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Sharif Neuroscience Symposium 2021

March 3-5th
Online Event

- Systems Neuroscience
- Computational Neuroscience
- Neuroimaging
- Neural Networks
- Human & Machine Vision
- Brain Computer Interface
- Biological and Artificial Intelligence

Sharif Neuroscience Symposium 2021

Symposium Information and Abstracts Booklet

March 2021

Contents

Preface

The third Sharif Neuroscience Symposium (SNS2021) which is being held from 3rd-5th of March 2021 (13-15th of Esfand 1399) aims to cover key advances in cognitive, computational and systems neuroscience as well as neuro-engineering by inviting experts in the fields from across the world to share their new findings and perspectives in a collegial atmosphere.

This year, the symposium consists of a series of 16 invited talks by internationally and nationally renowned experts across various research areas including cognitive neuroscience, learning and memory, decision making, sensory processing, vision sciences, motor control and computational neuroscience. In addition, the symposium received abstract submissions from various research groups in Iran and internationally. Following, double blind peer review by the SNS2021 scientific committee, 44 abstracts were selected for a combination of 9 oral and 35 poster presentations. Honorable mention goes to colleagues from International School of Advance Sciences (SISSA) and Institute for Research in Fundamental Sciences (IPM) for the sizeable number of high-quality submissions this year.

In addition to the main symposium, 5 satellite workshops covering areas from fMRI to neuromarketing were held or are being scheduled in the weeks leading to or following the main symposium and are warmly received by the community and attended by more than 100 participants overall.

The current booklet contains comprehensive information about the SNS2021, including the detailed meeting schedule, the list of symposium sponsors, abstracts of invited speakers, and all accepted abstracts. Special thanks go to the executive committee consisting of student in the electrical engineering department at Sharif University of Technology who worked tirelessly in the months leading to the symposium for making it a reality and a success. This year symposium is fully online and thus easily accessible to the research community worldwide. We hope that this symposium enhances the excitement about neuroscience among the researchers in the country and would be happy to see its positive scientific impact reverberate for months and years to come among the students and faculty in the field.

Ali Ghazizadeh, PhD
Symposium Chair, SNS 2021
Faculty, Electrical Engineering Department, Sharif University of Technology
Dean, School of Cognitive Sciences, IPM

Sponsors


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Liv Intelligent Technology

Liv intelligent technology knowledge-based company founded in 2019 has developed advanced medical equipment for clinical and research applications in the field of functional diagnostics and neurophysiology. Liv has also designed and manufactured non-contact infrared thermometer for the first time in Iran during the COVID-19 pandemic since fever was one of the first signs of Corona virus infection. Professional team of electrical engineers, medical engineers, software engineers and programmers in cooperation with medical researchers allows Liv to take leading positions in Iranian market of diagnostics and neurophysiology medical equipment. Our mission is to improve the quality of life through advanced medical technology.

Liv systems are based on customer focused effort within the framework of the Liv family. User friendly and intuitive handling of the recording and review software combined with the outstanding improvement of the functionality are trademarks of the Liv family, providing you with more time that you can then focus on your patient, rather than your machine. EEG, ABR, TDCS, NFB, EMG, ECG, EEG Cap, Software and Thermometer are our main products.

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Part I

Essential Information

Program

Tehran (GMT+3:30):

March 3rd		
from	to	Wednesday
14:00	14:30	Opening Ceremony
14:30	15:30	Rufin Vogels
15:30	16:00	Panel (Rufin Vogels)
16:00	17:00	Ali Asadollahi
17:00	17:30	Panel (Ali Asadollahi)
17:30	18:30	Maurice Smith
18:30	19:00	Panel (Maurice Smith)
19:00	20:00	Accepted Abstracts oral Presentation (1-3)

March 4th		
from	to	Thursday
8:30	9:15	Majid Nili
9:15	9:45	Panel (COGC)
9:45	10:00	Break
10:00	11:00	Accepted Abstracts oral Presentation (4-6)
11:00	12:30	Poster Session
12:30	13:00	Panel (Liv Intelligent Technology)
13:00	14:00	Mathew Diamond
14:00	14:30	Panel (Mathew Diamond)
14:30	15:30	Ali Ghazizadeh
15:30	16:00	Panel (Ali Ghazizadeh)
16:00	17:00	Nicole Rust
17:00	17:30	Panel (Nicole Rust)
17:30	18:30	Michael Shadlen
18:30	19:00	Panel (Michael Shadlen)
19:00	20:00	Jonathan W. Pillow
20:00	20:30	Panel (Jonathan W. Pillow)
20:30	21:30	Behrad Noudoost

March 5th		
from	to	Friday
8:30	9:15	Ian Max Andolina
9:15	9:45	Panel (Ian Max Andolina)
9:45	10:00	Break
10:00	11:00	Accepted Abstracts oral Presentation (7-9)
11:00	12:30	Poster Session
12:30	13:00	Break
13:00	14:30	Poster Session
14:30	15:30	Mohammad Nami
15:30	16:00	Break
16:00	17:00	Reza Rajimehr
17:00	17:30	Panel (Reza Rajimehr)
17:30	18:30	Kathleen E. Cullen
18:30	19:00	Panel (Kathleen E. Cullen)
19:00	20:00	Ziad Hafed
20:00	20:30	Break
20:30	21:30	Maryam Vaziri
21:30	22:00	Panel (Maryam Vaziri) / Closing Ceremony

US East Coast (GMT-5:00):

March 3rd		
from	to	Wednesday
5:30	6:00	Opening Ceremony
6:00	7:00	Rufin Vogels
7:00	7:30	Panel (Rufin Vogels)
7:30	8:30	Ali Asadollahi
8:30	9:00	Panel (Ali Asadollahi)
9:00	10:00	Maurice Smith
10:00	10:30	Panel (Maurice Smith)
10:30	11:30	Accepted Abstracts oral Presentation (1-3)

March 4th		
from	to	Thursday
0:00	0:45	Majid Nili
0:45	1:15	Panel (COGC)
1:15	1:30	Break
1:30	2:30	Accepted Abstracts oral Presentation (4-6)
2:30	4:00	Poster Session
4:00	4:30	Panel (Liv Intelligent Technology)
4:30	5:30	Mathew Diamond
5:30	6:00	Panel (Mathew Diamond)
6:00	7:00	Ali Ghazizadeh
7:00	7:30	Panel (Ali Ghazizadeh)
7:30	8:30	Nicole Rust
8:30	9:00	Panel (Nicole Rust)
9:00	10:00	Michael Shadlen
10:00	10:30	Panel (Michael Shadlen)
10:30	11:30	Jonathan W. Pillow
11:30	12:00	Panel (Jonathan W. Pillow)
12:00	13:00	Behrad Noudoost

March 5th		
from	to	Friday
0:00	0:45	Ian Max Andolina
0:45	1:15	Panel (Ian Max Andolina)
1:15	1:30	Break
1:30	2:30	Accepted Abstracts oral Presentation (7-9)
2:30	4:00	Poster Session
4:00	4:30	Break
4:30	6:00	Poster Session
6:00	7:00	Mohammad Nami
7:00	7:30	Break
7:30	8:30	Reza Rajimehr
8:30	9:00	Panel (Reza Rajimehr)
9:00	10:00	Kathleen E. Cullen
10:00	10:30	Panel (Kathleen E. Cullen)
10:30	11:30	Ziad Hafed
11:30	12:00	Break
12:00	13:00	Maryam Vaziri
13:00	13:30	Panel (Maryam Vaziri) / Closing Ceremony

Central Europe (CET) (GMT+1:00):

March 3rd		
from	to	Wednesday
11:30	12:00	Opening Ceremony
12:00	13:00	Rufin Vogels
13:00	13:30	Panel (Rufin Vogels)
13:30	14:30	Ali Asadollahi
14:30	15:00	Panel (Ali Asadollahi)
15:00	16:00	Maurice Smith
16:00	16:30	Panel (Maurice Smith)
16:30	17:30	Accepted Abstracts oral Presentation (1-3)

March 4th		
from	to	Thursday
6:00	6:45	Majid Nili
6:45	7:15	Panel (COGC)
7:15	7:30	Break
7:30	8:30	Accepted Abstracts oral Presentation (4-6)
8:30	10:00	Poster Session
10:00	10:30	Panel (Liv Intelligent Technology)
10:30	11:30	Mathew Diamond
11:30	12:00	Panel (Mathew Diamond)
12:00	13:00	Ali Ghazizadeh
13:00	13:30	Panel (Ali Ghazizadeh)
13:30	14:30	Nicole Rust
14:30	15:00	Panel (Nicole Rust)
15:00	16:00	Michael Shadlen
16:00	16:30	Panel (Michael Shadlen)
16:30	17:30	Jonathan W. Pillow
17:30	18:00	Panel (Jonathan W. Pillow)
18:00	19:00	Behrad Noudoost

March 5th		
from	to	Friday
6:00	6:45	Ian Max Andolina
6:45	7:15	Panel (Ian Max Andolina)
7:15	7:30	Break
7:30	8:30	Accepted Abstracts oral Presentation (7-9)
8:30	10:00	Poster Session
10:00	10:30	Break
10:30	12:00	Poster Session
12:00	13:00	Mohammad Nami
13:00	13:30	Break
13:30	14:30	Reza Rajimehr
14:30	15:00	Panel (Reza Rajimehr)
15:00	16:00	Kathleen E. Cullen
16:00	16:30	Panel (Kathleen E. Cullen)
16:30	17:30	Ziad Hafed
17:30	18:00	Break
18:00	19:00	Maryam Vaziri
19:00	19:30	Panel (Maryam Vaziri) / Closing Ceremony

China Standard Time (GMT+8:00):

March 3rd - March4th		
from	to	Wednesday
18:30	19:00	Opening Ceremony
19:00	20:00	Rufin Vogels
20:00	20:30	Panel (Rufin Vogels)
20:30	21:30	Ali Asadollahi
21:30	22:00	Panel (Ali Asadollahi)
22:00	23:00	Maurice Smith
23:00	23:30	Panel (Maurice Smith)
23:30	0:30	Accepted Abstracts oral Presentation (1-3)

March 4th - March 5th		
from	to	Thursday
13:00	13:45	Majid Nili
13:45	14:15	Panel (COGC)
14:15	14:30	Break
14:30	15:30	Accepted Abstracts oral Presentation (4-6)
15:30	17:00	Poster Session
17:00	17:30	Panel (Liv Intelligent Technology)
17:30	18:30	Mathew Diamond
18:30	19:00	Panel (Mathew Diamond)
19:00	20:00	Ali Ghazizadeh
20:00	20:30	Panel (Ali Ghazizadeh)
20:30	21:30	Nicole Rust
21:30	22:00	Panel (Nicole Rust)
22:00	23:00	Michael Shadlen
23:00	23:30	Panel (Michael Shadlen)
23:30	0:30	Jonathan W. Pillow
0:30	1:00	Panel (Jonathan W. Pillow)
1:00	2:00	Behrad Noudoost

March 5th - March 6th		
from	to	Friday
13:00	13:45	Ian Max Andolina
13:45	14:15	Panel (Ian Max Andolina)
14:15	14:30	Break
14:30	15:30	Accepted Abstracts oral Presentation (7-9)
15:30	17:00	Poster Session
17:00	17:30	Break
17:30	19:00	Poster Session
19:00	20:00	Mohammad Nami
20:00	20:30	Break
20:30	21:30	Reza Rajimehr
21:30	22:00	Panel (Reza Rajimehr)
22:00	23:00	Kathleen E. Cullen
23:00	23:30	Panel (Kathleen E. Cullen)
23:30	0:30	Ziad Hafed
0:30	1:00	Break
1:00	2:00	Maryam Vaziri
2:00	2:30	Panel (Maryam Vaziri) | Closing Ceremony

Symposium links

The third symposium consists of a main session in which all invited speeches and oral presentations take place. Panels and posters take place in separate online rooms. Poster rooms are numbered from 1-12 matching the assigned poster number for the accepted abstracts. All classes can be accessed using the same username and password provided to each registered participant. Please note that each username is only permitted to login from only one device at a time.

- Main session: https://vc.sharif.edu/ch/sns2021-main
- Panel session: https://vc.sharif.edu/ch/sns2021-panel
- Poster session 1: https://vc.sharif.edu/ch/sns2021-poster1
- Poster session 2: https://vc.sharif.edu/ch/sns2021-poster2
- Poster session 3: https://vc.sharif.edu/ch/sns2021-poster3
- Poster session 4: https://vc.sharif.edu/ch/sns2021-poster4
- Poster session 5: https://vc.sharif.edu/ch/sns2021-poster5
- Poster session 6: https://vc.sharif.edu/ch/sns2021-poster6
- Poster session 7: https://vc.sharif.edu/ch/sns2021-poster7
- Poster session 8: https://vc.sharif.edu/ch/sns2021-poster8
- Poster session 9: https://vc.sharif.edu/ch/sns2021-poster9
- Poster session 10: https://vc.sharif.edu/ch/sns2021-poster10
- Poster session 11: https://vc.sharif.edu/ch/sns2021-poster11
- Poster session 12: https://vc.sharif.edu/ch/sns2021-poster12

Invited Speakers *(In alphabetical order)*

- Dr. Ali Asadollahi, Assistant Professor, Department of Biology Sciences, Ferdowsi University of Mashhad
- Dr. Ian Max Andolina, Associate Faculty, Institute of Neuroscience, Shanghai Institute for Biological Sciences, Chinese Academy of Sciences (CAS), China
- Dr. Kathleen E. Cullen, Full Professor, Department of Biomedical Engineering, The Johns Hopkins University
- Dr. Mathew Diamond, Full Professor, Cognitive Neuroscience, International School for Advanced Studies (SISSA)
- Dr. Ali Ghazizadeh, Assistant Professor, Electrical Engineering Department, Sharif University of Technology
- Dr. Ziad M. Hafed, Professor, Center for Integrative Neuroscience (CIN) and Hertie Institute for Clinical Brain Research, University of Tübingen
- Dr. Mohammad Nami, Assistant Professor, Department of Neuroscience, School of Advanced Medical Sciences and Technologies, Shiraz University of Medical Sciences
- Dr. Majid Nili, Professor of Electrical and Computer Engineering, Tehran University
- Dr. Behrad Noudoost, Adjunct Associate Professor, Department of Neurobiology, Associate Professor, Department of Ophthalmology/Visual Sciences, University of Utah
- Dr. Nicole C. Rust, Associate Professor, Department of Psychology, University of Pennsylvania
- Dr. Reza Rajimehr, Research Scientist, MRC Cognition and Brain Sciences, University of Cambridge, Cambridge, UK
- Dr. Maurice Smith, Associate Professor of Biomedical Engineering, School of Engineering and Applied Sciences and Center for Brain Science, Harvard University
- Dr. Michael Shadlen, Full Professor, Department of Neuroscience, Columbia University
- Dr. Jonathan W. Pillow, Full Professor, Princeton Neuroscience Institute and Department of Psychology, Princeton University
- Dr. Maryam Vaziri-Pashkam, Research Fellow, Laboratory of Brain and Cognition, National Institute of Mental Health
- Dr. Rufin Vogels, Full Professor, KU Leuven, Faculty of Medicine, Belgium

Part II

Invited Speeches

(In order of presentation time)

Wednesday Talks:

Body representations in macaque inferior temporal cortex

Wednesday
14:30-15:30
Tehran time

Rufin Vogels
Full Professor, KU Leuven, Faculty of Medicine, Belgium

Many studies examined where and how the brain encodes faces but much less is known about another ecological important visual category: bodies. fMRI studies in humans and monkeys have shown body category-selective regions, i.e. body patches, in the occipito-temporal cortex. I will discuss monkey fMRI studies that revealed the body patch network of the inferior temporal cortex. Then, I will review single-unit recording studies of the stimulus selectivity of neurons in two of the fMRI-defined body patches. These studies suggest that, although the features that body patch neurons respond to differ from those of face patch neurons, the body and face patch systems show a similar functional organization, e.g. in terms of tolerance to changes in viewpoint

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TBA

Wednesday
16:00-17:00
Tehran time

Ali Asadollahi
Assistant Professor, Department of Biology Sciences, Ferdowsi University of Mashhad

TBA.

TBA

Wednesday
17:30-18:30
Tehran time

Maurice Smith
Associate Professor of Biomedical Engineering, School of Engineering and Applied Sciences and Center for Brain Science, Harvard University

TBA.

Thursday Talks:

TBA

Thursday
8:30-9:15
Tehran time

Majid Nili
Professor of Electrical and Computer Engineering, Tehran University

TBA.

Neuronal algorithms for extracting multiple percepts from a single stimulus

Thursday
13:00-14:00
Tehran time

Mathew Diamond
Full Professor, Cognitive Neuroscience, International School for Advanced Studies (SISSA)

When we examine the coding of tactile stimuli, it is natural to focus first on how the evoked neuronal activity underlies the perception of stimulus features. But a second percept, explicitly or implicitly, accompanies the tactile experience – the feeling of time occupied by that stimulus. To explore the connection between stimulus perception and time perception, we begin with human and rat psychophysics. When subjects judge the duration of a vibration applied to the fingertip (human) or whiskers (rat), increasing stimulus intensity leads to increasing perceived duration. Symmetrically, increasing vibration duration leads to increasing perceived intensity. From this relationship, we build a computational framework where the vibration-evoked firing early in the processing stream is accumulated by two integrators, in parallel, each integrator giving rise to a distinct percept. This framework makes predictions for the perceptual effects – on both intensity and duration – of direct manipulation of firing in sensory cortex, which we verify by optogenetics in rats. However, just when everything begins to make sense, the story becomes more complex: changing the physical features of the tactile stimulus causes the engagement of a very different pathway for the time percept. We conclude that the mechanisms underlying the feeling of stimulus duration are multiple and are adaptable to stimulus properties.

Acquired Object Salience: Neural Substrates and Behavioral Consequences

Thursday
14:30-15:30
Tehran time

Ali Ghazizadeh

Assistant Professor, Electrical Engineering Department, Sharif University of Technology

Our interactions with objects are often guided by past experiences with them or the lack thereof. Previously, we have demonstrated that rewarding or aversive outcome associations as well as mere perceptual exposures (familiarity vs novelty) biases gaze toward objects with effects that last for many months. For reward association, this gaze bias was shown to support efficient visual search. However, the neural substrates of experience dependent object salience remain poorly understood. Importantly, it is not known to what degree the coding of different dimensions of salience such as value, punishment and novelty are distributed across areas that control gaze. Here I will first review some of our recent studies that show cortical and subcortical areas involved acquired salience in nonhuman primates. I will then show results suggesting that the value and value uncertainty is learned and represented in parallel in prefrontal cortex (PFC) and basal ganglia. Both regions also similarly code punishment related object salience. However, novelty and recency salience seem to be preferentially encoded in PFC. Furthermore, behavioral and neural analysis as well as multi-alternative drift-diffusion modelling suggests that efficient search is likely to be accompanied by processing area enlargement for valuable objects. Finally, I will describe some preliminary results on learning and long-term memory of value-based object salience in humans.

How we remember what we have seen

Thursday
16:00-17:00
Tehran time

Nicole C. Rust
Associate Professor, Department of Psychology, University of Pennsylvania

Humans and other primates have a remarkable ability to remember the images that they have seen, even after seeing thousands, each only once and only for a few seconds. In this talk, I will describe recent work from our group focused on the mechanisms that support visual familiarity memory in the primate brain. In the first part of the talk, I will describe the correlates of the natural variation with which some images are inherently more memorable than others, both the brain as well as deep neural networks trained to categorize objects. In the second part of the talk, I will focus on how information about visual familiarity is signaled and then decoded to produce visual familiarity behavior.

Deciding to stop deciding: A cortical-subcortical circuit for forming and terminating a decision

Thursday
17:30-18:30
Tehran time

Michael Shadlen
Full Professor, Department of Neuroscience, Columbia University

TBA.

Inferring the dynamics of learning from sensory decision-making behavior

Thursday
19:00-20:00
Tehran time

Jonathan W. Pillow
Full Professor, Princeton Neuroscience Institute and Department of Psychology, Princeton University

The dynamics of learning in natural and artificial environments is a problem of great interest to both neuroscientists and artificial intelligence experts. However, standard analyses of animal training data either treat behavior as fixed, or track only coarse performance statistics (e.g., accuracy and bias), providing limited insight into the dynamic evolution of behavioral strategies over the course of learning. To overcome these limitations, we propose a dynamic psychophysical model that efficiently tracks trial-to-trial changes in behavior over the

course of training. In this talk, I will describe recent work based on a dynamic logistic regression model that captures the time-varying dependencies of behavior on stimuli and other task covariates. We applied our method to psychophysical data from both human subjects and rats learning a sensory discrimination task. We successfully tracked the dynamics of psychophysical weights during training, capturing day-to-day and trial-to-trial fluctuations in behavioral strategy. We leverage the model's flexibility model to investigate why rats frequently make mistakes on easy trials, demonstrating that so-called "lapses" often arise from sub-optimal weighting of task covariates. Finally, I will describe recent work on adaptive optimal training, which combines ideas from reinforcement learning and adaptive experimental design to formulate methods for inferring animal learning rules from behavior, and using these rules to speed up animal training.

Prefrontal control of visual cortical signals

Thursday
20:30-21:30
Tehran time

Behrad Noudoost

Adjunct Associate Professor, Department of Neurobiology, Associate Professor, Department of Ophthalmology/Visual Sciences, University of Utah

Visual attention is an integral part of our daily life. A network of cortical and subcortical structures are involved in control of visual attention. To date, how these areas interact with each other and the chain of events giving rise to visual attention are still unclear. I will present our findings regarding the neurons and neuromodulators involved in control of visual cortical signals and discuss how these findings help us untangle the neural circuitry of attention.

Friday Talks:

TBA

Friday
8:30-9:15
Tehran time

Ian Max Andolina
Associate Faculty, Institute of Neuroscience, Shanghai Institute for Biological Sciences, Chinese Academy of Sciences (CAS), China

TBA.

Neural functional Connectivity and its sleep-wake flip-flop

Friday
14:30-15:30
Tehran time

Mohammad Nami
Assistant Professor, Department of Neuroscience, School of Advanced Medical Sciences and Technologies, Shiraz University of Medical Sciences

Various dynamics in brain oscillations are found to alter upon wake-sleep transition and vice versa. Changes in sleep microstructure including cyclic alternating patterns as well as functional connectivity (FC) parameters i.e. sleep electroencephalography FFT coherence over time is a captivating idea for in-depth sleep research. Our team has strived analyzing qEEG and fNIRS data upon stage sleep transition. In the same vein, simultaneous EEG-fMRI has been employed in other research to evaluate brain functional activity upon wake-sleep transition. Static FC in Wake and Stage-2 Sleep (NREM2)/REM are shown to be comparable. Meanwhile, there are extensive disparities between FC dynamics upon wake and sleep when it comes to flip-flop transitions. This presentation is building upon the existing evidence to argumentatively discuss sleep-related reductions in effective connectivity and synaptic strength with regards to the role of sleep in wakefulness-related cognitive processes.

Semantic face processing in human brain

Friday
16:00-17:00
Tehran time

Reza Rajimehr
Research Scientist, MRC Cognition and Brain Sciences, University of Cambridge, Cambridge, UK

Extensive research has shown that perceptual information of faces is processed in a network of hierarchically-organized areas within ventral temporal cortex. For familiar and famous faces, perceptual processing of faces is normally accompanied by extraction of semantic knowledge about the social status of persons. Semantic processing of familiar faces could entail progressive stages of information abstraction. However, the cortical mechanisms supporting multi-stage processing of familiar faces have not been characterized. Here using an event-related fMRI experiment, familiar faces from four celebrity groups (actors, singers, politicians, and football players) and unfamiliar faces were presented to the human subjects (both males and females) while they were engaged in a face categorization task. We systematically explored the cortical representations for faces, familiar faces, subcategories of familiar faces, and familiar face identities using whole-brain univariate analysis, searchlight-based multivariate pattern analysis, and functional connectivity analysis. Convergent evidence from all these analyses revealed a network of overlapping and hierarchically-organized areas in posterior cingulate cortex (PCC) that contained decodable fMRI responses for representing different levels of semantic knowledge about familiar faces. Our results suggest a hierarchical organization in PCC for processing the semantic information of faces – analogous to the hierarchical organization within ventral temporal cortex for processing the perceptual information of faces.

Predictive coding of Natural Self-Motion: Implications for Perception and Action

Friday
17:30-18:30
Tehran time

Kathleen E. Cullen
Full Professor, Department of Biomedical Engineering, The Johns Hopkins University

A fundamental question in neuroscience is how does the brain compute accurate estimates of our self-motion relative to the world and our orientation relative to gravity in everyday life. In this talk, I will describe recent findings from my laboratory's research that have addressed this question and provided new insight into how the brain encodes self-motion information to ensure accurate perception and motor control.

First, we have recently examined the statistics of natural self-motion signals experienced by mice, monkeys, and humans, and then explored the neural coding strategies used by early vestibular pathways. Focusing on the relationships between neural variability, detection thresholds, and information transmission, our findings have revealed two distinct sensory channels at the level of the vestibular periphery. Notably, more regularly discharging afferents have better detection thresholds and use rate coding, while more irregular afferents take advantage of precise spike timing (i.e, temporal coding) and are better optimized for processing natural vestibular stimuli. Further, our research has established that the neurons at the first central stage of vestibular processing are substantially less sensitive to active motion. Notably, this ability to distinguish between active and passive motion is not a general feature of early vestibular processing, but is instead a characteristic of a distinct group of neurons known to contribute to postural control and spatial orientation. We have further shown that cerebellum builds a dynamic prediction (e.g., internal model) of the sensory consequences of self-motion during active behaviors, which in turn enables the preferential encoding of unexpected motion to ensure postural and perceptual stability. Moreover, when unexpected vestibular inputs become persistent during active motion, this mechanism is rapidly updated to re-enable the vital distinction between active and passive motion to ensure the maintenance of posture. Finally, we have established that posterior thalamocortical vestibular pathway even more selectively encode unexpected motion, thereby providing a

neural correlate for ensuring perceptual stability during active versus externally generated motion.

Taken together, these findings have important implications for our understanding of the brain mechanisms that ensure accurate perception and behaviour during everyday activities, including how motor-based predictions are dynamically updated as the relationship between a voluntary motor command and its sensory consequences changes.

Acknowledgements: Funded by the NIH/NIDCD, the Canadian Institutes of Health Research (CIHR), Natural Sciences and Engineering Research Council of Canada (NSERC), and Canada Foundation for Innovation (CFI).

Unraveling the neural mechanisms of perceptual saccadic suppression

Friday
19:00-20:00
Tehran time

Ziad M. Hafed

Professor, Center for Integrative Neuroscience (CIN) and Hertie Institute for Clinical Brain Research, University of Tübingen

Visual sensitivity, probed through perceptual detectability of sudden stimulus onsets, is strongly impaired around the time of saccades. This robust perceptual phenomenon exhibits intriguing stimulus selectivity properties, which have previously been interpreted as reflecting active suppressive signals directly derived from the eye movement commands. However, the neural mechanisms underlying these selective properties have remained elusive. In my talk, I will describe neurophysiological and behavioral experiments that strongly recast interpretations of perceptual saccadic suppression mechanisms. First, using neurophysiology in awake monkeys, and their concomitant behavior, I will describe how different cell types within the same sensory-motor structure can actually exhibit differential forms of saccade-induced suppression. Thus, some neuron types violate the selective properties of perceptual suppression that are so robust in humans. I will then move to identifying a retinal origin of perceptual saccadic suppression, using ex-vivo retinal ganglion cell neurophysiology. Remarkably, the visual dependencies of retinal suppression (in ex-vivo mouse and pig retinae) are the same as the perceptual dependencies reported by human observers seeing similar image sequences, with or without eye

movements. I will finally end by showing how this insight, of a visual origin of perceptual saccadic suppression, allows demonstrating that the classic stimulus selective properties of suppression can be easily violated with simple visual manipulations, thus potentially explaining the earlier monkey results alluded to above. This line of work demonstrates that perceptual saccadic suppression may not be saccadic at all, but instead reflects visual-visual interactions jumpstarted at the very first stage of visual processing in the brain.

Visual Processing of Object Shapes and Body Movements for Action

Friday
20:30-21:30
Tehran time

Maryam Vaziri-Pashkam
Research Fellow, Laboratory of Brain and Cognition, National Institute of Mental Health

The brain's output is movement and the primary function of the sensory systems, including vision, is to guide goal directed movements. Upon encountering an object, the visual system has to extract features that are relevant for proper motor interaction with that object. Although much is known about the abstract representation of object shapes in the brain, the computations and neural mechanisms that support visual object processing for action are poorly understood. In this talk, I will provide a framework for studying the visual processing of objects for action. My studies explore the processing of object images as well as real objects and complex body movements of other individuals. First, using evidence from neuroimaging, I will establish the presence of object representations in the human parietal cortex that may have a role in extracting object features relevant for actions. Next, I will present the results of a series of behavioral experiments that use motion tracking along with machine learning techniques to study visual processing of others' body movements in the context of real-time social interactions. The research program sketched in this talk aims to bridge between the study of visual processing and that of the goal directed movements.

Part III

Accepted Abstracts

Oral Presentations

Wednesday Presentations:

Neural frequency tagging reveals link between statistical learning and discrimination

Wednesday
19:00-19:15
Tehran time

De Rosa, M., Ktori, M., Vidal, Y., Bottini, R., Crepaldi, D.
SISSA - International School for Advanced Studies

Brains thrive on regularities hidden in the chaotic streams of sensory inputs. However, how efficient is this regularity detection? In this study we address the relation between statistical learning mechanisms and visual discrimination, and particularly whether a discrimination-selective neural signal can be elicited online purely on the basis of statistical cues and regardless of known categorical distinctions. To this aim, we adopted a fast-periodic visual stimulation (FPVS) design, a highly sensitive and behavior-free approach that uses electrophysiological recordings in the context of an oddball paradigm, and that capitalizes on the principle of neural entrainment. Sequences of words and pseudo-reading material presented at a fast rate of 6Hz were interleaved with oddballs, inserted periodically every 5 items. Crucially, sequences were made of stimuli that belonged to the same category (e.g., words in words) and the only distinction between base and oddball items was the frequency of individual tokens within a stream. Within a few minutes of stimulation, oddballs evoked a reliable neural response at the predefined stimulation frequency of 1.2 Hz (i.e., 6/5) and its harmonics, indicating the discrimination between two locally-defined, distinct groups of items solely informed by token frequency. Our findings provide evidence for an online neural marker of implicit statistical learning emerging fast and automatically, under rapid presentation conditions. This neural response was independent of stimulus familiarity, as it emerged similarly with words, pseudowords, letter strings and pseudoletters, and pinpoints a fundamental mechanism that might be at the basis of linguistic bootstrapping.

Decomposing the sources of neuronal spike variability

Wednesday
19:20-19:35
Tehran time

Mohammad Amin Fakharian[1,2], Saleh Fayyaz[1,2], Ali Ghazizadeh[1,2]

[1]School of Cognitive Sciences, Institute for Research in Fundamental Sciences, Tehran, Iran

[2]Electrical Engineering Department, Sharif University of Technology, Tehran, Iran

Neural spiking shows considerable variability not only during the time course of a trial but also between identical trials of the same task resembling a doubly stochastic process. However, a reliable method for estimating the contribution of different sources of variability in neural data are not available yet. Here, we use a normative approach (Fano-Factor or FF method) for estimating the normalized variability of spiking within trials (nWTV aka phi) as well as the normalized variability of spike rates between trials (nBTV). This method provides an improvement over one of the widely used alternatives (VarCE) by estimating absolute rather than relative nBTV and can accommodate concurrent changes in nWTV. Indeed, analysis of data across cortical and subcortical regions show significant and concurrent changes in nWTV and nBTV in response to stimuli. Notably, we find that in many cases the point process variability (nPPV) does not change significantly over the course of trial; suggesting that changes in nWTV have sources other than nPPV. Simulation results using synthetic leaky-integrate and fire (LIF) neural networks show that parameters such as presynaptic network rate variability, ratio of excitatory to inhibitory inputs as well as within and between correlation in presynaptic pools of neurons can replicate some of the observation including concurrent changes in output neurons nBTV and nWTV. Our approach opens the way to study and compare the network and private sources of variance across neuronal populations and across conditions and helps one understand the role of response variability in information processing in the brain.

Dynamics of history-dependent perceptual judgment

Wednesday
19:40-19:55
Tehran time

Iacopo Hachen[1], Sebastian Reinartz[1], Romain Brasselet[1], Alisea Stroligo[1], Mathew E. Diamond[1]

[1]International School for Advanced Studies (SISSA)

Perception is not the mere encoding of instantaneous physical features. A main determinant of perceptual choices is the pre-existing state of the subject as shaped by recent events. In other words, perceptual systems exhibit the important feature of being history-dependent. In a recent study (https://www.biorxiv.org/content/10.1101/2020.07.12.199489v1), we sought to characterize the role of stimulus history and its updating dynamics. We trained rats to classify whisker-mediated vibrations according to their mean speed, assigning each stimulus to one of two possible categories: 'strong' or 'weak'. Rats showed a response bias that was inversely correlated to stimulus values received in the preceding trials, but not dependent on previous choices or rewards. Specifically, receiving a high-speed stimulus led to a lower probability of classifying upcoming stimuli as 'strong' and vice versa, an effect which lasted for several trials. Surprisingly, the repulsive bias in a given trial n, following a stimulus in trial n-1, increased with the time interval between the two. The same key results were obtained by testing human subjects in an analogous tactile discrimination task. We modeled subjects' perceptual judgments as the result of a history-dependent shift in the decision criterion applied to sensory input, outperforming an ideal observer model based on current sensory information only.

Thursday Presentations:

Making decisions in the presence of temporally discrete cues: a computational approach

Thursday
10:00-10:15
Tehran time

Sajjad Zabbah[1,2] , Reza Ebrahimpour[1,2]

[1]School of Cognitive Sciences (SCS), Institute for Research in Fundamental Sciences (IPM), Niavaran, Tehran, Iran

[2]Department of Computer Engineering, Shahid Rajaee Teacher Training University, Tehran, Iran

Although our real-life decisions are mostly made based on pieces of evidence with different context which are available in different times, our knowledge about the mechanism of decision making in the brain is mostly shaped by experiments which provide a continuous stream of information to the observers. The results of these experiments show that the brain accumulates information from different sources of evidence to choose an option among some alternatives. The decision is made as soon as the accumulated evidence reaches a threshold [Gold and Shadlen 2007]. This process is mathematically explained by the drift-diffusion model and neuronally implemented by the attractor based spiking neural network [Wang 2002]. However, little is known about the ability of the suggested models to explain the decision-making process when pieces of evidence are presented at different times. In this study, we investigate the predictions of both the attractor and diffusion models in response to discrete pieces of evidence. We then compare the results of our computational experiments with recent behavioral studies in discrete environments [Kiani et al., 2013, Waskom and Kiani, 2018]. Results showed that the diffusion model cannot explain the sequence-dependent performance observed in human behaviors but can well explain the gap-independent performance. On the other hand, the attractor-based model, in contrast to drift-diffusion models, is able to explain the sequence-dependent behavior but not the gap-independent one. In other words, performance in the diffusion model is gap and sequence-independent but the performance of the attractor model depends on both the gap and the sequence. In conclusion, our computational modeling results indicate that both the diffusion model and the neuronally-informed attractor-based model

need revisions to be accounted for the process of decision-making in the discrete environment.

Saccade modulates synaptic efficacy between visual sensory areas

Thursday
10:20-10:35
Tehran time

Ehsan Rezayat[1], Mohammad-Reza A. Dehaqani[2,1], Behrad Noudoost[3]

[1]School of Cognitive Sciences, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran

[2]Cognitive Systems Laboratory, Control and Intelligent Processing Center of Excellence (CIPCE), School of Electrical and Computer Engineering, College of Engineering, University of Tehran, Tehran, Iran

[3]Department of Ophthalmology and Visual Sciences; University of Utah; Salt Lake City, UT

We examined whether the preparation for a saccadic eye movement modulates synaptic efficacy in visual areas in behaving monkeys. The neural activity enhanced during saccade preparation time in visual areas, and the receptive field of neurons move toward the saccade target location in similar covert attention tasks. We measured neural activity in area V4, inferior temporal (IT) cortex, and frontal eye field (FEF) during Object-Guided-Saccade task. While applying a biphasic pulse of micro-stimulation in area V4, we measured the synaptic efficacy of the connection between IT and V4 at a random time relative to the saccade. We found that more facilitation of synaptic efficacy during saccade preparation time toward the receptive field compare to saccades away from the receptive field. In these experiments, as well as showing the role of FEF in attention and saccades, we also demonstrated the role of FEF activity in the modulation of synaptic efficacy in visual areas.

Two distinct mechanisms for time perception are selected by context

Thursday
10:40-10:55
Tehran time

Maria Ravera*[1], Sebastian Reinartz*[1], Mario Fontanini[1], Mathew E. Diamond[1] (*equal contribution)

[1]Tactile Perception and Learning Lab, International School for Advanced Studies (ISAS/SISSA)

Every day we judge the duration of countless sensory events, implicitly or explicitly. Time perception has an intimate connection to the sensory features of the event 'when' rats judge the duration of a<1-second vibration applied to the whiskers, increasing vibration intensity leads to increasing perceived duration (Toso et al., 2021). When spike trains from vibrissal somatosensory cortex (vS1) are modelled as input to a leaky integrator, resulting neurometric curves match observed psychometric curves. Furthermore, optogenetic manipulation of vS1 alters perceived duration (Reinartz at al., 2019). However, when sensory events are marked by clear onset/offset signals, does the same integrative mechanism hold? We trained rats to classify stimuli, defined by 7 possible durations and 5 intensities, as 'long' or 'short' Each stimulus was either (i) 'uniform', a continuous, noisy vibration identical to those of earlier studies, or (ii) 'flanked', a noisy vibration where first and final 25ms were amplified, yielding clear onset/offset. In uniform sessions, perceived duration was biased by stimulus intensity and by optogenetic excitation of vS1, consistent with integration of vS1 sensory drive. In flanked sessions, the bias evoked by intensity and optogenetic excitation of vS1 disappeared. Individual stimuli were processed according to their context; in flanked context (85)

Friday Presentations:

Frequency modulation of brain oscillations based on attentional demands and speed of following behavior

Friday
10:00-10:15
Tehran time

Mohammad Bagher Khamechian[1,2], Mohammad Reza Daliri[1,2]

[1]Neuroscience and Neuroengineering Research Laboratory, Biomedical Engineering Department, School of Electrical Engineering, Iran University of Science and Technology, Tehran, Iran

[2]Cognitive Neurobiology Laboratory, School of Cognitive Sciences, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran

The oscillatory activity of the cortical neurons is hypnotized to play a crucial role in many brain functions in human and non-human primates. Many studies sought to reveal how different component of brain oscillations (e.g. oscillatory phase, power, etc.) may relate to behavior and cognitive functions. This is while there is no literature on how variation in the frequency of population responses changes the neural firing and also modulating the speed of behavioral action. We recorded the intra-cortical activity of area MT in a macaque visual cortex when it performed a change detection task. To examine instantaneous frequency (IF), we applied a General harmonic wavelet transform on local field potentials (1-120 Hz) to filter it into different frequency bands. Then, the IF of each band was computed by approximating the derivative of filtered signals. Our analyses illustrated a significant frequency modulation in the theta-to-alpha oscillations (4-13 Hz) for MT neural population by switching attention from outside the receptive field (RF) toward the stimulus inside the RF ($p <$ 3e—10 -7, sign test). The IF stimulus-selectivity had a direct correlation to the firing-rate of MT neurons at the population level ($r =$ 0.21, $p < 0.035$, Spearman correlation). This finding may imply that MT neurons can produce variable firing rates whenever their synaptic inputs are being bombarded with variable frequencies. Our further investigations revealed that the IF of the theta-to-alpha oscillation was significantly lower in fast compared to slow behavioral responses ($p <$ 7e—10 -5, sign test). We also observed a significant negative correlation between neural firing-rate and delta-to-alpha IF in fast responses ($r =$ -0.2, p ? 0.05, Spearman correlation). This finding suggests

that IF of the neural population potentially modulates spike threshold and engages with those mechanisms control neural spike timing for effective routing information into downstream associative areas.

Two distinct networks containing position invariant representations of actions in the human brain

Friday
10:20-10:35
Tehran time

E. Yargholi[1], GA. Hossein-zadeh[2], M. Vaziri-Pashkam[3]

[1]School of Cognitive Sciences, Institute for Research in Fundamental Sciences, Tehran, Iran

[2]School of Electrical and Computer Engineering, College of Engineering, University of Tehran, Tehran, Iran

[3]National Institute of Mental Health (NIMH) | NIMH Laboratory of Brain and Cognition

Humans can recognize others' actions in the social environment. This recognition ability is tolerant to drastic variations in the visual input caused by the movements of people in the environment. What neural underpinnings support this position-tolerant action recognition? In the present study, we aimed to identify regions in the brain that contain position-tolerant representations of actions and explore the representational content of these regions. We recorded fMRI data from twenty-two subjects while they observed video clips of ten different human actions in Point Light Display format. Each stimulus was presented in either the upper or the lower visual fields. We used multivoxel pattern analysis and a searchlight technique to identify brain regions that contain position tolerant action representation. In a generalization test, linear support vector machine classifiers were trained with fMRI patterns in response to stimuli presented in one position and tested with stimuli presented in another position. Results showed above-chance classification in the left and right lateral occipitotemporal cortex, right inferior intraparietal sulcus, and right superior intraparietal sulcus. To investigated the representational content of these regions, we constructed two models, one based on the movement of the body parts and another based on the similarity ratings obtained from an independent behavioral experiment. In a multiple regression analysis, we used these models to predict the cross-position decoding accuracies for each ROI. Results showed that the objective body-part model was a better predictor for the accuracies in the parietal regions,

while the model based on the subjective ratings of similarity was a better predictor of the accuracies in the occipitotemporal regions. These results suggest the existence of two distinct networks containing abstract representations of human actions.

Revealing hidden microcircuits using higher-order interactions of neuronal activity

Friday
10:40-10:55
Tehran time

Safura Rashid Shomali [1], S. Nader Rasuli [2,3], and Hideaki Shimazaki [4]

[1]School of Cognitive Sciences, Institute for Research in Fundamental Sciences (IPM)
[2]Department of Physics, University of Guilan
[3]School of Physics, Institute for Research in Fundamental Sciences (IPM)
[4]Center for Human Nature, Artificial Intelligence, and Neuroscience(CHAIN), Hokkaido University

We identify hidden neuronal motifs from the correlated activity of simultaneously recorded neurons. To elucidate hidden motifs of shared inputs to the observed neurons, we predict pairwise and triple-wise interactions of neurons under different motifs. Our tool is an analytical solution that accurately addresses the effect of strong/weak synaptic connections on spike-timing of leaky integrate-and-fire neurons receiving noisy inputs balanced near the neuron's threshold [Shomali et. al, 2018]. Comparing empirical interactions with predicted ones in the plane of triple-wise versus pairwise interactions, one can infer the hidden microcircuit that induces the observed interactions. We generalize this approach making it independent of the neuron models, by calculating the analytical boundaries for each motif, in extreme cases. Neurons in macaque V1 showed spare population activity characterized by positive pairwise but 'negative' triple-wise interactions [Ohiorhenuan et. al, 2010]. A quantitative comparison reveals that the motif of excitatory-to-pairs explains the sparse activity, ruling out the shared inhibition [Shomali et. al, 2019]. We verify the robustness of this result to adaptation, mixing motifs, and to the condition in which the balanced inputs are slightly away from the threshold. Furthermore, we find evidence for this motif, in other brain regions in rodents. Sustained triplet correlations in OFC during predictable correct choices encodes behavioral decisions [Balaguer-Ballester et. al, 2020]; we find

most of the data show negative triple-wise and positive pairwise interactions for correct choices. Similarly, hippocampal CA3 neurons show negative 3rd-order, positive 4th-order, and negative 5th-order interactions [Shimazaki et. al, 2015]. We extend our analysis to more than three neurons and present a table that links the strength and sign of higher-order interactions to hidden motifs. It affirms that such change of interactions' signs is exclusively explained by excitatory-to-pairs. These imply that non-trivially, the excitatory-to-pairs motif is ubiquitous across regions and species.

Poster Presentations

Thursday Posters:

Semi-analytical approximation to statistical moments of Bayesian preference learner in uncertain environment (Poster 1)

Poster 1
Thursday
11:00-12:30
Tehran time

Amirhossein Tehranisafa[1,2] , Atyie Sarabi Jamab[2], Reza Ghaderi[1]
[1]Department of Cognitive Modeling, Institute for Cognitive and Brain Sciences, Shahid Beheshti University, Tehran, Iran
[2]School of Cognitive Sciences, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran

The ability to learn other's preferences is crucial for social interaction. People apply this ability to learn others' attitude toward risk. In this study we address the computational properties of this learning mechanism. Our study is concerned with computationally efficient approximation of statistical moments of Bayesian preference leaner through semi-analytical approach.

According to decision theory, the probability of choosing a risky option increases with its subjective utility. Thus, our learner builds a mathematical model of a risky decision maker and then tries to make an accurate estimation for subjective parameters related to that decision maker.

At the starting point, the learner assumes some prior belief about the others' attitude. (usually a Gaussian probability distribution with some arbitrary moments). By observing the Other's choices, the learner receives the information about others' risk attitude. This information helps the learner to update parameters trial by trial. This update is done by Bayesian belief updating powered by Vibrational approximation. As a result, posterior belief can be represented in terms of a Gaussian distribution with updated moments. Also the learner can make a prediction about other's decision. This prediction is made by our developed statistical inference method called the approximation of moments of subjective utility passed through SoftMax mappings.

To evaluate our computational model, we employed both real and simulated data. In learning step, training our model with real experimental data showed that our Bayesian preference learner could dynamically adopt to others' trait in a quick manner (in 5 to 10 trials). The accuracy of learning was guaranteed by analyzing the whole data (28 trials) with the offline powerful estimator so-called maximum-likelihood. Finally, in prediction step, Monte-Carlo sampling showed that our model could predict the subject's decisions more accurate and efficient in comparing with other fixed-form or numerical well-known approximation methods.

How can networks of coupled oscillatory neurons shape different cognitive functions? (Poster 2)

Poster 2
Thursday
11:00-12:30
Tehran time

Golnaz Baghdadi[1], Farzad Towhidkhah[1]
[1]Biomedical Engineering Department, Amirkabir University of Technology

There is evidence to suggest that spiking neurons can be described as oscillators. By accepting this hypothesis, the next question is how different cognitive functions, such as perception, attention, inhibition, learning, or prediction, result from a set of coupled oscillators whose output is nothing more than a bunch of oscillations with specific patterns. In this study, we provided a suggested answer to this question using oscillatory neuronal networks and synchronization and desynchronization concepts.

Three neuronal networks were designed to model some aspects of perception, attention, and perdition functions. The units of these networks were modeled by van der Pol oscillators, used in several studies as one of the simple models of neurons. These oscillators were coupled unilaterally and bilaterally. The coupling coefficient values corresponding to weights in artificial neural networks or structural/functional connections in natural neural networks can be determined analytically or through learning algorithms. Changing the coupling coefficients among neuronal units can lead to synchronization and desynchronization phenomena. In the proposed models, the units' outputs are a set of oscillations with different patterns affected by these phenomena.

The results demonstrated that synchronization and desynchronization in coupled oscillatory neurons could be considered as a mechanism to pay more attention to a target stimulus and inhibit the effect of non-target stimuli. In simulations, the synchronization procedure also revealed a possible justification for some behaviors and patterns observed in psychophysical tasks. It was also shown that updating the coupling coefficient or the synchronization level among units could be suggested as one possible way that the brain uses for learning and predicting sequential events.

The results increase our insight into the neuronal oscillating behaviors and origins of various phenomena, and can be used to develop a model to predict possible causes of particular symptoms in attention deficit disorder.

Study of accuracy and confidence during perceptual decision-making task after adding an extra short duration cue (Poster 3)

Poster 3
Thursday
11:00-12:30
Tehran time

Zahra Azizi[1], Sajjad Zabbah[2], Azra Jahanitabesh[3], Reza Ebrahimpour[4]

[1]PhD student of Cognitive Science Department of Cognitive Modeling, Institute for Cognitive Science Studies, Tehran, Iran
[2]Institute for Research in Fundamental Sciences, School of Cognitive Sciences, Tehran, Iran
[3]Department of Psychology, University of California, Davis, California, United States
[4]Professor of Artificial Intelligence, Department of Computer Engineering, Shahid Rejaee Teacher Training University, Tehran, Iran

In many cases, decisions require information integration from pieces of evidence received in time interval. This research has mainly concentrated on the neural and behavioral mechanism underlying these decisions by studying behavioral, pupillometry and electroencephalography (EEG) data.

Accordingly, we applied a perceptual decision-making experiment using Random Dot Motions (RDM) paradigm. Participants had to indicate the predominant direction of motion of a cloud of moving dots (left or right) by saccadic eye movement towards the chosen target after receiving one or two pulses of 120 ms of information. Both the direction and strength of the motion changed randomly trial by trial. Moreover, the time interval of two pulses is selected randomly

from 0, 120, 360, and 1080 ms. Twelve healthy adult subjects participated in the study and meanwhile, pupillometry and EEG signals were recorded. In addition to behavioral and pupillometry analysis, to investigate EEG signals dynamically during the task, ERPs and Granger causal relationships between centro and frontal areas of brain were studied.

The results showed that participants integrate the decision evidence, invariant to gap interval to form their decision and confidence after receiving the second pulse of information. Unlike the accuracy, confidence did not improve along with accuracy. Instead, our data showed that receiving an extra short piece of information improves participants' confidence in correct choices but worsens participants' confidence in incorrect decisions which interpreted as improvement of metacognitive sensitivity. The grand-average ERPs and pupillometry results showed the same improvement in metacognition sensitivity. Also, Granger causal relationships between centro and frontal areas support the causal interactions between these areas during gaps.

In conclusion, the study indicated that although participants integrate the decision evidence perfectly and improve their accuracy and decision metacognition, their confidence did not improve significantly. Also, during the gaps, the interaction of centro and frontal areas of brain enhanced.

Feedback alignment with weight normalization provides a biologically plausible mechanism for flexible learning in the brain (Poster 4)

Poster 4
Thursday
11:00-12:30
Tehran time

Alireza RahmanSetayesh[1], Ali Ghazizadeh[1,2], Farokh Marvasti[1]

[1]Electrical Engineering Department, Sharif University of Technology, Tehran, Iran
[2]School of Cognitive Sciences, Institute for Research in Fundamental Sciences, Tehran, Iran

The mechanism by which plasticity in millions of synapses in the brain is orchestrated to achieve behavioral and cognitive goals is a fundamental question in neuroscience. In this regard, insights from learning methods in artificial neural networks (ANNs) and in particular the idea of back-propagation (BP) seem inspiring. However, the implementation of BP requires exact matching of error-feedback (EF) and feedforward (FF) weights, which is unrealistic given the known

connectivity pattern in the brain including the cerebral cortex. Notably, it is recently shown that given certain conditions, an arbitrarily random EF matrix for back propagating errors can lead to partial alignment of FF to EF weights overtime as well as surprisingly good accuracies in simple classification tasks using shallow ANNs (Feedback Alignment or FA). In this work, we took a closer look at FA to find out why it works in shallow networks and explored ways to boost its performance for deeper networks. We first show that the gradual alignment of FF to EF weights simply arises from the adapted version of the delta rule in FA and can happen even when errors resemble random yet autocorrelated noise. Moreover, we show that the performance of FA in deeper networks can improve significantly if a homeostatically-inspired weight normalization is applied to the neurons' synaptic inputs. Indeed, weight-normalization improved the performance of both BP and FA when class labels changed across time, a phenomenon which is less studied in ANNs yet is crucial for flexible learning in the brain in everyday life. Interestingly, with weight-normalization, FA accuracies almost matched that of BP following class label changes. Together our results, portrait a clearer picture of the FA mechanism and provide evidence for how brain plasticity and flexibility can occur using less stringent FA-like mechanisms while abiding by homeostatic limits on synaptic weight sizes.

Optimizing the Number of Brain Networks Extracted from Resting-State fMRI (Poster 5)

Poster 5
Thursday
11:00-12:30
Tehran time

Setareh Shojaei Azad, Reza Rajimehr, Hamid Soltanian-Zadeh
[1]CIPCE, School of Electrical and Computer Engineering, College of Engineering, University of Tehran, Tehran, Iran
[2]MRC Cognition and Brain Sciences, University of Cambridge, Cambridge, UK
[3]School of Cognitive Sciences, Institute for Research in Fundamental Sciences (IPM), Tehran, Iran
[4]Image Analysis Laboratory, Department of Radiology, Henry Ford Hospital, Detroit, MI, USA

Clustering algorithms are used to find cortical networks and dynamic brain states in resting-state functional Magnetic Resonance Imaging (rsfMRI) datasets. To determine an appropriate number of clusters in a dataset, various cluster validation indices are used.

Among these indices, internal validity indices are more appropriate in determining an optimal number of clusters. There are numerous internal validity indices, and various studies used one of them without a specific justification. We hypothesized that a systematical comparison of internal validity indices would determine the most appropriate index. To this end, we evaluated performances of 21 internal validity indices in finding the optimal number of clusters in rsfMRI datasets. We used a three-step approach in our analysis. In the first step, all internal validity indices were tested on benchmark datasets under the circumstances of different noise levels and different sample densities. In the second step, all internal validity indices were tested on simulated rsfMRI data again under different circumstances. From these two steps, we selected the indices which had the best performance in finding the optimal number of clusters. In the third step, these selected indices were evaluated on real rsfMRI data of 100 individuals from Human Connectome Project database to determine whether they capture dynamic brain states properly. From all these steps, we found that two indices, Ray-Turi (RT) and Xie-Beni (XB), had the best performance in properly identifying the number of dynamic brain states.

Latching dynamics as a basis for short-term recall (Poster 6)

Poster 6
Thursday
11:00-12:30
Tehran time

Kwang-Il Ryom[1], Vezha Boboeva[2], Oleksandra Soltadkina[1], Alessandro Treves[1]

[1]Internation School for Advanced Studies (SISSA), Trieste, Italy
[2]Imperial College, London, UK

If short-term memory (STM) is expressed by the activity of the same neurons that participate in the representation of long-term memories (LTM), what determines its drastically reduced capacity? Within the general hypothesis that interference between memories is critical, we consider the specific hypothesis that the imprecise mechanism for short-term storage and the necessity to rely on intrinsic, mind-wandering neural dynamics for retrieval and recall can make either interference from items in LTM or the randomness in retrieval trajectories the limiting factor, depending on the task.

We analyse latching dynamics expressed by a Potts network, taken as a model of the interactions among patches of cortex, when it hops

spontaneously from activity pattern to activity pattern, recalling them in a sequence resembling a random walk.

We show that by adding a mechanism that gives an extra "kick" to a small subset of L among p patterns in LTM, latching dynamics can be approximately restricted to the subset, which are effectively kept in STM. The usefulness of such partially spontaneous dynamics is critically limited by the nature of the short-term task it sub-serves, in agreement with established results and with our own observations in tasks requiring short-term memory of spatial locations. In free recall, where repetitions and mistakes are not penalised, the number of retrieved items tends to scale sublinearly with L, reflecting largely random exploration. In a task which is terminated by mistakes, instead, capacity is constrained by the interference of other items in LTM, with a limit dependent on the type of short-term kick. In contrast, modelling serial recall with hetero-associative short-term synaptic enhancement leads to guided dynamics, which if unconstrained can outperform human subjects, but also abolish latching dynamics. We believe that the model can help clarify some of the critical factors that limit STM functions.

An strong approach to detect sleep-deprived brain based on EEG signals (Poster 7)

Poster 7
Thursday
11:00-12:30
Tehran time

Mohammadreza Sedghi[1], Mahdad Esmaeili[1*], Ali Fakhari[2], Saeid Charsouei[3], Fatemeh Sheikhkanlu Milan[4], Mahdi Dolatyari Eslami[5], Sevda Ghoshouni[6], Sarvin Fathi daneshvar[6], Ali Norouzi, Shadi Farabi[6], Haniye Ahrabi[6], Amir Mohammad Sharafi[6], Shiva khanmohammadi[6], Leila Abdi[6], Asma mehdipour maralani[6], Aysan asl mohammad pour[6], Ali Ahmadalipour[2,6**]

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Sleep deprivation commonly results in an alteration of the brain and cognitive functions which are related to many potentially dangerous outcomes. Current clinical assessment methods only modestly distinguish sleep-deprived fatigued brains using the results of cognitive functions which are sometimes inconsistent. This paper, introduces a precise discriminative and robust approach to detect a sleep-deprived brain based on extracted biomarkers of a 2-dimensional discrete wavelet transform of the EEG signals. Cognitive performance and EEG signals were obtained from twenty-seven healthy participants (12 females; age range: 19-29 years old) after normal sleep and 24-hour sleep deprivation situations. A 2-D discrete wavelet transform coefficients of closed eye epochs in the resting-state of EEG signal for both conditions were calculated and five features were extracted from the transformed domain coefficients. Sleep-deprived and normal sleep EEG signals were precisely classified using SVM, ANFIS, and random forest classifiers, whereas random forest and SVM performs very close and better than ANFIS. Although mean differences of some cognitive tests were significantly different in the sleep deprivation night compared to the normal sleep night, the results of the classifiers of cognitive tests showed medium to the weak performance of these tests to detect sleep-deprived brain. The introduced EEG biomarkers exhibit very high predictive accuracy in comparison with traditionally used power spectrum density of EEG signals.

A faster approach to deep convolutional spiking neural networks (Poster 8)

Poster 8
Thursday
11:00-12:30
Tehran time

Shahriar Rezghi Shirsavar[1], Mohammad-Reza A. Dehaqani[1,2]

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Spiking neural networks (SNNs) are getting more attention since they can mimic natural neural networks better. Spiking deep neural networks (SDNNs) can learn with far less samples than deep convolutional neural networks (DNNs). Some libraries have been developed to simulate these networks but they do not perform fast enough in some

areas. In this paper we introduce Spiker, a high performance library written in C++/CUDA with Python bindings for SDNNs. Spiker is a stand-alone library with a flexible API that can work with PyTorch tensors or Numpy arrays. This library uses highly optimized libraries such as OneDNN and CUDNN as back end for convolution and pooling operations. The rest of the operations are optimized and are able to perform multiple times faster than existing solutions. Learning rules implemented in this library are unsupervised rules such as STDP or reward-modulated STDP (R-STDP).

Analysis BCI competition IV Datasets2a to Create Necessary Commands for Controlling Wheelchair (Poster 9)

Poster 9
Thursday
11:00-12:30
Tehran time

Morvarid Ghafouri[1], Ali Fallah[1], Saeed Rashidi[1]
[1]AmirKabir University (AUT)

A brain computer interface (BCI) provides a link between the human brain and a computer. The task of discriminating four classes (left and right hands, feet and tongue) of motor imagery movements of BCI is still challenging because most imaginary movements in the motor cortex have close spatial representations. We aimed to comparison of EEG signal decomposition method for BCI competition IV dataset 2a that is four-class motor imagery dataset. BCI consists of different parts like preprocessing, feature extraction, and classification which each one has some challenges in its design. Combine ICA and fix sized filter bank of instead simple filter which was applied several times, to overcome its weaknesses. Shrinkage estimator based common spatial pattern (CSP) is applied to overcome disadvantages of conventional CSP. Shrinkage estimator is a procedure to estimate covariance matrix that regularizes CSP versus overfitting and the best one is shrinkage estimator based variance CSP (SVCSP). Enhanced one versus one (OVO) structure is applied to classify EEG-based multiclass motor imagery signals. Then select best performing feature set for that particular type of model by using Sequential Forward Feature Selection (SFFS). Also, Adaptive Boosting (Adaboost) with decision trees as the weak learners have been proposed to improve performance. The best achieved classification accuracy is 0.65 in kappa criterion. The EEG signal of one of the subjects is applied to control

real wheelchair semi-online. The accuracy of recognition commands of moving to left, moving to right, moving straight, and stop.

High-Performance Computing Framework Based on Distributed Systems for Large-Scale Neurophysiological Data (Poster 10)

Poster 10
Thursday
11:00-12:30
Tehran time

Mohsen Hadianpour[1], Ehsan Rezayat[1], Mohammad-Reza A. Dehaqani[2,1]

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Due to the significantly drastic progress and improvement in neurophysiological recording technologies, neuroscientists have faced various complexities dealing with unstructured large-scale neural data. In the neuroscience community, these complexities could create serious bottlenecks in storing, sharing, and processing neural datasets. In this article, we developed a distributed high-performance computing (HPC) framework called 'Big neuronal data framework' (BNDF), to overcome these complexities. BNDF is based on open-source big data frameworks, Hadoop and Spark providing a flexible and scalable structure. We examined BNDF on three different large-scale electrophysiological recording datasets from nonhuman primate's brains. Our results exhibited faster runtimes with scalability due to the distributed nature of BNDF. We compared BNDF results to a widely used platform like MATLAB in an equitable computational resource. Compared with other similar methods, using BNDF provides more than five times faster performance in spike sorting as a usual neuroscience application.

A novel go-nogo-inspired reinforcement learning model suggests endogenous value learning even without counterfactual outcomes (Poster 11)

Poster 11
Thursday
11:00-12:30
Tehran time

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Context by distorting values of options with respect to the distribution of available alternatives, remarkably affects learning behavior. Providing an explicit counterfactual component, outcome of unchosen option alongside with the chosen one (Complete feedback), would increase the contextual effect by inducing comparison-based strategy during learning. But It is not clear in the conditions where the context consists only of the juxtaposition of a series of options, and there is no such explicit counterfactual component (Partial feedback), whether and how the relativity will be emerged. Here for investigating whether and how implicit and explicit counterfactual components can affect reinforcement learning, we used two Partial and Complete feedback paradigms, in which options were associated with some reward distributions.

Reinforcement learning procedure is happening in the striatum where encodes action values, and is modulated by dopamine. Some reinforcement learning studies have shown opposing activities with similar strength in these two clusters during learning. Inspired by the opposing role of dopamine on these two clusters of neurons, while they encode two competing option's values, we proposed a simple reinforcement learning model called Opposing Learning model, in which the chosen prediction error in addition to updating the chosen option value (classic standard Q-learning), updates the unchosen option value, though in an opposing manner. This mechanism is consistent with diffusive nature of dopamine release. By this model we encode the chosen and unchosen option's values relative to each other and consequently produce a contextual effect in the Partial feedback conditions. Our data shows also the contextual effect in the behavioral data. These results show that by extending counterfactual concept,

we can better account for why there is contextual effect in a condition where there is no extra information of unchosen outcome.

Friday Section 1 Posters:

The role of prefrontal cortex for visual feature binding (Poster 1)

Poster 1
Friday
11:00-12:30
Tehran time

Mohsen PartoDezfouli[1]

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We effortlessly perceive visual objects as unified entities, despite the preferential encoding of their various visual features in separate cortical areas. A 'binding' process is assumed to be required for creating this unified percept, but the underlying neural mechanism and specific brain areas are poorly understood. We investigated 'feature-binding' across two feature dimensions, using a novel stimulus configuration, designed to disambiguate whether a given combination of color and motion direction is perceived as bound or unbound. In the 'bound' condition, two behaviorally relevant features (color and motion) belong to the same object, while in the 'unbound' condition they belong to different objects. We recorded local field potentials from the lateral prefrontal cortex (lPFC) in macaque monkeys that actively monitored the different stimulus configurations. Our data show a neural representation of visual feature binding especially in the 4-12Hz frequency band and a transmission of binding information between different lPFC neural subpopulations. This information is linked to the animal's reaction time, suggesting a behavioral relevance of the binding information. Together, our results document the involvement of the prefrontal cortex, targeted by the dorsal and ventral visual streams, in binding visual features from different dimensions, in a process that includes a dynamic modulation of low-frequency inter-regional communication.

Face representation under partial occlusion in the inferior temporal cortex and prefrontal cortex (Poster 2)

Poster 2
Friday
11:00-12:30
Tehran time

Jalaledin Noroozi[1,2], Atlas Shahamati[2,4], Ehsan Rezayat[2], Mohammad-Reza A Dehaqani[2,3]

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Among all identity preserving transformations of visual objects, the underlying mechanism of occlusion is poorly understood. While a massive body of previous studies focuses on the representation of occluded objects, only a few studies aimed to address how the challenge of partial occlusion is resolved in our brain. To fully understand how the neural system resolves occlusion, the representation of the occluded object, the occluder items, and their relationship should be distinguished. To address this, we simultaneously examined neural responses of the inferotemporal (IT) and prefrontal cortex (PFC) of macaque monkeys viewing partially occluded faces. The three aspects of occlusion, including location, type, and face identities are independently varying in the stimulus set. The greater cognitive demand of partially occluded object recognition hinted at the contribution of higher-order areas and the role of top-down connections in occlusion processing. We directly addressed the frontotemporal interaction for the representation of occlusion by investigating how the network of IT and PFC neurons process both occluder and occluded objects over time. We applied a combination of encoding and decoding methods to the single and population of recoded neural data to explore the role of PFC feedbacks in the IT cortex for occlusion processing. We found an earlier distinct representation of occluder objects in ventrolateral prefrontal neurons compare with the IT population. While the representation of occluded objects mostly enhanced in the IT relative to the PFC population. These observations suggest a direct link between occluded processing in the IT cortex and occluder representation in PFC. Together, these results provide evidence for the existence of ef-

fective feedback originated from the PFC to the IT cortex during the representation of occlusion.

Exploring the Neural Bases of Stable Value Learning and Memory in Humans Using fMRI and EEG (Poster 3)

Poster 3
Friday
11:00-12:30
Tehran time

Sepideh Farmani[1], Kiomars Sharifi[2], Ali Ghazizadeh[1,2]
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It is recently shown that non-human primates (NHP) are able to retain the value of objects over extended periods. This stable value originates from past experiences and might lead to choosing an object even if it counteracts the current goals. While the existence of multiple memory systems in the brain is well documented, the neural underpinnings of long-term value-based memory particularly in humans are not clearly understood. The cortical and subcortical networks that holds value-based memory of objects in NHPs for many months was recently demonstrated (Ghazizadeh et al., 2018). We aim to address this question in humans using two different modalities of fMRI and EEG. We devised a learning procedure in which participants are trained for three sessions to learn the value of fractal objects. Each fractal is arbitrarily chosen to be associated with a reward or no reward (good vs. bad objects, respectively). The visual discrimination of good and bad objects in the brain is tested before, immediately after the training and a few days or weeks later using two different techniques of fMRI and EEG. Preliminary fMRI results indicate that immediately after the training, temporal and parietal areas are involved in good/bad object discrimination in passive viewing. In addition, our preliminary EEG results show differential event-related potentials to good versus bad objects over the parietal, temporal and occipitotemporal electrodes with latency of 200-300 ms in the passive viewing task following the value training sessions. Behaviorally, we observe well-preserved memories in the next day that nevertheless fade quickly across days and weeks. These findings will shed light on the neural basis of long-term value-based memories with implications for maladaptive behaviors such as drug addiction and for cross-species comparisons with NHP.

Rat sensitivity to multipoint statistics is predicted by efficient coding of natural scenes (Poster 4)

Poster 4
Friday
11:00-12:30
Tehran time

Riccardo Caramellino[1], Eugenio Piasini[2], Andrea Buccellato[3], Anna Carboncino[1], Vijay Balasubramanian[2], Davide Zoccolan[1]

[1]SISSA
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Extracting useful information from natural images is challenging and requires exploiting their statistical structure. Efficient coding theories posit that this can be done by allocating resources to represent visual features that are more variable, and therefore more informative, across natural scenes. Several studies have shown that, across natural images, there is a precise ranking in the variability of multipoint correlations and that the same ranking is found in human sensitivity to these statistics. This raises the question of whether such specialization of the visual system is hard-wired in the cortical circuitry, as the result of an evolutionary process, or is learned from the statistics of the visual environment during early postnatal development. Testing this hypothesis requires performing invasive experiments in animal models; ideally rodents, which would allow controlled rearing experiments. However, it is unknown whether other mammalian species share with humans the same sensitivity to multipoint correlations. To address this question, we selected four image statistics (from single- to four-point correlations) and trained four groups of rats to discriminate between white noise patterns and binary textures containing variable intensity levels of one of such statistics. An ideal observer model of the task explained well the behavioral performance of individual rats and allowed us to infer their sensitivity to the statistics they were tested on. We found the highest sensitivity for 1- and 2-point correlations, followed by 4-point and finally 3-point correlations. This matches the ranking observed for the variability of these statistics in natural images and for human accuracy at discriminating them from white noise. These results, which were further confirmed by within-subject comparisons of rat sensitivity to pairs of statistics, provide the first demonstration that rats and humans are similarly adapted to process the statistical structure of visual textures.

Ripple activity in the V1 and V4 area during top-down visual attention (Poster 5)

Poster 5
Friday
11:00-12:30
Tehran time

Jafar Doostmohammadi[1], Alwin Giesselman[2], Jochem Van-kempen[2], Ali Yoonessi[1], Ali Ghazizadeh[3], Alexander Thiele[2]

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Introduction: Sharp-wave ripples (SWRs) are high frequency short-lived oscillatory activity in the Local Field Potentials (LFP) of signals of hippocampus and sensory cortices of rodents. It has been suggested that they are implicated in mediating memory consolidation. Recording studies on monkey as well as human have shown that SWR occurred at higher rate especially when the gaze of subjects is focused near of the target object as well as when patients observed familiar pictures of scenes or faces observed familiar pictures and during free recall.

Methods: Two adult male rhesus monkeys were trained to perform a top-down visual attention paradigm. While maintaining fixation, monkeys were involving in the task, spikes and LFPs of visual areas including V1 and V4 were collected by two 16-channels laminar arrays. After mapping receptive field of V1 and V4, LFP re-referenced signal was band-pass filtered between (80-250 Hz), squared and normalized. Events from the normalized signal exceeded from 3.5 SD were selected as ripples.

Results: Like the investigations in rodent, we observed that ripple occurred was 0.04-0.05 Hz for sustained period both V1 and V4 areas of monkeys. Our results revealed that ripple rate in attention to inside versus away of receptive field in V1 and V4 (Wilcoxon test, p= 0.0018 and p= 0.0013). Furthermore, ripple rate was correlated with stimulus size, meaning that rate of occurrence was 0.05 Hz for small size which was significantly higher than ripple rate for large stimuli (0.02 Hz).

To assess connectivity in time of ripples between V1 and V4, we computed cross correlation (comudulogram) between V1 ripples and V4. Comudulogram revealed that when ripple was occurred at V1, V4 showed the gamma frequency band.

Our results suggested that ripple activity could serve as feed for-

ward rhythm which is necessary for visual discrimination during top-down attention.

Spatial Frequency Profile Predicts Functional Networks of IT Cortex(Poster 6)

Poster 6
Friday
11:00-12:30
Tehran time

Ramin Toosi[1], Mohammadreza A. Dehaqani[2,3], Mohammad Ali Akhaee[1], Behnam Karami[3], Roxana Koushki[3], Ehsan Rezayat[3], Farideh Shakerian[4], Jalaledin Noroozi[4,5]

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Visual brain shows various tuning characteristics based on natural images statistics. Spatial frequency (SF) is one of the main image statistics discriminating coarse and fine details which present in our natural environment. We found that the rhesus macaque inferior temporal (IT) cortex has well suited tuning characteristics for SF. It is inferred that based on their responses to different SFs, neurons form four functional clusters with separated decoding properties.

The experiment starts with a selectivity stage including 155 stimuli of various categories to select the six most responsive stimulus for each neuron. The selected stimuli alongside six faces and three objects had been filtered in five frequency ranges (band-pass SF filter). By shuffling the phase of images, we removed the object information and produced the scrambled version which hold the same SF information as the stimulus contains. The intact, filtered, and scrambled images (180 stimuli) randomly presented with two different exposure times, i.e. fast trials: 20ms and slow trials: 200ms.

Totally, 178 neurons of two monkeys were included in the analyses and based on their responses to the five SFs, they clustered into four subpopulations, including: low-pass (LP), high-pass (HP), band-pass

(BP), and band-stop (BS) spatial profiles. Investigating the population decoding performance of subpopulation revealed that LPs highly represents the face information in fast trials, while in slow trails the face information degrades and it is significantly lower than BP and BS subpopulations. The results showed the LP and BP subpopulation represented the category and identity information respectively better than other subgroups. Together, these results provide the evidence that functional networks of IT cortex can be distinguished by spatial profile of neurons.

Task-specific modulation of PFC activity for matching-rule governed decision-making(Poster 7)

Poster 7
Friday
11:00-12:30
Tehran time

Mohammad Zarei[1]

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Storing information from incoming stimuli in working memory (WM) is essential for decision-making. The prefrontal cortex (PFC) plays a key role to support this process. Previous studies have characterized different neuronal populations in the PFC for working memory judgements based on whether an originally presented stimulus matches a subsequently presented one (matching-rule decision-making). However, much remains to be understood about this mechanism at the population level of PFC neurons. Here, we hypothesized differences in processing of feature vs. spatial WM within the PFC during a matching-rule decision-making task. To test this hypothesis, the modulation of neural activity within the PFC during two types of decision-making tasks (spatial WM and feature WM) in comparison to a passive fixation task was determined. We discovered that neural population-level activity within the PFC is different for the match vs. non-match condition exclusively in the case of the feature-specific decision-making task. For this task, the non-match condition exhibited a greater firing rate and lower trial-to-trial variability in spike count compared to the feature-match condition. Furthermore, the feature-match condition exhibited lower variability compared to the spatial-match condition. This was accompanied by a faster behavioral response time for the feature-match compared to the spatial-match WM task. We attribute

this lower across-trial spiking variability and behavioral response time to a higher task-relevant attentional level in the feature WM compared to the spatial WM task. The findings support our hypothesis for task-specific differences in the processing of feature vs. spatial WM within the PFC. This also confirms the general conclusion that PFC neurons play an important role during the process of matching-rule governed decision-making.

Mapping Saliency in the Frontal Eye Field During Visual Processing(Poster 8)

Poster 8
Friday
11:00-12:30
Tehran time

Atlas Shahamati, Ehsan Rezayat, Jalaledin Noroozi, Mohammad-Reza A. Dehaqani

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The Frontal Eye Field (FEF), known for its role in transforming visual signals into saccade commands, is a visuomotor area of the Prefrontal Cortex. Having the unique position of being heavily interconnected with a multitude of visual cortical areas in both the dorsal and the ventral streams, FEF seems like an area with the ability to integrate the 'what' and the 'where' visual information. FEF also appears to play an essential role in higher cognitive functions such as spatial attention. These clues lead us to the idea that FEF may be more involved in mapping the visual world into an internal representation than previously assumed. We hypothesized that this area could be involved in representing features of objects that would eventually serve as a modulator for areas specialized in visual processing, such as the inferotemporal cortex (IT cortex).

To investigate this, we simultaneously recorded single neurons of the FEF and IT cortex of a monkey performing a Rapid Serial Visual Presentation task (RSVP). We calculated identity and category information in the FEF and IT cortex. Our results suggest FEF neurons are involved in representing two particular classes of stimuli: highly contrasted objects and rhesus monkeys, both of great importance in

guiding the attention. Contrast-considered the most salient feature of an object- is one of the defining elements that distinguish one target from another. Similarly, identifying a rhesus in a natural scene has behavioral and evolutionary significance for a fellow monkey and, therefore, a salient object. The fact that these two classes are being represented in the FEF along with observations of the temporal dynamics of FEF and IT neurons suggests the formation of a saliency map, where stimuli with high contrasts and with high behavioral significance are being represented earlier and faster in the FEF than the IT cortex.

EEG energy is the key regressor for localization in simultaneous EEG-fMRI studies(Poster 9)

Poster 9
Friday
11:00-12:30
Tehran time

Ali Ataei[1], Arash Amini[1], Ali Ghazizadeh[1,2]
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Simultaneous EEG-fMRI studies are capable of tracking fast cognitive processes by using the EEG signal as a regressor on the slow changing BOLD. This paradigm is based on the implicit assumption of a linear relation between the electric potentials and the BOLD responses. However, while the electric potentials at the scalp is roughly linked linearly with the neural activity, the BOLD relationship with the neural activity is known to be highly non-linear. Here, we suggest that the energy of EEG better correlates with the BOLD activity based on first order physiological principles. In order to examine this hypothesis, we redid the analysis on a previously published study that involved decision making on two food items in human subjects undergoing simultaneous EEG-fMRI recordings. Addition of EEG energy revealed significant activations in the right parietal operculum (PO) and insula including the gustatory cortex (GC) that could not be detected by EEG regressor alone. Activity in both regions conform well with the role of PO in decision making and GC in appetitive processing and imagery. Importantly, no positive correlation was found with higher powers of EEG signal (powers 3 or 4). Our finding introduce EEG energy as an indispensable regressor in 'EEG-informed fMRI analysis' for future studies.

Is there any real and observable multivariate coding available in fMRI data? (Poster 10)

Poster 10
Friday
11:00-12:30
Tehran time

Mansooreh Pakaravan[1] and Ali Ghazizadeh[2,3]

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It is often assumed that the pattern of activity across neuronal populations or regions can synergistically code information about the world such that the whole is more informative than the sum of its parts. In particular, multivariate pattern analysis (MVPA) using functional magnetic resonance imaging (fMRI) data has been used as evidence for coding of various cognitive and sensorimotor processes beyond what can be gleaned from conventional univariate analysis (UVA). However, in many cases, it is unclear to what degree the results of MVPA are reflecting multivariate pattern coding as opposed to univariate response differences between conditions. Here, we argue that almost all previously reported MVPA results arise from a mere increase in sensitivity which is to be expected when combining a large number of 'weak classifiers' (i.e. single voxels) within searchlights. We propose instead that 'real' multivariate coding should result in changes in higher order statistics across voxels between conditions (for instance in second order statistics, sMVPA). We first show that such second-order effects are readily observed in population neuronal spike data and confirm that in such a case sMVPA should be observable in fMRI data by hemodynamic coupling simulations. Surprisingly, analysis of several fMRI datasets in both human and non-human primates shows a lack of significant modulation of second-order statistics by task conditions despite significant univariate and multivariate coding based on mean activity. Together, our results suggest that care should be taken in interpreting multivariate discrimination that can arise from mere sensitivity boost as being a 'true' population code especially when higher-order statistics are not affected by the task conditions.

A low cost protocol for reconditioning of deep-brain neural microelectrodes with material failure for electrophysiology recording (Poster 11)

Poster 11
Friday
11:00-12:30
Tehran time

Mohammad Hossein Ghajar[1], Leila Rezayat[2], Ehsan Rezayat[1], Mohammad-Reza A. Dehaqani[3,1]

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Up to now, a large variety of neural microelectrodes are developed. Although there are a lot of published works in this area, the majority of them are about the fabrication methods and rarely discuss the reconditioning procedure or how to re-use the electrodes that their performance is decreased because of material failure. In this research, firstly, it is answered that why the performance of neural microelectrodes decreases. Secondly, a general low-cost protocol for reconditioning and re-using electrodes are proposed that can be utilized for the most types of electrodes with material failure. Lastly, the proposed reconditioning protocol is applied experimentally to single-site tungsten microelectrodes to demonstrate the effectiveness of the protocol. Neural signal recording Results clearly indicate that a large number of electrodes can be reconditioned well.

Changing the learning time of cognitive tasks using training in monkey cages (Poster 12)

Poster 12
Friday
11:00-12:30
Tehran time

Meysam Zare[1], Atlas Shahamati[1], Jalaledin Noroozi[1] ,Ehsan Rezayat[1], Mohmmad-Reza A. Dehaqani[1,2]

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In neurophysiology, nonhuman primates represent an important model for studying the brain. Nonhuman primates are capable to learn sophisticated behavioral tasks. During the last few decades and

since insights into the neuronal mechanisms of cognitive control and executive functions were gained by physiological experiments. The behavioral tasks used in these studies are often complex and highly demanding. They frequently require the animals to follow intricate selection and response rules and may include storage of numerous items in working memory, and sustained covert attention to peripheral stimuli. Training of such tasks is usually acquired by a succession of many discrete steps, and the primates need a lot of time to learn. The spent time it takes to learn depends on the monkey's cognitive task almost for six months and one and a half years. Accordingly, we trained the two monkeys using the object delayed-match-to-sample task in their cage, and after learning, we transferred one of the monkeys to the set-up and repeated the learning steps by fixated paradigm. Our results showed, decrease that the time spent learning in the monkey (NO=1). The Monkey (NO=1) took four months to learn the object delayed-match-to-sample task by fixated. Any improvement in the training method that reduces stress to the animal, increases the speed of training or improves performance on the task.

Friday Section 2 Posters:

Altered functional connectivity in patients with stuttering: a resting-state fMRI study (Poster 1)

Poster 1
Friday
13:00-14:30
Tehran time

Seyedehsamaneh Shojaeilangari[1], Narges Radman[1,2], Mohammad Ehsan Taghizadeh[3], Hamid Soltanian-zadeh[4]

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Stuttering is a speech disorder characterized by an involuntary disruption in normal fluency, time patterning, and rhythm of speech. Although extensive functional neuroimaging studies have explored brain activation alterations in stuttering, its core causes still remain unclear. Here, using fMRI imaging, we investigated resting-state functional connectivity of 15 adults with persistent developmental stuttering (PDS) and 15 age and educational matched control group individuals to reveal the connectivity differences related to stuttering. We were also interested in exploring how the severity of stuttering varies across individuals to highlight compensatory connectivity patterns in less symptomatic PDS.

Using a seed-driven technique, we decided to investigate the dynamic interaction of the most prominent regions related to language production as well as perception with the whole brain under the task free condition. Our aim was to identify all regions that might be involved in language function including the seed regions located in the cerebellum, basal ganglia, frontal lobe, temporal lobe, and motor area in the parietal lobe.

Image preprocessing and statistical analysis have been done using CONN v.19c and SPM12 toolboxes.

Our results revealed decreased connectivity of left frontal pole and left middle frontal gyrus (MidFG) with right precentral/postcentral gyrus in stuttering individuals compared with control participants. Additionally, our finding indicated the reduced connectivity in the

PDS group between the left superior temporal gyrus (STG) and several brain regions including the right limbic lobe, right fusiform, and right cerebellum, as well as the left middle temporal gyrus (MTG). Additionally, stronger functional connections between MidFGl and left caudate, as well as between MTGr and language areas in the left cerebrum (Broca's and Wernicke's area), with decreased stuttering symptom severity in PDS, suggest that impaired function of these cortical/subcortical regions may enable the most successful compensation for stuttering symptoms.

Beyond the brain-centered outlooks: A perspective of integrated multi-disciplinary understanding of brain activities based on systems theory (Poster 2)

Poster 2
Friday
13:00-14:30
Tehran time

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Cognition, perception, and movement are often considered as outcomes of neural networks functions that act and react in response to various stimuli. This approach is based on linear causality, which reduces the brain functions to one-to-one correspondences among its own structures. This routine neurophysiological approach neglects the brain behavior as a complex event arising from dynamic interactions and counteractions with the whole being. It is so essential to recognize the brain as a vital center involving in a web of interacting organs that generates and receives various types of biologic information including mechanical, neurochemical, hormonal, electromagnetic, etc.

This article arises from an inter-disciplinary viewpoint that concerns the recent findings of various organs-brain axes, empirical observations in academic clinical settings, and bio-mathematical studies based on systems theory that configured collectively. The related literature from manuscripts and scientific databases were studied, interpreted and explained qualitatively.

The behavior of biologic systems should be investigated as the consequence of interacting/counteracting events happen in a non-linear dynamics that conducted by the flow of information. All the elements including the organs, energy, and information are needed to establish an integrative self-organizing system that collectively could provide multi-stability in both physiological and pathological states. Concerning the recent studies that indicate the mutual effects between the brain and other organs including gut/microbiota, and heart our understanding would shift to a different perspective of the brain as a subsystem of a super-complex adaptive biological system i.e. the living human body.

The divided branches of human biologic sciences and healthcare systems including neuroscience, cognitive sciences, psychiatry, psychology, health psychology, psychosomatic medicine, and emerging sciences necessarily need a common framework to find out the role of the brain as a critical module in a united entity with super-complex dynamics iterations. To achieve this goal, the convenient clinical and para-clinical approaches are not effective. What we need is firstly a holistic attitude towards bio-dynamical systems and then the requirements like bio-mathematical laboratories, computational biology centers, and Converging technologies.

Localization of Seizure Onset Zone through Simultaneous EEG-fMRI recording: Component-related BOLD Changes (Poster 3)

Poster 3
Friday
13:00-14:30
Tehran time

Elias Ebrahimzadeh[1,2], Hamid Soltanian-Zadeh[1,2,3]

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Simultaneous EEG-fMRI is an effective technique for the identification of the seizure onset zone (SOZ) in patients with refractory epilepsy. Presurgical evaluation of patients with epilepsy is one of the areas where EEG and fMRI combination has considerable clinical relevance for localizing the brain regions generating interictal epileptiform activity. Various algorithms have been proposed to localize

SOZ, however, none has yet been able to offer a solution to effectively address this issue. We hypothesize that an integration of information from EEG taken from outside and inside of MRI can improve localization of SOZ when using simultaneous EEG-fMRI recording. To test this hypothesis, we first extracted spike patterns from outside of scanner EEG, by detecting and averaging the interictal epileptiform discharges (IED). Then, having implemented the correlation between the identified pattern and inside-scanner EEG, we extracted the temporal information when an epileptic seizure was triggered. We then convolved the obtained regressor with the hemodynamic response function (HRF) using the general linear model (GLM) to localize the SOZ. We applied the proposed method on 11 medication-resistant patients with epilepsy whose data was recorded in the National Brain Mapping Lab (NBML). The results of the proposed method were in line with the information provided in EEG for each of the 5 patients, and for the 6 patients who were candidates for brain surgery, they provided further information. The results showed a significant improvement in localization accuracy and precision compared to existing methods in the literature. The obtained results would assist clinicians to better determine the seizure onset zone, guide epilepsy surgery, and improve post-surgical outcomes for epilepsy patients.

Transcranial direct current stimulation: modulation of problem solving in adults with low life skills (Poster 4)

Poster 4
Friday
13:00-14:30
Tehran time

Behnam Ghabel Damirchi*[1,2]

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[2]Secretary of the Cognitive Neuroscience Working Group, Iran's Brain Mapping's Student Branch, Tehran, Iran

Introduction: Transcranial direct current stimulation (tDCS) is a non-invasive method of neuromodulation used in human basic and clinical neuroscience. In the current study, we investigated the impact of anodal tDCS over the left dorsolateral prefrontal cortex (l-dlPFC) in adults with low life skills.

Methods: Forty adults with low life skills were screened by ten life skills questionnaire and recruited by purposive sampling method and randomly assigned 1:1 to tDCS or sham-control (20 in each group).

Active tDCS comprised 20-min sessions of 2 mAmp direct current delivered over the l-dlPFC (F3 according to the 10-20 international system), 10 consecutive sessions. Sham was administered similarly, but with current turned off after 30?s. The London Tower test was measured pre and post-treatment. Data were evaluated through a covariance test.

Results: Stimulation significantly enhanced problem-solving skills and its 3 components (problem-solving time, trial time, and problem error). No effects were found for the time delay component.

Conclusion: These findings provide direct evidence for the role of the l-dlPFC in the problem-solving skills of adults with low life skills. From a methodological perspective, brain stimulation can be used as a tool to modulate and to explore components of problem-solving. Therefore, this approach can be applied as a non-invasive method to enhance the problem-solving of these individuals.

The Normalization Model Captures the Effects of Object-based Attention in the Human Visual Cortex (Poster 5)

Poster 5
Friday
13:00-14:30
Tehran time

Narges Doostani[1], Gholam-Ali Hossein-Zadeh[2,1], Maryam Vaziri-Pashkam[3]

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The normalization model of attention has been proposed as a unifying framework to account for various effects of attention in the visual cortex, and its success in predicting neural responses has been documented in primate electrophysiology studies. Here, using a human fMRI study, we investigated whether the normalization model can predict attentional modulations when participants attend to an object in a cluttered scene. We used a blocked-design paradigm in which half-transparent stimuli from the two categories of human bodies and houses were presented either in isolation or in pairs. A cue at the beginning of the block indicated the attended object. When paired, stimuli were superimposed to enforce object-based attention. We focused on the object-selective regions lateral occipital corte (LOC) and

posterior fusiform area (pFs), and the category-selective regions extrastriate body area (EBA) and parahippocampal place area (PPA) and determined the preferred and null stimuli for each voxel in each region. Results showed that shifting attention from the preferred to the null stimulus significantly reduced voxel responses in all these regions. Also, the effect of the unattended stimulus on the responses depended on voxel selectivity for that stimulus, with the unattended preferred stimulus having larger effects on the responses than the unattended null stimulus. We modeled voxel responses in different attentional conditions using a linear, a weighted average, and a normalization model. Results indicated that while the linear and the weighted average models were better than chance in predicting the responses, the normalization model had significantly better predictions than the other two models in all regions and especially captured the effect of voxel selectivity on the attentional modulations. These results suggest that when attending to objects in a cluttered scene, the responses in the object selective cortex are determined by divisive normalization.

Localizing sensory processing sensitivity and its subdomains within its relevant trait space: a data driven approach (Poster 6)

Poster 6
Friday
13:00-14:30
Tehran time

Taraneh Attary, Ali Ghazizadeh

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[2]School of Cognitive Sciences, Institute for Research in Fundamental Sciences, Tehran, Iran

Sensitivity arising from enhanced processing of external and internal stimuli or sensory processing sensitivity (SPS) is consistently observed in a sizable chunk of the population and has been recognized as a distinct trait for over two decades. The relationship of SPS to other similar traits has been studied extensively yet a clear picture that allows one to localize SPS and its subdomains with respect to other relevant traits is currently lacking. Here we used a data-driven approach using t-distributed stochastic neighbor embedding (t-SNE) to portrait SPS as measured by the Highly Sensitive Person Scale (HSPS) in relation to Big-Five Inventory (neuroticism, extraversion, openness, agreeableness, and conscientiousness) as well

as to shyness, alexithymia, autism quotient, anxiety, and depression (a total of 11 traits) using data from more than 800 participants. Hierarchical clustering revealed two major trait clusters: cluster 1 included shyness, alexithymia, autism, SPS, depression, anxiety, and neuroticism while cluster 2 included extraversion, openness, agreeableness, and conscientiousness. Further examination showed that despite the overall placement of SPS within cluster 1, there was a schism among the three subdomains of SPS with questions addressing aesthetic sensitivity (AES) falling within cluster 2 and questions addressing ease of excitation (EOE) and low sensory threshold (LST) belonging to cluster 1. In cluster 1, SPS subdomains EOE and LST were neighbored by neuroticism, shyness, and alexithymia while in cluster 2, AES was close to and hard to distinguish from openness. A similar spread across clusters was seen for questions addressing autism consistent with it being a spectrum disorder. In contrast, the three subcategories of alexithymia while being separable were close to each other and contained within cluster 1. Together, our results give credence to the view of SPS as a distinct yet non-unitary trait and provide insight for further refinements of the current SPS scales.

Unconscious processing strategies dissociate global and details visual object processing (Poster 7)

Poster 7
Friday
13:00-14:30
Tehran time

Samane Navab Kashani[1], Reza khosrowabadi[1], Mohammad-Reza A. Dehaqani[2,3]

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The various neural substrates activate during object recognition in categorization compare identification levels. The manipulation of visual perception through the priming paradigm at different levels of abstraction (i.e., categorization and identification) can reveal the underlying mechanism of global and details processing.

Although plenty of studies suggested the priming aftereffect influences at conscious and unconscious setups, the dissociation of such

mechanism for categorization versus identification is poorly understood.

We employed words and pictures as prime stimuli followed by a name-picture verification task using a binocular rivalry set up to investigate the modulation of the visual perception at different levels of abstractions. Furthermore, the unconscious processing of the brain in different hemispheres and foveal priming were addressed using this experiment.

While we observed impairment of category perception in conscious priming after effect, there was great facilitation of identity perception. Incorporation of word priming in the left hemisphere with binocular rivalry setup also illustrates the role of unconscious priming aftereffect in detail and global visual information processing. The observed results suggested that in a completely inverted direction of the conscious process, the unconscious word process facilitates the global processing (i.e. categorization) and impair the detail processing (i.e. identification) of face stimuli.

A link between hemispheric laterality of brain and retinal thickness in schizophrenia (Poster 8)

Poster 8
Friday
13:00-14:30
Tehran time

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The retina is the only part of the central nervous system, which is outside its structure, and therefore in recent years, more attention has been paid to it. THE retinal RNFL layer in psychiatric disorders has been a topic of interest in recent years. OCT (Optical coherence tomography) is a device used to measure the retina's thickness. We analyzed the thickness of the retinal RNFL layer in schizophrenia from the data in 11 published articles, that have comparable data selected

from 24 articles that measured the retinal RNFL layer thickness in schizophrenia. Because the temporal part of one eye and the nasal part of another one are coupled together and go to one hemisphere, it provides an opportunity to investigate hemispheric laterality in subjects. So to see the effects of hemispheric laterality in the retina, we analyzed the left and right eyes' temporal and nasal parts separately. We found that the left and right eyes are not the same thickness; In fact, the right temporal and left nasal areas, which go through the optic nerves to the brain's right hemisphere, show a significant reduction in people with schizophrenia.

This result is in line with some recent evidence in schizophrenia.fMRI studies have shown that the M pathway in the right hemisphere shows increased activity than the left hemisphere in people with schizophrenia. Another study also showed that the optic nerves in the two hemispheres are different. The asymmetry of the two hemispheres of the brain has received a lot of attention in people with schizophrenia, and some consider this disease to be the result of the lack of successful formation of the lateralization process in the brain.

RNA tracking: predicting cell types in nervous system (Poster 9)

Poster 9
Friday
13:00-14:30
Tehran time

Ali Saadat[1], Amirmohammad Farzaneh[1], Babak Hossein Khalaj[1]
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Cellular differentiation is a process in which a cell changes from one cell type to another. Understanding this dynamic process is of particular importance, especially for cells in the nervous system. RNA abundance in a cell is a strong signal of the state of that cell. Single-cell RNA sequencing (scRNA-seq) provides the expression profiles of individual cells and is considered the gold standard for defining cell states. The main challenge is that scRNA-seq provides only a static snapshot at a point in time, but cellular differentiation is a time-resolved phenomenon. Recent work, called RNA velocity, suggests a method to predict the future state of cells by distinguishing between unspliced and spliced mRNAs in a common cell. RNA velocity calculates the time derivative of the gene expression state which can be used to predict the future state of cells on a timescale of hours. We

proposed a method (called RNA tracking) to estimate the second time derivative of the gene expression state which can be exploited to predict cell states more accurately. We used two different datasets to test our method: 1) the hippocampus cells dataset 2) the mouse chromaffin cells dataset. Both hippocampus and chromaffin cells play crucial roles in the nervous system, so understanding how they are made from embryonic stem cells is essential. Our results show that not only our method outperform RNA velocity in terms of accuracy but also our method can predict cell states for a longer period of time.

Detection of neural propagating action potentials by digital holographic microscopy (Poster 10)

Maryam Mohammadi, Vahideh Farzam Rad, Ali-Reza Moradi

Poster 10
Friday
13:00-14:30
Tehran time

We introduce digital holographic microscopy (DHM) as a versatile alternative for the detection of individual action potentials of neurons. Current detection methods include electrical recordings or exogenous fluorescent probes, which suffer from drawbacks such as low temporal resolution and phototoxicity. Instead, DHM in transmission mode provides a non-invasive, label-free, and full morphometric imaging of phase samples, such as biological specimens. Numerical reconstruction of the recorded holograms of the cells leads to the measurement of real-time optical path length fluctuations caused by propagating spikes. Hence, across the entire cell membrane, the possible generation of spikes during the stimulation can be detected. In our experiments, the electrical stimulation of cells is performed through controllable addressing proper voltages into a pre-designed array of micro-electrodes on a patterned transparent substrate, while cells are positioned on it. This method provides stimulation with subcellular spatial resolution. However, in order to study the possible cross-talk between the propagating spikes, we also conduct other experiments in which adjacent cells are stimulated simultaneously. Quantitative phase imaging by DHM has the potential to be used in understanding the neurophysiological behavior of single cells in neuroscience.

Representation of social information in dorsomedial prefrontal cortex predicts agreeableness trait (Poster 11)

Poster 11
Friday
13:00-14:30
Tehran time

Sandra Arbula[1], Elisabetta Pisanu[1], Raffaella I. Rumiati[1,2]

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Personality traits are key indices of individual variability in complex behaviors, and the view that each trait is associated with specific neural mechanisms is increasingly gaining ground. However, the direct evidence of such neural mechanism associated with each trait is still scarce. Here we investigated the mechanisms underlying agreeableness, one of the five major dimensions of personality, which has been linked mainly to socio-cognitive functions. In particular, we examined whether individual differences in the neural representations of social information during task-based fMRI are related to differences in agreeableness of individuals.

By means of multivariate similarity analyses, we have demonstrated that neural representations of social information vary among individuals with different levels of agreeableness in a functionally relevant way: processing socially meaningful and meaningless content led to similar encoding patterns in individuals with low agreeableness, while in more agreeable individuals these patterns were more dissimilar. Critically, this strong correlation was significant only in the dorsomedial prefrontal cortex, a brain region consistently involved in social cognition, as corroborated also by our meta-analytic decoding results.

Overall, this finding represents an important step in characterizing the neural determinants of one of the Big Five personality traits, and provides a sound account of the behavioral variability associated with this trait.

An Autoclaveable integrated circuit to monitor vital signs of people with viral diseases (Poster 12)

Poster 12
Friday
13:00-14:30
Tehran time

Babak Rezaee Afshar[1]

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In this paper, the construction of an Autoclaveable integrated circuit (AIC) using the recording of bioelectric signals including electroencephalography, electromyography and electrocardiography is reported. This AIC consists of six pins that are used to measure the biosignal in millimeter sized. The size of this AIC is 28 *20 * 8 mm and the total weight of the system is 5 grams, which can be used with a voltage of 3.3 volts to 12 volts. The functional purpose is to provide information about vital biosignals implantable, autoclaveable, and very small so that it can be used in the event of the spread of communicable diseases such as Covid 19 to obtain vital signals in patients with viral diseases. The system does not require any additional electronic components to operate and works by connecting AIC to monitoring systems. The developed system enables fast and convenient guidance of specialists in emergency situations and enables the user or caregiver to manage therapeutic changes with useful treatment.

Scientific Committee *(In alphabetical order)*

- Dr. Saeed Behzadipour, Associate professor, Mechanical Engineering Department, Sharif University of Technology, Neuro-Rehabilitation
- Dr. Mohammadreza Daliri, Professor, Electrical Engineering Department, Iran University of Science and Technology (IUST), Cognitive neuroscience
- Dr. Reza Ebrahimpour, Professor of Cognitive Neuroscience, Shahid Rajaee University (SRTTU), School of Cognitive Sciences, Institute for Research in Fundamental Sciences(IPM), Cognitive Neuroscience
- Dr. Ali Ghazizadeh, Assistant professor, Electrical Engineering Department, Sharif University of Technology, School of Cognitive Sciences, Institute for Research in Fundamental Sciences(IPM), Systems and Computational Neuroscience
- Dr. Sepideh Hajipour, Assistant Professor of Electrical Engineering Department, Sharif University of Technology, BCI, Neural Data Analysis
- Dr. Babak Hossein-Khalaj, Professor of Electrical Engineering, Sharif University of Technology, Brain and Biological Dynamic Models
- Dr. Mehran Jahed, Associate Professor, Department of Electrical Engineering, Sharif University of Technology, Bio-robotics, Sensory and Motor Neuroscience
- Dr. Hamidreza Rabiee, Professor, Department of Computer Engineerin, Sharif University of Technology, Neural Data Analysis and Artificial Intelligence
- Dr. Mehdi Sanayei, Assistant Professor of Cognitive Neuroscience, School of Cognitive Sciences, Institute for Research in Fundamental Sciences(IPM), Cognitive Neuroscience
- Dr. Bijan Vosoughi-Vahdat, Professor of Electrical Engineering Sharif University of Technolog, Modelling of the Nervous System

Executive Team

SNS is organized by the students in the electrical engineering department at Sharif University of Technology. Below is the list of undergraduate and graduate students who organized the third symposium (SNS2021):

- **Executive Heads:**
  Yasamin Esmaeili, Nima Zargarnezhad, Mohammad Amin Fakharian, Omid Sharafi
- **Executive Members:**
  Armin Panjehpour, Amirreza Hatamipour, Parastoo Azizeddin, Saba Pashaei, Amirhossein Bargharari
- **Web Developers:**
  Omid Sharafi, Arsalan Firoozi