition on behavior and motor unit activity with and without visual feedback*

Yori Escalante [1], James Khim [1], Yuming Lei [1]

[1] *Texas A&M University*

3-E-71 *A multivariate analysis of central-peripheral communication during a precision grip task reveals indications of a non-cortical bidirectional connectivity in the high gamma band*

Zahra Eshagh Nimvari [1], Prabhav Mehra [1], Orla Hardiman [1], Helene Arnold [1], Saroj Bista [1], Marjorie Metzger [1], Leah Nash [1], Eileen Giglia [1], Serena Plaitano [1], Peter Bede [1], Madeleine Lowery [2], Muthuraman Muthuraman [3], Lara McManus [1], Bahman Nasseroleslami [1]

[1] *Trinity College Dublin,* [2] *University College Dublin,* [3] *Neural Engineering with Signal Analytics and Artificial Intelligence (NESA-AI)*

3-E-72 *The effect of reward and punishment on learning, memory and transfer of real-world motor skill learning*

Cong Yin [1], Yaoxu Wang [1], Yu Chen [1], Xinyue Yang [1]

[1] *Capital University of Physical Education and Sports*

3-E-73 *The decoding of extensive samples of motor units in human muscles reveals the rate coding of entire motoneuron pools*

Simon Avrillon [1], Francois Hug [1], Roger Enoka [2], Arnault Caillet [3], Dario Farina [3]

[1] Université Côte d'Azur, [2] University of Colorado, [3] Imperial College London

F – POSTURE AND GAIT

3-F-74 *Early manifestation of muscle activity during passive and spontaneous movements in preterm and full-term infants*

Damiana Rubeca [1], Francesca Sylos-Labini [2], Yury Ivanenko [3], Francesco Lacquaniti [2], Irina Solopova [4], Irina Y. Dolinskaya [5], Dmitry S. Zhvansky [5]

[1] Università degli studi di Tor Vergata, [2] University of Rome Tor Vergata, [3] IRCCS Fondazione Santa Lucia, [4] Russian Academy of Sciences, [5] Moscow Institute of Physics and Technology

3-F-75 *Complexity and variability of neuromuscular control during human locomotor development*

Francesca Sylos-Labini [1], Valentina La Scaleia [2], Germana Cappellini [2], Arthur Dewolf [3], Yury Ivanenko [2], Francesco Lacquaniti [1]

[1] University of Rome Tor Vergata, [2] IRCCS Fondazione Santa Lucia, [3] Università degli studi di Tor Vergata

3-F-76 *Simulating plantar cutaneous afferent responses to behaviorally relevant forces*

Luke Cleland [3], Erika Howe [2], Liam McSweeney [3], Chris Nester [4], Kristen Hollands [5], Jo Reeves [6], Nicholas Strzalkowski [7], Leah Bent [2], Hannes Saal [3]

[2] University of Guelph, [3] University of Sheffield, [4] Keele University, [5] University of Salford, [6] University of Bath, [7] Mount Royal University

3-F-77 *Interpersonal coordination during walking of adults and children with hand contact*

Margherita Villani [1], Yury Ivanenko [1], Francesco Lacquaniti [2], Francesca Sylos-Labini [2]

[1] IRCCS Fondazione Santa Lucia, [2] University of Rome Tor Vergata

3-F-78 *Foot placement control strategies for human locomotion are context-dependent*

Wei-Chen Wang [1], Nidhi Seethapathi [1]

[1] Massachusetts Institute of Technology

3-F-79 *Revealing forelimb pose representations in the cervical spinal cord of decerebrate cats through high-density linear electrode recordings*

Yuta Soga [1], Kazutaka Maeda [2], Shiro Egawa [2], Shusei Fukuyama [3], Mirai Takahashi [3], Tetsuro Funto [1], Kaoru Tkakusaki [3], Kazuhiko Seki [2]

[1] The University of Electro-Communications, [2] National Center of Neurology and Psychiatry, [3] Asahikawa Medical University

3-F-80 *The cortical N1 response to balance disturbance is larger in anxious children and associated with the error-related negativity*

Aiden Payne [1], N. Brad Schmidt [1], Alex Meyer [2], Greg Hajcak [2]

[1] Florida State University, [2] Santa Clara University

3-F-81 *Precise cortical contributions to sensorimotor feedback control during reactive balance in aging and Parkinson's disease*

Scott Boebinger [1], Aiden Payne [2], Giovanni Martino [3], Kennedy Kerr [1], Jasmine Mirdamadi [4], Michael Borich [4], Lena Ting [5]

[1] Georgia Institute of Technology & Emory University, [2] Florida State University, [3] University of Padova, [4] Emory University, [5] Emory University and Georgia Institute of Technology

3-F-82 *The role of expectation in the neural processing of vestibular stimuli in humans*

Toby Ellmers [1], Sanya Srivastava [1], Adolfo Bronstein [1]

[1] Imperial College London

G – THEORETICAL & COMPUTATIONAL MOTOR CONTROL

3-G-83 *Preparatory weight shifts when transitioning from two- to one-legged stance might reduce effort in the presence of physiological noise: a simulation study*

Hannah Carey [1], Friedl De Groote [1]

[1] Katholieke Universiteit Leuven

3-G-84 *Linking neural population dynamics in the motor cortex to optimal feedback control of motor behavior*

Hari Teja Kalidindi [1], Frederic Crevecoeur [1]

[1] Université Catholique de Louvain

3-G-85 *Hierarchical goal-driven model of the cortico-basal ganglia loop during a time delay task*

John Lazzari [1], Zidan Yang [2], Hidehiko Inagaki [2], Shreya Saxena [1]

[1] Yale University, [2] Max Planck Florida Institute for Neuroscience

3-G-86 *Bifurcation analysis on a two-neuron model of central pattern generators for both rhythmic and discrete movements*

Kotaro Muramatsu [1], Hiroshi Kori [1]

[1] The University of Tokyo

3-G-87 *Optimization of peripheral electrical stimulation to improve muscle contraction patterns*

Laura Toni [1], Simone Romeni [2], Claudio Verardo [1], Luca Pierantoni [1], Silvestro Micera [3]

[1] Scuola Superiore Sant'Anna, [2] EPFL, [3] The BioRobotics Institute and Department of Excellence in Robotics and AI

3-G-88 ***Reduced complexity and altered spatiotemporal coordination in finger control after stroke***

Jing Xu [1], Michael Rosenberg [2], Patrick Ihejirika [1]

[1] *University of Georgia,* [2] *Emory University*

3-G-89 ***Clinical sensory organization task effects on prefrontal cortical activation patterns in older adults with and without hypertension***

Alka Bishnoi [1], Manuel Hernandez [2]

[1] *Kean University,* [2] *University of Illinois Urbana-Champaign*

3-G-90 ***EMUsort and LITMUS: the enhanced motor unit sorter and robust benchmarking of motor unit sorters***

Sean O'Connell [1], Jonathan Michaels [2], Runming Wang [3], Manikandan Venkatesh [1], Nevin Aresh [1], Samuel Sober [4], Chethan Pandarinath [1]

[1] *Emory University and Georgia Institute of Technology,* [2] *Western University,* [3] *Johns Hopkins School of Medicine,* [4] *Emory University*

3-G-91 ***Full-body modeling of human musculoskeletal system and neural control of locomotion with hierarchical reinforcement learning***

Yanan Sui [1]

[1] *Tsinghua University*

POSTER SESSION 4

FRIDAY, APRIL 19, 2024

A – ADAPTION & PLASTICITY IN MOTOR CONTROL

4-A-1 ***Action effects of sequential actions are pre-planned in parallel similar to their coupled actions***

Alexandros Karagiorgis [1], Anwesha Das [1], Katja Kornysheva [2], Elena Azañon [3], Max-Philipp Stenner [1]

[1] *Otto-von-Guericke University Magdeburg,* [2] *University of Birmingham,* [3] *Leibniz Institute for Neurobiology Magdeburg*

4-A-2 ***What makes some chords hard to play? Exploring the role of muscle synergies, biomechanical and cognitive factors of difficulty***

Ali Ghavampour [1], Shuja Sayyid [1], Jonathan Michaels [1], Jean-Jacques Orban De Xivry [2], J. Andrew Pruszynski [1], Joern Diedrichsen [1]

[1] *Western University,* [2] *Katholieke Universiteit Leuven*

4-A-3 ***Study of key handwriting characteristics in healthy children and children with neuro-oncological diseases***

Alisa Shalamkova [1], Vsevolod Chernyshev [2], Vera Tolchennikova [3]

[1] *HSE student,* [2] *HSE University,* [3] *People's Friendship University of Russia*

4-A-4 ***Anticipatory adjustments in reach and grasp: the influence of expected mechanical perturbations***

Anna Akbas [1], Mariusz Furmanek [2], Grzegorz Juras [1], Mathew Yarossi [3], Eugene Tunik [3]

[1] *Academy of Physical Education in Katowice,* [2] *University of Rhode Island,* [3] *Northeastern University*

4-A-5 ***Repeated exposure to visuo-motor delays in an interception task: No evidence for dual-adaptation in the temporal domain***

Celine Honekamp [1], Loes Van Dam [1]

[1] *Technical University of Darmstadt*

4-A-6 ***Effect of central sensitization and neck pain on acquisition and retention of a forearm force matching tracking task***

Hailey Tabbert [1], Nicholas Antony [1], John Srbely [2], Paul Yielder [1], Bernadette Murphy [1]

[1] *Ontario Tech University,* [2] *University of Guelph*

4-A-7 ***The effect of ethanol on movement and dynamic***

Ian Howard [1], Sylvia Terbeck [2]

[1] *University of Plymouth,* [2] *Liverpool John Moores University*

4-A-8 ***Neuroplasticity of finger representations induced by a TMS-based BCI-neurofeedback approach***

Ingrid Odermatt [1], Sanne Kikkert [1], Manuel Schulthess-Lutz [1], Ernest Mihelj [1], Paige Howell [1], Caroline Heimhofer [1], Roisin McMackin [2], Patrick Freund [3], Nicole Wenderoth [1]

[1] *ETH Zürich,* [2] *Trinity College Dublin,* [3] *University Hospital Zürich*

4-A-9 ***Role of DLPFC and SMG in Proprioception and Motor Skill learning: a cTBS study***

Manasi Wali [1], Hannah Block [1]

[1] *Indiana University Bloomington*

4-A-10 ***Examining the impact of acute cardiovascular exercise, declarative practice, and focused-attention meditation on memory consolidation of motor learning***

Maria Montenegro [1], Angelina Huynh [1], David Wright [1], Yuming Lei [1]

[1] *Texas A&M University*

4-A-11 *The importance of how tools are held when performing motor tasks*

Martine Gilles [1], Jason Dellai [2], Gilles Dietrich [2]

[1] *Institut National de la Recherche Scientifique,* [2] *Université Paris Cité*

4-A-12 *Top-down processing activates deprived sensory brainstem nuclei following tetraplegia*

Paige Howell [1], Finn Rabe [1], Sarah Meissner [1], Simon Schading-Sassenhausen [2], Patrick Freund [2], Nicole Wenderoth [1], Sanne Kikkert [1]

[1] *ETH Zürich,* [2] *University Hospital Zürich*

4-A-13 *Subjective processes underlie risk-seeking bias in action timing selection under risk*

Ryoji Onagawa [1], Kazutoshi Kudo [2], Katsumi Watanabe [1]

[1] *Waseda University,* [2] *The University of Tokyo*

4-A-14 *Human somatosensory cortex contributes to the encoding of newly learned movements*

Shahryar Ebrahimi [1], Bram Van Der Voort [1], David Ostry [1]

[1] *McGill University*

4-A-15 *Adaptation in whole body movements*

Tjasa Kunavar [1], Benjamin Fele [1], Marko Jamšek [1], David Franklin [2], Jan Babic [1]

[1] *Jozef Stefan Institute,* [2] *Technical University of Munich*

4-A-16 *Enhancing co-adaptive myoelectric interfaces with eye tracking*

Amber Hsiao-Yang Chou [1], Maneeshika Madduri [2], Si Jia Li [2], Jason Isa [2], Andrew Christensen [2], Sam Burden [2], Amy Orsborn [2]

[1] *University of Washington, Seattle,* [2] *University of Washington*

4-A-17 *Mindful movement: the neuromechanical abstraction of gravity is shared between motor and cognitive systems*

Chase Rock [1], Young-Hui Chang [1]

[1] *Georgia Institute of Technology*

4-A-18 *Impact of a new tool on movement smoothness: application to the hairdressing sector*

Jason Dellai [1], Martine Gilles [2], Laurent Claudon [3], Gilles Dietrich [1]

[1] *Université Paris Cité,* [2] *Institut National de la Recherche Scientifique,* [3] *Institut National de Recherche et de Sécurité*

4-A-19 *Can myoelectric prosthetic hand control and learning be explained by isometric force control and corticomuscular coherence?*

Mohamed Omar Mohamed [1], Greg Wood [1], David J. Wright [1], Johnny Parr [1]

[1] *Manchester Metropolitan University*

4-A-20 *Athletic training characterizes the activation in human spinal locomotor circuitry*

Toshiki Tazoe [1], Yukio Nishimura [1], Kazutake Kawai [2]

[1] *Tokyo Metropolitan Institute of Medical Science,* [2] *Nihon University*

4-A-21 *Implicit adaptation determines proprioceptive bias measured by active hand localization*

Zhaoran Zhang [1], Kunlin Wei [1]

[1] *Peking University*

B – CONTROL OF EYE & HEAD MOVEMENT

4-B-22 *Similar gaze-gait interactions during perturbed walking in younger and older adults*

Sabine Grimm [1], Jutta Billino [2], Wolfgang Einhäuser [1]

[1] *Chemnitz University of Technology,* [2] *Justus Liebig Universität Giessen*

4-B-23 *Interperformer coordination in wind instrument ensembles: relationship between synchronicity of performers' head movements and musical phrase*

Tomohiro Samma [1], Tsubasa Maruyama [2]

[1] *Keio University,* [2] *National Institute of Advanced Industrial Science and Technology*

C – DISORDERS OF MOTOR CONTROL

4-C-25 *Reduced reciprocal inhibition during clinical tests of spasticity is associated with impaired reactive standing balance control in children with cerebral palsy*

Jente Willaert [1], Lena Ting [2], Anja Van Campenhout [1], Kaat Desloovere [1], Friedl De Groote [1]

[1] *Katholieke Universiteit Leuven,* [2] *Emory University and Georgia Institute of Technology*

4-C-26 *EMG-EMG wavelet coherence during 1:1 in-phase coordination in Parkinson's patients*

Madison Weinrich [1], Osmar Neto [2], Yiyu Wang [3], Brock Balthazor [1], Deanna Kennedy [1]

[1] *Texas A&M University,* [2] *Anhembi Morumbi University,* [3] *Northwestern University*

4-C-27 *Medication improves movement velocity, reaction time, and movement time but not amplitude or error during memory-guided reaching in Parkinson's disease*

Michael Trevarrow [1], Miranda Munoz [1], Yessenia Rivera [1], Rishabh Arora [2], Quentin Drane [3], Gian Pal [4], Leo Verhagen Metman [5], Lisa Goelz [6], Daniel Corcos [1], Fabian David [1]

[1] Northwestern University, [2] USF Health Morsani College of Medicine, [3] Creighton University School of Medicine, [4] Robert Wood Johnson Medical School, [5] Northwestern University Feinberg School of Medicine, [6] University of Illinois Chicago

4-C-28 *Deterioration of cognitive aspects of motor control following subthalamic nucleus deep brain stimulation surgery for Parkinson's disease*

Miranda Munoz [1], Rishabh Arora [2], Yessenia Rivera [1], Quentin Drane [3], Gian Pal [4], Leo Verhagen Metman [5], Sepehr Sani [6], Joshua Rosenow [5], Lisa Goelz [7], Daniel Corcos [1], Fabian David [1]

[1] Northwestern University, [2] USF Health Morsani College of Medicine, [3] Creighton University School of Medicine, [4] Robert Wood Johnson Medical School, [5] Northwestern University Feinberg School of Medicine, [6] Rush University Medical Center, [7] University of Illinois Chicago

4-C-29 *Tool-use planning deficits in limb apraxia are amplified when tool and hand movements are misaligned*

Simon Thibault [1], Laurel Buxbaum [2], Aaron Wong [2]

[1] Thomas Jefferson University, [2] Moss Rehabilitation Research Institute

4-C-30 *Neural decoding of locomotor states from deep brain electrodes to support closed-loop therapies for gait in Parkinson's patients*

Stefano Scafa [1], Ruijia Wang [2], Paula Sánchez López [2], Camille Varescon [3], Icare Sakr [2], Kyuhwa Lee [4], Alessandro Puiatti [5], Henri Lorach [2], Antoine Collomb-Clerc [6], Gregoire Courtine [2], Jocelyne Bloch [3], Eduardo Martin Moraud [3]

[1] University of Lausanne, [2] EPFL, [3] CHUV, [4] Wyss Center for Bio and Neuroengineering, [5] The University of Applied Sciences and Arts of Southern Switzerland, [6] Sorbonne Université

4-C-31 *Comparison of frequency content under different deep brain stimulation states and setting patterns during continuous motor task*

Yun Sun [1], Jaya Nataraj [1], Rahil Soroushmojdehi [1], Alireza Mousavi [1], Terence Sanger [1]

[1] University of California, Irvine

4-C-32 *Neurophysiology vs neuroanatomy of deep brain stimulation in Parkinson's disease*

Alena Kutuzova [1], Cosima Graef [1], Bradley Lonergan [1], Yen Foung Tai [1], Shlomi Haar [1]

[1] Imperial College London

D – FUNDAMENTALS OF MOTOR CONTROL

4-D-33 *The impact of handedness on the Fitts' relationship during imagined and perceived movements*

Aarohi Pathak [1], April Karlinsky [2], Ying Bai [3], Molly Brillinger [1], Xiaoye Michael Wang [1], Emma Gowen [3], Ellen Poliakoff [3], Timothy Welsh [1]

[1] University of Toronto, [2] California State University, [3] University of Manchester

Poster Cluster (4-D-34 and 4-E-35)

4-D-34 *Different motor unit control schemes between two lower limb muscles*

Francois Dernoncourt [1], Simon Avrillon [1], Thomas Cattagni [2], Tijn Logtens [3], Francois Hug [1]

[1] Université Côte d'Azur, [2] Nantes University, [3] Imperial College London

4-E-35 *The volitional control of individual motor units is constrained within low-dimensional manifolds by common inputs*

Julien Rossato [1], Simon Avrillon [2], Kylie Tucker [3], Dario Farina [4], Francois Hug [2]

[1] IRCCS Fondazione Santa Lucia, [2] Université Côte d'Azur, [3] The University of Queensland, [4] Imperial College London

Poster Cluster (4-D-36 to 4-D-38)

4-D-36 *Bayesian inference as a framework for the sense of agency*

Christoph Schneider [1], Raz Leib [2], David Franklin [2], Mathias Hegele [3], Johannes Keyser [1]

[1] Justus Liebig Universität Giessen, [2] Technical University of Munich, [3] Center for Mind, Brain & Behavior

4-D-37 *Prior belief in another agent directly decreases our sense of agency*

Raz Leib [1], Niklas Heimburger [1], Sae Franklin [1], David Franklin [1]

[1] Technical University of Munich

4-D-38 *A modified Bayesian integration framework for the sense of agency*

Sae Franklin [1], Iain Hunter [1], David Franklin [1], Raz Leib [1]

[1] Technical University of Munich

4-D-39 *Optogenetic manipulation of peripheral sensory nerve activity: facilitation and suppression through ChR2 and eNpHR3.0*

Akito Kosugi [1], Moeko Kudo [1], Ken-Ichi Inoue [2], Masahiko Takada [2], Kazuhiko Seki [1]

[1] National Center of Neurology and Psychiatry, [2] Kyoto University

4-D-40 *Sequential planning is not always associated with a reaction time cost*

Armin Panjehpour [1], Mehrdad Kashefi [1], Joern Diedrichsen [1], J. Andrew Pruszynski [1]

[1] *University of Western Ontario*

4-D-41 *Partial interference between adaptive and flexible control policies indicates shared neural mechanisms*

Astrid Doyen [1], Philippe Lefèvre [1], Frederic Crevecoeur [1]

[1] *Université Catholique de Louvain*

4-D-42 *Assessing inter-subject variability in repetitive motion: canonical and idiosyncratic components of gait in healthy and pathological subjects*

Axel Roques [1], Samuel Gruffaz [2], Nicolas Vayatis [2], Pierre-Paul Vidal [3]

[1] *Centre Borelli (UMR9010),* [2] *Université Paris Saclay,* [3] *Centre Borelli*

4-D-43 *EMG-EMG coherence of muscle coupling during bimanual coordination: age-associated differences and the effect of visual feedback*

Brock Balthazor [1], Yiyu Wang [2], Osmar Pinto Neto [3], Madison Weinrich [1], Deanna Kennedy [1]

[1] *Texas A&M University,* [2] *Northeastern University,* [3] *Anhembi Morumbi University*

4-D-44 *Towards the study of cortico-striatal interactions underlying sensorimotor integration*

Catia Fortunato [1], Mostafa Safaie [1], Cecilia Gallego-Carracedo [1], Genji Kawakita [2], Joanna Chang [1], Bence Bagi [1], Jimmie Gmaz [1], Juan Gallego [1]

[1] *Imperial College London,* [2] *Swarthmore College*

4-D-46 *Muscle synergies in force field adaptation*

Michael Herzog [1], Denise Berger [2], Marta Russo [3], Andrea D'Avella [4], Thorsten Stein [1]

[1] *Karlsruhe Institute of Technology,* [2] *Fondazione Santa Lucia,* [3] *IRCCS Fondazione Santa Lucia,* [4] *University of Rome Tor Vergata*

4-D-47 *A novel approach to rapid TMS mapping for multiple upper limb muscles*

Mitsuaki Takemi [1], Kenjun Hayashida [1], Junichi Ushiba [1]

[1] *Keio University*

4-D-48 *Muscle coactivation primes the nervous system to quickly initiate and correct voluntary movements*

Philipp Maurus [1], Ameen Alizada [1], Tyler Cluff [1]

[1] *University of Calgary*

4-D-49 *Comparing motor skill learning processes and their impact on the properties of complex motor tasks*

Reshma Babu [1], Hannah Block [1]

[1] *Indiana University Bloomington*

4-D-50 *Using Neuropixels to compare neuronal population activity across the macaque fronto-parietal grasping network*

Roberta Nocerino [1], Jan Churan [1], Benjamin Dann [1], Hans Scherberger [1]

[1] *German Primate Center*

4-D-51 *Partial slips may inform fast grip force adaptation to heavier loads in the absence of visual cues.*

Sophie Du Bois De Dunilac [1], David Córdova Bulens [1], Stephen Redmond [1]

[1] *University College Dublin*

4-D-52 *Subcortical consolidation of a motor sequence depends on demands for flexibility*

Cheshta Bhatia [1], Pawel Zmarz [1], Bence Olveczky [1]

[1] *Harvard University*

4-D-53 *Motor imagery leads to predictive tactile suppression*

Dimitris Voudouris [1], Katja Fiehler [2]

[1] *Justus Liebig Universität Giessen,* [2] *University of Giessen*

4-D-54 *The impact of task on StartReact may be different from its influence on the startle reflex*

Ermyntrude Adjei [1], Kelsey Wright [1], Julius Dewald [2], Jun Yao [1]

[1] *Northwestern University,* [2] *Northwestern University Feinberg School of Medicine*

4-D-55 *Rotational population dynamics in lumbar spinal networks during locomotion of awake rats*

Rune Berg [1], Salif Komi [1], Jaspreet Kaur [1], Madelaine Bonfils [1], Jakob Sørensen [1]

[1] *University of Copenhagen*

4-D-56 *Hierarchical division of labor during cognitive-motor sequences*

Saurabh Vyas [1], Eric Trautmann [1], Tala Fakhoury [1], Ashok Litwin-Kumar [1], Michael Shadlen [2], Mark Churchland [1]

[1] *Columbia University,* [2] *Columbia University Medical Center*

E – INTEGRATIVE CONTROL OF MOVEMENT

4-E-58 *Vestibular signals differentially influence reach trajectory selection during planning versus execution*

Cesar Canaveral [1], Simon Haché [1], Léonie Vadnais-Cuddihy [1], Paul Cisek [1], Andrea Green [1]

[1] *Université de Montréal*

4-E-59 *Motor cortical dynamics during voluntary gait modification in the mouse*

Eric Kirk [1], Keenan Hope [1], Britton Sauerbrei [2]

[1] *Case Western Reserve University,* [2] *Case Western Reserve University School of Medicine*

4-E-60 *Supranormal proprioception in legally-blind individuals with residual vision*

Fabrice Sarlegna [1], Najib Abi Chebel [2], Florence Gaunet [1], Christine Assaiante [1], Pascale Chavet [2], Christophe Bourdin [3]

[1] *Centre National de la Recherche Scientifique,* [2] *Aix Marseille Université,* [3] *Protisvalor*

4-E-61 *Vestibular and visual contributions to online steering control*

Jo-Yu Liu [1], Luc Selen [1], James Cooke [1], W. Pieter Medendorp [2]

[1] *Radboud University,* [2] *Radboud University Nijmegen*

4-E-62 *Stimulation of the caudal origin of the frontal aslant tract (FAT) in the superior frontal gyrus impairs self-paced rhythmic movements independently from the effector*

Luigi Cattaneo [1], Marco Tagliaferri [1]

[1] *University of Trento*

4-E-63 *Progressively shifting patterns of co-modulation among premotor cortex neurons carry dynamically similar signals during action execution and observation*

Zhonghao Zhao [1], Marc Schieber [1]

[1] *University of Rochester*

4-E-64 *Intuitive grasping with tools. Awkward end postures are not automatically avoided when grasp orientation is rotated with respect to hand orientation*

Molly Hewitt [1], Ken Valyear [1], Simon Watt [1]

[1] *Bangor University*

4-E-65 *Neural representations of goal-directed reaching cued with unimodal and multimodal sensory information*

Nicholas Kreter [1], Michelle Marneweck [1]

[1] *University of Oregon*

4-E-66 *Function and manipulation tool knowledge in anterior temporal and superior parietal regions: an fMRI study with representational similarity analysis*

Ryo Ishibashi [1], Nobuhiro Hagura [1], Matthew Lambon Ralph [2]

[1] *National Institute of Information and Communications Technology,* [2] *University of Cambridge*

4-E-67 *Multiplicative joint coding in preparatory activity for reaching sequence in macaque motor cortex*

Tianwei Wang [1], Yun Chen [2], Yiheng Zhang [3], He Cui [2]

[1] *German Primate Center,* [2] *Chinese Institute for Brain Research,* [3] *Center for Excellence in Brain Science and Intelligence Technology*

4-E-68 *Muscle feedback in humans, an anticipatory system to prepare the body for changes in the environment*

Jean-Marc Aimonetti [1], Edith Ribot-Ciscar [2], Rochelle Ackerley [3]

[1] *Aix-Marseille Université,* [2] *CRPN,* [3] *CNRS CRPN*

F – POSTURE AND GAIT

4-F-70 *Locomotor variability reveals neuromechanical control modules for stability by foot placement in mice*

Antoine De Comite [1], Nidhi Seethapathi [1]

[1] *Massachusetts Institute of Technology*

4-F-71 *Aging effects on modulation of spinal excitability with balance task difficulty and cognitive dual task performance*

Camille Guzman [1], Michael Borich [2], Trisha Kesar [2]

[1] *Georgia Institute of Technology & Emory University,* [2] *Emory University*

4-F-72 *Dual task interference from auditory and visual secondary tasks do not interfere with walking in young adults with ADHD*

Cary Higgins [1], Jenna Yentes [1]

[1] *Texas A&M University*

4-F-73 *The role of postural demands on tactile perception in young and older adults*

Fabian Wachsmann [1], Dimitris Voudouris [1], Katja Fiehler [2]

[1] *Justus Liebig Universität Giessen,* [2] *University of Giessen*

4-F-74 *The Nodulus and Uvula in the primate cerebellum integrate vestibular and neck proprioceptive sensory information*

Robyn Mildren [1], Kathleen Cullen [1]

[1] *Johns Hopkins University*

4-F-75 *Spinal networks act as a continuous attractor during pause of movement*

Salif Komi [1], Jaspreet Kaur [1], Madelaine Bonfils [1], Jakob Sørensen [1], Nicolas Bertram [1], Rune Berg [1]

[1] *University of Copenhagen*

4-F-76 *The relationship between corticospinal tract connectivity and balance performance during non-steady state walking*

Shraddha Srivastava [1]

[1] *The Medical University of South Carolina*

4-F-77 *Conscious movement processing maladaptively reduces the cortical N1 response to discrete balance perturbations in healthy adults.*

Johnny Parr [1], Richard Mills [1], Adolfo Bronstein [2], Toby Ellmers [2], Elmar Kal [3]

[1] *Manchester Metropolitan University,* [2] *Imperial College London,* [3] *Brunel University London*

4-F-78 *Motor unit coordination during locomotion in mice*

Kyle Thomas [1], Rhuna Gibbs [1], Hugo Marques [2], Megan Carey [2], Samuel Sober [1]

[1] *Emory University,* [2] *Champalimaud Foundation*

4-F-79 *Neural correlates of complex arm reaches during different full-body contexts in freely moving rhesus macaques*

Zurna Ahmed [1], Irene Lacal [1], Matthias Nuske [2], Richard Vogg [2], Neda Shahidi [1], Florentin Wörgötter [3], Alexander Ecker [2], Alexander Gail [1]

[1] *German Primate Center,* [2] *University of Göttingen,* [3] *Department for Computational Neuroscience, Third Physics Institute, University of Göttingen*

G – THEORETICAL & COMPUTATIONAL MOTOR CONTROL

4-G-80 *Natural walking would require dynamic reflex gain modulation: Computational study*

Gunwoo Park [1], Seungwoo Yoon [1], Friedl De Groote [2], Seungbum Koo [1]

[1] *Korea Advanced Institute of Science and Technology,* [2] *Katholieke Universiteit Leuven*

4-G-82 *Sequential learning in recurrent neural networks create memory traces of learned tasks*

Joanna Chang [1], Claudia Clopath [1], Juan Gallego [1]

[1] *Imperial College London*

4-G-83 *Advancing prosthetic control: a dilated causal CNN-enhanced transformer framework for natural hand kinematics*

Jyotindra Narayan [1], Aldo Faisal [2]

[1] *University of Bayreuth,* [2] *Imperial College London*

4-G-84 *Action-based and sensory-based temporal predictions differentially dampen the perception of expected touch*

Ziliang Xiong [1], Xavier Job [2], Konstantina Kilteni [3]

[1] *Radboud University,* [2] *Karolinska Institutet,* [3] *Donders Institute for Brain, Cognition and Behavior, Radboud University*

4-G-85 *Mind in motion: investigating the interplay of cognition and movement*

Regina Zaghi-Lara [1], Luis M. Martinez [2], Felipe Criado-Boado [3]

[1] *CSIC Spanish National Research Council,* [2] *Instituto de Neurociencias de Alicante CSIC-UMH,* [3] *Instituto de Ciencias del Patrimonio*

4-G-86 *Optimal reaching subject to computational and physical constraints reveals structure of the sensorimotor control system*

Sridevi Sarma [1]

[1] *Johns Hopkins University*

4-G-87 *Shannon entropy as a framework for redundancy problem*

Mehmet Imir [1], Senih Gürses [1]

[1] *Middle East Technical University*

4-G-88 *Modeling the contribution of sensory feedback and internal models on motor cortex activity dynamics and task execution*

Muhammad Noman Almani [1], Shreya Saxena [1]

[1] *Yale University*

4-G-89 *The impact of haptic communication on coordination and role distribution in collaborative object manipulation*

Yiming Liu [1], Raz Leib [1], Aldo Faisal [2], David Franklin [1]

[1] *Technical University of Munich,* [2] *Imperial College London*

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Sabrina Abram, *University of California, Berkeley*

Sabrina Abram completed her PhD at Simon Fraser University with Max Donelan and is now a postdoctoral fellow at UC Berkeley, working with Rich Ivry. Sabrina is interested in how people learn. Her graduate work focused on how people use reinforcement learning to optimize energy during walking, and her current work investigates how reinforcement learning is implemented by the brain when people make decisions.

Inbar Avni, *Ben-Gurion University*

Dr. Inbar Avni earned her PhD from Ben-Gurion University, specializing in quantifying motor recovery post-stroke. Currently a postdoc at the University of Pittsburgh, her research explores neuroplasticity across various pathologies.

Chen Avraham, *Ben-Gurion University*

Chen Avraham is a PhD candidate in Biomedical Engineering at the Technion - Israel Institute of Technology. She conducts her research within the Neurorehabilitation and Sensorimotor Neuroscience Laboratory, under the supervision of Dr. Firas Mawase. She combines computational and behavioral approaches to study human motor skill learning.

Nicholas Card, *University of California, Davis*

Nicholas is a postdoctoral fellow in the Neuroprosthetics Lab at the University of California, Davis, where he's developing brain-computer interfaces to restore function to people with motor impairments. Nicholas completed his undergraduate and graduate training at the University of Pittsburgh, where he studied the organization of cortical motor circuitry in primates.

Eve Charbonneau, *Université de Montréal*

Eve Charbonneau received the bachelor's degree in physics from the Université de Montréal in 2019, where she is currently pursuing the Ph.D. degree in biomedical engineering with the Laboratory of Simulation and Movement Modeling. Her research activity is focused on simulation, biomechanics, perception-action coupling, and optimal control of acrobatic sports.

Anwesha Das, *Leibniz Institute for Neurobiology Magdeburg/ Otto von Guericke University Magdeburg*

I am a doctoral student working at Leibniz Institute for Neurobiology Magdeburg, Germany. I did my master's in neuroscience from National Brain Research Centre, India. In my PhD, I am investigating the role of short breaks in early motor sequence learning using behavioral paradigms and MEG, in healthy young humans.

Madeline Gilchrist, *Western University*

I am a PhD student working with Dr. Brian Corneil and Dr. Penny MacDonald at Western University in London, Ontario, Canada. My research investigates the generation and contextual control of express visuomotor responses in patients with Parkinson's disease and other movement disorders.

Naama Kadmon-Harpaz, *Harvard University*

Naama is a post-doctoral fellow at the Olveczky lab at Harvard, researching the roles of the motor cortex and the basal ganglia in motor learning. She completed her PhD with Prof. Tamar Flash at the Weizmann Institute, studying the neural computations underlying arm movements in primates.

Mehrdad Kashefi, *Western University*

Mehrdad Kashefi is a PhD candidate in the laboratory of Drs. Andrew Pruszynski, and Jörn Diedrichsen. He studies the neural mechanism of controlling long sequential actions with human behavior, artificial neural network simulations, and monkey electrophysiology.

Salif Komi, *University of Copenhagen*

I am a Post-Doctoral researcher in the group of Prof. Rune Berg at the University of Copenhagen. I earned a PhD in Neuroengineering from EPFL, Switzerland. I study the network mechanisms dictating the spinal population dynamics driving movements, from both computational and experimental perspectives.

Julius Koppen, *Erasmus Medical Center*

I am a PhD student at the Narain lab at Erasmus MC, The Netherlands, juggling my passions for neuroscience, triathlon, nurturing plants and functional programming. My aim is to contribute to our understanding of the brain by drawing upon a background in biophysics and a passion for software development.

Irene Lacal, *German Primate Center*

Irene Lacal is a postdoctoral researcher in Alexander Gail's Sensorimotor Group at the German Primate Center. Her work focuses on investigating the neural dynamics underlying action selection and execution during full-body movements. Her goal is to shed light on the neurophysiological basis of decision-making during unconstrained interactions with the environment.

Laureline Logiaco, *Massachusetts Institute of Technology*

Laureline Logiaco currently works at MIT with Ila Fiete. She was a graduate student advised by Angelo Arleo and Wulfram Gerstner, and a postdoc with Sean Escola and Larry Abbott at Columbia University. She uses theory, modeling, and data analysis to study the neural network mechanisms supporting motor control.

Jennifer Mak, *University of Pittsburgh*

Jennifer Mak is a PhD candidate in Bioengineering at the University of Pittsburgh. Her thesis work looks at how stroke affects the brain mechanisms that result in attention and motor dysfunction. The goal of her work is to ultimately develop technology-driven methods that will facilitate stroke rehab.

Tatiana Malevich, *University of Tuebingen*

I graduated from the HSE University (Moscow, Russia) with a master's degree in cognitive sciences and cognitive neuroscience. Since 2018, I have been working on my PhD project in the Lab of Dr. Ziad Hafed (University of Tuebingen, Germany), focusing on neurophysiology of visual and oculomotor systems.

Manuel Molano-Mazon, *Centre de Recerca Matematica*

I am a neuroscientist with a background in mathematics. I work at IDIBAPS (Barcelona) at the laboratory of Jaime de la Rocha, where I use computational tools to investigate decision-making. My latest work examines how decision evidence accumulation updates movement, revealing a systematic motor command adjustment in rats and humans.

Marion Naffrechoux, *Lyon Neuroscience Research Center (IMPACT Team)*

PhD student at Lyon Neuroscience Research Center and Dynamique Du Langage laboratory in France since 2020, I am working on Developmental Coordination Disorder and particularly on somatosensory deficits as an explanation of the motor disorder. In this context, I am interested in body representations for motor control.

Mattia Rigotti-Thompson, *Emory University and Georgia Institute of Technology*

Mattia is a PhD student at the Wallace H. Coulter Department of Biomedical Engineering, working under the guidance of Dr. Chethan Pandarinath. His research focuses on characterizing how intended movements are encoded by neural activity within the motor cortex, with the goal of improving practical use of brain-computer interfaces.

Janneke Schwaner, *University of California, Irvine; Katholieke Universiteit Leuven*

Janneke is currently a post-doc at KU Leuven, working with Prof Friedl de Groote. Her research focuses on the neuromechanics of unsteady, unpredictable locomotion. With the use of unique experimental- and novel modelling approaches she aims to better understand the integration of muscle mechanics and neural control to agile locomotion.

Surabhi Simha, *Emory University and Georgia Institute of Technology*

Surabhi Simha is a postdoctoral fellow in the Department of Biomedical Engineering at Emory University/Georgia Institute of Technology. In her PhD, she studied the principles underlying energy optimization in human gait. She is currently using computational models to study the role of muscle and muscle spindles in human behaviour.

Oliver Stanley, *Johns Hopkins University*

Oliver Stanley received his Bachelor of Science in Bioengineering and Neurobiology from the University of Washington, Seattle and is now a doctoral candidate in Biomedical Engineering at the Johns Hopkins University. Under the mentorship of Dr. Kathleen Cullen, his work leverages video, kimenatic, and electrophysiological recording to investigate how the brain uses vestibular information to ensure stable and accurate gaze, head, and limb movements during locomotion.

Juliana Trach, *Yale University*

Juliana Trach is a graduate student at Yale University. Her work examines interactions between cognitive and motor processing and how the structure of cognitive representations impacts behavior. In addition to research with adult populations, she uses fMRI to study learning and memory in infancy. She is advised by Sam McDougle and Nick Turk-Browne.

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