Society for the
Neural Control
of Movement
NCM

34th Annual Meeting

Panama City, Panama

Westin Playa Bonita

2025

SATELLITE MEETING
April 28, 2025

ANNUAL MEETING
April 29 – May 2, 2025

@ncm-soc | #NCMPan25 | ncm-society.org

Program at a Glance

Schedule is subject to change

Time
8:00
8:15
8:30
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Monday, 28-Apr

- **Registration /Information Desk Open**
- **Satellite Meeting**
- **First Timer Social** (18:30 - 19:30)
- **Opening Reception Westin Playa Bonita** (19:30 - 21:30)

Tuesday, 29-Apr

- **Registration / Information Desk Open**
- **Posters on Display**
- **Exhibits on Display**
- ***Session 1 Panel I*** *Thanawalla* (08:00 - 10:00)
- **Break** (10:00 - 10:30)
- ***Early Career Talk*** *Devika Narain* (10:30 - 11:05)
- ***Session 2 Individual I*** (11:05 - 13:05)
- ***Session 3*** **Posters, Exhibitors & Lunch** (13:05 - 15:30)
- ***Session 4 Panel II*** Singh (15:30 - 17:30)
- **NCM Board Meeting** (17:30 - 20:30)
- **Trainee Social** (17:30 - 18:30)
- **Free Time**

Wednesday, 30-Apr

- **Registration / Information Desk Open**
- **Posters on Display**
- **Exhibits on Display**
- ***Session 5 Panel III*** *Miller* (08:00 - 10:00)
- **Break** (10:00 - 10:30)
- ***Session 6 Individual II*** (10:30 - 12:30)
- ***Session 7*** **Posters, Exhibitors & Lunch** (12:30 - 15:00)
- ***Session 8 Panel IV*** *Liu* (15:00 - 17:00)
- **Members' Meeting** (17:00 - 17:30)
- **Free Time**

Thursday, 1-May

- **Registration / Information Desk Open**
- **Posters on Display**
- **Exhibits on Display**
- ***Session 9 Panel V*** *Hatsopoulos* (08:00 - 10:00)
- **Break** (10:00 - 10:30)
- ***Session 10 Panel VI*** *Capogrosso* (10:30 - 12:30)
- ***Session 11*** **Posters, Exhibitors & Lunch** (12:30 - 15:00)
- **Free Time and/or Excursions**
- **Free Time**

Friday, 2-May

- **Registration / Information Desk Open**
- **Posters on Display**
- ***Session 12 Panel VII*** *Wang* (08:00 - 10:00)
- **Break** (10:00 - 10:30)
- ***Session 13 Individual III*** (10:30 - 12:30)
- ***Session 14*** **Posters & Lunch** (12:30 - 15:00)
- ***Session 15 Panel VIII*** *Oby* (15:00 - 17:00)
- ***Distinguished Career Award*** *Richard Ivry* (17:00 - 18:00)
- **Closing Drinks Reception** (18:00 - 19:00)

Table of Contents

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,

It is my pleasure to welcome you to Panama City, Panama, for the 34th Annual Meeting of the Society for the Neural Control of Movement!

We are delighted to host our first-ever NCM meeting in Latin America, in a truly unique location— in a unique and vibrant setting where the continents of North and South America meet and the city is surrounded by remarkable biodiversity. This year's meeting will take place April 28 – May 2, 2025, at the Westin Playa Bonita Hotel.

We have an exciting program ahead, with an impressive number of submissions: 70 individual oral submissions, and 154 poster submissions. This year's satellite meeting, "New Frontiers at the Intersection of Cognition and Motor Control," organized by Sam McDougle (Yale), Dan O'Shea (Stanford), and Saurabh Vyas (Columbia), sets the stage for bold ideas. The satellite will bring together researchers across disciplines to explore pressing questions: What will it take to truly understand motor cognition? What should our moonshot goals be for the coming decade? And what kinds of collaborations and frameworks will help us get there?

Our main program features two outstanding keynote presentations. On Tuesday, April 29, we'll hear from Devika Narain, winner of the 2025 Early Career Award, who will share her innovative work on the neural basis of temporal precision in movement. Then, on Friday, May 2, we'll close the meeting with a keynote from Richard Ivry, our 2025 Distinguished Career Award recipient, whose trailblazing work on the cerebellum has shaped the way we think about cognition and action.

NIH funding—through an R13 conference grant from NINDS—has allowed us to provide vital support to trainees and early career researchers, ensuring the next generation of scientists can fully engage with and contribute to our field. We are also grateful for the generous support of our industry sponsors, which has helped expand access and increase opportunities for international participation.

As always, the NCM community remains a global one—we are proud to welcome delegates from 31 countries and to continue building diversity across our podium and program. In an era when international collaboration faces growing challenges, our shared commitment to supporting the global scientific community through open exchange and mutual learning feels more important than ever.

I would also like to extend deep thanks to the NCM leadership team: Adrian Haith (Vice-President and Program Chair), Alaa Ahmed (Secretary/Treasurer), Kazuhiko Seki (Academic Development Chair), and the entire Board of Directors. We welcome newly elected board members Nobuhiro Hagura and Elvira Pirondini and thank Samuel McDougle and Hansjörg Scherberger for continuing for a second term.

In addition to our scientific programming, we can gather for informal evening meet-ups in old Panama City, officially called Panamá Viejo — the first European city on the Pacific coast of the Americas and the starting point for expeditions to the Inca Empire. You can catch the bus on Wednesday evening at 18:30 to Old Panama City to explore and find unique bars, restaurants and new things to explore!

I look forward to an extraordinary meeting and to seeing many of you in person. Let's make this an energizing and forward-looking week for our community!

Warm regards,

Kathleen 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
Megan Carey[2]	*Champalimaud Center of the Unknown*	Portugal	2022 – 2025
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
Nina van Mastrigt*	*Justus-Liebig-Universität Gießen*	Germany	2024 - 2026
David Franklin[1]	*Technical University of Munich*	Germany	2024 - 2027
Neeraj Gandhi[2]	*University of Pittsburgh*	USA	2024 - 2027
Katya Kornysheva[1]	*University of Birmingham*	GBR	2024 - 2027
Lena Ting[1]	*Emory University & Georgia Tech*	USA	2024 - 2027

[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 2025 Annual Meeting:

NAME	INSTITUTION	COUNTRY	TERM
Nobuhiro Hagura	*National Institute of Information and Communication*	Japan	2025 - 2028
Samuel McDougle	*Yale University*	USA	2025 - 2028
Elvira Pirondini	*University of Pittsburgh*	USA	2025 - 2028
Hansjörg Scherberger	*German Primate Center*	Germany	2025 - 2028

NCM ADMINISTRATION

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

Podium Conference Services

- Michelle Smith
- 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
33rd Annual Meeting*	April 15 – 19, 2024	Dubrovnik	Croatia	Valamar Lacroma, Dubrovnik
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

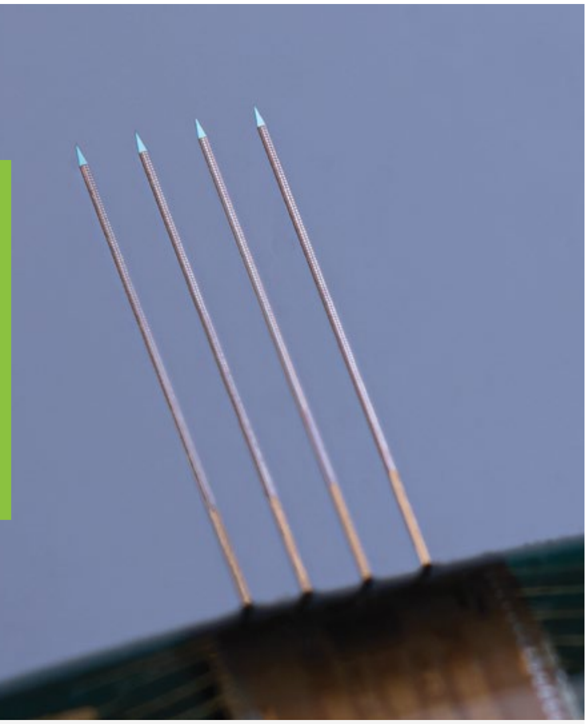
23rd Annual Meeting*	April 16 – 20, 2013	San Juan, Puerto Rico	USA	El San Juan Hotel & Casino
22nd Annual Meeting*	April 23 – 28, 2012	Venice	Italy	Hilton Molino Stucky
21st Annual Meeting*	April 26 – 30, 2011	San Juan, Puerto Rico	USA	El San Juan Hotel & Casino
20th Annual Meeting*	April 20 – 25, 2010	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	Apri 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

CMOS-APS Electrode

SiNAPS

Simultaneous Neural Recording Active Pixel Sensor Technology



Features of SiNAPS

Acquisition from All Pixels

Not limited to recording only a subset like other active probes

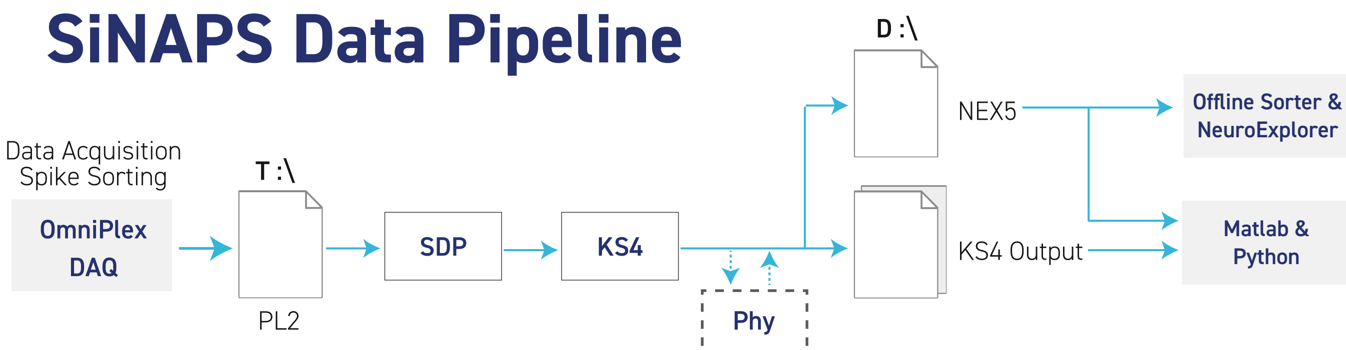
Single-Shank, Multi-Shank and New Long NHP Probes

256, 512, 1024 pixels, and up to 120mm in length now available

SiNAPS Data Pipeline (SDP)

Data Management and sorting with Kilosort 4

SiNAPS Data Pipeline



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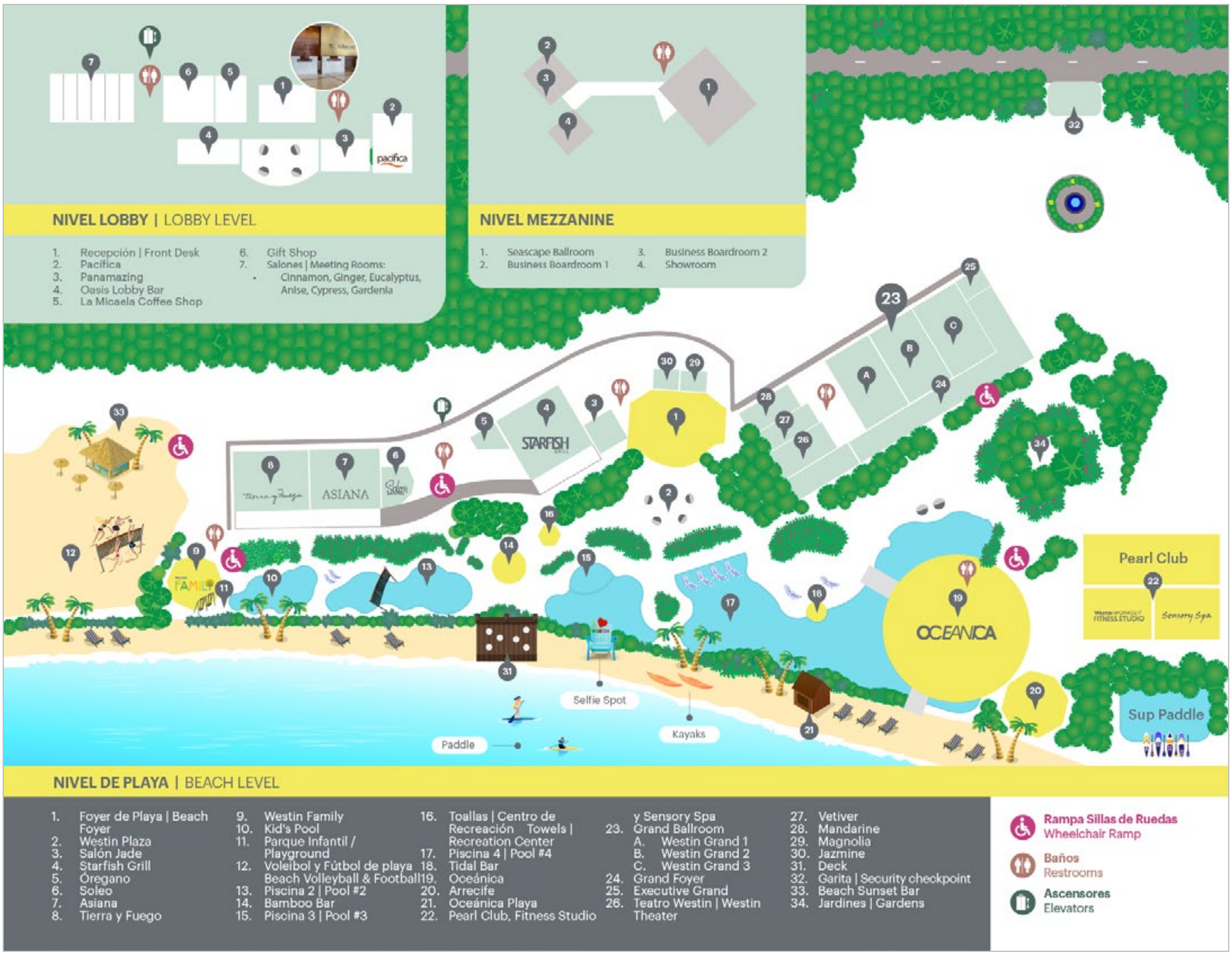
CONFERENCE VENUE

Westin Playa Bonita

Km 6 Camino a Veracruz
Panama City, Panama

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



REGISTRATION

SATELLITE MEETING

Satellite Meeting registration fees include access to the full day meeting with refreshment breaks and a buffet lunch on Monday April 28th.

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

YYour 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, trainee delegates have a banner on their name badge. 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 28	08:00 – 18:00
Tuesday, April 29	07:30 – 17:30
Wednesday, April 30	07:30 – 17:00
Thursday, May 1	07:30 – 15:00
Friday, May 2	07:30 – 18:00

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

POSTER INFORMATION

ANNUAL MEETING

There are two Poster Sessions during the Meeting and posters have been allocated to either 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 29, between 07:30 and 10:00
Remove:
Wednesday, April 30, no later than 17:30

POSTER SESSION 2

Set-up:
Thursday, May 1, between 07:30 and 10:00
Remove:
Friday, May 2, immediately after the poster session completion at 15:00

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 50. 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 **Westin Network** and **no password is required.** 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 #NCMPan25 @ncm_soc when referring to the meeting. We ask all NCM delegates to respect no live tweeting/posting 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/posts 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 Westin Playa Bonita is a completely non-smoking facility indoors.

CODE OF CONDUCT

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 28 19:30 – 21:30

OPENING RECEPTION

Location: **Beach Bar of the Westin Playa Bonita**

Wednesday, April 30 17:00 – 17:30

NCM MEMBERS MEETING

Location: **Grand Ballroom AB**

Friday, May 2 18:00 – 19:00

CLOSING DRINKS RECEPTION

Location: **Foyer outside the Grand Ballroom**

NCM Excursions

NCM invites you to take advantage of your visit to Panama City 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, MAY 1, 2025

THE PANAMA CANAL: A HISTORIC AND ENGINEERING MARVEL

15:30 – 18:00 (approximately)

Cost: $85 per person USD

Includes coach transportation, licensed guide, Miraflores Locks and Imax Theatre entrance fee, water and snacks

The Panama Canal, known as the 8th Wonder of the World, is a 50-mile (80 kms) ship channel that joins the Caribbean Sea and the Pacific Ocean. The Panama Canal shortcut greatly reduces the time for ships to travel between the Atlantic and Pacific oceans, enabling them to avoid the lengthy, hazardous route around the southernmost tip of South America. It is a key conduit for international maritime trade and one of the greatest works of engineering in history. The Miraflores Locks is one of three sets of locks, which work as water lifts, raising and lowering ships from sea level up to the Gatun Lake water level.

The visit includes the Imax Theater located at the Miraflores Locks, where guests will watch a short documentary that explains the history and functioning of the Canal; and Miraflores visitor center from which guests may have the opportunity to see ships going through the lock.

FROM COCOA TO CANE TOUR

15:30 – 18:00 (approximately)

Cost: $140 per person USD

Includes coach transportation, licensed guide, bottle of water, artisanal chocolate and rum tasting

Considered the most cosmopolitan capital in Central America, Panama offers a gastronomic experience due to its cultural history. It has also been designated by UNESCO among its "Creative Cities in Gastronomy" – a network formed to promote innovation and creativity for new urban, sustainable, and inclusive strategies.

Old Town is the perfect spot to indulge your senses while strolling through its narrow streets full of history with new and antique buildings. Old Town opens to its visitors the opportunity of going back in time, and reminiscing key moments of Panama's history.

During this walking tour, guests will stop at an artisanal chocolate laboratory where guests will activate senses while learning about the production of artisanal chocolate. The experience is complete with the creation of an individual custom chocolate bar.

Following the chocolate visit, guests will make their way to a rum bar with the opportunity to taste different artisanal rums with touches of flavours such as raspadura, molasses, coffee, and more.

PATHS OF HISTORY: EXPLORING THE OLD TOWN

15:30 – 18:00 (approximately)

Cost: $75 per person USD

Includes coach transportation, licensed guide, MOLA Museum Entrance, an audio device to ensure ease of hearing, bottled water and snacks

Experience the historical, charming, and vibrant neighborhood of Casco Antiguo. Casco Antiguo, also known as Casco Viejo, or the "old quarter", is Panama City's historic district. Considered a UNESCO Cultural World Heritage Site, the district dates back to 1673, and features vibrant plazas and picturesque brick-paved streets surrounded by colourful buildings.

During the walking tour, guests will encounter some religious history at the Metropolitan Cathedral of Panama City located in the main square, Plaza Mayor, as well as the Church of San Jose, famous for its amazing golden altar. Guests will also be taken to the Plaza de Francia, a beautiful plaza that pays homage to the French role in the construction of the Panama Canal. The plaza is also home to Las Bóvedas, a monument that was once used as a defence against pirate attacks. The tour will conclude with a visit to Paseo Esteban Huertas, where guests will have pristine views of the city skyline and bay.

The walking tour includes a visit to the MOLA Museum, a tribute to Panamian culture and art. In its five galleries, guests will learn about the history and evolution of the ancient art of creating molas, a fundamental piece of the traditional dress for women in the Guna community, one of the seven indigenous groups of Panama.

New frontiers at the intersection of cognition and motor control

NCM SATELLITE MEETING, PANAMA CITY, PANAMA

MONDAY, APRIL 28, 2025

Sessions held at the Westin Playa Bonita Hotel

The NCM conference has long been a venue for showcasing exemplary studies of intelligent behaviors. Many approaches have focused on how the sensorimotor system learns and generates movement. Separate studies have focused on how cognitive areas implement abstract thought and logical reasoning to guide actions over long timescales. Critically, despite the interconnectedness of these systems, current research rarely explores their interaction. How might we go about identifying and understanding the distributed circuits that implement cognitive-motor computations that convert thought into action? Perhaps the recent advent of large-scale neural measurement and manipulation technology will play a central role. However, is observation and causal manipulation sufficient, or are there still conceptual hurdles to overcome? Is this just a data science problem, or a theory problem? What does a more holistic understanding of the neural control of movement even look like?

There is a growing consensus that motor control and cognition are inherently intertwined, accompanied by a recognition that our field must focus on understanding their interaction within naturalistic behavior. However, the methods to achieve this remain unclear. We believe a central cause of this uncertainty is the absence of a unifying goal—a guiding beacon to aim for and a benchmark against which to measure progress. In essence, what will it mean to understand motor cognition? Will a deep learning model capable of goal-driven manipulation across diverse contexts suffice? Will we require a structured algorithmic understanding based on well-defined cognitive principles? Should we work backwards from neural recordings, reverse-engineering mechanisms from neural population dynamics, brain network interactions, and causal perturbations? Or should we proceed forward from tasks with well-understood solutions and clear hypotheses? Against this backdrop, the primary aim of this satellite meeting is to establish moonshot-style goals for our field in tackling motor cognition, setting forth a bold, measurable set of research objectives. Our speakers, drawn from robotics, cognitive science, and neurophysiology, will bring diverse perspectives on what progress will look like and what research programs are needed to achieve it. In panel discussions, we will focus the discussions on a "challenge question." We will ask panelists to broadly explore what they believe should be a measurable overarching goal for the study of their topic (e.g., long-range planning), and offer perspectives on how exactly they would go about achieving that goal. These discussions should inspire innovative research collaborations, elucidate a set of open problems, and guide the emerging scholars in our community who are now asking, "What's our field's big question for the next decade?"

The satellite is organized by:

Sam McDougle, *Yale University*

Dan O'Shea, *Stanford University*

Saurabh Vyas, *Columbia University*

MONDAY, APRIL 28

08:00 – 08:30 **REGISTRATION**

08:30 – 08:45 **OPENING REMARKS**

08:45 – 09:30 **OPENING KEYNOTE**

Computational principles underlying the learning of sensorimotor repertories

Daniel Wolpert, *Columbia University*

09:30 – 11:00 **SESSION 1**

The control of cognitive and motor sequences in frontal and parietal cortex

Theresa Desrochers, *Brown University*

Future movement plans during sequential reaching

Andrew Pruszynski, *Western University*

Exploring motor working memory

Hanna Hillman, *Yale University*

PANEL DISCUSSION

11:00 – 11:30 COFFEE BREAK

11:30 – 13:10 **SESSION 2**

Dynamical constraints on neural population activity

Emily Oby, *Queen's University*

A combinatorial neural code for long-term motor memory

Nuo Li, *Duke University*

Performance anxiety is associated with biases in learning from reward and punishment in skilled performers

Marta Herrojo Ruiz, *University of London*

PANEL DISCUSSION

13:10 – 14:30 LUNCH

14:30 – 16:10 **SESSION 3**

What is the role of cognition in motor skill learning?

Adrian Haith, *Johns Hopkins University*

Real-world object manipulation tasks: Where action meets cognition

Randy Flanagan, *Queen's University*

Cognitive maps of sensorimotor programs

Joonhee (Leo) Lee, *Johns Hopkins University*

PANEL DISCUSSION

16:10 – 16:30 COFFEE BREAK

16:30 – 17:15 **CLOSING KEYNOTE**

From intention to action: A theoretical treatment of the interface between cognition and motor control

Myrto Mylopoulos, *Carleton University*

17:15 – 17:30 **CLOSING REMARKS**

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.*

Annual Conference Schedule

All sessions will be held in the Westin Playa Bonita Hotel. Presentations will be in the Grand Ballroom AB with posters in Grand Ballroom C and foyer.

DAY 1 MONDAY, APRIL 28, 2025

19:00 – 19:30 **FIRST TIMER SOCIAL**

Soleo Bar

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**

Beach Bar

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 outside at the beach to kick off the annual conference!

DAY 2 TUESDAY, APRIL 29, 2025

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

Cerebellar circuit elements for the control of limb movement

Organizer: **Ayesha Thanawalla**
Discussant: **Eiman Azim**

Ayesha Thanawalla [1], Alice Geminiani [2], Abdulraheem (Abed) Nashef [3], Meike Van Der Heijden[4]

[1] Salk Institute for Biological Studies, [2] Champalimaud Center for the Unknown, [3] University of Colorado School of Medicine, [4] Virginia Tech

10:00 – 10:30 BREAK

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

Prior beliefs for predicting movements: From neurons to manifolds

Devika Narain, *Erasmus Medical Center*

11:05 – 13:05 **SESSION 2, INDIVIDUAL I**

OS1.1 - ***Neuroethology of bodily and manual actions in freely moving monkeys***

Luca Bonini [1]
[1] University of Parma
Presenting Author: **Luca Bonini**

OS1.2 - *Motor cortical influence during ethological motor behavior*

Andrew Miri [1], David Xing [1], Amy Kristl [1], Natalie Koh [1], Zhengyu Ma [1]

[1] *Northwestern University*

Presenting Author: **Andrew Miri**

OS1.3 - *Motor cortical dynamics during reaching connect posture-specific attractors*

Mehrdad Kashefi [1], Jonathan Michaels [2], Joern Diedrichsen [1], J. Andrew Pruszynski [1]

[1] *Western University,* [2] *York University*

Presenting Author: **Mehrdad Kashefi**

OS1.4 – *Conditioning of limb impedance affects adaptation to novel dynamics*

Iain Hunter [1], Sae Franklin [1], Raz Leib [1], David Franklin [1]

[1] *Technical University of Munich*

Presenting Author: **Iain Hunter**

OS1.5 - *Population dynamics in the motor control and restoration of head stabilization driven by vestibular pathways during locomotion*

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

[1] *Johns Hopkins School of Medicine*

Presenting Author: **Ruihan Wei**

OS1.6 - *Hierarchical model balancing efficiency and safety in human motor control*

Tjasa Kunavar [1], Jan Babic [1], Erhan Oztop [2], Mitsuo Kawato [3]

[1] *Jozef Stefan Institute,* [2] *Ozyegin University,* [3] *ATR Brain Information Communication Research Laboratory*

Presenting Author: **Tjasa Kunavar**

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

15:30 – 17:30 SESSION 4, PANEL II

From motion to action: Neural mechanisms of interceptive sensorimotor control

Organizer: **Tarkeshwar Singh**
Discussant: **John Douglas Crawford**

Tarkeshwar Singh [1], He Cui [2], Neeraj Gandhi [3], Deborah Barany [4]

[1] *Pennsylvania State University,* [2] *Chinese Institute for Brain Research, Beijing,* [3] *University of Pittsburgh,* [4] *University of Georgia*

17:30 – 18:30 *The Gardens, weather permitting*

TRAINEE SOCIAL

Sponsored by: REALITY LABS

All trainees 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.

DAY 3 WEDNESDAY, APRIL 30, 2025

08:00 – 10:00

SESSION 5, PANEL III

Poking the manifold: leveraging modeling, learning, and perturbations to causally test latent dynamics

Organizer: **Lee Miller**
Discussant: **Matthew Perich**

Lee Miller [1], Dan O'Shea [2], Alex Cayco Gajic [3], Ian Oldenburg [4]
[1] Northwestern University, [2] Stanford University, [3] École Normale Supérieure, Paris, [4] Rutgers University

10:00 – 10:30 BREAK

10:30 - 12:30

SESSION 6, INDIVIDUAL II

OS2.1 - *Motor adaptation in redundant input spaces occurs through changes in both internally-generated feedforward control and sensory-driven feedback control*

Katherine Perks [1], Lydia Smith [1], Sam Burden [1], Amy Orsborn [1]
[1] University of Washington

Presenting Author: **Katherine Perks**

OS2.2 - *Region-specific neural dynamics and interactions during complex dexterous movements*

Ahmet Arac [1], Sanjay Shukla [1], Erica Nagase [1], Alan Yao [1], Nicolas Jeong Lee [1], Kate Santoso [1], Emily Stenzler [1], Kasey Kim [1], David Lipkin [1], Angela Kan [1], Christina Abdishoo [1]
[1] University of California, Los Angeles

Presenting Author: **Ahmet Arac**

OS2.3 - *Hierarchical state decoding for seamless selection between multiple iBCI functions*

Anna Pritchard [1], Samuel Nason-Tomaszewski [1], Brandon Jacques [1], Yahia Ali [2], Kaitlyn Tung [3], Payton Bechefsky [4], Leigh Hochberg [5], Nicholas Au Yong [1], Chethan Pandarinath [1]

[1] Emory University and Georgia Institute of Technology, [2] Georgia Institute of Technology & Emory University, [3] Georgia Institute of Technology, [4] Coulter Department of Biomedical Engineering, Emory University and Georgia Tech, [5] Brown University

Presenting Author: **Anna Pritchard**

OS2.4 - *A novel peripheral neural interface to manipulate limb movement through myocontrolled optogenetic sensory nerve stimulation*

Akito Kosugi [1], Moeko Kudo [1], Shiro Egawa [1], Ken-Ichi Inoue [2], Masahiko Takada [2], Kazuhiko Seki [1]

[1] National Center of Neurology and Psychiatry, [2] Kyoto University

Presenting Author: **Akito Kosugi**

OS2.5 - *Developing a sensory representation of an extra robotic digit*

Lucy Dowdall [1], Giulia Dominijanni [2], María Molina [1], Edmund Da Silva [1], Fumiya Lida [1], Matteo Bianchi [3], Dani Clode [1], Tamar Makin [1]

[1] University of Cambridge, [2] École Polytechnique Fédérale de Lausanne, [3] University of Pisa

Presenting Author: **Lucy Dowdall**

OS2.6 – *Neuro-musculoskeletal modeling reveals muscle-level neural dynamics of adaptive learning in sensorimotor cortex*

Mackenzie Weygandt Mathis [1]

[1] EPFL

Presenting Author: **Mackenzie Mathis**

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

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

The role of Basal Ganglia in complex walking: implications for aging and neurodegenerative diseases

Organizer: **Shuqi Liu**
Discussant: **Gelsy Torres-Oviedo**

Shuqi Liu [1], Julia Choi [2], Caterina Rosano [1], Katrina Nguyen [3]

[1] University of Pittsburgh, [2] University of Florida, [3] University of Colorado Anschutz Medical Campus

17:00 – 17:30 **NCM MEMBERS MEETING**

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

18:30 **CATCH A BUS TO OLD TOWN** from the hotel front entrance!

Limited to the first 100 people

8:00 – 10:00 **SESSION 9, PANEL V**

Sensorimotor control of the tongue during feeding and voluntary movement sequences

Organizer: **Nicholas Hatsopoulos**
Discussant: **Callum Ross**

Nicholas Hatsopoulos [1], John Barrett [2], Ellen Lumpkin [3], Dan O'Connor [4]

[1]University of Chicago, [2] Northwestern University, [3] University of California, Berkeley, [4] Johns Hopkins School of Medicine

10:00 – 10:30 BREAK

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

Single-neuron dynamics: unveiling the single-cell type underpinnings of behavior, disease phenotypes, and therapy in motor disorders

Organizer & Discussant: **Marco Capogrosso**

Marco Capogrosso [1], George Mentis [2], Kimberly Dougherty [3], Claudia Kathe [4], Thomas Hutson [5], Serena Donadio [6]

[1] University of Pittsburgh, [2] Columbia University, [3] Drexel University, [4] University of Lausanne, [5] Wyss Center for Bio and Neuroengineering, [6] Rehab and Neural Engineering

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

15:00 – onwards FREE TIME AND TICKETED EXCURSIONS

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

Computational mechanisms underlying contextual modulation in motor learning

Organizer: **Tianhe Wang**
Discussant: **Samuel McDougle**

Tianhe Wang [1], Apoorva Sharma [2], Kahori Kita [3], Daniel Wolpert [4]

[1] *University of California, Berkeley,* [2] *Yale University,* [3] *Johns Hopkins University,* [4] *Columbia University*

10:00 – 10:30 BREAK

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

OS3.2 - *Determining the cognitive contributions to reduced movement vigor in people with Parkinson's disease*

Jonathan Wood [1], Amanda Therrien [1], Aaron Wong [1]

[1] *Thomas Jefferson University*
Presenting Author: **Jonathan Wood**

OS3.3 - *Walking toward riches: reward pays the cost of effort*

Chadwick Healy [1], Alaa Ahmed [2]

[1] *University of Colorado,* [2] *University of Colorado, Boulder*
Presenting Author: **Chadwick Healy**

OS3.4 - *Reward influences movement vigor through multiple motor cortical mechanisms*

Adam Smoulder [1], Patrick Marino [2], Emily Oby [3], Sam Snyder [2], Steven Chase [1], Aaron Batista [2]

[1] *Carnegie Mellon University,* [2] *University of Pittsburgh,* [3] *Queen's University*
Presenting Author: **Adam Smoulder**

OS3.5 - *Muscle spindles provide flexible sensory feedback for movement sequences*

William P. Olson [1], Varun Chokshi [1], Jeong Jun Kim [1], Noah J. Cowan [1], Daniel H. O'Connor [1]

[1] *Johns Hopkins School of Medicine*
Presenting Author: **Daniel O'Connor**

OS3.6 - *Understanding surprise: Dual predictive systems in whisker sensorimotor control*

Ritu Roy Chowdhury [1], Kalpana Gupta [1], Yuyao Sun [1], Franziska Gekeler [1], Shubodeep Chakrabarti [1], Cornelius Schwarz [1]

[1] *Eberhard Karls University of Tübingen*
Presenting Author: **Ritu Roy Chowdhury**

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

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

Inter-area communication for motor control

Organizer & Discussant: **Emily Oby**

Emily Oby [1], Matthew Perich [2], Sam Snyder [3], Stefan Lemke [4], Maureen Hagan [5]

[1] *Queen's University,* [2] *Université de Montréal,* [3] *University of Pittsburgh,* [4] *University of North Carolina,* [5] *Monash University*

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

Notes from the Underground: Psychological perspectives on cerebellar function

Richard Ivry, *University of California, Berkeley*

18:00 – 19:00 CLOSING DRINKS RECEPTION

Foyer

TUESDAY, APRIL 29, 2025

08:00 – 10:00 SESSION 1, PANEL I

Cerebellar circuit elements for the control of limb movement

Ayesha Thanawalla [1], Alice Geminiani [2], Abdulraheem (Abed) Nashef [3], Meike Van Der Heijden[4]

[1] Salk Institute for Biological Studies, [2] Champalimaud Center for the Unknown, [3] University of Colorado School of Medicine, [4] Virginia Tech

Discussant: **Eiman Azim**

The ability to perform a wide repertoire of movements with precision and to maintain accuracy despite environmental changes relies on neural circuitry in the central nervous system. The cerebellum has long been known to play a critical role in controlling movement and adapting to environmental perturbations. The cerebellum is thought to refine and adapt movement through learning and implementing an internal model that predicts the outcome of motor commands, rapidly adjusts ongoing movement, and reduces error on subsequent actions. Crucial to its ability to learn, Purkinje cells in the cerebellar cortex receive instructive signals from climbing fibers that originate in the inferior olive and synapse onto Purkinje cells, whose dendrites are major sites for plasticity in the cerebellum. While the cerebellar cortex is thought to be the computational hub of the cerebellum, the cerebellar nuclei receive input from the Purkinje cells and, through its widespread connectivity, communicate with the brain and spinal cord, allowing the cerebellum to influence downstream motor structures. Defining how specific components orchestrate cerebellar learning and motor refinement at a circuit level benefits from a cell type- and pathway-specific approach. By describing recent advances in our understanding of the role of distinct cerebellar circuit elements, this panel aims to emphasize the insights into cerebellar function obtained through cell type-specific approaches in mice. Four speakers were selected for their ongoing work exploring distinct components of cerebellar circuitry. Alice Geminiani (Carey lab) will present optogenetic evidence that climbing fibers provide instructive signals for locomotor adaptation, thus being essential for cerebellar control of whole-body limb movement. Abed Nashef (Person lab) will describe a Purkinje neuron rate and synchrony code that is correlated with specific kinematic features during skilled reaching movements, shedding light on the interaction between Purkinje neurons and the cerebellar nuclei that facilitate online control of movement. Ayesha Thanawalla (Azim lab) will present work defining distinct cerebellar output networks and the rapid bidirectional control of forelimb kinematics and muscle activity by cerebellar nuclear neurons. Meike van der Heijden will describe the neural activity of cerebellar nuclear neurons that distinctly represent cerebellar-associated motor disorders – tremors, ataxia, and dystonia. Eiman Azim will lead a panel discussion focussing on key themes, including: a) How cell-specific interrogation of neural circuits is revealing new insight into cerebellar function; b) How distinct cerebellar circuit elements may function in motor learning vs motor execution; c) The degree to which disruption in any of these pathways influences cerebellar-linked movement disorders; d) how to facilitate increased interaction between those studying cerebellar function in mice and primates.

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

Prior beliefs for predicting movements: from neurons to manifolds

Devika Narain, *Erasmus Medical Center*

Timing and motor control are inexorably linked, and from this interplay emerge various feats of motor precision that pervade the animal kingdom. Yet, laboratory measurements of the timing of movements are riddled with variability and biases that paint a contrasting picture. Previous work has sought to resolve this conundrum using Bayesian theory, which formalizes how prior beliefs about temporal variables shape precise actions under environmental uncertainty. While these frameworks account for various behaviors in different domains, the neural mechanisms underlying the acquisition and use of such prior beliefs continue to elude us. Here, we propose a role for cerebellar circuits in acquiring prior knowledge to shape rudimentary predictive motor behaviors, such as the conditioned eyelid response in Pavlovian eyeblink conditioning. We will show evidence that cerebellar Purkinje cells encode probability distributions of the stimuli and propose a mechanism for how this manifests in the kinematics of the motor output. Furthermore, at the population level, we will show that cerebellar cortical dynamics assume a topological organization in the form of curved manifolds, which encode prior knowledge along the curvature of these topologies. In the second part of the talk, we will present methodological work that aims to unravel topologies and embed these in their intrinsic dimensions to decode task-relevant information. Towards the end, we will use this method to test the hypothesis that the curvature of neural manifolds encodes prior knowledge in sensorimotor timing tasks. Overall, we will propose a neural mechanism for how prior beliefs for the temporal control of movements are acquired by neurons and eventually encoded in the topologies of populations, while adhering to the predictions of normative theory that explain the emergence of precise sensorimotor timing behaviors.

11:05 – 13:05 SESSION 2, INDIVIDUAL I

OS1.1 - *Neuroethology of bodily and manual actions in freely moving monkeys*

Luca Bonini [1]

[1] *University of Parma*

Presenting Author: **Luca Bonini**

Decades of brain research on the cortical motor system have leveraged nonhuman primates to investigate the anatomo-functional organization of voluntary, goal-directed actions. However, the concept of "goal" and its relationship to the voluntary nature of an action remain widely debated. Studies using intracortical microstimulation (ICMS) have revealed that the frontal motor system encodes final postures of multiple body parts resembling those seen in natural actions. Single-neuron recordings suggest that premotor neurons encode the achievement of specific outcomes, such as reaching a spatial location or obtaining a piece of food, often independently of the sequence of extension-flexion movements or even the effector used to achieve them. This supports the idea that goal coding is a key organizational principle of the premotor cortex. However, these studies are derived from laboratory experiments in restrained contexts (RCs), under the assumption that this knowledge generalizes to freely moving contexts (FMCs). To date, no study has directly investigated the premotor control of natural actions in freely moving monkeys.

To fill this gap, we developed a neuro-behavioral platform enabling stepwise wireless recording of the same premotor neurons in both RC and FMC while filming two monkeys' behavior with a multicamera system. We found that neurons often encoded the same hand and mouth actions differently in RC and FMC. Furthermore, in FMC, we identified cells selectively encoding actions untestable during RC and others displaying mixed selectivity for multiple actions, consistent with an organization based on cortical motor synergies rather than action goals at different levels of complexity. Interestingly, cross-context decoding of the actions testable in both contexts demonstrated that neural activity in FMC is richer and more generalizable to RC than vice versa, possibly due to the coordinated control of head movement with specific effectors, such as the hand and the mouth, as revealed by head-free ICMS. During reaching-grasping actions directed at objects of different sizes in FMC, we could accurately decode both head movements and grip types, suggesting the existence of previously overlooked synergistic control of distal and proximal motor components in the premotor cortex underlying the flexible organization of primate natural actions.

Our findings support the relevance of neuroethological approaches in unveiling the neural bases of spontaneous, natural behaviors.

11:05 – 13:05 OS1.2 - *Motor cortical influence during ethological motor behavior*

Andrew Miri [1], David Xing [1], Amy Kristl [1], Natalie Koh [1], Zhengyu Ma [1]

[1] *Northwestern University*

Presenting Author: **Andrew Miri**

It remains poorly resolved when and how motor cortical output directly influences muscle activity through descending projections. The involvement of motor cortex in motor learning and movement preparation complicates the interpretation of lesion and other inactivation results vis-à-vis movement execution, as disturbance to processes on which execution depends can impede execution itself. Direct motor cortical influence could take several possible forms: motor cortex could drive the totality of limb muscle activity patterns, it could participate in unison with the rest of the motor system in generating motor output without playing a necessary role, or it could selectively influence particular components of muscle activity, such that it informs ("instructs") ongoing muscle activity pattern.

To address when and how motor cortical output directly influences muscle activity, we combined optogenetic silencing, electromyography, and Neuropixels recording in mice performing a naturalistic climbing behavior where they effectively traverse an unpredictable terrain. We found that during climbing, the caudal forelimb area (CFA, rodent homolog of forelimb M1) informs muscle activity pattern, acting mainly by selectively exciting certain muscles while exerting smaller, bidirectional effects on their antagonists. Analysis of Neuropixels recordings identified components of CFA activity that correlate with its short latency influence on muscles. These components partially overlap with those that correlate with muscle activity, but are entirely different from those that correlate with forelimb kinematics. This suggests that selective motor cortical influence does not rely on the activity components the field has traditionally focused upon. We also discovered that a substantial fraction of CFA neurons are primarily active during a very limited subset of the forelimb muscle activity states that occur during climbing. This is analogous to the firing of many hippocampal neurons only at particular locations within an environment. These CFA firing patterns are not consistent with the idea that motor cortical activity is well-described as a low-dimensional linear dynamical system.

We have also extended our approach to mice freely exploring an arena that elicits a broad range of naturalistic behaviors, including stereotyped, species-typical behaviors like eating and grooming, and those that challenge agility and dexterity like climbing and walking on an irregular grid. Results here suggest that selective direct motor cortical influence extends to a broad range of naturalistic behaviors. We have also found that CFA's influence on muscles during climbing is substantially larger than during single-forelimb reaching, suggesting a substantial behavioral dependence of direct motor cortical influence. Other results indicate that this variation across behaviors extends to CFA's interactions with the rostral forelimb area, the rodent homolog of forelimb premotor cortex, as well.

11:05 – 13:05 OS1.3 - *Motor cortical dynamics during reaching connect posture-specific attractors*

Mehrdad Kashefi [1], Jonathan Michaels [2], Joern Diedrichsen [1], J. Andrew Pruszynski [1]

[1] *Western University*, [2] *York University*

Presenting Author: **Mehrdad Kashefi**

One of the central questions in motor neuroscience is how the population of motor cortical neurons control voluntary movement. Much of our current understanding of this question is based on so-called center-out reaching tasks that involve reaching from a single start location to various spatial targets — a situation that confounds reach direction with limb posture at the spatial target. Because of this confound, previous studies lack the required condition variability to probe the geometry of neural dynamics (NDs) for movements across different postures and extents. To address this confound, we trained two macaques to move their arm between all possible combinations of five targets located on the vertices and at the center of a rectangle in a 2D exoskeleton (KINARM). This target geometry allowed us to dissociate the abstract cue of the final target from the direction of the reach in certain trial types. For example, diagonal reaches included movements with the same start location and in the same direction but with different extents. Similarly, some reaches shared the same final target and direction but began from different starting locations. We used Neuropixels probes to record single-unit activity from multiple brain regions in two monkeys. In Monkey M, we recorded from primary motor cortex (M1; N=962) and dorsal premotor cortex (PMd; N=833). In Monkey P, we recorded from M1 (N=1310), PMd (N=620), the supplementary motor area (SMA; N=590), pre-SMA (N=310), dorsolateral prefrontal cortex (dlPFC) (N=380), and the internal segment of the globus pallidus (GPi, N=549). In both monkeys, in M1 and PMd, we observed an elegant compositional arrangement of NDs for movement with different postures, extents, and directions with two striking features. First, a posture subspace with attractor points for each spatial target. These attractors were visited whenever the arm rested in its respective target before or after the reach. Second, rotational dynamics that linked the attractor points. These rotational patterns were aligned such that more similar rotational dynamics were associated with more similar reach directions. In monkey P, we could decode start and end locations and movement extent from all recorded sites, though dynamics' geometry differed significantly across regions. To gain mechanistic insight, we trained recurrent neural networks (RNNs) to control a biomechanical arm in a 2D workspace and analyzed their NDs in the same 5-target task. A posture subspace emerged consistently across training parameters. However, RNN dynamics most closely resembled M1/PMd when two factors were applied: (1) regularization of hidden activity smoothness and (2) a spinal RNN module between the main RNN and the arm model. Our work provides fundamental insight into the geometry of NDs in the primate motor cortex during self-initiated reaching, with important implications for brain-computer interface design.

11:05 – 13:05 OS1.4 - *Conditioning of limb impedance affects adaptation to novel dynamics*

Iain Hunter [1], Sae Franklin [1], Raz Leib [1], David Franklin [1]

[1] *Technical University of Munich*

Presenting Author: **Iain Hunter**

Adaptation to changes in our environment is accompanied by increased muscle co-contraction. This increases the mechanical impedance of the limbs, which resists changes in the environment until a more efficient control strategy, such as a predictive controller, is learned. Increased co-contraction is particularly important for stabilizing motion in unstable and unpredictable environments. However, the impact of co-contraction on adaptation and generalization is relatively understudied. Heald et al., (2018) used explicit commands to increase co-contraction and showed that this accelerates motor learning, but did not examine the underlying mechanism. Here we examine how prior conditioning of co-contraction affects the adaptation to novel dynamics, and the generalization of the motor memory.

Participants were randomly assigned to either high or low impedance groups. Electromyographic (EMG) activity was recorded from six muscles (three antagonistic pairs) throughout the experiment. Participants grasped the handle of a robotic manipulandum and performed 2,450 reaching movements. The protocol included pre-exposure (450 trials in the null field (NF)), conditioning, and exposure phases. During the conditioning phase, participants performed 1000 trials to a single target either in the NF (low impedance group), or in a divergent force field (high impedance group) to promote changes in muscle co-contraction. Finally, all participants performed 1000 reaches to a single target (0°) in a counterclockwise curl field (CF). Force channel trials were interspersed throughout the pre-exposure, conditioning and exposure phases, to enable measurement of force compensation and generalization.

Prior conditioning successfully altered the co-contraction in each group, causing differences in early adaptation to the force field. The high impedance group produced small kinematic errors, relative to those generated by the low impedance group. The low impedance group demonstrated higher variability of adaptation, however, both groups had similar speeds of adaptation to the force field. This may be due to a rapid increase in co-contraction in the low impedance group. Interestingly, the difference in the initial errors affected the spatial generalization of learning. Participants in the high impedance group exhibited more localized adaptation compared to the low impedance group, who generalized across a wider range of target directions. This suggests that increased impedance enhances error correction in the state space experienced during training, consistent with the motion-referenced learning framework. Overall, our work demonstrates that increased impedance narrows the generalization of motor memory.

11:05 – 13:05 OS1.5 - *Population dynamics in the motor control and restoration of head stabilization driven by vestibular pathways during locomotion*

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

[1] *Johns Hopkins School of Medicine*

Presenting Author: **Ruihan Wei**

Vestibulospinal reflexes are essential for maintaining balance and head stability during locomotion. Individuals with vestibular sensory loss suffer from severe gaze instability and postural imbalance, significantly impairing their mobility. The vestibulo-collic reflex in particular, which activates neck muscles in response to head movement, is thought to play a central role in stabilizing the head during locomotion. We thus sought to better understand vestibular contributions to head stability and motor control strategies across different locomotion contexts, as well as to determine the effectiveness of prosthetic vestibular stimulation at restoring function. We recorded single and multi-motor unit activity in the splenius capitis and sternocleidomastoid muscles using intramuscular EMG in normal monkeys, monkeys with complete bilateral vestibular loss (BVL), and BVL monkeys during head-coupled vestibular prosthetic stimulation. Head and trunk positions were tracked using a head-mounted 6D motion sensor and marker-based tracking systems, while limb movements were analyzed using high-speed video and DeepLabCut. Single and multi-motor unit activity and head stabilization were evaluated during overground and treadmill walking at various speeds. Principal components analysis was applied to the EMG data to quantify population muscle activation for each locomotor context.

In normal monkeys, neck motor unit recruitment was gait phase-locked and antagonistic, facilitating effective head stabilization under various walking conditions. Principal component analysis revealed a consistent activation geometry that scaled with speed during treadmill walking. In contrast, speed-matched overground walking displayed a distinct geometry with heightened neck muscle responses and enhanced head stabilization. Following bilateral vestibular loss, monkeys exhibited pronounced head oscillations and inadequate compensation for body motion, with reduced phase-locking of neck muscle activity. BVL monkeys failed to adopt a consistent strategy across speeds, although overground walking retained a unique activation geometry compared to speed-matched treadmill locomotion. With head-coupled vestibular prosthetic stimulation, the head motion became more stable, and the gait phase-dependent modulation of neck muscle recruitment was restored. Population-level muscle activity regained a motor control strategy again displaying a consistent activation geometry that scaled with speed during treadmill walking and a unique activation geometry during overground walking.

In summary, our results first reveal the presence of population-based motor strategies within and between conditions during simple, innate behaviors, which enable flexible control of head stabilization. In addition, our findings demonstrate the critical role of the vestibular system in coordinating neck motor activity to generate compensatory head movements, ensuring head stabilization in space during locomotion. Finally, our results indicate that prosthetic stimulation can restore the control strategies that the brain uses to maintain balance and head stability during natural behavior, which may provide a foundation for advancing the treatment of vestibular dysfunction by improving strategies for restoring effective locomotion in affected individuals.

11:05 – 13:05 OS1.6 - *Hierarchical model balancing efficiency and safety in human motor control*

Tjasa Kunavar [1], Jan Babic [1], Erhan Oztop [2], Mitsuo Kawato [3]

[1] *Jozef Stefan Institute,* [2] *Ozyegin University,* [3] *ATR Brain Information Communication Research Laboratory*

Presenting Author: **Tjasa Kunavar**

Our research presents a novel perspective on motor learning, exploring how ecological fitness (organism's specific traits and abilities that aid survival in its environment) factors into human motor control. Our sensorimotor system is crucial for ecological fitness since it enables adaptive movement control vital for survival. We delve into how ecological factors contribute to survival by enhancing movement efficiency, while considering the risk of injury associated with failure. Existing motor control theories, which primarily focus on isolated body movements, often neglect these ecological aspects. By redefining computational motor control optimality to incorporate ecological fitness, we propose a strategy that alternates between success-driven efficiency and failure-driven safety. This insight was made possible by an experimental paradigm specifically designed to challenge the sensorimotor system with the realistic possibility of failure and injury risk, underscoring the robustness of the adaptive strategies we identified. Our experimental paradigm involved whole-body squat-to-stand motions with novel backward force perturbations. An integral part of the learning process were failures - movements when the participant lost postural balance and had to make corrective steps to prevent a fall. Participants adapted to the perturbed squat-to-stand movements and dramatically reduced failures, while showing various adaptations to prevent falls. We show that computational motor learning mechanisms of the brain are not flat and utilize hierarchical organization for efficiency, adaptability and robustness. Our data suggests a top-level ecological controller in human motor learning, optimizing for safety or efficiency based on failure or success, to form motor plans to be used by lower-level control. Adaptation of motor plan occurs through fast reinforcement learning mechanism after failed execution of motion. To achieve the intended plan, motor control processes encompass internal model learning and feedback gain tuning mechanisms in addition to the feedback control. Adaptation of motor control is slower and predominantly occurs as a result of adaptation of internal model during movement execution irrespective of movement success. This new model provides a more holistic view of human motor control, integrating risk management in a hierarchical learning system applicable to ecological situations.

15:30 – 17:30 SESSION 4, PANEL II

From motion to action: Neural mechanisms of interceptive sensorimotor control

Tarkeshwar Singh [1], He Cui [2], Neeraj Gandhi [3], Deborah Barany [4]

[1] Pennsylvania State University, [2] Chinese Institute for Brain Research, Beijing, [3] University of Pittsburgh, [4] University of Georgia

Discussant: **John Douglas Crawford**

Interceptive movements, from catching a ball to chasing a toddler running towards the street, represent a complex class of motor behaviors that provide an ideal paradigm for investigating fundamental questions in motor control. Unlike stationary targets, moving targets fundamentally transform sensorimotor demands by requiring precise spatiotemporal coordination, continuous integration, and adaptive error correction. This session brings together four animal and human research programs examining how the brain processes motion signals to guide interceptive movements. The speakers present approaches spanning non-human primate neurophysiology, human TMS, EEG, and behavioral studies to unravel the neural computations underlying interception.

He Cui will present pioneering work in non-human primates performing manual interception of circular moving targets. Their findings reveal that monkeys accurately compensate for both sensory and motor delays during interception. Single-unit recordings demonstrate that posterior parietal cortex encodes planned movement parameters rather than instantaneous visual information, while motor cortex exhibits mixed selectivity for both movement planning and ongoing target motion. Novel analyses of population-level neural dynamics suggest orthogonal encoding of target velocity in motor cortical activity, supporting robust forward predictions for motor planning and timing control.

Raj Gandhi will discuss how the brain overcomes neural processing delays using the saccadic system as a model. Through integrated human behavioral and monkey neurophysiology studies, his work reveals systematic variations in interceptive saccade parameters based on target motion features. Superior colliculus recordings demonstrate that target motion reshapes classical receptive field properties and alters neural response profiles, providing insight into early sensorimotor transformations for interception.

Deborah Barany will present TMS investigations of how visual motion information shapes motor cortical output during interceptive movement preparation. Her studies reveal that corticospinal excitability is selectively enhanced prior to intercepting faster-moving targets, independent of target distance or eye movement strategy. This modulation appears specific to movement preparation rather than motion perception, providing direct evidence for how target motion parameters influence motor system excitability.

Tarkesh Singh will present research on mechanisms of motion processing for postural control and interception. His studies reveal that while young adults utilize both retinal and extraretinal motion signals for posture stabilization, older adults rely predominantly on extraretinal mechanisms. EEG findings demonstrate connectivity between motion-processing areas and premotor regions during motor planning. His work also highlights how extraretinal signals modulate long-latency reflexes to stabilize posture during interactions with moving objects.

WEDNESDAY, APRIL 30, 2025

08:00 – 10:00 SESSION 5, PANEL III

Poking the manifold: leveraging modeling, learning, and perturbations to causally test latent dynamics

Lee Miller [1], Dan O'Shea [2], Alex Cayco Gajic [3], Ian Oldenburg [4]

[1] Northwestern University, [2] Stanford University, [3] École Normale Supérieure, Paris, [4] Rutgers University

Discussant: **Matthew Perich**

100 years after Bernstein's pioneering efforts to understand the brain's control of redundant motion, interest has focused on analyses of "neural manifolds", low-dimensional representations of neural activity which result from the redundancy within the brain itself. This approach has led to new insights about motor preparatory activity and the relationship between neural and behavioral dynamics. In addition to the ability to record exponentially larger numbers of neurons, the past decade has ushered in tremendous advances in optogenetics, as well as AI-inspired neural network models that link task computation to latent dynamics and behavior. These complementary approaches to understanding the relation between neural activity and behavior go well beyond the limitations of correlational analysis of recorded activity.

Miller will begin by providing an overview of the concepts and analytical approaches needed to understand the discipline. He will present data demonstrating the remarkable stability between low-dimensional, latent signals and well-learned behavior. These include data recorded during learning, and in the cage, where the physical constraints of the lab setting are eliminated. The dynamics of the latent signals differ to the extent that linear decoding of EMG fails across the contexts, but the results shed light on how these behaviors are controlled. Next, Cayco Gajic will present modeling studies examining the tension between the need for a stable representation of behavior, while still enabling rapid adaptation with learning. She will describe a multi-region RNN model of the interaction between the motor cortex and cerebellum, capable of learning a visual motor adaptation task, and propose an optogenetic experiment to test its validity. Then, Duncker will describe work combining computational modeling with analyses of neural population responses to optogenetic and ICMS perturbations during reaching. This approach allows her to evaluate hypotheses about the network-level dynamical mechanisms underlying pattern generation in motor cortex. She will show that stimulation in M1 perturbs reaching only to the extent that it alters neural states within an identifiable low-dimensional dynamical subspace. Finally, Oldenburg will describe his pioneering work using holographic optogenetics to control the activity of hundreds of neurons in behaving mice with millisecond precision, allowing him to evoke user-designed population vector activity, and to test predictions in actual neuron networks. Compared to ICMS or typical optogenetic methods, holographic control of network activity promises the ability to manipulate network activity with unprecedented precision.

We seek to engage the audience in a discussion of the strengths and weaknesses of the recording, stimulation, and modeling approaches, and the necessary next steps to advance the field of neuronal manifolds to understand the causal connections linking circuits to activity to behavior.

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

OS2.1 - *Motor adaptation in redundant input spaces occurs through changes in both internally-generated feedforward control and sensory-driven feedback control*

Katherine Perks [1], Lydia Smith [1], Sam Burden [1], Amy Orsborn [1]

[1] *University of Washington*

Presenting Author: **Katherine Perks**

Introduction: To control a familiar motor effector, like a computer mouse, we rely on both sensory information (feedback control) and internal predictions about how the effector works (feedforward control). But how do we adapt to unfamiliar effectors? Human psychophysics studies have identified multiple types of motor adaptation using visuomotor perturbations. However, these experiments often focus on assessing changes in feedforward control and lack methods to simultaneously quantify feedback control. They also use simplified tasks where each dimension of movement is associated with a unique dimension of feedback, which does not reflect the redundancy inherent in natural motor tasks and effectors. Redundancy may create challenges for learning as not all input changes produce distinct feedback. We hypothesize that adapting both feedforward and feedback control is critical to learning redundant sensorimotor transforms. We designed a novel paradigm that combines visuomotor perturbations in a rich input space with a control theory-based task that disentangles the two forms of control (Yamagami 2021; Yang 2021). This allowed us to study feedforward and feedback control changes during input-redundant motor learning in non-human primates for the first time.

Methods: We trained two male rhesus macaques to control the movement of a 1D cursor using unconstrained 3D hand movements. We specified an ‘intuitive’ initial control axis in 3D space M_i onto which hand position was projected and transformed into cursor position. The monkeys used M_i to perform a 1D tracking task, which consisted of following a pseudo-random moving target while also correcting for a disturbance applied to the cursor. The target and disturbance trajectories contain distinct frequencies, which enables separate quantification of feedforward and feedback control. Once the monkeys were well-trained on the task using M_i, we leveraged the redundant input space to create perturbed control axes M_p, which rotated M_i by 20°, 60°, 90° or 180° (a total of N=8 perturbations, complete in one monkey and in progress in the other). As the monkeys adapted to the perturbations, we recorded their movements and quantified their feedforward and feedback control to link changes in each controller to changes in behavior and performance.

Results: Monkeys adapted to all M_p but adapted faster as they were exposed to more perturbations. This suggests they learned not only the particular M_p but also general learning strategies. Surprisingly, the 180° rotation required the most time to learn, despite sharing the same task-relevant axis as M_i. We found the monkeys used many different strategies to increase the amount of feedback received, including making larger movements early in learning to compensate for less overlap between their movements and M_p. We found performance gains correlated with improvements in feedforward control as well as aspects of feedback control, which has not previously been reported. This supports our hypothesis that motor learning in redundant input spaces involves updating both internally-generated predictions and the way feedback signals are used. Our results provide novel insight into how motor adaptation occurs in previously unstudied contexts and will enable new ways to study the neural mechanisms of motor learning.

10:30 – 12:30 OS2.2 - *Region-specific neural dynamics and interactions during complex dexterous movements*

Ahmet Arac [1], Sanjay Shukla [1], Erica Nagase [1], Alan Yao [1], Nicolas Jeong Lee [1], Kate Santoso [1], Emily Stenzler [1], Kasey Kim [1], David Lipkin [1], Angela Kan [1], Christina Abdishoo [1]

[1] *University of California, Los Angeles*

Presenting Author: **Ahmet Arac**

Complex motor actions, such as reach-and-grasp movements, rely on the coordinated activity of multiple brain regions, each contributing distinct computations to control behavior. To uncover the neural principles underlying this process, we recorded spiking activity across 10 brain regions (primary and secondary motor and primary sensory cortices, multiple regions in caudateputamen, globus pallidus externa and interna, motor nucleus of thalamus, and deep cerebellar nucleus) in mice performing a skilled reach-and-grasp task. Through detailed kinematic analysis, we identified four distinct behavioral phases: a preparatory phase, two movement phases, and a post-grasp phase. Each phase exhibited unique kinematic parameters, highlighting the modular nature of the movement.

Single-neuron analyses revealed that while similar proportions of neurons (60–80%) across regions responded during each phase, the strength of these responses varied. Notably, response strengths were consistently lowest during the first movement phase across all regions, with region-specific variations emerging in subsequent phases, particularly in the primary sensory cortex (S1). Despite these similarities in single-unit activity, dynamical systems modeling revealed distinct, phase-specific computational rules across regions. Using recurrent switching linear dynamical systems (rSLDS) modeling, we demonstrated that neural state transitions aligned closely with behavioral phase transitions in the primary motor cortex (M1) and secondary motor cortex (M2). However, this alignment was less consistent in other regions, underscoring region-specific computational dynamics. The properties of the dynamical rules were also different across phases and regions.

To explore inter-regional interactions, we implemented data-driven recurrent neural network (RNN) modeling combined with in silico perturbation experiments. These analyses highlighted a specialized role for M2 in modulating M1 activity during the pre-grasp phase. This finding was confirmed through optogenetic inhibition of M2 during neural recordings in M1, which disrupted the reach-and-grasp behavior when applied before the grasp but had no effect afterward. Further, RNN-based pairwise inhibition experiments revealed phase-specific influences of other regions on M1, demonstrating a dynamic and context-dependent hierarchy within the motor network.

Additional analyses of trajectory tangling provided insight into neural variability across phases. S1 exhibited significantly higher tangling (as shown before) across trials compared to other regions, while other regions exhibiting low tangling. Intriguingly, M1 tangling remained consistently low across phases, while M2 tangling progressively increased, suggesting a differential role for M2 in shaping motor output.

In summary, our results demonstrate that reach-and-grasp behavior is composed of kinematically distinct phases, each governed by unique neural computations and inter-regional interactions. While single-unit responses often appeared similar across regions, the underlying dynamical rules were highly region- and phase-specific. These findings reveal a sophisticated interplay of hierarchical and parallel processing within the motor network, advancing our understanding of how different brain regions coordinate to execute complex motor tasks.

10:30 – 12:30 OS2.3 - *Hierarchical state decoding for seamless selection between multiple iBCI functions*

Anna Pritchard [1], Samuel Nason-Tomaszewski [1], Brandon Jacques [1], Yahia Ali [2], Kaitlyn Tung [3], Payton Bechefsky [4], Leigh Hochberg [5], Nicholas Au Yong [1], Chethan Pandarinath [1]

[1] Emory University and Georgia Institute of Technology, [2] Georgia Institute of Technology & Emory University, [3] Georgia Institute of Technology, [4] Coulter Department of Biomedical Engineering, Emory University and Georgia Tech, [5] Brown University

Presenting Author: **Anna Pritchard**

Intracortical brain-computer interfaces (iBCIs) have demonstrated significant potential for restoring control of movement and speech for people with tetraplegia and dysarthria. In previous demonstrations, iBCI users had arrays placed targeting a single control modality (brain areas canonically associated with hand or speech). Recently, BrainGate2 Clinical Trial participant T16 had 4 microelectrode arrays placed in precentral gyrus (PCG) targeting hand (Brodmann's area 6d) and speech (6v&55b) *modalities*. Recording from multiple brain networks enables multifunctional control, but usability is severely limited without the ability to switch between *functions* (controllable outputs within a modality), as alternatives require either constant activation of all functions or manual switching. Here, we investigate the potential for a hierarchical state decoder to infer the iBCI user's intended functional output. Inspired by at-home iBCI computer use where cursor control may not be a constant intent, we first designed a cursor-and-click task during which T16 was randomly prompted to use various hand or speech functions (e.g. move pinky, speak, think, do nothing). We identified channels that encoded specific functions (e.g. channels modulated differently for think vs say 'bring', or move pinky up vs control cursor with pinky). Trials were classified by condition from all (71% acc. all 9 conds.), hand (75% 4 hand conds.), and speech (67% 5 speech conds.) arrays. This suggests that PCG shows distinctions between not only hand and speech modalities, but also distinct functions within hand and speech. Next, we designed a multifunctional iBCI task where T16 was instructed to sequentially read a sentence, use brain-to-text to type the sentence, and use the cursor iBCI to select incorrect text predictions. Offline, we modeled the data with Hidden Markov Models (HMMs) to distinguish task phases (idle, read, speak, cursor). We compared individual hand- and speech- array HMMs against a single HMM using all arrays for classifying all functions (all/speech/cursor acc. 62%/90%/78% single; 54%/89%/72% dual). Finally, we demonstrated the feasibility of these HMMs to decode T16's functional intent in an online iBCI setting. T16 performed a similar multifunctional task as before, but the cursor and speech decoders were de/activated according to the decoded user intention. Speech (90% acc.) and cursor (70%) classification reflect offline results with minimal latencies for decoded speech onset/offset (-0.83+/-0.73s onset, 0.32+/-0.43s offset). Next we will demonstrate the use of state decoders for switching between functions within a modality (cursor and robot) and integrate function-switching with personal iBCI use. These decoders enable iBCI users to independently switch control between multiple modalities, may enable control of multiple functions within a modality, and can be extended to facilitate multifunctional iBCI control across a multitude of applications.

10:30 – 12:30 OS2.4 - *A novel peripheral neural interface to manipulate limb movement through myocontrolled optogenetic sensory nerve stimulation*

Akito Kosugi [1], Moeko Kudo [1], Shiro Egawa [1], Ken-Ichi Inoue [2], Masahiko Takada [2], Kazuhiko Seki [1]

[1] *National Center of Neurology and Psychiatry,* [2] *Kyoto University*

Presenting Author: **Akito Kosugi**

Neural interfaces targeting the peripheral nervous system, such as cochlear implants, are primarily designed to restore lost sensory perception, with relatively few addressing motor functions. While functional electrical stimulation has been used to restore motor functions, it often faces challenges in adapting to dynamic movements due to the difficulty in modulating multiple muscle activities. In this study, we focused on proprioceptive reafferent signals that are generated by one's own movement (reafference). These signals not only contribute to somatosensory perception through transmission to the somatosensory cortex, but also play a crucial role in generating muscle activity via the spinal reflex loop. Since these signals are distributed throughout the spinal cord, their modulation can influence multiple muscle activities through the reflex loop, offering the potential to correct inappropriate dynamic movements. In addition, this event could occur without the need for volitional motor commands, thereby reducing a cognitive effort to restore motor functions. Here, we propose a novel peripheral neural interface that targets the somatosensory reafferent signal to restore motor functions. Using optogenetics, we specifically modulated peripheral sensory nerve activity during animal's reaching movements to examine the effects of neuromodulation on ongoing movements.

First, we investigated the optimal serotype and administration route of adeno-associated virus (AAV) vectors for selective targeting of large-diameter afferents associated with tactile and proprioceptive sensations in common marmosets. We found that systemic administration through intravenous injection of the capsid variant of a serotype-9 AAV vector (AAV-PHP.B) selectively transduced channelrhodopsin 2 (ChR2) into large-sized dorsal root ganglion (DRG) neurons. In acute electrophysiological experiments, we confirmed the selective activation of large-diameter afferents via optical stimulation to the peripheral nerve.

Next, we trained animals to perform a visually-guided reaching task. After completing the training, we transduced ChR2 into large-sized DRG neurons. During task performance, we applied transdermal optical stimulation to the afferent nerve from the wrist flexor muscles (median and ulnar nerves). When we applied the stimulation by triggering the EMG activity of the agonistic muscle of reaching (triceps brachii muscle), animals exhibited undershot reaching and failed to reach the target. Further analysis revealed that this undershooting was caused by reduced activity in the triceps brachii muscle, which was due to the recruitment of reciprocal inhibitory reflex induced by optogenetic stimulation. These results highlight the significant impact of optogenetic sensory nerve stimulation on ongoing movement. Furthermore, this suggests the potential of a novel peripheral neural interface that targets peripheral sensory nerves to correct overshooting limb movement, such as dysmetria.

10:30 – 12:30 OS2.5 - *Developing a sensory representation of an extra robotic digit*

Lucy Dowdall [1], Giulia Dominijanni [2], María Molina [1], Edmund Da Silva [1], Fumiya Lida [1], Matteo Bianchi [3], Dani Clode [1], Tamar Makin [1]

[1] University of Cambridge, [2] École Polytechnique Fédérale de Lausanne, [3] University of Pisa

Presenting Author: **Lucy Dowdall**

Our motor system relies on somatosensory feedback to inform about the state of our limbs and interactions with our environment. This creates challenges for wearable technology that interface with our sensorimotor system, as they are thought to have 'open-loop' control, with no direct tactile feedback available. However, a neglected area is the natural sensory feedback we can receive from how such devices are worn on, and controlled by, our bodies.

When using an extra robotic finger - the Third Thumb (Dani Clode Design), worn on the side of the hand (the 'palm'), participants can successfully develop a sense of proprioception (Kieliba et al., 2021). This implies the natural sensory feedback can be used to inform about device 'somatosensation'.

To characterise how this natural feedback is experienced, we identified two key components – skin stretch of the palm when the Thumb moves and vibrotactile information when objects engage with the Thumb tip. We then developed two artificial feedback systems for use with the Thumb that replicated these aspects (stretch and vibration) to offer comparison between natural feedback and artificial touch technology. Participants (N=20) performed a softness discrimination task (where we expected the skin stretch to excel) and a texture discrimination task (where we expected the vibrotactile to excel) with the natural and artificial systems. People could successfully perform the tasks with the artificial systems, however they performed comparably with the natural feedback, demonstrating we can extract meaningful information from it.

To then explore how our somatosensory system processes this information, we used fMRI to study the representational similarity patterns across the hand and Thumb in primary somatosensory cortex (S1) (N=50). We found that after only limited exposure, the brain already organises this tactile input from the Third Thumb in a topographically appropriate manner and in a distinct way from the palm.

Next, we examined how this natural tactile input supports motor learning. Participants completed 7 days of Thumb-hand collaboration training (n=30), whilst controls received 7 days of keyboard training (n=20). Following this altered finger-synchronisation motor training, we observed reduced inter-finger information content in S1, with larger changes in the Third Thumb group. Importantly, Thumb training produced specific increases in representational similarity between the Third Thumb and biological hand. This integration implies construction of a sensory representation of the Third Thumb in relation to the fingers through their co-usage.

Overall, we have demonstrated the utility of tactile feedback received as a natural by-product of how technologies interface with our body. Our brain can access a sensory representation after only limited exposure to such feedback, which can be integrated with our body following training. Such sensory cues could provide a way of 'closing' the sensorimotor loop.

10:30 – 12:30 OS2.6 – *Neuro-musculoskeletal modeling reveals muscle-level neural dynamics of adaptive learning in sensorimotor cortex*

Mackenzie Weygandt Mathis [1]

[1] *EPFL*

Presenting Author: **Mackenzie Mathis**

The neural activity of the brain is intimately coupled to the dynamics of the body. In order to predict the sensorimotor consequences of our actions, compelling behavioral studies in humans, non-human primates, and in rodents have shown the existence of internal models — predictive models of our body in the environment. However, the neural computations that update these internal models during motor learning remains largely unknown. There is growing evidence in several sensory areas, such as in the visual and auditory primary cortex, that activity of layer 2/3 encodes sensory prediction errors when unexpected stimuli are presented, which theoretically could serve as a teaching signal. Notably, somatosensory (S1) is essential in rodents and humans learning to adapt arm movements, but, if equivalent prediction errors are observed in S1 has not been established. Lastly, an outstanding question more generally for prediction errors is in which coordinate frameworks would such errors be computed? Here, we directly test whether errors are encoded in S1 during a motor adaptation task in mice. We find that layer 2/3 neurons encode sensorimotor prediction errors (SmPEs), and critically, we identify muscle spaces as the coordinate framework. To do this, we developed a novel 50-muscle model of the adult mouse forelimb that is capable of studying motor control and learning in a physics-simulator. Using model-derived features, we find that during adaptive learning, functionally distinct neurons are mapped onto specific computational motifs. S1 neurons more prominently encode SmPEs, and the neural latent dynamics change in S1 (but not in motor cortex; M1) during this within-session learning. Together, our results provide a new model of how neural dynamics in S1 enables adaptive learning.

15:00 – 17:00 SESSION 8, PANEL IV

The role of Basal Ganglia in complex walking: implications for aging and neurodegenerative diseases

Shuqi Liu [1], Julia Choi [2], Caterina Rosano [1], Katrina Nguyen [3]

[1] *University of Pittsburgh,* [2] *University of Florida,* [3] *University of Colorado Anschutz Medical Campus*

Discussant: **Gelsy Torres-Oviedo**

Mobility deficits such as reduced locomotor adaptations and dual-task abilities are common with aging and can represent prodromal signs of neurodegenerative diseases including Parkinson's disease (PD) and Alzheimer's disease and related dementias (ADRD). In fact, mobility decline often precedes cognitive symptoms in ADRD. Therefore, it is reasonable to hypothesize that shared neural mechanisms underlie the diseases that are thought to be motor, such as PD, or cognitive, such as ADRD. Our panel will discuss one such potential neural mechanism: the basal ganglia.

The panel includes experts in human and animal locomotor control, aging, and neurodegenerative diseases. We will show behavioral, electrophysiology, and neuroimaging evidence on the role of basal ganglia underlying complex walking behaviors, the influence of aging, and implications in patients with PD or Mild Cognitive Impairment (MCI), an early stage of ADRD.

Caterina Rosano will discuss results from an epidemiological study showing that striatal dopaminergic neurotransmission, measures through neuroimaging, predicts gait speed changes during dual-tasks in older adults, independent of age, sex, and physiological factors such as muscle strength or joint pain. The mechanisms underlying this relation and its therapeutic implications will be discussed.

Shuqi Liu will present data linking two behaviors critical for mobility, dual-task walking and locomotor adaptation, in young and older adults with or without MCI. She will argue that walking tasks that are typically automatic and controlled by subcortical structures like the basal ganglia will require cortical compensations with aging, but the availability of the compensation is impacted by cognitive health.

Julia Choi will present locomotor adaptation data in PD patients with Freezing of Gait (FoG). Behavioral and electrophysiological data from patients who underwent Deep Brain Stimulation (DBS) in the globus pallidus internus (GPi) show that impaired walking adaptation is related to distinct GPi oscillations in PD with FoG. She will discuss how combining bidirectional DBS with locomotor adaptation can provide insights into the brain activity underlying gait dysfunction in PD.

Katrina Nguyen will show locomotor adaptation results from mice with normal vs. pathological dopaminergic circuits. She will revisit classic locomotor paradigms in freely behaving mice, while leveraging new tools for detailed body pose estimation to assess how movements evolve longitudinally in healthy and unilaterally dopamine depleted mice. She will share data for pathological behaviors that emerge and normal behaviors that recover over the course of learning.

In sum, we will show that basal ganglia dysfunction could underlie neurodegenerative diseases predominantly observed in older populations and have both motor and cognitive symptoms, and discuss the potentials of these non-invasive approaches for early detection and interventions in PD and ADRD.

THURSDAY, MAY 1, 2025

08:00 - 10:00 SESSION 9, PANEL V

Sensorimotor control of the tongue during feeding and voluntary movement sequences

Nicholas Hatsopoulos [1], John Barrett [2], Ellen Lumpkin [3], Dan O'Connor [4]

[1]University of Chicago, [2] Northwestern University, [3] University of California, Berkeley, [4] Johns Hopkins School of Medicine

Discussant: **Callum Ross**

The tongue is an important structure for organismal survival because it mediates the critical functions of feeding and, in some species, communication. The neural control of the tongue in human speech has received much attention; in contrast, the neural control of the tongue and associated orofacial structures during feeding is understudied, especially when compared with control of the limbs and eyes. The tongue is particularly interesting because it is a mid-line, soft body hydrostat that possesses no bones or joints and yet its movement and shape can be exquisitely controlled. What is the role of sensory feedback in guiding tongue movements and posture, and what is the role of cortex in this control and coordination with other organs, such as jaws and hands? Nicho Hatsopoulos will begin by presenting evidence that orofacial areas of primary motor (M1of) and somatosensory (S1of) cortices carry detailed information on tongue kinematics during feeding in macaque monkeys. By recording implanted marker kinematics using a novel 3D x-ray video radiography technology together with single unit activity from electrode arrays implanted in M1of and S1of, he will show how neural population activity from these areas can decode kinematic and shape variables across the feeding sequence with accuracies comparable to those of the arm and hand. Ellen Lumpkin will discuss the role of the sensory periphery in feeding by focusing on mechanosensation of the tongue and palate. Using neuroanatomical and calcium imaging approaches, she has found that the complement of trigeminal mechanosensory neurons innervating the tongue is distinct from those innervating palate and skin. In particular, the majority of lingual mechanosensory neurons respond transiently to dynamic stimuli whereas the palate is densely innervated by slowly adapting, pressure-sensitive afferents that innervate epithelial Merkel cells. John Barrett will expand on the functional role of the tongue by considering how it can be used to reach for and retrieve food pellets by coordinating its movements with the jaw and hand in mice. He will characterize the motor syntax of the tongue consisting of an initial reach, deformation of the tongue tip around the pellet, retraction, and finally securing the pellet by coordinated action of the tongue, jaw and hands. He will present on-going work examining neural activity patterns in orofacial and hand primary motor cortices together with 3D kinematic tracking of the tongue and hand to understand how the cortex mediates this coordinated behavior. Finally, Dan O'Connor will present results on the sensorimotor control of voluntary tongue sequences with mice trained to perform "sequence licking" tasks. He will focus on how ascending sensory signals from tongue mechanoreceptors and jaw muscle spindle afferents are integrated with motor signals from regions of primary somatosensory and motor cortices to guide flexible, goal-directed tongue/jaw movements.

10:30 – 12:30 SESSION 10, PANEL VI

Single-neuron dynamics: unveiling the single-cell type underpinnings of behavior, disease phenotypes, and therapy in motor disorders

Marco Capogrosso [1], George Mentis [2], Kimberly Dougherty [3], Claudia Kathe [4], Thomas Hutson [5], Serena Donadio [6]

[1] *University of Pittsburgh,* [2] *Columbia University,* [3] *Drexel University,* [4] *University of Lausanne,* [5] *Wyss Center for Bio and Neuroengineering,* [6] *Rehab and Neural Engineering*

Discussant: **Marco Capogrosso**

With the emergence of high-count neurotechnologies and new mathematical tools we've been witnessing the development of population neural dynamics as a central tool to study motor control. This framework seems to overcome the limitations on the analyses that can be conducted at a single neuron level to provide insights on the computations executed by large neural networks during motor planning and execution. However, while we enjoy the explosion of this scientific framework, we shouldn't neglect that single neuronal types have profound impact on behavior, particularly in specialized circuits. Indeed, neurons are not static input-output functions, but rather complex biochemical structures that adapt in response to changes in the environment. In this panel, we will explore how adaptations of single neuronal types in the spinal cord underpin the emergence of motor phenotypes in major motor disorders. We will show how single-cell type changes drive motor recovery and how they can be targeted to develop therapies. To build our case we present a 5 speakers panel divided in two sessions: a basic science session and a new therapies horizon session. In the basic science session Dr. Mentis will demonstrate how the adaptation of a single ion channel in motoneurons is responsible for widespread muscle weakness and atrophy in Spinal Muscular Atrophy (SMA), a progressive motoneuron disease. Importantly, Dr. Mentis will introduce the idea that these changes are driven by homeostatic adaptation rules that re-shape the function of motoneurons in response to SMA-altered circuits. Following this path, Dr. Dougherty will introduce her most recent work in Spinal Cord Injury (SCI). Using a combination of ex-vivo electrophysiology and single-cell type manipulation in mice she will demonstrate that SCI dramatically changes the membrane properties of inhibitory interneurons in the dorsal horn that govern presynaptic gating of sensory afferent and may lead to the emergence of overt hyperreflexia. Finally, Dr. Kathe will show how a group of interneurons in the spinal cord that participate but are not critical to movement in intact mice become necessary components of motor recovery after SCI. The New Therapies Horizon builds on these insights to propose new therapies that target these single-neuron type level changes to improve behavior. Specifically, PhD-candidate Donadio will show how electrical stimulation of the primary afferents can be used to reverse the SMA-driven changes in ion channels of spinal motoneurons and significantly improve strength and fatigue in humans with SMA. Finally, Dr. Hutson will present the proof-of-concept of an optogenetic stimulation therapy that targets hyperexcitable motoneurons after SCI to treat hyperreflexia and spasticity. Discussion with the audience will focus on how single neuronal cell types shape motor behavior and if this can be leveraged to build the new therapies

FRIDAY, MAY 2, 2025

08:00 – 10:00 SESSION 12, PANEL VII

Computational mechanisms underlying contextual modulation in motor learning

Tianhe Wang [1], Apoorva Sharma [2], Kahori Kita [3], Daniel Wolpert [4]

[1] *University of California, Berkeley,* [2] *Yale University,* [3] *Johns Hopkins University,* [4] *Columbia University*

Discussant: **Samuel McDougle**

Understanding the role of context is a central issue in learning and memory. Even simple learning processes, such as classical conditioning, rely on forming associations with relevant contextual cues. Over the past 15 years, context has garnered considerable attention in sensorimotor learning research. While traditional computational approaches incorporating meta-learning mechanisms into Kalman filters and state-space models to capture some of the contextual effects, they often struggle to explain the flexibility of motor learning in diverse environments. In contrast, emerging computational methods, including hierarchical Bayesian frameworks and artificial neural networks, have successfully accounted for a broad range of phenomena in motor learning, habit formation, and decision making, substantially advancing our understanding of how context shapes learning. These advances have also fueled new research into the role of context in various motor learning processes, prompting debate on various issues such as whether different sensorimotor adaptation processes share similar contextual modulation, whether contextual effects extend beyond basic adaptation to more complex motor skills, and what neural mechanisms underlie these contextual modulations.

This session will try to address these questions by bringing together researchers who employ a variety of behavioral tasks and computational frameworks. Wolpert will review the role of contextual inference in motor learning and show how contextual inference may underlie the differences in motor learning under distinct training curricula. He will also describe the role of visual and dynamic inputs on the way motor learning tasks are decomposed. Wang will introduce a cerebellar-like network that captures a wide range of contextual effects in implicit adaptation without relying on explicit contextual modulation. He will also present empirical findings that distinguish two distinct implicit components in sensorimotor adaptation, each displaying unique contextual sensitivities. Sharma will demonstrate how internal timing can serve as a contextual cue to separate implicit motor memories in a dual-adaptation paradigm. Kita will examine the retention and spontaneous recovery of newly learned motor skills following extended breaks, exploring how principles of contextual modulation may generalize to de novo learning. Finally, Hagura will lead a panel discussion addressing key questions, including how different processes, such as implicit recalibration and explicit aiming, are modulated by context in potentially distinct ways, and what neural mechanisms support these contextual modulations in motor learning.

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

OS3.2 - *Determining the cognitive contributions to reduced movement vigor in people with Parkinson's disease*

Jonathan Wood [1], Amanda Therrien [1], Aaron Wong [1]

[1] *Thomas Jefferson University*

Presenting Author: **Jonathan Wood**

Whether and how we move depends on a tradeoff between the effort required and the payoff (i.e., reward) we receive from moving. Impairment of this tradeoff has been hypothesized to underlie reduced movement vigor (i.e., bradykinesia) in Parkinson's disease (PD), although the exact nature of this disruption remains unclear. As dopamine has long been linked to reward, its reduced availability in PD could result in a devaluation of perceived reward outcomes. Alternatively, people with PD may perceive moving as excessively effortful. A third possibility is that PD disrupts the mapping between effort and reward. We assessed these alternative hypotheses in 3 separate tasks in people with PD ON and OFF their dopamine medication and compared them to matched controls. Determining the specific source of impairments in the effort/reward tradeoff is critical to understanding movement vigor more broadly and why bradykinesia arises in people with PD.

We first assessed reward perception using a standard behavioral economics task in which participants chose between a certain or risky monetary reward. Reward perception was quantified as the difference in the expected value of certain and risky choices where a person was equally likely to choose either option. Surprisingly, we found no effect of disease (PD ON vs controls p=0.59) or medication status (PD ON vs OFF p=0.36) on reward perception. Contrary to prior theories of dopamine and reward processing, this finding indicates that PD may not significantly impact the perception of reward.

Next, we assessed effort perception using an isometric force-matching task. Here, people were cued to produce a given force magnitude and then attempt to reproduce the same perceived force without cues. While everyone could accurately produce the cued forces, the reproduced forces for people with PD were smaller than for controls (p=0.03), suggesting that people with PD perceived their exertions to be more effortful (and hence did not need to push as strongly to reproduce the perceived force). However, we did not find an effect of medication status (p=0.49), suggesting this perception is not contingent on dopamine availability.

Finally, we assessed the mapping between effort and reward by measuring participants' willingness to exert a given force for a given reward. Specifically, we quantified the change in force preference as a function of reward magnitude. While controls were willing to exert greater forces compared to people with PD regardless of reward magnitude (p=0.004), the change in force preference across rewards was similar for both groups (p=0.40) and for people with PD ON vs OFF medication (p=0.58). Thus, the effort/reward mapping was not significantly modulated by PD or dopamine. Overall, this work surprisingly hints that reward perception may not contribute to bradykinesia in people with PD. Rather, the perception of effort may play a critical, and previously underappreciated role in movement vigor.

10:30 – 12:30 OS3.3 - *Walking toward riches: reward pays the cost of effort*

Chadwick Healy [1], Alaa Ahmed [2]

[1] *University of Colorado,* [2] *University of Colorado, Boulder*

Presenting Author: **Chadwick Healy**

Slowing of movements is a symptom of numerous motor and psychiatric disorders, yet our understanding of what determines movement speed is not well characterized. The preferred speed of walking is thought to be determined primarily by energetic cost, but can reward influence walking speed? Recent findings have shown that the speed at which we move reflects the value of what we hope to acquire in eye movements and arm reaches, suggesting a link between the neural processes that control movements and those that assign value. People reach and saccade faster to objects that promise greater reward and when there is greater opportunity cost of time. However, there is currently little understanding of how upcoming reward and a history of reward influence walking speed, a measure often thought to be prescribed by energetic cost alone.

Here, we integrate a self-paced treadmill with a virtual reality system to immerse subjects in a realistic environment that probes the effects of reward, reward history, and effort on walking speed. Sixteen subjects (n = 16; 7 Females; 22.4 ± 4.95 yrs) completed two sessions with different baseline effort conditions. In the high effort session, subjects donned a weight vest with approximately 15% of their body mass. During each session, subjects completed a series of walking trials in virtual reality that involved walking along a path collecting varied values of rewards visualized as apples. We manipulated the value of the rewards (high/10-apples, medium/5-apples, and low/1-apple), as well as the history of reward by changing the average payout of an environment. A rich environment had a higher probability of high reward (50% high, 30% med., 20% low), and a poor environment had a higher probability of low reward (20% high, 30% med., 50% low). Subjects walked at their own pace through the virtual world, where they encountered a series of rewards. Every 40 meters, a cue appeared 30 m ahead, the value of the reward was revealed after walking 10 m further, then subjects walked 20 m further to collect the reward.

Walking speeds increased as the revealed upcoming reward value increased ($P < 0.0001$). For the same upcoming reward value, speeds were faster in a rich environment than a poor environment ($P = 0.0107$). Even when the value of the reward was not revealed, subjects walked at faster speeds in a rich environment ($P = 0.0119$), suggesting there is an opportunity cost of time. In addition, subjects walked slower in the high effort condition versus the low effort ($P = 0.0278$), confirming that movement speed considers both the reward and effort of a movement rather than either one alone.

Our findings are the first to show that walking speed is sensitive to explicit reward and reward history and is modulated by effort, building on recent findings that both reward and effort can modulate movement speed. These results show significant promise that walking speed can provide a non-invasive marker of cognitive function and motivation.

10:30 – 12:30 OS3.4 - *Reward influences movement vigor through multiple motor cortical mechanisms*

Adam Smoulder [1], Patrick Marino [2], Emily Oby [3], Sam Snyder [2], Steven Chase [1], Aaron Batista [2]

[1] *Carnegie Mellon University,* [2] *University of Pittsburgh,* [3] *Queen's University*

Presenting Author: **Adam Smoulder**

When greater rewards are at stake, humans and animals alike tend to quicken the speed and latency of movements without sacrificing their accuracy - that is, they act with enhanced vigor. How does the brain translate changes in motivation into increased movement vigor? Rhesus monkeys performed a delayed reaching task in which we cued the reward (Small, Medium, or Large) that would be given upon trial success. In population recordings from primary motor cortex (M1) and dorsal premotor cortex (PMd) we identified multiple neural correlates of motor vigor affected by reward.

First, we observed correlated effects of reward magnitude and upcoming movement vigor on movement preparatory neural activity. We identified a “vigor axis” in neural population space whereby the response of the motor cortex population correlated with movement vigor on a trial-by-trial basis. We found that greater rewards positively modulated activity along the vigor axis. We also observed that greater rewards made reach-direction conditions more separable in neural activity, and greater separability correlated with greater vigor.

Second, we found that reward facilitated the transition from preparation to movement. We calculated a neural changepoint time for each trial and saw that it decreased with greater reward. We also found that the neural speed (time derivative of firing rates) preceding movement onset was faster for greater rewards. Both of these metrics were correlated with the animals’ movement vigor.

Third, we saw that reward altered neural trajectories during movement execution. Greater reward appeared to “stretch” trajectories and quicken the traversal of neural activity along them. These effects imply gain-like effects of reward on motor cortical activity, hinting at potential underlying mechanisms of the effects we observed (e.g., neuromodulatory drive).

We considered that these motor cortical correlates between reward and vigor might be driven by a single source. In this case, we would expect neural correlates of vigor to exhibit strong correlation structure themselves. Instead, we observe limited correlations between the metrics, implying multiple aspects of motor cortical activity both affect movement vigor and are modulated by reward.

Lastly, we note that when we controlled for vigor across reward conditions, we saw little-to-no impact on the ability to decode the reward cue from the neural activity. This indicates that reward effects on motor cortical activity far exceed those we would expect from reward-mediated differences in movement vigor, and that motor cortex does not simply encode reward information that is directly relevant to behavior.

We conclude that reward influences multiple aspects of motor cortical activity that relate to movement vigor, and that reward effects on motor cortex exceed those that can be explained by differences in behavior.

10:30 – 12:30 OS3.5 - *Muscle spindles provide flexible sensory feedback for movement sequences*

William P. Olson [1], Varun Chokshi [1], Jeong Jun Kim [1], Noah J. Cowan [1], Daniel H. O'Connor [1]

[1] *Johns Hopkins School of Medicine*

Presenting Author: **Daniel H O'Connor**

Muscle spindle afferents (MSAs) are stretch-sensitive neurons that provide critical real-time feedback to the nervous system about body position and movement. While their activity is partially linked to kinematics, they are subject to complex top-down modulation during behavior. We recorded from MSAs innervating the jaw musculature (located in the mesencephalic trigeminal nucleus, MEV) in behaving mice performing a licking motor sequence task. In our task, head fixed mice licked a moving 'port' through an arc of seven locations surrounding the mouse's face to receive a water reward. The sequence progressed in opposite directions on alternating trials.

MSA ensemble activity during sequence performance was complex, evolving over single lick cycles as well as over entire licking sequences. MSAs encoded movement in a complex jaw–tongue orofacial space; while some MSAs encoded jaw movement, others were sensitive to joint conformations of the jaw and tongue. A minority of the MSAs stably encoded kinematics, and kinematics could be decoded from MSA ensembles based on this sparse population encoding. We further found that kinematics alone accounted for less than half of the total MSA spiking variability. Much of the activity was instead linked to task variables that were independent from the kinematics, including the progression of the sequence (i.e. beginning, middle, or end) as well as reward context (i.e. pre- or post-reward licking). These task related changes paralleled higher-order control signals recorded from sensorimotor cortex during this task in prior work from our group. Taken together, our work indicates that higher-order signals can dynamically tune incoming proprioceptive feedback as a mechanism for implementing flexible sensorimotor control.

10:30 – 12:30 OS3.6 - *Understanding surprise: Dual predictive systems in whisker sensorimotor control*

Ritu Roy Chowdhury [1], Kalpana Gupta [1], Yuyao Sun [1], Franziska Gekeler [1], Shubodeep Chakrabarti [1], Cornelius Schwarz [1]

[1] *Eberhard Karls University of Tübingen*

Presenting Author: **Ritu Roy Chowdhury**

The predictive coding framework suggests that the brain continuously generates and updates predictions to minimize sensory prediction errors, but we still don't fully understand how these predictive mechanisms relate to movement. We sought to systematically separate two systems that attenuate movement-generated sensory flow—sensory gating (SG) and state estimation (SE). We hypothesized that SG applies a broad temporal filter to movement-related sensory consequences, while SE selectively attenuates expected sensory inputs at specific times, thereby amplifying relevant inputs.

We recorded S1-spiking effects in mice performing a whisker-reach task, adapting Curtis Bell's 1981 'open-loop' paradigm from fish to mammals. First, we investigated SG's temporal profile while maintaining a fixed probability of sensory consequences. Next, we increased the probability of sensory inputs at specific time points to characterize SE-driven attenuation patterns. We show for the first time that SG peaks around movement onset, while SE disrupts this profile by producing a new peak of sensory attenuation around expected time points. Additionally, we found that SE helps to suppress whisker movements evoked by surprising sensory inputs.

Optogenetic manipulations suggest that the cerebellum plays a key role in SE-induced sensory attenuation but not in the one induced by SG. Together, these findings advance our understanding of how the brain uses multiple predictive mechanisms to optimize sensorimotor control and behavior.

15:00 – 17:00 SESSION 15, PANEL VIII

Inter-area communication for motor control

Emily Oby [1], Matthew Perich [2], Sam Snyder [3], Stefan Lemke [4], Maureen Hagan [5]

[1] *Queen's University,* [2] *Université de Montréal,* [3] *University of Pittsburgh,* [4] *University of North Carolina,* [5] *Monash University*

Discussant: **Emily Oby**

Motor control is remarkable in its flexibility- allowing us to perform a wide range of complex movements, adapt to new tasks, and choose appropriate action for a given context or environment. The brain achieves this flexibility, at least in part, through the dynamic interactions between distinct brain areas in the sensorimotor loop. From the sensory cortices processing incoming information, to the motor areas executing precise movements, and the higher-order brain areas responsible for planning and decision-making, each area interacts and communicates with other areas in order to orchestrate the movement. How is communication instantiated and modulated across brain areas to allow for flexible motor control? In this session, we will explore recent work that examines how the sensorimotor brain areas coordinate and communicate their activity, enabling flexible and precise motor control.

Neural communication must be dynamic and flexible in order to guide behavior. **Matt Perich** will explore methods to estimate principles of inter-areal communication and demonstrate that transient interactions between sensory and motor areas can enable flexible behavioral output.

Behavioral tasks like eye-hand movements engage brain areas across networks to coordinate behavior and can allow us to study neural mechanisms of communication across brain areas. **Maureen Hagan** will show how the temporal patterns of neural activity across areas is modulated by behavioral demands and may be a signature of inter-area neural communication.

Precise, genetically-defined manipulators of cortical, subcortical, or cerebellar areas can each disrupt skilled motor control in rodents. However, the manner by which these distributed areas may interact to control skilled movements remains unclear. **Stefan Lemke** will present evidence that the strength of cross-area coordination captured from large-scale neurophysiology during motor control covaries with the ability to perform skilled movements in genetic mouse models with typically and atypically developed nervous systems.

Finally, **Sam Snyder** will share a causal test of the flexibility of interactions between primary motor (M1) and premotor cortex (PMd). Using a brain-computer interface task designed to challenge monkeys to break observed correlations between M1 and PMd, he will show that inter-area interactions are more flexible than within area interactions.

Together this panel will highlight the importance of understanding how distinct populations of neurons interact and communicate to plan, execute, and learn new movements. The discussion will focus on our understanding of how the brain flexibly controls movement and if this can shed light on how disruptions to the sensorimotor neural networks might contribute to motor impairments.

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

Notes from the Underground: Psychological Perspectives on Cerebellar Function

Richard Ivry, *University of California, Berkeley*

The cognitive neuroscience revolution provided a new theoretical framework for using the tools of neuroscience to study the mind. Central to this paradigm shift was the idea that the focus of our analysis should be on the component operations underlying task domains rather than on the tasks themselves. I will provide a retrospective on our efforts to apply this strategy to motor control, and in particular to develop a functional account of the role of the cerebellum in coordinated movement, sensorimotor learning, and cognition. Using simple model tasks, the behavioral analysis of healthy individuals and patients with cerebellar disorders has provided insight into unique computational characteristics of this subcortical structure. Prominent among these is the idea that the cerebellum is critical for tasks that require the precise representation of temporal information. This hypothesis places an important constraint on the predictive capacity of the cerebellum, providing an account across a range of task domains of conditions that are cerebellar dependent and, as important, conditions that are cerebellar independent. These dissociations are essential for building a psychological level account of how the cerebellum supports coordinated movement and thought.

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 two sessions, each on display for two days.

SESSION 1

Tuesday, April 29, 2025	**8:00 – 17:30**
Wednesday, April 30. 2025	**8:00 – 17:30**

SESSION 2

Thursday, May 1, 2025	**8:00 – 15:00**
Friday, May 2, 2025	**8:00 – 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 – Control of Eye & Head Movement

B – Fundamentals of Motor Control

C – Posture and Gait

D – Integrative Control of Movement

E – Disorders of Motor Control

F – Adaptation & Plasticity in Motor Control

G – Theoretical & Computational Motor Control

POSTER SESSION 1

TUESDAY, APRIL 29, 2025

A – CONTROL OF EYE & HEAD MOVEMENT

1-A-1 ***Simulation of bilateral control of horizontal saccades in mTBI***

John Anderson [1]

[1] *University of Minnesota*

1-A-2 ***Handedness modulates visual attention during bimanual reaching***

Florian Kagerer [1], Faith Houck [1]

[1] *Michigan State University*

1-A-3 ***Cell types and priors: Cerebellar encoding of sensorimotor timing***

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

[1] *Erasmus University Medical Center*

1-A-4 ***Spatially uninformative sounds modulate midbrain visual activity with and without primary visual cortical input***

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

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

1-A-5 ***Spontaneous recovery of saccadic adaptation explained by a postdictive model***

Max Johann Schuhriemen [1], Jana Masselink [1], Markus Lappe [1]

[1] *University of Münster*

1-A-6 ***Dark contrasts are immune to saccadic suppression in the primary visual cortex***

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

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

B – FUNDAMENTALS OF MOTOR CONTROL

1-B-7 ***Transmission of Cortical Beta-Band Oscillations to a motor neuron pool is uniform and independent of motor neuron size***

Emanuele Abbagnano [1], Dario Farina [1]

[1] *Imperial College London*

1-B-8 ***Influence of uncertainty on preparatory activity in motor cortex during reaching***

Tapas Arakeri [1]

[1] *University of Pittsburgh*

1-B-9 ***Planning while moving: when two hands are better than one***

Pierre-Michel Bernier [1], Adrien Coudière [2], Hugo Leblan-Falzone [2], Lucette Toussaint [2], Frédéric Danion [2]

[1] *Université de Sherbrooke,* [2] *CNRS, Université de Poitiers, Université de Tours, CeRCA*

1-B-10 *Neural encoding of action intention and observation in human motor and posterior parietal cortex: insights from intracortical recordings in tetraplegic participants*

Vasiliki Bougou [1], Jorge Gamez [2], Emily Rosario [3], Charles Liu [4], Kelsie Pejsa [2], Ausaf Bari [5], Richard Andersen [2]

[1] *California Institute of Technology,* [2] *Division of Biology and Biological Engineering, California Institute of Technology, Pasadena, CA,* [3] *Casa Colina Hospital and Centers for Healthcare, Pomona, CA,* [4] *Keck School of Medicine of USC,* [5] *University of California, Los Angeles*

1-B-11 *Hand dominance influences Spatiotemporal finger coordination in precision grip, not finger individuation*

Charisma Byrd [1], Timothy Ma [2], Divya Rai [1], Jeremy Brown [3], Jing Xu [4]

[1] *The University of Georgia,* [2] *New York University,* [3] *Johns Hopkins School of Medicine,* [4] *University of Georgia*

1-B-12 *Single-neuron and population approaches reveal spatially structured neural dynamics across frontal motor cortex*

Ryan Canfield [1], Tomohiro Ouchi [1], Leo Scholl [1], Pavithra Rajeswaran [1], Lydia Smith [1], Amy Orsborn [1]

[1] *University of Washington*

1-B-13 *Differential muscle activation corresponds to similar movements in walking Drosophila*

Raveena Chhibber [1], Lili Karashchuk [2], Chris Dallmann [3], Elliott Abe [1], John Tuthill [1], Bing Brunton [1]

[1] *University of Washington,* [2] *Allen Institute for Neural Dynamics,* [3] *University of Wurzburg*

1-B-14 *Short trains of transcutaneous vagus nerve stimulation increase pupil size and online measurements of corticospinal excitability*

Ronan Denyer [1], Shiyong Su [1], Mantosh Patnaik [1], Julie Duque [1]

[1] *Université Catholique de Louvain*

1-B-15 *Keeping track of objects in real and virtual environments*

Katja Fiehler [1], Bianca Baltaretu [2], Meaghan Mcmanus [2]

[1] *University of Giessen,* [2] *Justus Liebig University Giessen*

1-B-16 *Reward and effort levels modulate phase-amplitude coupling and granger causality within and between the sensorimotor cortices before movement planning*

Taruna Yadav [1], Oman Magaña-Tellez [2], Joseph Francis [2]

[1] *University of Houston Biomedical Engineering,* [2] *University of Houston*

1-B-17 *First in-human tests with intramuscular braided multi-electrode probes for advanced clinical electrodiagnosis and experimental use*

Simon Giszter [1], Taegyo Kim [1], Ben Binder-Markey [1], Chalermpong Chewachutirungruang [1]

[1] *Drexel University*

1-B-18 *Characterizing cortical activity during cognitive set-shifting and upper limb perturbations*

Iran Gutierrez [1], Janna Protzak [2], Michael Borich [1], Lena Ting [2]

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

1-B-19 *Punishing temporal judgement boosts sense of agency and modulates its underlying neural correlates*

Christopher Hill [1]

[1] *Louisiana State University*

1-B-21 *Sensitive 3D whole-face movement detection and and synchronized electrophysiological analysis in mice*

Kyle Daruwalla [1], Irene Nozal Martin [1], Linghua Zhang [1], Diana Naglič [1], Andrew Frankel [1], Zainab Ahmad [1], Helen Hou [1]

[1] *Cold Spring Harbor Laboratory*

1-B-22 *Neural representation of internal models for sensorimotor planning*

Sanghoon Kang [1], Juliana Trach [1], Samuel Mcdougle [1]

[1] *Yale University*

1-B-23 *Similar patterns of online target selection with the dominant and non-dominant arm*

Isaac Kurtzer [1], Ryota Nishishiba [1], Elan Adhami [1], Daniel Tanis [2], Tarkeshwar Singh [3]

[1] *New York Institute of Technology - College of Osteopathic Medicine,* [2] *New York Institute of Technology,* [3] *Pennsylvania State University*

1-B-24 *Auditory input regulates vocal tract constriction dynamics during speech production*

Matthew Masapollo [1], Susan Nittrouer [2], Rosalie Gendron [3], Erin Wyndham [3], Ally Marcellus [3], Dorsa Moslemian [3], David Ostry [3]

[1] *University of Oklahoma Health Sciences,* [2] *University of Florida,* [3] *McGill University*

1-B-25 *Modulation of the activity of neurons in the primary motor cortex (M1) by the premotor areas and the posterior parietal cortex*

Youstina Mikhail [1], Léo Choinière [1], Sandrine Cote [2], Léane Pellerin [1], Stephan Quessy [1], Numa Dancause [1]

[1] *Université de Montréal,* [2] *Université du Québec à Trois-Rivières*

1-B-26 *ATHENA: automatically tracking hands expertly with no annotations*

Daanish Mulla [1], Mario Costantino [1], Erez Freud [1], Jonathan Michaels [1]

[1] *York University*

1-B-27 *Evaluating grasp-related tuning differences in the macaque frontoparietal grasping network*

Roberta Nocerino [1], Jan Churan [1], Benjamin Dann [1], Hans Scherberger [1]

[1] *German Primate Center*

1-B-28 *Sequence preparation is not always associated with a reaction time cost*

Armin Panjehpour [1], Mehrdad Kashefi [2], Joern Diedrichsen [2], J. Andrew Pruszynski [2]

[1] *University of Western Ontario,* [2] *Western University*

1-B-29 *Pragmatic representations of self and other's action in the monkey putamen*

Cristina Rotunno [1], Matilde Reni [1], Carolina Giulia Ferroni [2], Gemma Ballestrazzi [1], Elena Borra [1], Monica Maranesi [1], Luca Bonini [1]

[1] *University of Parma,* [2] *Italian Institute of Technology, Ferrara*

1-B-30 *Differential representation of initiation and execution of locomotion in cortical and striatal circuits*

Deepak Singla [1], Andrew Weakley [2], Long Yang [2], Sotirios Masmanidis [2]

[1] *Graduate Student,* [2] *University of California, Los Angeles*

1-B-31 *How plan-based generalization affects the apparent relationship between explicit strategies and implicit recalibration*

Jordan Taylor [1], Yifei Chen [1]

[1] *Princeton University*

1-B-32 *The role of sensory consequences in movement replication*

Nina Van Mastrigt [1], Johannes Keyser [2], Dimitris Voudouris [3], Mathias Hegele [3], Katja Fiehler [3]

[1] *Justus Liebig Universität Giessen,* [2] *University of Hamburg,* [3] *Justus-Liebig-Universität Giessen*

1-B-33 *Handwriting movements are pre-ordered individually prior to sequence execution*

Helena Wright [1], Jason Friedman [2], Joseph Galea [1], Katja Kornysheva [1]

[1] *University of Birmingham,* [2] *Tel Aviv University*

1-B-34 *Hierarchical neural dynamics in motor cortex and striatum across naturalistic behaviors*

David Xing [1], Andrew Miri [1], Joshua Glaser [2]

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

1-B-35 *Neural dynamics switch between motor preparation and execution*

Ziwei Yin [1], Katja Kornysheva [1]

[1] *University of Birmingham*

C – POSTURE AND GAIT

1-C-36 *Neural correlates of walking and reaching in the monkey lateral frontal cortex*

Davide Albertini [1], Rossella Sini [1], Federica Tili [1], Francesca Lanzarini [2], Monica Maranesi [1], Luca Bonini [1]

[1] *University of Parma,* [2] *Ernst Strüngmann Institute (ESI) for Neuroscience*

1-C-37 *Human-human physical interaction in a challenging postural balance task*

Silvia Buscaglione [1], Marta Russo [2], Dagmar Sternad [1]

[1] *Northeastern University,* [2] *National Research Council*

1-C-38 *Computational modeling of sensorimotor circuits and interactions controlling cycle and phase durations during locomotion following spinal cord injury*

Alain Frigon [1], Natalia Shevtsova [2], Johannie Audet [1], Sirine Yassine [1], Sergey Markin [2], Boris Prilutsky [3], Ilya Rybak [2]

[1] *Université de Sherbrooke,* [2] *Drexel University,* [3] *Georgia Institute of Technology*

1-C-39 *Vestibulospinal neurons respond to support surface perturbations in a freely-behaving rhesus macaque model of postural control*

Olivia Leavitt Brown [1], Kathleen Cullen [1]

[1] *Johns Hopkins School of Medicine*

1-C-40 *Aging and cognitive-motor challenge differentially modulate cortical motor contributions to standing balance control*

Catherine Mason [1], Camille Guzman [2], Taylor Leone [1], Rish Rastogi [1], Rajashree Ramamoorthy [3], Nathan Baune [1], Sujay Edavalapati [1], Keenan Whitesides [1], Alejandro Lopez [1], Michael Borich [1], Trisha Kesar [1], Lena Ting [3]

[1] *Emory University,* [2] *Georgia Institute of Technology & Emory University,* [3] *Emory University & Georgia Institute of Technology*

D – INTEGRATIVE CONTROL OF MOVEMENT

1-D-41 *Dual-task walking uncovers distinctive EEG effects on encoding and retention stages of working memory in healthy young adults: A Mobile Brain-Body Imaging (MoBI) study*

Esteban Avendano [1], Edward Freedman [1], Emma Mantel [1], Shahzoda Nasimjonova [1], John Foxe [1]

[1] *University of Rochester*

1-D-42 *Standing, and alternating sitting and standing, as better for task performance and visual attention than only sitting*

Cédrick Bonnet [1], Wafa Cherigui [2], Mélen Guillaume [2], Sergio Rodrigues [3]

[1] *University of Lille,* [2] *SCALab,* [3] *UNESP*

1-D-43 *The superior colliculus directs goal-oriented forelimb movements*

Shrivas Chaterji [1]

[1] *Champalimaud Center for the Unknown, Lisbon*

1-D-44 *The role of trajectory prediction in juggling*

Abir Chowdhury [1], Heiko Maurer [1], Alap Kshirsagar [2], Kai Ploeger [2], Jan Peters [2], Hermann Müller [1]

[1] *Justus Liebig Universität Giessen,* [2] *Technische Universität Darmstadt*

1-D-45 *Neural contributions to abstract and motor task sequences*

Hannah Doyle [1], Rhys Yewbrey [2], Katja Kornysheva [3], Sarah Garnaat [4], Nicole Mclaughlin [1], Theresa Desrochers [1]

[1] *Brown University,* [2] *Bangor University,* [3] *University of Birmingham,* [4] *Dartmouth-Hitchcock Medical Center*

1-D-46 *Finger tapping at maximal speed evokes a Crossover-Fatigability effect*

Caroline Heimhofer [1], Jenny Imhof [1], Ingrid Odermatt [1], Marc Bächinger [2], Nicole Wenderoth [1]

[1] *ETH Zürich,* [2] *Neural Control of Movement Lab*

1-D-47 *Effects of Cervical tSCS at sub-motor thresholds on force proprioception and motoneuron activity*

Rita Kharboush [1], Alejandro Pascual Valdunciel [1], Jaime Ibañez Pereda [2], Dario Farina [1]

[1] *Imperial College London,* [2] *University of Zaragoza*

1-D-50 *Modulation of corticospinal excitability in an upper-limb obstacle-avoidance reaching task*

Justin Mccurdy [1], Haleh Mahmoudi [1], Brendan Jarvis [1], Deborah Barany [1]

[1] *University of Georgia*

1-D-51 *Enhanced muscle activity during jumping behavior in tendon-specific Piezo1 gain of function mice*

Kohei Nakamura [1], Akito Kosugi [2], Ryo Nakamichi [1], Ryota Kurimoto [1], Takahide Matsushima [1], Tomoki Chiba [1], Kazuhiko Seki [2], Hiroshi Asahara [1]

[1] *Institute of Science Tokyo,* [2] *National Center of Neurology and Psychiatry*

1-D-52 *Connectome-based modelling reveals a core brain network predicting hand motor behaviour*

Enrica Pierotti [1], Luigi Cattaneo [1], Luca Turella [1]

[1] *University of Trento*

1-D-53 *All sensory-to-motor pathways through the Drosophila central nervous system*

Sophia Renauld [1], Alexander Bates [1], Minsu Kim [1], Jasper Phelps [1], Helen Yang [1], Diego Pacheco Pinedo [1], Zaki Ajabi [1], Mo Osman [1], Serene Dhawan [2], Tony Azevedo [3], Laia Serratosa [4], Ruairi Roberts [4], Arie Matsliah [2], Eric Perlman [5], Zeta Ai [6], The Flywire Consortium [7], Mala Murthy [2], Ben Di Bivort [8], Jan Drugowitsch [1], Rachel Wilson [1], Wei-Chung Allen Lee [1]

[1] *Harvard Medical School,* [2] *Princeton University,* [3] *University of Washington,* [4] *Aelysia,* [5] *Yikes LLC,* [6] *Zeta AI,* [7] *The Flywire Consortium,* [8] *Harvard University*

1-D-54 *Stability of rhythmic movements in the face of dynamic, cognitive and perceptual interactions*

Helene Serre [1], Dagmar Sternad [1], Joo-Hyun Song [2], Tri Nguyen [2], Se-Woong Park [3]

[1] *Northeastern University,* [2] *Brown University,* [3] *University of Texas at San Antonio*

1-D-55 *A quantitative, physiologically-meaningful breakdown of the constituent components of the brain and kinematic responses to environmental events reveals causal relationships between neural activity and motor responsiveness*

Tiziana Vercillo [1], Andrea D'avella [2], Antonella Maselli [3], Giulio Gabrieli [1], Richard Somervail [1], Giandomenico Iannetti [1]

[1] *Istituto Italiano di Tecnologia,* [2] *Tor Vergata University, Rome,* [3] *National Research Council of Italy*

E – Disorders of Motor Control

1-E-56 *Effects of exercise therapy on cerebellar activity in cervical dystonia*

Rabeya Zinnat Adury [1], David Arpin [1], David Vaillancourt [1], Aparna Wagle Shukla [1]

[1] *University of Florida*

1-E-57 *Reorganization of the cortical motor maps of multiple upper extremity muscles with rehabilitation therapy in stroke survivors*

Arianna Alston [1], Christian Schranz [2], Ja'quann Gallant [1], Na Jin Seo [1]

[1] *Medical University of South Carolina,* [2] *University of Innsbruck*

1-E-58 *Brain-heart interactions underlying movement disorder symptoms in Parkinson's disease*

Diego Candia-Rivera [1], Mario Chavez [2]

[1] *Paris Brain Institute,* [2] *Centre National de la Recherche Scientifique*

1-E-59 *Unimanual predictors of bimanual cooperative control in subacute stroke*

Léandre Gagné-Pelletier [1], Isabelle Poitras [2], Marc Roig [3], Catherine Mercier [1]

[1] *Laval University,* [2] *University of Calgary,* [3] *McGill University*

1-E-60 *The contribution of ipsilesional premotor and somatosensory cortex on skilled forelimb use after a unilateral ischemic injury to primary motor cortex in the rat*

Federico Barban [1], Matthew Nishimoto [2], Heather Hudson [3], David Guggenmos [3]

[1] *University of Genoa,* [2] *University of Kansas,* [3] *University of Kansas Medical Center*

1-E-61 *Understanding nicotine dependence through bimanual force control performance in chronic smokers*

Hyunjoon Kim [1], Joonho Lee [2], Hanall Lee [3], Tae Lee Lee [3], Hajun Lee [3], Nyeonju Kang [3]

[1] *Boston University,* [2] *University of Florida,* [3] *Incheon National University*

1-E-62 *The impact of synaptic dynamics on the efficacy of neurostimulation technologies*

Julia Ostrowski [1], Marco Capogrosso [2], Genis Prat Ortega [2], Serena Donadio [3], Luigi Borda [1], Scott Ensel [2]

[1] *Carnegie Mellon University,* [2] *University of Pittsburgh,* [3] *Rehab and Neural Engineering*

1-E-63 *Aberrant motor planning and preparation of hand movement in schizophrenia spectrum disorder: An fMRI study*

Harun Rashid [1]

[1] *Philipps Universität Marburg*

1-E-64 *Inconsistencies among neurophysiological, matching and metacognitive data on proprioception*

Najib Abi Chebel [1], Fabrice Sarlegna [2]

[1] *Aix Marseille Univ, CNRS, ISM,* [2] *CNRS (Centre National de la Recherche Scientifique)*

1-E-65 *The influence of tremor on pallidal activity in patients with Parkinson's disease*

Alexey Sedov [1], Philip Pavlovsky [1], Veronika Filiushkina [2], Svetlana Usova [1], Anna Gamaleya [3], Alexey Tomskiy [3]

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

1-E-66 *Associations between the Neural Mechanisms of Music Listening and Gait in persons with Parkinson's Disease*

Elizabeth Stegemoller [1], Lydia Linch [1]

[1] *Iowa State University*

1-E-67 *A robotic object hit and avoid task is sensitive to executive dysfunction in older adults with signs of dementia*

Brandon Woolman [1], Alexandra Watral [2], Kevin Trewartha [3]

[1] *Michigan Technological University,* [2] *Robert D. and Patricia E. Kern Center for the Science of Health Care Delivery,* [3] *Department of Psychology and Human Factors*

F – ADAPTATION & PLASTICITY IN MOTOR CONTROL

1-F-68 *Comparison of implicit motor adaptation between naturalistic and traditional lab-based perturbations*

Jenna Floyd [1], Saif Miskin [1], Colin Berkley [1], Scott Albert [2], Dan Blustein [1]

[1] *Acadia University,* [2] *Johns Hopkins School of Medicine*

1-F-69 *Micro-offline contributions to early skill learning: a comparative analysis*

Ethan Buch [1], Leonardo Cohen [2]

[1] *National Institute of Neurological Disorders & Stroke,* [2] *NINDS, NIH*

1-F-70 *Sensorimotor co-adaptation during reaching in a visuomotor rotation task*

Nour Al Afif [1], Michael Croteau [1], Mikayla Lalli [1], Daniel Deletsu [1], Rakshith Lokesh [2], Josh Cashaback [3], Michael Carter [1]

[1] *McMaster University,* [2] *Northeastern University,* [3] *University of Delaware*

1-F-71 *Reshaping circuit electrophysiological properties via noninvasive stimulation: short-term plasticity in humans*

Yasin Dhaher [1], Subaryani Soedirdjo [1], Yu-Chen Chung [1], Hyungtaek Kim [1]

[1] *UT Southwestern Medical Center*

1-F-72 *Disruption of dorsal premotor cortex impairs retention of human motor learning*

Shahryar Ebrahimi [1], Mohammad Darainy [1], Timothy Manning [1], David Ostry [1]

[1] *McGill University*

1-F-73 *Integration of touch location with body posture for an additional robotic body part*

Celia Foster [1], Eva Chapman [2], Mario Kleiner [3], Andrew Dott [2], Lucy Dowdall [1], Dani Clode [1], Tamar Makin [1]

[1] *University of Cambridge,* [2] *MRC Cognition and Brain Sciences Unit, University of Cambridge,* [3] *Psychtoolbox Project, Tuebingen*

1-F-74 *How do humans manage the curse of dimensionality in motor learning?*

Eric Grießbach [1], Adrian Haith [2]

[1] *Champalimaud Foundation,* [2] *Johns Hopkins School of Medicine*

1-F-75 *Type and timing of error signals on initial implicit changes in visuomotor adaptation*

Denise Henriques [1], Zacchary Nabaee-Tabriz [1], Parmin Rahimpoor-Marnani [1], Bernard 'T Hart [1]

[1] *York University*

1-F-76 *The influence of leg movements on performance during a visuomotor reach adaptation task*

Olivia Kim [1], Levi Mindlin [1]

[1] *Bates College*

1-F-77 *Whole body motor adaptation in goldfish using fish operated vehicle*

Zhuoxin Liu [1]

[1] *Ben-Gurion University of the Negev*

1-F-78 *Motor adaptation via pure visual change*

Zekun Sun [1], Dawei Bai [1], Brian Scholl [1], Samuel Mcdougle [1]

[1] *Yale University*

1-F-79 *Transcranial ultrasound stimulation (TUS) of the hippocampus affects rapid motor memory consolidation*

Maria Paz Montenegro [1], Yuming Lei [1]

[1] *Texas A&M University*

1-F-80 *Learning sign language with real-time kinematic feedback*

Indranil Nyamsuren [1], Jonathan Tsay [1]

[1] *Carnegie Mellon University*

1-F-81 *A theoretical model of acquisition and long-term retention in multifrequency bimanual coordination*

Ji Chul Kim [1], Se-Woong Park [2]

[1] *University of Connecticut,* [2] *University of Texas at San Antonio*

1-F-82 *Sensorimotor and neurophysiological underpinnings of speech audio-motor memories*

Nishant Rao [1], Rosalie Gendron [2], Timothy Manning [2], David Ostry [2]

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

1-F-83 *Investigation of sensorimotor interactions between the trunk and the upper limb in healthy volunteers*

Ana Carolina Schmaedeke [1], Thiago A. Grova [1], Filipe M. Azaline [1], Bia Ramalho [2], Claudia D. Vargas [1]

[1] *Federal University of Rio de Janeiro,* [2] *University of São Paulo*

1-F-84 *Contributions of visual, dynamic, and kinematic cues to compositional motor learning*

Sabyasachi Shivkumar [1], Anvesh Naik [1], James Ingram [2], Máté Lengyel [2], Daniel Wolpert[1]

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

1-F-85 *Motor unit mechanisms of speed control in mouse locomotion*

Kyle Thomas [1], Rhuna Gibbs [1], Hugo Marques [2], Megan Carey [2], Samuel Sober [1]

[1] *Emory University,* [2] *Champalimaud Foundation*

1-F-86 *Neural mechanisms of implicit and explicit motor learning*

Jonathan Tsay [1]

[1] *Carnegie Mellon University*

1-F-87 *Modulations of the implicit recalibration system during De Novo motor learning*

Tianhe Wang [1], Richard Ivry [2], Yuling Li [1]

[1] *University of California, Berkeley,* [2] *University of California*

1-F-88 *Motor decision is optimally tuned by the uncertainty in the environment and the body*

Tianhe Wang [1], Maoxin Xia [1], Richard Ivry [2]

[1] *University of California, Berkeley,* [2] *University of California*

G – THEORETICAL & COMPUTATIONAL MOTOR CONTROL

1-G-89 *Deep imitation learning for neuromechanical control: realistic walking in an embodied fly*

Elliott Abe [1], Charles Zhang [2], Raveena Chhibber [1], Grant Chou [1], Jason Foat [3], Dang Truong [1], Bence Olveczky [2], Nathan Sniadecki [1], John Tuthill [1], Talmo Pereira [4], Bing Brunton [1]

[1] University of Washington, [2] Harvard University, [3] University of California, San Diego, [4] Salk Institute for Biological Studies

1-G-90 *Error clamp behavior in visuomotor adaptation is not a singularity: challenges for modeling*

Mireille Broucke [1], Bernard 'T Hart [2], Denise Henriques [2], Jean-Jacques Orban De Xivry [3]

[1] University of Toronto, [2] York University, [3] Katholieke Universiteit Leuven

1-G-91 *Control of internal dynamics in the transport of a complex object*

Krishna Sarvani Desabhotla [1], Silvia Buscaglione [1], Rakshith Lokesh [1], Dagmar Sternad[1]

[1] Northeastern University

1-G-92 *Submovements and cognitive load: The effect of varying cognitive load on the production of submovements, and the effect of submovement rate on cognitive load*

Jason Friedman [1]

[1] Tel Aviv University

1-G-93 *Loss of complexity in stroke-impaired spatiotemporal finger control revealed by reduced individual and task specificity*

Patrick Ihejirika [1], Michael Rosenberg [2], Jing Xu [1]

[1] University of Georgia, [2] Emory University

1-G-94 *Neural properties underlying the efficiency-robustness trade-off in motor control: insights from RNNs*

Matthew Laporte [1], Dominik Endres [2], Gunnar Blohm [1]

[1] Queen's University, [2] Philipps-University Marburg

1-G-95 *The temporal dynamics of physical fatigue and its meural mechanisms*

Vivian Looi [1], Aram Kim [1], Agostina Casamento-Moran [1], Vikram Chib [1]

[1] Johns Hopkins School of Medicine

1-G-96 *The average progression of learning can obscure multiple learning trends: A computational cautionary tale*

Romina Mir [1], Francisco Valero-Cuevas [1]

[1] University of Southern California

1-G-97 *A computational counterexample to the need for sophisticated tactile sensing when learning to manipulate*

Romina Mir [1], Francisco Valero-Cuevas [1]

[1] University of Southern California

1-G-98 *Memory-sensory integration in skilled sequence production*

Amin Nazerzadeh [1], Medha Kumar Porwal [1], J. Andrew Pruszynski [2], Jörn Diedrichsen [2]

[1] University of Western Ontario, [2] Western University

1-G-99 *Unsupervised generative model for neural-drive estimation through real-time spike detection in low-density surface EMG interfaces*

Matteo Pizzi [1], Dario Farina [1]

[1] Imperial College London

1-G-100 *Interaction between motor adaptation and arm choice in virtual reality*

Tanya Subash [1], Victor Barradas [2], Payam Piray [1], Nicolas Schweighofer [1]

[1] University of Southern California, [2] Tokyo Institute of Technology

1-G-101 *Toward intention-driven neuroprostheses: Using eye fixations to predict joint moments in upper limb movements*

Lars Taubenberger [1], Priyanka Date [1], Tony Tang [1], Zhiqi Liu [1], Albert Vette [1]

[1] University of Alberta

1-G-102 *Working memory capacity limits human temporal credit assignment during motor reinforcement learning*

Tianyao Zhu [1], Tania Rabie [1], Jason Gallivan [1], Daniel Wolpert [2], Randy Flanagan [1]

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

POSTER SESSION 2

THURSDAY, MAY 2, 2025

A – CONTROL OF EYE & HEAD MOVEMENT

2-A-1 ***Age-related differences in gaze distribution during locomotion: prioritizing safety or exploration?***

Sophie Meissner [1], Jochen Miksch [2], Sascha Feder [2], Sabine Grimm [2], Wolfgang Einhäuser [2], Jutta Billino [1]

[1] *Justus Liebig Universität Giessen,* [2] *Chemnitz University of Technology*

2-A-2 ***Prosthesis stimulation and the flocculus activity for Compensatory Saccade during the head impulse test in the vestibular impaired monkey***

Yoshiko Kojima [1], Leo Ling [1], James Phillips [1]

[1] *University of Washington*

2-A-3 ***Differential effect of reward and sensory errors on saccade adaptation and associated mislocalization***

Frauke Heins [1], Markus Lappe [1]

[1] *University of Muenster*

2-A-4 ***Eye movement abnormalities during visually guided reaching in subacute stroke participants***

Isabelle Poitras [1], Lydia Kuhl [1], Sean Dukelow [1]

[1] *University of Calgary*

2-A-5 ***The role of visual interaction in movement coordination among wind instrument ensemble musicians***

Tomohiro Samma [1], Tsubasa Maruyama [2]

[1] *Keio University,* [2] *National Institute of Advanced Industrial Science and Technology*

2-A-6 ***Hand-eye coordination: a dual model predictive control theory***

Jingwen Zhao [1], Dorian Verdel [2], Etienne Burdet [1]

[1] *Imperial College London,* [2] *Imperial College of Science, Technology and Medicine*

B – FUNDAMENTALS OF MOTOR CONTROL

2-B-8 ***Cortical correlates of tactile suppression during active and passive movements***

Belkis Ezgi Arikan [1], Dimitris Voudouris [2], Benjamin Straube [3], Katja Fiehler [2]

[1] *University Hospital Essen,* [2] *Justus Liebig Universität Giessen,* [3] *University of Marburg*

2-B-9 ***The sitting position at work: comfortable but not optimal for perception, attention, decision and performance***

Cédrick Bonnet [1]

[1] *University of Lille*

2-B-10 ***Effects of transcutaneous vagus nerve stimulation on motor reflexes elicited by mechanical perturbations during reaching movements***

Clara Braconnier [1], Shiyong Su [1], Frederic Crevecoeur [1], Julie Duque [1]

[1] *Université Catholique de Louvain*

2-B-11 ***Improved error labeling in generative motor sequence learning***

Dushyanthi Karunathilake [1], Fumiaki Iwane [2], Leonardo Cohen [3], Ethan Buch [4]

[1] *HCPS, NINDS, NIH,* [2] *NINDS,* [3] *NINDS, NIH,* [4] *National Institute of Neurological Disorders & Stroke*

2-B-12 ***Disentangling the effects of inhibitory control and reward prospect on decision urgency and corticospinal excitability***

Thibault Fumery [1], Fostine Chaise [1], Fanny Fievez [1], Gerard Derosiere [2], Pierre Vassiliadis [3], Julie Duque [1]

[1] *Université Catholique de Louvain,* [2] *French National Institute of Health and Medical Research (INSERM),* [3] *Swiss Federal Institute of Technology Lausanne*

2-B-13 ***Multichannel electrode neuronal spinal cord recordings on behaving nonhuman primates***

Enrique Contreras [1], Yuta Soga [2], Shiro Egawa [3], Kazutaka Maeda [3], Woranan Hasegawa [3], Kumiko Oida [3], Chika Sasaki [3], Amit Yaron [4], Joachim Confais [5], Saeka Tomatsu [6], Tomomichi Oya [3], Tomohiko Takei [7], Shinji Kubota [8], Kazuhiko Seki [3]

[1] *NCNP Japan,* [2] *The University of Electro-Communications,* [3] *National Center of Neurology and Psychiatry,* [4] *IRCN, Tokyo University,* [5] *Cynbiose,* [6] *National Institute for Physiological Sciences,* [7] *Tamagawa University,* [8] *National Institute of Neuroscience*

2-B-14 ***Rapid finger responses reflect probabilistic information about upcoming mechanical perturbations***

Marco Emanuele [1], J. Andrew Pruszynski [2], Joern Diedrichsen [2], Jonathan Michaels [3]

[1] *University of Western Ontario,* [2] *Western University,* [3] *York University*

2-B-15 *The modulation of corticospinal excitability and short-interval intracortical inhibition during the preparation of an individualized finger motor task*

Véronique Flamand [1], Kaven Hamel [2], Alexandre Campeau-Lecours [1], Catherine Mercier [3]

[1] Université Laval, [2] Cirris et Université Laval, [3] Laval University

2-B-16 *Behavioral and neural constraints on motor unit control*

Ciara Gibbs [1], Vishal Rawji [1], Simon Avrillon [2], Peter Bryan [1], Aritra Kundu [1], Dario Farina [1], Juan Gallego [1]

[1] Imperial College London, [2] Nantes Université

2-B-17 *Egocentric gaze and allocentric background reference frames are integrated to represent and express motor memory*

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

[1] National Institute of Information and Communications Technology

2-B-18 *Encoding of muscle synergies by interneuronal populations in the spinal cord*

Borong He [1], Paola Salmas [1], Vincent Chi Kwan Cheung [1]

[1] The Chinese University of Hong Kong

2-B-19 *Motor working memory & mental rotation*

Hanna Hillman [1], Taylor Mcclure [1], Samuel Mcdougle [1]

[1] Yale University

2-B-20 *Chronic stability of human motor manifolds that enable iBCI cursor control*

William Hockeimer [1], Brian Dekleva [1], Nicolas Kunigk [1], Michael Boninger [2], Steven Chase [3], Jennifer Collinger [1]

[1] University of Pittsburgh, [2] University of Pittsburgh Medical Center, [3] Carnegie Mellon University

2-B-21 *Does cognitive load affect movement preparation and coordination differently based on side of brain damage?*

Shanie Jayasinghe [1], Pramisha Thapa [2]

[1] The University of Minnesota-Twin Cities, [2] University of Minnesota Twin Cities

2-B-22 *Cerebellar control of context-dependent motor timing*

Ilse Klinkhamer [1], Age Klopstra [2], Charlotte Wissing [2], Marit Runge [2], Devika Narain [2]

[1] Erasmus Medical Center, [2] Erasmus University Medical Center

2-B-23 *Action planning and execution under sensory uncertainty in younger and older adults*

Nicholas Kreter [1], Catherine Sager [1], Deborah Barany [2], Michelle Marneweck [1]

[1] University of Oregon, [2] University of Georgia

2-B-24 *Effects of orally administered Deschloroclozapine on fine hand movements in Rhesus Macaques*

Jennifer Mejaes [1], Allain-Thibeault Ferhat [1], Fabian Munoz Silva [1], Matthew Rendon [1], Vincent Ferrera [1]

[1] Columbia University

2-B-25 *Posture affects limb preference during reaching in primates*

Charles D. Holmes [1], Suhwan Hong [2], Sergei Gepshtein [3], Lawrence H. Snyder [2], Eric Mooshagian [1]

[1] University of California, San Diego, [2] Washington University School of Medicine, [3] Salk Institute for Biological Studies

2-B-26 *Corticostriatal contributions to skilled motor actions and trial and error learning*

Mark Nicholas [1], Eric Yttri [1]

[1] Carnegie Mellon University

2-B-27 *Spatial gradient of population representations about hand and eye positions in macaque motor cortex*

Tomohiro Ouchi [1], Ryan Canfield [1], Leo Scholl [1], Amy Orsborn [1]

[1] University of Washington

2-B-28 *Neural dynamics underlying behavior are preserved across species in an evolutionarily-conserved brain region*

Olivier Codol [1], Margaux Asclipe [1], Joanna Chang [2], Mostafa Safaie [2], Junchol Park [3], Joshua Dudman [4], Guillaume Lajoie [1], Juan Gallego [2], Matthew Perich [1]

[1] Université de Montréal, [2] Imperial College London, [3] HHMI Janelia Research Campus, [4] Howard Hughes Medical Institute

2-B-29 *Continuous visual feedback increases the accuracy of our self-attribution of action outcomes*

Christoph Schneider [1], Raz Leib [2], David Franklin [2], Mathias Hegele [3], Johannes Keyser [4]

[1] Justus Liebig Universität Giessen, [2] Technical University of Munich, [3] Center for Mind, Brain & Behavior, [4] University of Hamburg

2-B-31 *Structured representation of a symbolic action grammar across primate frontal cortex*

Lucas Tian [1], Kedar Garzón [2], Josh Tenenbaum [3], Xiao-Jing Wang [4], Winrich Freiwald [1]

[1] The Rockefeller University, [2] Columbia University, [3] Massachusetts Institute of Technology, [4] New York University

2-B-32 *Algorithmic and retrieval strategies have differential impacts on implicit recalibration in a visuomotor adaptation task*

Yiyu Wang [1], Jordan Taylor [1]

[1] *Princeton University*

2-B-33 *Time-to-contact is embodied in cortical preparatory activity during flexible manual interception*

Yongxiang Xiao [1], Cong Zheng [1], Ruichen Zheng [1], Yiheng Zhang [1], He Cui [1]

[1] *Chinese Institute for Brain Research, Beijing(CIBR)*

2-B-34 *Eliminating interlimb transfer asymmetry in motor skill learning*

Cong Yin [1], Yaoxu Wang [1]

[1] *Capital University of Physical Education and Sports*

C – POSTURE AND GAIT

2-C-36 *Does the interplay of postural constraints and reward probability influence movement vigor?*

Alessandro Garofolini [1], Giacomo Costa [2], Chiara Venturini [2], Alaa Ahmed [3], Matteo Bertucco [4]

[1] *Institute for Health and Sport (IHES), Victoria University,* [2] *Biomedicine and Movement Sciences, University of Verona,* [3] *University of Colorado, Boulder,* [4] *University of Verona*

2-C-37 *Cortico-basal ganglia dynamics underlying sensorimotor integration during skilled locomotion*

Martin Esparza [1], Ioana Lazar [1], Catia Fortunato [1], Mostafa Safaie [1], Juan Gallego [1]

[1] *Imperial College London*

2-C-38 *Intervention of freezing of gait in a neuromusculoskeletal model*

Daisuke Ichimura [1]

[1] *National Institute of Advanced Industrial Science and Technology (AIST)*

2-C-39 *The role of fidgety movements in infant locomotor development revealed by longitudinal comparisons of muscle synergies*

Jiayin Lin [1]

[1] *The Chinese University of Hong Kong*

2-C-40 *Assessing trade-offs between risk and effort during walking*

Jackeline Tafur-Oviedo [1], James Finley [1]

[1] *University of Southern California*

D – INTEGRATIVE CONTROL OF MOVEMENT

2-D-42 *MEG reveals simultaneous intrinsic and extrinsic motor plans in parietofrontal cortex*

Gunnar Blohm [1], Douglas Cheyne [2], J Douglas Crawford [3]

[1] *Queen's University,* [2] *Hospital for Sick Children Research Institute,* [3] *York University*

2-D-43 *Feedback gains reflect unfolding decisions during ongoing actions*

Cesar Canaveral [1], Sasha Feradji [1], Andrea Green [1], Paul Cisek [1]

[1] *Université de Montréal*

2-D-44 *Cerebellar EEG oscillation related to repetitive vocalization in human*

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

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

2-D-45 *Micro offline gains do not reflect offline learning or consolidation of motor sequence memories*

Jörn Diedrichsen [1], Anwesha Das [2], Mehrdad Kashefi [1], Mohammad Amin Nazerzadeh [1], Max-Philipp Stenner [3], Elena Azañon [2]

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

2-D-46 *The importance of 3D information in virtual obstacle avoidance: Effects of perceptual uncertainty and feedback*

Martin Giesel [1], Constanze Hesse [1]

[1] *University of Aberdeen*

2-D-47 *Pupil size reflects the attenuation of motor fatigability by reward*

Jenny Imhof [1], Caroline Heimhofer [1], Marc Bächinger [2], Richard Ramsey [1], Nicole Wenderoth [1]

[1] *ETH Zürich,* [2] *Neural Control of Movement Lab*

2-D-48 *Cognitive maps of sensorimotor programs*

Joonhee Lee [1], Yixuan Wang [1], Agostina Casamento-Moran [1], Daniel Mcnamee [2], Vikram Chib [1]

[1] *Johns Hopkins School of Medicine,* [2] *Champalimaud Foundation*

2-D-50 *Preliminary evaluation of a neurally controlled powered knee-ankle prosthesis*

John Mccullough [1]

[1] *Massachusetts Institute of Technology*

2-D-51 *Prediction of sensory attributes of action-outcome shape action kinetics early during movement*

Roy Mukamel [1], Batel Buaron [1], Alexandra Agiv [2]

[1] *Tel Aviv University,* [2] *Tel-Aviv University*

2-D-52 *Brain mechanical properties relate to decision-making and movement behaviour*

Truc Ngo [1], Jan Calalo [1], Seth Sullivan [1], John Buggeln [1], Mary Kramer [1], Kyra Twohy [1], Curtis Johnson [1], Joshua Cashaback [1]

[1] *University of Delaware*

2-D-53 *Dynamic connectivity between the primary and premotor cortices during Ipsilateral and Contralateral reaching-to-grasp movements in Macaque Monkeys*

Soraya Rahimi [1], Stephan Quessy [1], Numa Dancause [1]

[1] *Université de Montréal*

2-D-54 *A shared-control AI-iBCI system for seamless navigation in real-world scenarios using virtual reality in Macaque monkeys*

Ophelie Saussus [1], Sofie De Schrijver [1], Pinhao Song [2], Renaud Detry [2], Peter Janssen [1]

[1] *Katholieke Universiteit Leuven,* [2] *KU Leuven*

2-D-55 *Evidence of nonmotor prediction errors in the human cerebellum during reinforcement learning*

Juliana Trach [1], Samuel Mcdougle [1]

[1] *Yale University*

2-D-56 *Somatosensory inputs to primate primary motor cortex: dual roles in voluntary movement*

Junichiro Yoshida [1], Woranan Hasegawa [1], Satomi Kikuta [1], Shinji Kubota [2], Kazuhiko Seki [1]

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E – DISORDERS OF MOTOR CONTROL

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Serena Donadio, *University of Pittsburgh*

Serena Donadio obtained her M.Sc. in Bioengineering from the Polytechnic University of Turin, Italy. Her research focuses on spinal cord stimulation (SCS) therapies for Spinal Muscular Atrophy (SMA). Recently awarded an SMA Foundation fellowship, she explores innovative neurostimulation strategies to advance motor control and improve outcomes for individuals with neurological disorders.

Lucy Dowdall, *University of Cambridge*

Lucy is a Cognitive Neuroscience PhD student in Prof Tamar Makin's Plasticity lab at the University of Cambridge. Her research focuses on the role of somatosensory feedback in sensorimotor learning, where she uses motor augmentation technology as a model to explore plasticity in our sensorimotor system.

Alice Geminiani, *Neuroscience Program, Champalimaud Centre for the Unknown, Lisbon*

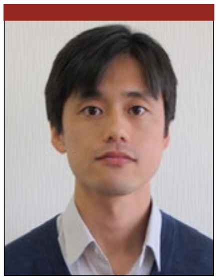
Alice Geminiani is a postdoc in the Carey lab (Champalimaud Foundation), where she investigates cerebellar mechanisms for locomotor adaptation using optogenetics and electrophysiology. During her PhD at Politecnico di Milano and first postdoc at the University of Pavia, she developed spiking neural networks to study cerebellar computations underlying motor adaptation.

Chadwick Healy, *University of Colorado*

Chad recently earned his PhD at University of Colorado Boulder with Alaa Ahmed. Previously, he managed the human factors engineering team at SpaceX, collaborating with engineers and astronauts to design the next generation of spacecraft. His research focuses on how factors such as reward and effort influence human movement decisions.

Iain Hunter, *Technical University of Munich*

Iain Hunter is a postdoctoral researcher in the Chair for Neuromuscular Diagnostics (run by Prof. David Franklin) at the Technical University of Munich. He is interested in sensorimotor control with current focus on how impedance affects adaptation to novel dynamics.



Akito Kosugi, *National Center of Neurology and Psychiatry*

Akito is a postdoctoral fellow working with Dr. Kazuhiko Seki at the National Center of Neurology and Psychiatry in Japan. His research focuses on the peripheral nervous system of non-human primates, specifically examining how the modulation of proprioceptive reafferent signals influences motor control during dynamic limb movements.

Stefan Lemke, *University of North Carolina - Chapel Hill*

Stefan Lemke is a postdoc at UNC with Adam Hantman, studying how distributed brain networks control movements in typically and atypically developed brains. Stefan grew up in Minnesota before graduate school at UCSF with Karunesh Ganguly and a Marie Curie Fellowship at the Italian Institute of Technology with Stefano Panzeri.

Shuqi Liu, *University of Pittsburgh*

Shuqi is a PhD candidate in the Sensorimotor Learning Lab at the University of Pittsburgh, mentored by Dr. Gelsy Torres-Oviedo. She studies the impact of brain aging and cognitive health on motor learning and community mobility, using non-invasive neuroimaging and behavioral experiments.

Abdulraheem Nashef, *University of Colorado*

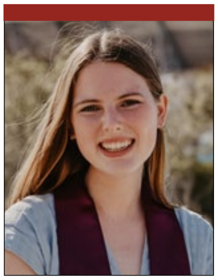
Raheem is a postdoctoral fellow, with Dr. Abigail Person in the University of Colorado, studying the role of the cerebellum in the control of reaching in mice. Previously, he worked with Dr. Yifat Prut to study the role of the cerebellar-thalamocortical pathway in the control of reaching in monkeys.

Katrina Nguyen, *University of Colorado School of Medicine*

Katrina Nguyen is currently a postdoctoral fellow in Abigail Person's lab at the University of Colorado School of Medicine. She holds a doctorate in biomedical engineering from Carnegie Mellon University. Her research focuses on measuring activity in the cerebellar cortex and linking basal ganglia and cerebellar circuit interactions during skilled reaching in mice.

Katherine Perks, *University of Washington*

Katherine is a Neuroscience PhD candidate in Dr. Amy Orsborn's lab at the University of Washington. She is interested in understanding how the brain learns flexible, effective motor control through both internally-generated and sensory-driven processes. Her work combines control theory with neural interfaces and rich behavioral assays in non-human primates.



Anna Pritchard, *Emory University & Georgia Institute of Technology*

Anna is a 3rd year Biomedical Engineering Ph.D. student in the Systems Neural Engineering Lab at Emory University & Georgia Tech, advised by Dr. Chethan Pandarinath. She is a member of the BrainGate consortium, investigating multifunctional applications of intracortical brain-computer interfaces.

Ritu Roy Chowdhury, *Eberhard Karls University of Tübingen / Center for Integrative Neuroscience (CIN), IMPRS-MMFD*

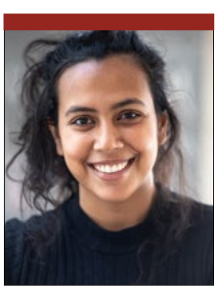
Ritu Roy Chowdhury is a final-year PhD student at the International Max Planck Research School for the Mechanisms of Mental Function and Dysfunction (IMPRS-MMFD) and the University of Tübingen, Germany. Her research explores how movement shapes sensory perception through predictive coding. When not in the lab, she dabbles in art and poetry, and meditates with her neighbors' cat."

Apoorva Sharma, *Yale University*

Apoorva Sharma is a PhD student in Sam McDougle's lab at Yale University, studying how motor learning interacts with cognitive factors like attention and memory. Her current work explores how contextual cues aid motor memory formation. Broadly, she aims to investigate how sensory evidence integrates to shape movement plans and support diverse movement repertoires.

Sam Snyder, *University of Pittsburgh*

Sam is currently a graduate student studying neuroscience at the University of Pittsburgh. His research focuses on how flexible brainwide interactions support diverse behaviors. His work is advised by Aaron Batista, Emily Oby, Steve Chase, Byron Yu, and Matt Smith.



Ayesha Thanawalla, *Salk Institute for Biological Studies*

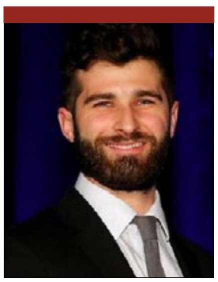
Ayesha Thanawalla is a postdoctoral fellow at the Salk Institute for Biological Studies. Her work combines intersectional viral targeting of neuronal subtypes and pathways in the cerebellum and spinal cord with high-resolution kinematic tracking and electromyography to explore neural circuits involved in forelimb motor control.

Tianhe Wang, *University of California Berkeley*

Tianhe Wang is a PhD candidate at the University of California, Berkeley. Wang's research focuses on: (1) uncovering the computational principles that govern motor control and flexible learning behaviors in humans; and (2) investigating the cerebellum's role in motor and cognitive functions.

Ruihan Wei, *Johns Hopkins University*

Dr. Ruihan Wei is a postdoctoral fellow in Biomedical Engineering at Johns Hopkins University. Her research focuses on neural control of movement, vestibular function, and postural stability in non-human primates. With expertise in neurophysiology, biomechanics, and computational modeling, she investigates sensorimotor transformations underlying balance and locomotion, particularly in vestibular-impaired conditions.



Jonathan Wood, *Jefferson Moss Rehabilitation Research Institute*

Jonathan is a postdoctoral research fellow at the Jefferson Moss Rehabilitation Research Institute working with Dr. Aaron Wong and Dr. Amanda Therrien. His primary research interest is to understand how neurologic conditions such as Parkinson's disease impacts the learning and control of movement.

NOTES

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