Festival of Touch

4-7 July 2023

St Charles campus Aix-Marseille University, France

Website: https://touch2023.sciencesconf.org/
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3 place Victor Hugo, 13003 Marseille, France

A joint meeting of:

Research IN Touch
https://researchintouch.info/

IASAT
International Association for the Study of Affective Touch
https://iasat.org/

Full program

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Welcome to the Festival of Touch...

The Festival of Touch aims to bring together researchers working in the sense of touch from across the world. It will be a joint meeting of two conferences: Research in Touch and the meeting of the International Association for the Study of Affective Touch.

Research objectives:

- We wish to present cutting-edge research in touch and encourage discussion.
- The main theme of the Festival of Touch will be how fundamental touch mechanisms are encoded and interpreted, with a goal of making touch feel better.
- We will link the two joint conferences together by having symposia that span general touch research and affective touch, to increase interactions and discussions amongst researchers.

Objectives:

- *Inclusivity*: we will invite touch researchers from all over the world to participate and we encourage all levels to contribute, from students to established researchers.
- *Openness*: we want to spread the message of touch far and wide and the conference will be open to all people interested in touch, where we will encourage industrial participation.
- *Environment*: we will encourage travel with lower environmental impact. We will have less meat in the catering, use biodegradable items, and decrease plastic use.

Main organisational comittee: Rochelle Ackerley, Francis McGlone, Nick Holmes
Local comitee: Rochelle Ackerley, Jean-Marc Aimonetti, Mariama Dione, Roger Watkins, Nadia Tir

Keynote speakers

Sliman Bensmaia (4 July morning)
Biological and Bionic Hands: Natural Neural Coding and Artificial Perception
James and Karen Frank Family Professor, Department of Organismal Biology and Anatomy, University of Chicago, USA

Our ability to manipulate objects dexterously relies fundamentally on sensory signals originating from the hand. To restore motor function with upper-limb neuroprostheses requires that somatosensory feedback be provided to the tetraplegic patient or amputee. Given the complexity of state-of-the-art prosthetic limbs, and thus the huge state-space they can traverse, it is desirable to minimize the need of the patient to learn associations between events impinging upon the limb and arbitrary sensations. With this in mind, we seek to develop approaches to intuitively convey sensory information that is critical for object manipulation – information about contact location, pressure, and timing – through intracortical microstimulation (ICMS) of primary somatosensory cortex (S1). To this end, we test in psychophysical experiments with monkeys, the sensations evoked by ICMS of S1. Based on these results, we show how to build a biomimetic encoding algorithm for conveying tactile feedback through a cortical interface and show that artificial touch improves the dexterity of brain-controlled bionic hands.

Davide Filingeri (4 July afternoon)
Wet, damp, moist, humid…what do we really feel? Thermo-tactile interactions in skin wetness sensing
ThermosenseLab, Skin Sensing Research Group, School of Health Sciences, The University of Southampton, Southampton, UK

We sweat during a run, and we feel wet. We grab the kitchen cloth, and it feels damp. We put on a body lotion and our skin feels moist. We step outside during a warm summer day in a Mediterranean island, and the air immediately feels humid. But how do these common sensory experiences arise in our brains, and what do we really "feel" when experiencing wetness, dampness, moistness, and humidity? Over the past 10 years, our research group has reported that wetness perceptions are a phenomenon of the central nervous system, resulting from higher-order neural structures integrating multisensory thermal (e.g. cold) and tactile (e.g. stickiness) inputs arising from the skin's contact with moisture. Also, we have recently observed that the cold-sensing Transient Receptor Potential Melatstatin-8 (TRPM8) ion channel plays the dual role of cold and wetness receptor in human skin. Our findings have contributed to the development of an empirical neurophysiological model which helps explaining how, in the (apparent) absence of a skin hygroreceptor, healthy young adults may integrate thermal and tactile cues to perceive wetness on their skin. But how wetness sensing develops during childhood and potentially declines in later life, and how physiological and pathological changes in the perception of skin wetness across the lifespan impact on humans' ability to interact with their surrounding environments, remains understudied. This talk will provide an overview of our group's recent investigations on the mechanisms of human skin wetness sensing, and of its inter-individual variability, in both health and disease.

Rochelle Ackerley (5 July morning)
IASAT presidential lecture: The story of C-tactile (CT) afferents and their role in affective touch
CNRS Researcher, Laboratoire de Neurosciences Cognitives, CNRS – Aix-Marseille University, Marseille, France

Since their initial discovery in cats, low-threshold C-fiber mechanoreceptors, known as C-tactile (CT) afferents in humans, has captivated researchers over their properties and potential role in affective touch. We have been recording from CT afferents for over 30 years, yet only a handful of papers have described their characteristics. I will summarize these and extend our ideas on what we believe CTs to do. This ranges from their exquisite sensitivity to gentle stroking, through to their optimal activation at different temperatures. I will link this to perceptual studies using similar approaches and highlight what we know – and do not know – about the role of CTs in touch. Although CTs likely support gentle, positive affective touch encoding, affective touch is much more than this, as not every affective touch experience relies on CTs or must necessarily be pleasant.

Gary R. Lewin (5 July afternoon) Photo by Pablo Catagnola
Touch is really skin deep: cellular and molecular mechanisms of sensory mechanotransduction
Molecular Physiology of Somatic Sensation Laboratory, Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC), Berlin-Buch, Germany.

Touch is one of the most sensitive, fastest and emotionally resonant of all our senses. The thrill of a brush of hair or the shock of an unseen spider web are both initiated by mechanoreceptors with high sensitivity and speed. In order to initiate such sensation sensory endings in the skin must be capable of detecting the tiniest of vibrations that can be in the nanometer range. Mechanically gated ion channels are the primary transducers of such forces and our work is focused on identifying these molecules and understanding how they achieve sensitivity and speed of sensory transduction. I will introduce two mechanically gated ion channels Piezo2 and Elkin1 which together may account for the majority of sensory transduction. However, recent work has indicated that we have to reevaluate the role of cells within the skin that form specialized end-organs innervated by the sensory mechanoreceptors e.g. Meissner's corpuscles. I will present evidence that these cells play an integral part in sensing touch and tuning the sensitivity of skin mechanoreceptors. The start of touch is indeed only skin deep.

Ingvars Birznieks (6 July morning)
Sense of touch and movement go hand in hand
School of Medical Sciences, UNSW Sydney, Australia

The interdependence of movement and skin biomechanics determines tactile afferent signals which shape our perception and control our hand movements. Friction is a key component of this process, as it is integral to any skin-surface interactions. In sense of touch friction has several functional contexts. When we explore the properties of different materials, we slide our fingers over the surface because movement enables skin mechanoreceptors to obtain a wealth of sensory information. Gentle caressing movements transmit social signals and emotions. In both circumstances, friction determines the tactile afferent response, and consequently may influence our perception and subjective attitude towards these stimuli. In motor control, knowledge of friction informs grip forces, so that the most fragile objects can be held without slipping or being crushed by excessive force. Our hands can also perform powerful actions such as rock climbing or using tools where friction and grip forces required to avoid slips set capability limits. Therefore, apart from automatic grip force adjustments, perception of slipperiness contributes to motor control by cognitive selection of a safe and achievable action plan. During object manipulation, sensing friction without exploratory rubbing movements is challenging. Our research has revealed that movement kinematics encompassing submillimeter range lateral movements may be sufficient to enable friction sensing. We have demonstrated this in psychophysics experiments, by biomechanical analyses, and during object manipulation. We have also shown tangential torque plays an important role. We demonstrate learning algorithms that extract these instantaneous stimulus parameters from afferent input, helping us to understand the neural code.

India Morrison (6 July afternoon)
The neuroscience of human social touch
Department of Biomedical and Clinical Sciences, Linköping University, Linköping, Sweden

Our knowledge of the neural underpinnings of affective touch has burgeoned over the past two decades, on levels from the receptor to larger-scale functional neuroanatomy of the brain. Yet we still understand very little about how these mechanisms might contribute to the role of touch in human social interaction. This talk outlines ways in which specific properties of touch can be organized by the human nervous system during affiliative social interactions. It examines candidate mechanisms for how the brain may integrate sensory features of human touch alongside contextual and "person-level" processes such as memory, expectation, and motivation. In particular, recent investigations of co-modulation between the brain and the neuropeptide oxytocin have suggested that oxytocin neuromodulation during touch-mediated social interactions is flexible and context-dependent. In humans, parietotemporal brain pathways may play a selective role in these context-sensitive processes, potentially allowing "tuning" of brain and body responses during social interactions. Such brain-hormone co-modulation during touch-mediated human social interactions allows for dynamic changes in interactants' behavior and physiological states. These processes can serve not only in the formation and maintenance of affiliative relationships, but also in the body's regulation of acute stress reactivity. Looking to the future, these emerging lines of evidence foster a view of touch as a playing a temporal role in human interaction—unfurling not just during a single social interaction but over the course of a relationship.

Francis McGlone (7 July morning)

Tribute to Tiffany Field
We were pleased to welcome Tiffany Field to speak, but unfortantely, she was no longer able to come. Francis McGlone will deliver a tribute to Tiffany Field. Francis McGlone will present an overview of the vast contribution that Tiffany Field has made to our field and will then present a study of his that is based directly on Tiffany Field's work, demonstrating its wide impact.

Touch and Neuroprotection: A Putative Contribution by C-LTMRs (Francis McGlone)
University of Liverpool, Liverpool, UK

An evolutionary ancient class of nerve fibres innervating the skin of the body called c-afferents, have played a fundamental role in protecting organisms. This is best exemplified by the role of the nociceptor (pain) and the pruriceptor (itch), and thanks to Inge Zotterman we now have a triumvirate of protective c-fibres with the discovery of the 'hedonoceptor' (rewarding touch), the c-low threshold mechanoreceptor (C-LTMR). A growing body of research in human and non-human animals is exposing the impact of C-LTMR directed touch on several neurodevelopmental markers as evidenced by e.g., the quantity of maternal touch in early life being correlated with behavioural variation between individuals whereby epigenetic mechanisms are posited to play a critical, and protective, role in shaping developing brain networks. Here we asked if such 'neuroprotective' consequences of touch would be operational in a model of perinatal neocortical injury where it has been shown that such injury can devastate motor, cognitive and affective function, in both humans and laboratory animals. Touch has been shown to improve recovery after focal brain injury by e.g., preventing hippocampal damage in rats submitted to neonatal hypoxia-ischemia; reducing anxiety related to neonatal isolation rearing; and in humans to increase activation in medial prefrontal and cingulate cortex. We therefore decided to determine if this treatment would improve the functional outcome after a large neocortical injury such as neonatal hemidecortication. The current study showed that even a short period (11 days) of TS following a radical procedure such as hemidecortication could significantly improve functional outcome.

Symposia

Symposium 1: Illusions & prosthetics
Tuesday 4th July 2023, 10:40-12:00
Calogero Oddo: Recovering touch through biomimetic prosthetics
Nick Holmes: The use of TMS centrally and peripherally to interfere with basic aspects of touch
Laura Crucianelli: Touch and temperature illusion with the rubber hand
Chris Dijkerman: Touch time: The effect of a finger length illusion on tactile temporal-order judgments

Symposium 2: Wetness, slip, and texture
Tuesday 4th July 2023, 16:00-17:45
Rochelle Ackerley: The perception of drops of water in humans
Roland Bennewitz: Tactile perception of finger pad friction
Mariama Dione: The encoding of touch during active exploration of natural textures
Benoit Delhaye: Mechanisms in fingertip slip
Gustavo Luengo: Tribological & physico-chemical aspects that drive tactile perception of hair/skin in cosmetics

Symposium 3: Tactile interactions and social touch
Wednesday 5th July 2023, 09:00-10:00
Malika Auvray: Recognizing tactile gestures and their emotional content through auditory signals
Katerina Fotopolou: Not the Protagonist of my Own Life: Touch, the Body and Anorexia Nervosa
Konstantina Kilteni: The influence of motor prediction on somatosensory perception

Symposium 4: Traversing the periphery: 1st order neurons
Wednesday 5th July 2023, 16:00-17:30
Amaury Francois: In search of the neuronal basis of social and affective touch (in mice)
Slav Bagriantsev: 3D architecture and bi-cellular mechanism of touch detection in Meissner corpuscle
Andreas Themistocleous: Understanding the link between neuropathic pain & neuronal injury after nerve injury
Saad Nagi: PIEZO2-dependent rapid pain system in humans

Symposium 5: Skin mechanics
Thursday 6th July 2023, 10:20-12:00
Cornelius Schwarz: Temporally local coding and perception of tactile stimuli in rodents and humans
Victor Infante: Influence of skin physiology on friction and perception in touch
Neeli Tummala: Biomechanical filtering diversifies whole-hand tactile encoding
Sarah McIntyre: From skin to social nervous system: primary afferent responses to human touch

Symposium 6: Affective touch: more than skin stroking
Thursday 6th July 2023, 14:00-15:40
Annett Schirmer: EEG insights into the somatosensory processing of affective touch
Uta Sailer: Positive and negative emotional impact in touch interactions
Anna Ciaunica: The first senses - touch and in utero experiences
Martine Van Puyvelde: When parent-infant research becomes a festival of touch: importance of infant's ecological context
Laura Case: Affective Deep Pressure: Neural Mechanisms and Effects on Chronic Pain

Sympoisum 7: Affective touch and disorders
Friday 7th July 2023, 11:00-12:00
Leehe Peled-Avron: Effects of psilocybin on social touch perception in individuals with resistant major depressive disorder
Mariana Von Mohr: The social buffering of pain by affective touch
Paula Salamone: Self- and other-produced affective touch after Ketamine: a double-blind placebo-controlled study

Symposium 1: Illusions & prosthetics (4th July, 10:40-12:00)

Calogero Maria Oddo
The BioRobotics Institute and Department of Excellence in Robotics & AI Interdisciplinary Research Center Health Science Sant'Anna School of Advanced Studies, Pisa, Italy

Touch science and engineering: from bionics to medical and collaborative robotics and the metaverse

In the presented scientific approach, robotic systems are developed by capitalizing on a fertile interaction between robotics and neuroscience, so that the advancements of neuroscientific research can lead to the development of more effective technologies, which in turn contribute to the fundamental understanding of physiological processes. A first case study proposed is with piezoresistive MEMS sensors, applied to bionic hand prostheses to restore rich tactile skills, such as texture discrimination in upper limb amputees. The developed biorobotic technologies and artificial intelligence methods, based on information encoding with neuromorphic spikes emulating physiological tactile representation, can be applied to a variety of sensory augmentation scenarios. Additional technologies were explored to cover large areas of robot or human bodies, including sensors based on cultured biological cells such as MDCK, piezoelectric ZnO nanowires grown with seedless hydrothermal method, and Fiber Bragg Gratings (FBGs). Selected achievements are shown in the talk, discussing the application of tactile sensing technologies in a gripper able to manipulate fragile and deformable objects in collaboration with NASA-JPL, enabled by combining FEM and machine learning, or for sensorizing the full area of an anthropomorphic robotic arm featured on the cover of Nature Machine Intelligence. Particularly, endowing robotic arms with large sensorized skins allows the implementation of smart collaborative policies, such as safe interaction and programming by demonstration, that can be deployed in the factories of the future.

Nicholas P Holmes, Luigi Tamè
School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham, UK

Tickling the tactile brain with transcranial magnetic stimulation: A systematic review and meta-analysis

Transcranial magnetic stimulation (TMS) is a non-invasive means of stimulating the brain by creating a rapidly-changing electromagnetic field on the scalp. TMS has been extremely effectively for studying the primary motor cortex (M1) and the descending corticospinal tracts. This success is possible because of the output produced by M1 with every TMS pulse – a motor evoked potential (MEP). TMS over other parts of the brain does not produce an immediately-observable output, which raises problems over how to position the magnet, how intense to stimulate, and how to measure the effects of stimulation. For 10 years, Luigi, a small army of students, and myself have used TMS over the primary somatosensory cortex (S1) in attempts to interfere with simple aspects of tactile processing such as the detection and discrimination of brief vibrations applied to the fingertips. The success of this work has been mixed. To better understand how to use TMS over S1, we are systematically reviewing and meta-analysing all relevant studies. My talk will provide an update on our progress so far (warning: systematic review is very time-consuming!). Our working hypothesis is that TMS over S1 is likely to be more effective at interfering with discrimination tasks as compared to simple detection tasks, and that this would be consistent with classic studies of touch perception in nonhuman primates. We will test that hypothesis using meta-analysis.

Laura Crucianelli
Department of Neuroscience, Karolinska Institutet, Stockholm, Sweden

Radiant thermal signals give rise to a contactless rubber hand illusion

Illusions of body ownership, such as the rubber hand illusion (RHI), can provide some insight into the interplay between vision, proprioception, and touch during processes of multisensory integration. Previous studies investigated the modulation of some characteristics of the tactile input, for example velocity, softness, and temperature. However, the contributing role of thermal signals to the sense of body ownership, over and above tactile stimulation, remains unexplored. Here, we induced a contactless RHI (n=33), whereby visual and radiant thermal signals were combined to give arise to an illusion of body ownership towards the rubber hand in absence of tactile stimulation. Participants looked at a beam of light on a realistic rubber hand, which was moved in synchrony or out of synchrony with a heat lamp placed on top of the participants' own hidden left hand. Our results showed that the synchronous activation of thermoreceptors on the real hand and visual stimulation on the rubber hand was successful in

inducing an illusion of body ownership, as measured with self-report questionnaires. Participants also perceived the source of heat as closer to the rubber hand as compared to the asynchronous condition (i.e., thermal drift). The illusion was abolished when substituting the heat lamp with a normal lamp, and when the rubber hand was placed in an implausible position, ruling out the possibility that such effects were due to visual or cognitive expectations. Thus, thermosensation plays an important role to the way we recognise our body as our own, even without tactile stimulation.

H. Chris Dijkerman*, Chrysi Stergianni, Krista Overvliet
Helmholtz Institute, Utrecht University, the Netherlands

Touch time: the role of body representations in time perception

Previous studies have shown that changes to the perceived size of body parts can affect spatial tactile judgements. For example, visually enlarging the arm results in an enhanced spatial discrimination ability (1). Spatial processing has been suggested to be highly related to temporal processing as well (2). This may also be the case for tactile perception, which is inherently a spatiotemporal modality. In this presentation, we will review some of the evidence for a link between body size perception and tactile time perception. In addition, we will present a new study in which we tested whether a visual length illusion of the finger, influences temporal judgements of touches on that finger, while the real tactile distance remains the same. In this study, participants performed a tactile temporal order judgement task, while viewing their hand in a mediated reality set-up (MIRAGE) under two different conditions: while experiencing a finger stretch illusion (3), or with an undistorted view of the hand. 10 different stimulus onset asynchronies ranging from -200 to 200 ms were used. We fitted a psychometric curve for each participant and condition and extracted the slope at the inflection point, a measure of the discriminability of the stimuli. The results showed that when the index finger appeared to be longer, the slope was significantly steeper, suggesting that participants were better able to determine the temporal order of the tactile stimuli. This finding shows that a visual illusion of finger size, and thus body perception, influences temporal tactile processing and suggests that time perception and body size perception are linked.

References: 1. Kennett S et al., Curr Biol. 2001;11(15):1188–91, 2. Walsh V. Trends Cogn Sci. 2003;7(11):483–8, 3. Newport R, et al. Iperception. 2015;6(5):1–4.

Symposium 2: Wetness, slip, and texture (4th July, 16:00-17:45)

Rochelle Ackerley
CNRS Researcher, Laboratoire de Neurosciences Cognitives, Aix-Marseille University, Marseille, France

The perception of drops of water in humans

Much work in the tactile domain has focused on interactions with solids, yet we come into contact with liquids on a regular basis. Research on wetness perception has increased in the past 10 years, where the importance of touch and temperature cues has been demonstrated. We aimed to investigate how drops of water are perceived on the hand. We applied drops to the right palm in three main tasks: (i) two-forced choice drop mass discrimination task, (ii) intensity perception at different drop heights, (iii) intensity perception at different drop masses. We also obtained touch and temperature detection thresholds and other measures. We found that in the mass discrimination task, the just noticeable difference between drops was ~10 mg. Participants were highly precise at determining the water drop intensity from different heights and over different drop masses. We also characterized the drops over the different conditions in a complementary physical study and were able to theoretically predict the peak force by known parameters. We find that humans are extremely good at distinguishing between small drops of water, which we postulate is mainly based on vibratory tactile signals and small changes in local strain forces. These results provide insights into the precision of the somatosensory system in humans and how very subtle force signals can be readily sensed. This opens up potential routes for using drop detection tests for clinical diagnostics of somatosensory disorders and to innocuously quantify subtle changes in somatosensation.

Roland Bennewitz, Maja Fehlberg, Angelika Gedsun, Riad Sahli, Sairam Saikumar
INM - Leibniz Institute for New Materials, 66123 Saarbrücken, Germany

Tactile perception of finger pad friction

The texture of surfaces is key to the tactile perception of materials in touch. Finger pad friction is one of the main channels of texture perception. We have studied the perceived similarity between randomly rough surfaces under tactile exploration. Surfaces had the same nominal overall roughness, but independently varied topographic shape and fine-scale roughness. Roughness at small length scale dominated the perception of similarity, apparently by its influence on finger pad friction. In a second study on elastic materials with surfaces carrying a regular array of micropillars, we revealed that bending of the micropillars is key to the tactile perception of such fibrillar textures. Given the importance of friction in the perception of textures, we investigated whether participants can correctly compare their own finger pad friction on different textures, an found a Weber coefficient of 0.2. This just noticeable difference in relative friction was also found for differences caused by a variation of sliding velocity. We are now exploring variations in the perception of pleasantness for differently textured surfaces of the same material.

Mariama Dione
Laboratoire de Neurosciences Cognitives, CNRS – Aix-Marseille University, Marseille, France

How touch is encoded by mechano-afferent fibers during active exploration of natural textures

Humans spontaneously use lateral motion of the finger over surfaces to explore them. Lateral motions may appear as simple slipping gestures, but actually involve quite complex force and vibration dynamics. Indeed, if we decompose this movement, the finger pad is first pressed against the surface, then stretched, then it slips over it (eliciting vibrations), and it is finally unstretched. In this talk, I will present preliminary results showing how mechano-afferent fibers respond to texture exploration through a natural active touch stimulation involving lateral motion of a finger. We used the microneurography technique, to collect neural data during active touch in awake humans. We used a variety of textures (rough, sticky, hard, soft, pleasant, N = 18), several modes of touch (slow, fast or explorative movements), and collected position, force, vibration, and muscle data. Our results indicate that mechano-afferent fibers (N = 37) respond at specific moments within the lateral motion reflecting the distinct mechanical events involved. The slowly-adapting fibers (SAs) respond more at motion initiation/termination, while fast-adapting mechanoreceptors (FA) respond more during sliding. Furthermore, in a subset of afferents, we correlated firing with physical and perceptual descriptors. These relationships suggest that a subset of SAs (SA2) code the friction coefficient of the texture, while FAs code the vibratory aspects. Finally, FA firing increased with faster movement speed, while SAs were relatively insensitive to changes in speed. These findings expand current knowledge on the neurophysiology of touch in humans.

Benoit Delhaye
FNRS Researcher, Université catholique de Louvain, Belgium

Tactile signals underlying slip detection and avoidance during active manipulation of objects

The most basic requirement to manipulate objects with our fingers is to avoid dropping them. This is achieved by applying a sufficient amount of grip force to prevent slippage. Critically, this force depends on friction: a stronger grip is required for slippery surfaces and a looser grip is sufficient for sticky surfaces. Humans seamlessly manipulate objects of different friction by precisely modulating the amount of grip force applied to an object. Besides, this modulation requires feedback from tactile afferents in the finger. However, to date, the sensory mechanisms signaling friction are mostly unknown. In this talk, I will provide evidence that the sensory signal eliciting adjustments to friction is not friction per se, but a warning signal about an impending loss of grip, in the form of surface skin strain resulting from partial, but not complete, slip. Indeed, during tangential loading, the object-finger interface is subjected to partial slips, i.e. localized loss of grip between the skin and the surface. First, I will show that tactile afferents from the fingertips signal partial slip events faithfully. Second, that partial slip is ubiquitous during the active manipulation of objects. Finally, I will provide evidence that partial slip is a key sensory signal to adjust the grip force to friction during manipulation.

Gustavo Luengo
L'OREAL Research & Innovation, Aulnay-sous-Bois, France

Tribological and Physico-chemical aspects that drive tactile perception of skin and hair in cosmetics
In cosmetic science a great diversity of materials and formulations are used to protect or improve the sensorial properties of skin and hair. To achieve this goal, It is important to understand how the tribological and physico-chemical properties of the substrate are translated into sensorial subjective appreciation of the consumer and in particular during active touch (i.e. skin softness) or passive self-perception (i.e. skin comfort after application of a cream for example). Knowledge of the structure of the cosmetic substrate is essential. Here we will review our past and current work the tribological properties of the hair and skin surface. In particular, the role of the surface topography and physicochemical state (surface hydrophobicity, hair alignment, skin microrelief, etc.) on tactile friction and sensory perception. As examples we will mention our pioneering studies on the influence of age on tactile acuity, the effect of thin polymer coatings on the psychophysical detectability of a hair's lubricating treatment or the challenge of skin's surface structuring to obtain biomimetic coatings. We will terminate with a focus on our most recent work about how tactile perception and friction of hair affects perceived frizziness; the decoding of the feeling of skin tightness by monitoring the mechanical strains at the depth of cutaneous mechanoreceptors and the determination of perception thresholds of hair attributes using tactile stimulators. In conclusion these studies reinforce the need of a better understanding of the connection between formulation's ingredients and human perception response.

Symposium 3: Tactile interactions and social touch (5th July, 9:00-10:00)

Malika Auvray
CNRS senior Researcher, ISIR, Sorbonne University, Paris, France

Social touch at a distance: Recognizing tactile gestures and their emotional content through auditory signals
Social touch allows communicating specific emotions and intentions and has been shown to be crucial for development and well-being. Furthermore, a decrease in socio-tactile interactions is linked to higher anxiety and feeling of loneliness. Thus, with the increase of social isolation and distant communication, it appears timely to allow distant affective interactions. Skin-to-skin tactile interactions create vibrations that are of similar nature to auditory ones, suggesting the possibility for tactile signals to be transposed into auditory signals. To investigate if tactile gestures and their emotional content can be recognized through the auditory channel, the vibratory signals from prototypical skin-to-skin touches were recorded with a violin microphone and amplified by means of basic sensory signal processing. In a first experiment, participants listened to the sounds corresponding to different skin-to-skin touches (i.e., stroking, rubbing, tapping, hitting). They were found to be able to recognize and correctly categorize them. In a second experiment, participants were presented with the sounds corresponding to six skin-to-skin touches conveying different emotional intentions (i.e., love, sympathy, joy, attention, impatience, fear, anger). They were able to recognize and categorize them into different emotional messages. Additional control experiments were run with similar gestures but different non-human surfaces. Our study shows for the first time that both skin-to-skin tactile gestures and their emotional content can be recognized through their auditory counterparts. This line of research sets up the grounds for future possibilities to allow socio-affective interactions at a distance.

Katerina Fotopolou
Professor in Psychodynamic Neuroscience, University College London, Clinical, Educational and Health Psychology research Department

Not the Protagonist of my Own Life: Touch, the Body and Anorexia Nervosa
Eating disorders are heterogeneous disorders of high morbidity and mortality rates. While however there has been extensive evidence and theory regarding genetic, biological and cognitive predisposing, precipitating and maintenance factors, less emphasis has been placed on the sensory aspects of the disorder and particularly the role of affective touch and other somatic, interoceptive deficits. I will present series of studies in anorexia nervosa investigating the perception of affective touch, and its integration with other sensory and particularly interoceptive modalities giving rise to cognitive and metacognitive bodily representations and beliefs in patients with acute anorexia nervosa, versus patients recovered from anorexia nervosa versus healthy controls. I will also present and synthetize other somatosensory and interoceptive studies conducted in this population, including studies on CT-optimal touch and discuss our findings in this light.

Konstantina Kilteni
Department of Neuroscience, Karolinska Institute, Department of Sensorimotor Neuroscience, Donders Institute for Brain, Cognition and Behavior

Self-touch versus externally generated touch: the influence of motor prediction on somatosensory perception

How do we distinguish self-touch sensations (e.g. feel our hand caressing our leg) from touches of external causes (e.g. feel the touch of an insect on our leg) to generate the appropriate behaviour? This classification might seem trivial; however, it is a demanding task for the brain given the massive amount of somatosensory information that needs to be processed at any given moment. Dominant motor control theories propose that the brain uses efferent information to predict the somatosensory consequences of our actions and attenuate the associated responses (somatosensory attenuation), thereby increasing the salience of externally generated touches. In this talk, I will provide an overview of our work on somatosensory attenuation, focusing on when these predictive proceses are engaged and how they are implemented in the human brain.

Symposium 4: Traversing the periphery: 1st order neurons (5th July, 16:00-17:30)

Amaury Francois
Neuronal circuits of affective touch lab, Institut de Génomique Fonctionnelle, CNRS INSERM Université de Montpellier

In search of the neuronal basis of social and affective touch (in mice)

Our team focus on understanding the physiological function of C-low threshold mechanoreceptors (C-LTMRs), a specific population of somatosensory neurons in mice that appears particularly well suited, physiologically and anatomically, to perceive affective and social touch. In order to identify the mechanisms underlying the perception of affective touch, we developed new techniques to artificially manipulate the neuronal activity of these C-LTMRs and investigate social touch in rodents. In this presentation, I will present our latest results regarding the modulation of C-LTMRs and its effects on diverse social interaction. Precisely, I will demonstrate that C-LTMRs functional deficiency induces social isolation and reduces tactile interactions in adulthood, and conversely, that transient increase in C-LTMRs excitability in adults is rewarding, promotes touch-seeking behaviours and has pro-social influences on group dynamics. I will also discuss new insights on how the information carried by the C-LTMRs is integrated into the central nervous system.

Slav Bagriantsev
Department of Cellular and Molecular Physiology, Yale University School of Medicine, New Haven, CT

Three-dimensional architecture and bi-cellular mechanism of touch detection in Meissner corpuscle

Mechanosensory corpuscles detect transient touch and vibratory signals in the skin of vertebrates, enabling navigation, foraging, and precise manipulation of objects. The corpuscle core comprises a terminal neurite of a mechanoreceptor afferent surrounded by Schwann cell-derived lamellar cells (LCs). However, the precise corpuscular ultrastructure and functional relationship between LCs and sensory afferents are unknown. Here we use enhanced focused ion beam scanning electron microscopy to determine the three-dimensional architecture and reveal the ultrastructural relationship between LCs and mechanoreceptor afferents in an avian Meissner (Grandry) corpuscle. Furthermore, simultaneous electrophysiological recordings from both cell types revealed that mechanosensitive LCs use calcium influx to trigger action potentials in the afferent and thus serve as physiological touch sensors in the skin. The elaborate architecture and bi-cellular sensory mechanism in the corpuscles, which comprises the afferents and LCs, create the capacity for more nuanced encoding of the submodalities of touch. This work is supported by grants from NSF (IOS-1923127) and NIH (1R01NS097547).

Andreas Themistocleous
Nuffield Department of Clinical Neurosciences, University of Oxford
Understanding the link between neuropathic pain & neuronal injury after nerve injury
Microneurography is the only neurophysiological technique that records neuronal activity directly from nerves in awake patients. Recording from nociceptive fibres provides unrivalled insight into peripheral neuronal activity and how it can relate to chronic neuropathic pain. The unmyelinated nociceptive fibres, tested by microneurography, are not assessed by conventional nerve conduction studies and are important for sensing pain. Nociceptive fibres are heterogenous, they show different stimulus-response functions and some are mechanically-insensitive in the naive state. We still have an incomplete understanding of which nociceptive afferent population and which activity is the key driver of neuropathic pain. Microneurography has the potential to answer these fundamental questions. The application of microneurography to the study of neuropathic pain is under-utilised. We believe that these techniques should be adopted more widely by the neuropathic pain field.

Saad Nagi
Linköping University, Sweden
PIEZO2-dependent rapid pain system in humans
The ability to perceive and respond to our environment is essential for survival. While progress has been made in understanding nonpainful mechanical sensations, the neural mechanisms behind painful mechanical sensations remain less explored. Here, we aim to identify the neural basis of a specific type of mechanical pain evoked by the pulling of single hairs. Using psychophysics, we have observed that hair-pulling generates an easily distinguishable percept and an urge to move towards the hair-pull stimulus. It also evokes a rapid nociceptive reflex. Even weak hair-pull forces elicit pain, indicating a highly sensitive pain system. Preferentially blocking Aβ fibers in healthy participants abolishes hair-pulling pain, and rare patients with selective Aβ deafferentation do not perceive pain from hair-pulling. Patients with PIEZO2 deficiency syndrome also exhibit deficits in perceiving hair-pulling pain, suggesting that the perception of hair-pull pain relies on PIEZO2 mechanotransduction. Using in vivo calcium imaging in murine hair-pull nociceptors, we establish that PIEZO2 sets the threshold for mechanical sensitivity in these neurons. Furthermore, we find a shared transcriptomic identity between murine hair-pull nociceptors and a previously uncharacterized class of human neurons associated with hair follicles, which we confirm through immunohistochemistry of human skin biopsies. Using microneurography and targeted pharmacology, we elucidate that these human neurons represent a new class of rapidly conducting nociceptors that show selective tuning to painful hair-pull stimuli. In summary, our findings highlight a rapidly conducting human nociceptive system dependent on PIEZO2 mechanotransduction. This system enables precise signaling of mechanical pain evoked by hair pulling and exhibits molecular, cellular, and functional specialization.

Symposium 5: Skin mechanics (6th July, 10:20-12:00)

Cornelius Schwarz
Center for Integrative Neuroscience, University Tübingen, Germany
The Slip hypothesis: Temporally Local Coding and Perception of Tactile Stimuli in Rodents and Humans
Perceptual systems may have evolved to employ specific physical features characteristic or even unique of the sensory signal at hand, rather than implement generic mathematical analysis of sensory data. Further, perceptual computation may involve neural as well as pre-neuronal elements, the latter based in the physics of the world. In the touch system, one such specific, pre-neuronal element is the phenomenon of biomechanical, frictional events, which are generated by the relative movement of the integument in touch with object surfaces. These short, high amplitude, vibrotactile events are called stick-slip movements ('slips'). Biomechanical evidence from the rodent whisker system showed that the kinematic outlay of slips carries rich information about the objects touched. Neurophysiological evidence from recordings of primary afferents and the first synaptic station in the brain stem, showed that the early whisker-related tactile system responds in an utmost precise fashion to the kinematics of short vibrotactile events, and that there is almost no integration of the vibrotactile signal beyond the typical duration of slips. In S1, the neuronal population responds very well to changes in the kinematic outline of vibrotactile events, but rather poorly to event rate changes. Matching psychophysical results, which we carried out in rodents as well as the fingertip system in humans, indicate that local kinematic shape of short events dominates perception while integration of event rate has a comparatively poor perceptual effect. In summary, the available data suggests an alternative possibility to think about tactile (neuronal) coding, compared to the one the field has followed as its dominant theory for decades: the tactile

system may detect local (shorter than 10 ms) kinematic patterns in the vibrotactile signal, rather than doing extensive integration across time to come up with 'intensity' (sum of signal), or 'frequency (sum of spectral components).

Victor Hugo Pacagnelli Infante, Martina C. Meinke, Roland Bennewitz
INM - Leibniz Institute for New Materials, 66123 Saarbrücken, Germany

Influence of skin physiology on friction and perception in touch

Friction is a key mechanism in the perception of surface textures and in affective touch. It depends strongly on the interaction details between skin and material. So far, no study has addressed the high variability of individuals in friction and perception by a direct correlation with the individuals' skin physiology. The aim of our work is to elucidate the influence of glabrous-skin physiology on friction and perception. Sixty individuals (23 males, 37 females) with an age from 20 to 70 years (average 34 ± 10 years) were enrolled in this study. We measured the skin hydration, finger ridge distance, skin mechanical properties, stratum corneum thickness, number of Meissner Corpuscles (MCs) per mm², and the two-point discrimination threshold in touch. Experiments were performed on the index finger of the dominant hand with non-invasive biophysical and imaging techniques such as laser scan microscopy, optical coherence tomography, corneometry, and a suction device. Participants explored six different surfaces with random roughness of well-defined spectral definition and six elastic surfaces with different arrays of micrometer pillars by touch. We recorded the coefficient of friction between finger pad and surfaces during tactile exploration. Friction was correlated with parameters such as hydration and deformability of skin. Surprisingly, we did not find correlations of friction with the thickness of the stratum corneum. The perception of microscopic surface features was correlated with age and the number of MCs. We will discuss the strong variation in friction between participants in the light of their skin physiology and suggest their influence on tactile perception.

Hannes Saal
Department of Psychology, University of Sheffield, UK

Deformation of individual fingerprint ridges during tactile interactions

The human fingertip can detect small tactile features with a spatial acuity roughly the width of a fingerprint ridge. However, how individual ridges deform under contact to support accurate and high-precision tactile feedback is debated. In this talk I will present recent work, where we imaged the sub-surface deformations of hundreds of individual fingerprint ridges during contact events. We quantified the deformations in multiple skin layers resulting from static indentation, stick-to-slip events, sliding of a flat surface in different directions, and interaction with small tactile features, such as edges and grooves. Results suggest that the primary components of ridge deformation and, potentially, neural responses are deformations of the ridge flanks and their relative movement orthogonal to the skin surface, rather than overall bending of the ridges. The findings highlight the profound role of the skin in shaping tactile feedback.

Neeli Tummala
University of California, Santa Barbara (ReTouch Lab, Prof. Yon Visell)

Biomechanical Filtering Diversifies Whole-Hand Tactile Encoding

Skin oscillations generated by manual touch are detected by numerous exquisitely sensitive Pacinian corpuscle neurons (PCs) distributed throughout the hand. When subjected to direct, localized stimuli, most PCs exhibit highly similar frequency response characteristics to one another, suggesting potential redundancies in PC population responses that seem at odds with principles of efficient neural encoding. Prior studies show that propagating skin oscillations are modified by frequency-dependent attenuation imparted by the soft tissues of the hand. In principle, such biomechanical filtering effects that modulate the transmission of skin oscillations could promote PC response diversity. To examine this hypothesis, we employed high-resolution optical vibrometry to characterize the biomechanical transmission of touch-evoked skin oscillations throughout the whole hand. We observed complex, distance- and frequency-dependent patterns of transmission that reflected the interplay between soft tissue mechanics and hand morphology. To investigate the effects of biomechanical filtering on tactile encoding by populations of PCs, we next utilized our vibrometry dataset to drive an ensemble of physiologically-validated spiking PC neuron models. We observed biomechanical transmission to diversify PC frequency selectivity and modulate PC spiking activity in a distance-dependent manner, thus mitigating redundancy among PC responses. Our findings clarify the prominent role of biomechanical filtering in diversifying tactile encoding by PC populations throughout the hand and shed light on the neuromechanical basis of haptic perception.

Sarah McIntyre
Linköping University, Sweden

From skin to social nervous system: primary afferent responses to human touch

Touch is a critical part of our social lives, and this is likely to be reflected in the organisation of the somatosensory system. The skin-to-skin mechanical techniques we use during social touch interactions are grounded in the affordances and vulnerabilities of our physical bodies. Here we look for the through-line connecting mechanical skin deformations and primary afferent responses to socially relevant judgments and interpretations. We recently developed a set of six standardised touch expressions composed of skin contact characteristics observed in naturalistic interactions between socially close individuals. Using newly developed human touch tracking technology, we showed that the distribution of contact features is broader, more complex and more dynamic than stimuli previously tested in microneurography recordings used to investigate primary afferents. In our own microneurography recordings we found unequal capacity of primary afferent classes to differentiate them. In particular, spike trains of individual slowly adapting type II (SA-II) and fast adapting hair follicle afferents (HFA) can reliably differentiate the skin contact features of the expressions, outperforming other afferent classes including C-tactile (CT) afferents. Furthermore, discrimination was best at a functionally relevant time scale. Classification required 3-4 seconds of spike train input and was robust to shifts in spike timing of up to 10ms; a time scale which is 1-2 orders of magnitude greater than that required for non-social functions. Using complex naturalistic stimuli we have shown how primary afferent responses to skin deformations provide the sensory scaffolding for the social nervous system.

Symposium 6: Affective touch: more than skin stroking (6th July, 14:00-15:40)

Annett Schirmer
Department of Psychology, Leopold Franzens University Innsbruck, Austria

EEG insights into the somatosensory processing of affective touch

Microneurography has been invaluable for research on affective touch and peripheral nerve fibers such as C-tactile (CT) and Aβ afferents. Unfortunately, the technique is challenging and not readily accessible to most neuroscientists in the field. Thus, it is important to develop approaches that can complement and usefully extend peripheral nerve recordings. One promising step in this direction entails the measurement of somato-cortical responses in the electroencephalogram (EEG). Recent studies have been able to dissociate such responses between C-tactile and Aβ targeted touch. A negative deflection in the event-related potential markedly differed as a function of stroking site and velocity. Whereas stroking of hairy skin modulated this negativity in an inverted u-shaped manner, stroking of glabrous skin produced a monotonically increasing negativity. Additionally, Rolandic Rhythms decreased with increasing velocity irrespective of the skin type being stroked. Together, these measures predicted tactile pleasure and helped dissociate individual differences in tactile preferences. Thus, not only does the EEG shed light on central aspects of tactile processing, it may also be useful in furthering our understanding of peripheral nerve signals and their projections to the brain.

Uta Sailer
Faculty of Medicine , University of Oslo, Norway

Why is touch (un)pleasant? How the fulfilment of universal needs shapes the positive and negative affect triggered by touch

Touch is a complex experience where many factors determine whether positive or negative feelings arise. In other experiences such as product interactions, the fulfilment of universal psychological needs has been identified as a central source of positive affect. Therefore, we aimed to investigate how need fulfilment contributes to positive and negative affect in touch. In two studies, participants recalled the most positive and most negative touch event within a certain period, and described it by open and closed questions on the type and location of the touch, who initiated it, its physical characteristics, the assumed intention, and more. A questionnaire assessed the degree to which the event fulfilled nine different psychological needs. Positive and negative touches were similar in terms of the type of touch and the part of the body touched, but differed in terms of the assumed intention and the stated reasons why the touch was positive or negative. Need fulfilment together with physical and other characteristics of the touch explained a whole 72 % of the variance in positive affect, and 44% of the variance in negative affect. The findings

show that 1) the same type of touch can be experienced largely differently depending on the context, and 2) need fulfilment was able to explain these different experiences. Thus, need fulfilment appears to be crucial for the affect that touch triggers and should be considered in future studies on the factors that make touch (un)pleasant.

Anna Ciaunica
Institute of Cognitive Neuroscience, University College London, UK

Getting in touch with the lost self: depersonalisation experiences modulate vicarious affective touch and self-touch (via video)

Depersonalisation (DP) is characterized by distressing feelings of being detached from one's self and body, often described as being "out of touch" with oneself. We conducted two online experiments looking at the relationship between non-clinical experiences of DP and vicarious affective touch and self touch. In Experiment 1 we found that people with lower occurrences of DP rate the perceived pleasantness of the imagined social touch as received by the self higher than if received by the other. By contrast, we found no difference in the perceived pleasantness of affective touch imagined as being received by the self vs the other in people with higher occurrences of DP experiences. In Experiment 2, we designed a new affective self-touch intervention in order to explore the effect of affective self-touch stroking on one's dorsal forearm on the perceived pleasantness and vividness of tactile experiences as being received by the self and others. We found that both low and high DP participants, following the affective self-touch intervention, report significantly higher ratings of vividness of tactile perception. These findings may have key implications for potential sensory tactile-based interventions for people experiencing distressing feelings of DP.

Martine van Puyvelde
Research Unit VIPER – Department LIFE - Royal Military Academy Brussels – Belgium; Brain, Body, and Cognition – Department of Psychology - Vrije Universiteit Brussel – Belgium; Faculty of Science, School of Natural Sciences and Psychology, Liverpool John Moores University, Liverpool, United Kingdom

When parent-infant research becomes a festival of touch: the importance of the infant's ecological context

In this presentation, I will present the main results of a series of studies in which we examined the impact of parental stroking and static touch on the parasympathetic regulation of the infant. Parasympathetic regulation of the HPA-axis is a basic need in the healthy development of an infant to build their future stress regulation system and their level of stress resilience. Our studies showed 1/ how stroking touch intuitively delivered by mothers and fathers to their infant corresponded with the velocity and skin locations of typical CT-optimal touch and, 2/ that parent stroking touch evoked significantly more infant parasympathetic regulation than static touch. Moreover, in a study in which we applied a 30-days "gentle touch stimulation" program and asked mothers to provide daily 10-min of typical CT-optimal gentle stroking touch to their infants, the infants were significantly more resistant to a still face stress test, both on a physiological and micro-behavioral level than infants that were part of a control group. All these studies were performed at the parents' home to respect the ecological context of the infant. When presenting this research, I will show how small deviations from the infants' context may impact their responses on certain experiments and how infants may sometimes impose their world and conditions on the researcher and the clinician.

Laura Case
Department of Anesthesiology, UC San Diego

Affective deep pressure: neural mechanisms and effects on chronic pain (via video)

Studies of CT afferents have provided a foundational understanding of the neural processing of social touch and its effects on emotion and pain. Deep pressure—embedded in hugs, cuddles, and massage—also alters mood and pain. However, little is known about the sensory and neural mechanisms for its perception. We designed a novel paradigm to study affective deep pressure and demonstrate its neural response. Our studies of patients with rare somatosensory conditions as well as healthy volunteers undergoing temporary nerve blocks suggest that deep pressure perception depends on myelinated sensory afferents and involves a novel molecular mechanism for mechanotransduction. Finally, we show that pressure from a weighted blanket can reduce aspects of chronic pain, with deeper pressure needed in patients who are socially disconnected.

Symposium 7: Affective touch and disorders (7th July, 11:00-12:00)

Leehe Peled-Avron
Bar-Ilan University, Israel

The effects of psilocybin (‘magic mushrooms') on social touch perception in individuals with resistant major depressive disorder

Individuals with depression often experience difficulties in social interactions. Social interactions consist of both verbal and non-verbal means of communication, among which is social touch which is used to convey several types of emotion. Depression is associated with negative attitudes towards social touch and these negative attitudes mediate interpersonal difficulties. Psilocybin, the active compound in several types of fungi (‘magic mushrooms') has been shown to alleviate symptoms of depression. Yet its effects on social interaction and specifically on social touch have yet to be explored. In this study, we examined the effect of psilocybin administration on perception of social touch in individuals with resistant major depressive disorder. Participants watch photos of either humans or inanimate objects touching or not. Participants are then asked to rate their emotions towards the objects in the photos. The responses are recorded a week before and a week after administration of 25mg of synthetic psilocybin during psychedelic assisted psychotherapy. 10 participants have completed the treatment (5 were administered psilocybin and 5 placebo). Results demonstrate a significant increase in emotionality ratings in the human touch condition after psilocybin administration, no such difference was found for the ratings of the control conditions or following placebo administration. These results point to a potential improvement of the attitudes towards social touch following a psychedelic intervention in depression and may suggest a possible mechanism through which psilocybin alleviates depressive symptoms.

Mariana Von Mohr
Royal Holloway, University of London, UK

The social buffering of pain by affective touch

Social bonding and support are important for human well-being. Close social bonds, or attachment relationships, have long been suggested to serve safety and distress-alleviating functions. Evidence from non-human mammals further suggests that it is not the mere presence of conspecifics but rather certain active behaviours (e.g. tactile contact, grooming, licking by conspecifics) that are important for affective regulation. In humans, even though there are many ways to provide active social support, recent experimental studies and theoretical postulations suggest that affective touch in particular, which is mediated by the CT system, is crucial for the formation and maintenance of social bonds and may work as a potent interpersonal homeostatic regulator. To examine this issue, in a series of studies, we have examined the role of affective touch as a form of social support during social and physical pain. Our findings suggest that affective touch reduces feelings of social exclusion (a form of social pain) as well as subjective pain ratings, and its associated neural responses, in response to noxious stimulation. Yet, such effects vary in relation to the social context and in particular, if the touch is provided in a context in which a degree of trust and attachment is already established. These findings will be discussed in relation to bottom-up sensory mechanisms and top-down cognitive mechanisms (e.g., learned expectations) associated with affective touch, under an allostatic regulatory framework.

Paula Salamone
Linköping University, Sweden

Self- and other-produced affective touch after Ketamine: a double-blind placebo-controlled study

A coherent sense of self is crucial for social functioning and mental health. The N-methyl-D-aspartate antagonist ketamine induces short-term dissociative experiences and has therefore been used to model an altered state of self-perception. However, the mechanisms for its effects on the bodily sense of self remain largely unknown. In this randomized double-blind placebo-controlled within-subject study, 30 participants received intravenous ketamine while performing a previously validated task during functional MRI: self-touch and touch by someone else were used as a measure of self-other-distinction. Afterwards, tactile detection thresholds during self- and other-touch were assessed, as well as dissociative states, interoceptive awareness, and social touch attitudes. Compared to placebo, ketamine administration induced a higher state of dissociation and a reduction of self-other distinction in the temporoparietal cortex. This reduction correlated with ketamine-related reductions in interoceptive awareness. Our results indicate that disrupting the self-experience by ketamine-administration affects self-other-distinction in a region associated with touch perception and social cognition. This process may be driven by ketamine-induced effects on top-down signaling, rendering the processing of predictable self-generated and unpredictable other-generated touch more similar. Our findings provide further evidence for the intricate relationship of the bodily self with social touch.

Methods focus: Microneurography in humans (5th July, 10:30-10:55)

Roger Watkins
Laboratoire de Neurosciences Cognitives, CNRS – Aix-Marseille University, Marseille, France

Microneurography: tapping into the peripheral language of touch

Over the last 50 years, the technique of microneurography has provided us with valuable insights into activity in human nerves. Using microneurography, we can both observe and replicate patterns of activity to touch stimuli in individual mechanoreceptive afferents. This allows us to study direct links between activity in peripheral nerves and touch sensation. The steps in performing the technique will be outlined, including how recordings from individual neurons are made and how these can be linked to perception. Then extension of the technique to perform single afferent microstimulation will be introduced, and how this can be used to test theories of touch coding, using elemental touch sensation. Finally, developments and improvements will be presented, which provide avenues for future investigations with the technique.

Short oral presentations (bold = presenter)

Short oral presentations #1 (4th July, 10:00-10:20)

Probing temporal rules for artificial tactile feedback in a sensory-motor brain-machine interface

Alexandre Tolboom 1, Henri Lassagne 1, Daniel Shulz 1, Luc Estebanez 1, Valérie Ego-Stengel 1
1 : Institut des Neurosciences Paris-Saclay, Université Paris-Saclay, Centre National de la Recherche Scientifique

Brain-Machine-Interfaces (BMIs) aim to improve the autonomy of human patients. Nevertheless, beyond the restoration of movement, the fine control of prosthetics requires the recovery of tactile sensory feedback. Although BMIs with artificial somatosensory inputs have recently been implemented in patients, few studies have focused on the temporal constraints of feedback integration. In this study, we aim to explore the impact of the temporal latency between a motor command and the feedback update after movement. Therefore, we have developed an ultra-fast bidirectional BMI based on chronic electrophysiological recordings in M1 and 2D patterned optogenetic stimulation of the primary somatosensory cortex (S1) in mice. Thanks to our control algorithm based on the incremental displacement of the prosthesis triggered by single spikes, we achieved a 4.4-ms minimal latency for the complete loop — the fastest closed-loop BMI to our knowledge. In our protocol, single M1 neurons were conditioned to control the rotation of a virtual bar. The photostimulation pattern on S1 provided feedback of the prosthesis angular position to the animal. On a subset of animals, we showed that such optostimulations could generate perceptions similar to the ones evoked by equivalent tactile stimuli. Results showed that our incremental algorithm was efficient to achieve fine control. We obtained well-guided trajectories by using a 50-ms latency for tactile feedback. Decreasing/increasing the latency to 5/300-ms impaired the ability of the animals to move and stabilize the prosthesis in the target area, suggesting the existence of a specific range of time windows in the S1-M1 dialogue.

Restoration of thermal sensation in upper limb amputees

Solaiman Shokur 1, Francesco Iberite 2, Jonathan Muheim 1, Silvestro Micera 1
1 : NeuroX, EPFL, 2 : Scuola Universitaria Superiore SantÁnna [Pisa]

Developments in bionic hands with sensory feedback have allowed amputees to perceive objects' compliance, texture, and shape. In contrast, there is a dearth of research exploring the possibility of restoring thermal sensation. The thermal sensation could not only allow users to perceive if an object in contact with their prosthetic is warm, cold, or dangerously hot but could also help them better perceive the contact with other humans. In a recent study, we described a wearable thermal device called the MiniTouch that can integrate existing prosthetics and provide users with this crucial missing information. Investigation of 27 amputees revealed that a majority of them (17) experienced referred thermal sensations in their phantom hand when stimulated at specific points of their residual arm. The MiniTouch exploits the phantom thermal sensations on the residual arm to give sensations that are phenomenologically similar to those experienced on the intact arm. The MiniTouch has three main elements: a sensory skin that mimics the thermal proprieties of human skin (maintains 32°C at baseline and thermal conductivity similar to the skin) and a thermode that stays in contact with the skin in one of the refereed thermal positions and a controller that mediates the temperature. Using our device, blindfolded users could discriminate in real-time between objects at different temperatures but also different materials, such as glass, copper, or plastic, relying on thermal proprieties. Our technology opens the possibility for affective touch for prosthetic users.

Short oral presentations #2 (4th July, 14:00-15:00)

Body mapping of skin wetness sensitivity in children, younger, and older adults

Alessandro Valenza 1, 2, Charlotte Merrick 1, Riley Wootten1, Jasmin Dearden 1, Hannah Blount 1, Jade Ward 1, Charlotte Wildgoose 1, Antonino Bianco 2, Alex Buoite-Stella 3, Peter Worsley 4, Davide Filingeri 1

1 : ThermosenseLab, Skin Sensing Research Group, School of Health Sciences, The University of Southampton, Southampton, UK; 2 : Sport and Exercise Sciences Research Unit, SPPEFF Department, University of Palermo, Palermo, Italy; 3 : Department of Medicine, Surgery and Health Sciences University of Trieste, Trieste, Italy; 4 : PressureLab, Skin Sensing Research Group, School of Health Sciences, The University of Southampton, Southampton, UK

Perceiving skin wetness, i.e. hygrosensing, is crucial for behavioural thermoregulation. Humans lack skin hygroreceptors and we rely on the multisensory integration of thermal and tactile cues to detect wetness. Yet, how hygrosensation develop throughout the lifespan remains unclear. This study investigated age-related differences in wetness sensitivity across the body. Twelve-children (4F/8M, 12±3y), 41-younger (21F/20M, 25±4y) and 21-older adults (11F/10M, 55±6y), reported the perceived magnitude of wetness perception arising from the application of a cold-wet (5°C below local skin temperature, Tsk), neutral-wet (equal to Tsk), and warm-wet (5°C above Tsk) temperature-controllable probe (1.32cm2; 0.8ml of water) to the forehead, neck, and foot (dorsum). We found that age impacted cold wetness sensing only. Specifically, children were 20% more cold-wet sensitive than older adults (mean difference: +20.4mm [95%CI: 1.3, 39.5]; p=0.033), yet they were as sensitive as younger adults (+8.5mm [95%CI: -8.7, 25.8], p=0.467). We also found that regional differences in wetness perceptions were present across all age groups. Specifically, the foot was 11% more sensitive to cold-wetness (mean difference: +11.1mm [95%CI: 2.2, 20.0]; p=0.011) and 13% less sensitive to warm-wetness (mean difference: -12.9mm [95%CI: 2.8, 23.0]; p=0.008) than the neck.We show that, while children and younger adults present similar wetness sensitivity, ageing (and likely associated neural degeneration) may impair cold-wetness sensitivity. Interestingly, adult-like body regional patterns of wetness sensitivity are present as early as of ~12 years of age. This knowledge could inform the design of products and garments mapped to the sensory needs of different age groups.

Touch inhibits cold: non-contact cooling reveals a thermotactile gating mechanism.

Ivan Ezquerra-Romano 1, Patrick Haggard 1

1 : Institute of Cognitive Neuroscience, University College London

The receptors classes that transduce thermal and mechanical energies are largely distinct, but we have unified, coherent thermotactile experiences of the objects we touch. These experiences must emerge from the interaction of thermal and tactile signals within the nervous system. One logical way to study these interactions would involve comparing the sensations caused by purely thermal stimulus with the effects of a thermotactile stimulus. This approach has remained elusive for cold perception due to the lack of non-tactile and temperature-controlled cooling stimulators. We have recently developed a novel thermal stimulator which can deliver non-tactile, focal and temperature-controlled cooling. We have used this method to test cold perception with and without touch using signal detection methods. We found that touch reduces the sensitivity to near-threshold cooling across three (n=12*3) experiments in humans. In a control experiment, we rule out this inhibitory interaction is due to attentional mechanisms. Our findings suggest that touch inhibits cold perception, perhaps via a mechanism analogous to the well-established 'gating' of pain by touch, and consistent with known early-stage interactions between somatosensory pathways in the spinal cord. Future studies can now further characterise interactions between cooling and mechanical signals in the nervous system.

Tactile coding on the fingers and toes: insights from double simultaneous stimulation across limbs

Kelda Manser-Smith 1, Matthew Longo 1, **Luigi Tamè** 2

1 : Birkbeck, University of London; 2 : University of Kent

It has been shown that there are common representations of homologous fingers of the two hands (i.e., index and middle fingers) suggesting the presence of specific interactions between homologous body parts of the upper limbs of the two sides of the body. However, it is unknown whether such interactions are also present across different limbs that are morphologically similar such as hands and feet. Here, we investigated the effect of tactile double simultaneous stimulation (DSS) between the fingers and toes to explore between-limb tactile interactions. Participants performed a go/no-go task to detect a tactile stimulus on a target digit (e.g., left index finger) in isolation or with a simultaneous stimulus distractor on a non-target digit, either on the hand (e.g., left middle finger) or on another limb (e.g., left big toe = homologous; left second toe = non-homologous). In different blocks the target digit could be a digit on the left hand (i.e., index finger, middle finger) or on the left foot (i.e., big toe, second toe). Results showed that DSS of homologous digits across the upper and lower limbs does not alter tactile sensitivity, regardless of the stimulated body parts (hand and foot). By contrast, there is a selective interference when DSS is applied on non-homologous digits when the target is a digit on the foot, but not when it is a digit on the hand. These findings provide behavioural evidence in humans regarding the presence of common representations for homologous digits across hand and foot.

Invited to touch: how tactile expertise and personality traits influence the esthetic appraisal of visually presented tactile materials

Marella Campagna 1, Rebecca Chamberlain 1

1 : Goldsmiths University of London

The haptic modality plays a crucial role in humans' existence, promoting social bonding, favouring information gathering, providing high levels of arousal. So far, tactile aesthetics' field, has revealed some underlying preferences in the haptic exploration related to intrinsic stimulus properties, the principle of unity and variety and the Gestalt laws of grouping (Gallace & Spence, 2011; Klatzky & Peck, 2012). However, attractiveness to human touch has emerged to be also influenced by individual's characteristics, e.g., the innate proclivity to touch objects for hedonic purposes, and degree of familiarity, according to a mere exposure effect, further highlighting the impact of top-down processes on haptic hedonic reactions (Etzi et al., 2014; Nagano et al., 2013). This study aims to investigate how individuals' differences (e.g., tactile expertise, need for touch, familiarity, personality traits) impact the aesthetic appraisal of 18 videos, depicting a manipulation of usual (e.g., sandpaper) and unusual (e.g., crinoline) materials, by means of a 7-point Semantic scale. Judgments of liking, interest, pleasantness, perceived haptic invitation will be derived and correlated with surfaces physical properties and individuals' characteristics. Pleasantness ratings are expected to be influenced by participants degree of familiarity, tactile expertise and surface's conveyed comfort, whereas materials touch-ability is assumed to be affected by subjective need for touch, Openness to experience, expertise. The present study will contribute to gain knowledge in a field still partially known, while also pointing to individual differences as potential crucial factors that might be incorporated into product design, to better target, fulfil consumers' tactile needs.

To touch or not to touch: An investigation of material discomfort

Müge Cavdan 1, Knut Drewing 1,

1 : Experimental Psychology Department, Justus Liebig University Giessen

Touching materials can evoke emotions ranging from pleasantness to unpleasantness, even pain. While pleasant touch and pain have been studied extensively, unpleasant touch did not capture the same attention. In the current study, we identified aversive materials that are typically associated with strong feelings of discomfort. We explored how people associate discomfort reactions of tactile materials. In a survey, people rated the occurrence of discomfort reactions (e.g., goose bumps), their attribution to touch or sound, and their relation to pleasantness for 15 materials that we had identified previously. While discomfort from hard and rough materials (e.g., wadding, plastic, or microfiber) was associated predominantly with touch, other discomforting materials such as styrofoam were strongly associated with sound. Next, we experimentally tested whether the survey results generalize to sensory experience using a small set of putatively neutral and highly aversive materials from the survey. People rated the material unpleasantness, discomfort reaction, and sensory attribution (touch vs. sound). In line with the survey, the discomfort was mainly attributed either to touch (specific textiles, rough or organic stuff) or to exploration-related sound (chalk+blackboard or styrofoam). We discuss these discomfort results in terms of learned and hard-wired mechanisms.

Emotional experience of texture and dynamic touch qualities

Weda Judith 1, Angelika Mader 1, Van Schaijk Melissa 2, Adam Meijer 1, Dasha Kolesnyk 1, Jan Van Erp 1, 3,

1 : Human Media Interaction Group, Twente; 2 : Saxion University of Applied Sciences; 3 : TNO Soesterberg

Social touch is an emotionally rich experience. When we mediate social touch through technology some of the tactile and emotional richness is lost because tactile actuators cannot display the full richness of a direct social touch. We propose to add carefully designed textures to existing haptic actuators like pressure actuators to enhance and intensify mediated touch experiences. When designing experiences where different tactile elements are combined it is important to know if any of these tactile elements have an inherent meaning, emotional or otherwise, and what happens to the emotional experience if the tactile elements are combined with other sensory modalities for instance in a video call or VR environment. We know that touch can intensify the emotional experience of other modalities. Therefore, if we want to build multimodal technology that facilitates rich emotional and social experiences we have to explore how material and dynamic factors of touch contribute to the emotional experience of that touch in unimodal as well as in multimodal systems.

Short oral presentations #3 (5th July, 10:00-10:30)

Impacts of interindividual differences on the perception of social touch

Louise Kirsch 1

1 : Centre Neurosciences intégratives et Cognition, Centre National de la Recherche Scientifique, Université Paris Cité

Social touch has been shown to be crucial for development and well-being. However, despite its importance, the consequences of a lack of social touch has been little studied in human adults, while tactile interactions have decreased drastically these past decades with the increase of people suffering from social isolation. In this talk, I will put together the results of our recent studies shedding some lights on: (i) the role of touch in buffering feelings of social isolation and rejection, especially in times of

forced social distancing; (ii) the impact of observed vicarious touch on stress levels, and finally (iii) the physiological markers of vicarious social touch (i.e. heart rate and facial electromyographic activity). In these different studies, I will highlight the important effects of interindividual differences. Indeed, loneliness, anxiety, as well as the degree of a lack of social touch seem to be strong mediators of social touch perception; partially explaining why some individuals are or are not attracted towards social touch, and why observing positive social interactions may benefit some individuals or may even worthen stress levels in some others. Altogether, these studies highlight the necessity for future studies to better investigate the underlying mechanisms of vicarious and felt social touch by taking into account individual differences, and the degree of tactile and social deprivation.

Body perception and social touch preferences in times of grief

Adam Enmalm 1, Sarah McIntyre 1, Rebecca Boehme 1, 2
1 : Center for Social and Affective Neuroscience; 2 : Center for Medical Image Science & Visualization, Linköping University

Grief is a core human experience. The time following the loss of a loved one is associated with an increased risk for negative health outcomes. Yet, only a few studies investigate bodily consequences of grief and consoling behaviors, specifically the potentially supportive role of interpersonal touch during grief. We conducted an online-study where participants were assigned into a recent-loss group (defined as losing a loved one within the last two years) or a no-recent-loss group. Participants filled in questionnaires and rated videos of short touch gestures and interactions. Overall, the groups rated the vicarious touch gestures similarly, with the recent-loss group endorsing touch more and considering it more consoling. However, discrepancies between groups were found for some types of touch, including slow affective stroking. The majority of people in the recent-loss sample reported that they perceived their own body and their bodily states less in the first six months following their loss. Two-thirds of these participants also reported feeling the presence of the deceased at least once, with more than half reporting several times. Grief-sensations were experienced mostly in the chest and upper body, the same areas where the consoling effect of a hug was perceived. These results contribute to a deeper understanding of the role that the body and bodily interactions like social touch play in grieving and consolation. Our findings can be seen as a first point of reference on how to interact with grieving individuals and could contribute to novel interventions for individuals with prolonged grief disorder.

A multi-component visual and C-tactile mediated assessment of body image disturbances

Valentina Cazzato 1, Christina Ralph-Nearman 2, Armen Arevian 3, Sahib Khalsa 4, Francis McGlone 5, Jamie Feusner 6
1 : School of Psychology, Liverpool John Moores University, UK; 2 : Department of Psychological & Brain Sciences, University of Louisville, KY, US; 3 : Chorus Innovations, Inc., Los Angeles, CA, US; 4 : Laureate Institute for Brain Research, Tulsa, OK, US; 5 : University of Liverpool, UK; 6 : Department of Psychiatry, University of Toronto, ON, CA

Tactile anhedonia and body image disturbance are core features of eating disorders (EDs). Here, we examined whether attitudinal components of body image perception might relate to C-Tactile (CT) mediated touch, as well as to specific girth-related body dissatisfaction. Sixty healthy females (Mage=26.72, SD=5.20) completed a range of psychophysical somatosensory tests which consisted in ratings of pleasantness of CT-optimal (3 cm/s) and non-CT-optimal (0.3 and 30 cm/s) touch applied to five body sites, for directly experienced touch (Experiment 1) and for vicarious self- vs. other-directed touch (Experiment 2). All participants took part in a computerized body perception assessment, i.e., 'Somatomap 3D' of perceived, actual, and ideal aspects of body-part sizes. Self-reports of EDs risk, body dysmorphic concerns and of bodily awareness were also collected. Both groups rated CT touch as more pleasant compared to the two non-CT optimal touch at all body sites. Furthermore, participants perceived each body area to be slimmer than it actually was, with the exception of the abdomen area protrusion, which was perceived larger than the actual body measurement. For self-directed touch, lower overall touch preference applied to the upper arm was related to greater dissatisfaction score for the same body part. Abdomen protrusion discrepancy and dissatisfaction (but not CTs preference) scores were significantly associated with higher EDs risk, accounting for the largest variance of EDs symptomatology. These findings support the need for a personalized approach for the assessment of women' perceptions and concerns of specific disliked body-parts in relation to both C-tactile and visual perception modalities.

Short oral presentations #4 (5th July, 14:00-15:00)

Nav1.7 is required for normal C-Low threshold mechanoreceptor function

Steve Middleton 1, Irene Perini 2, Kim Chisholm, Greg Weir, Håkan Olausson 2, David Bennett
1 : Nuffield Department of Clinical Neurosciences [Oxford]; 2 : Linköping University, Sweden

Touch sensation is a critical component of the sensory system giving us the ability to detect, discriminate and explore our environment, while also providing a substrate for social interaction. Patients with bi-allelic loss of function mutations in the voltage-gated sodium channel Nav1.7 present with congenital insensitivity to pain (CIP), but little is known how these patients perceive affective touch. We have shown using psychophysics and facial electromyography that these patients have abnormalities in their encoding of affective touch. Whilst understandably there has been a focus linking sodium channels to nociception, little is known about the roles of different voltage-gated sodium channels in C-Low threshold mechanoreceptor (C-

LTMR) function. To specifically investigate the role of Nav1.7, we turned to rodent genetic models. Mouse C-LTMRs express high levels of Nav1.7. Genetic loss or selective pharmacological inhibition of Nav1.7 in C-LTMRs resulted in a significant reduction in the total sodium current density, an increased mechanical threshold and reduced sensitivity to non-noxious cooling. The behavioural consequence of loss of Nav1.7 in C-LTMRs in mice, was an elevation in the von Frey mechanical threshold and less sensitivity to cooling on a thermal gradient. Our most recent data demonstrates that similar to human C-LTMRs, mouse C-LTMRs respond to brush stimuli of different speeds and are directionally sensitive. To conclude, in vivo characterisation of genetically labelled C-LTMRs identifies similarities between human and rodent C-LTMRs, and we propose that Nav1.7 is not only essential for normal pain perception, but also for normal C-LTMR function, cool sensitivity and affective touch.

Spinal cord oxytocin circuits modulate pain responses by engaging circuits of affective touch.

Manon Bohic 1, Aman Upadhyay 2, Mark Gradwell 2, Ahmed Negm 3, Shibin Du 2, Jessica Keating 2, 4, Yuanxiang Tao 2, Amaury Francois 5, Cedric Peirs 3, Emmanuel Bourinet 5, Victoria Abraira 2

1 : Rutgers University; 2 : Rutgers University; 3 : Neuro-Dol, Institut National de la Santé et de la Recherche Médicale, Université Clermont Auvergne; 4 : Oregon Health and Science University, Portland; 5 : Institut de Génomique Fonctionnelle, Institut National de la Santé et de la Recherche Médicale, Centre National de la Recherche Scientifique, Université de Montpellier

Top-down modulation of spinal sensory processing is constantly at play in our everyday life but it varies depending on our internal state (fear, stress, positive emotions) and neuromodulators play a key role in this descending modulation. Positive tactile interactions (caress, hug, massage, hand-holding...) induce the release of a key neuromodulator, oxytocin, by neurons of the hypothalamus in the central nervous system, including the spinal cord. We investigated whether underexplored spinal oxytocin circuits might influence how the spinal cord processes touch and pain peripheral input before the information is sent to the brain. We found that oxytocin-positive fibers project mainly to the superficial dorsal horn of the spinal cord, which overlaps with expression of the oxytocin receptor in spinal neurons that process pain input and social touch. We correlated this finding with similar expression patterns in the human spinal cord. Using anatomy, pharmaco- and opto-genetics, behavior and electrophysiology, we discovered that this superficial spinal oxytocin circuit can drastically reduce sensory-evoked and ongoing neuropathic pain in mice. In conclusion, descending oxytocin projections tune the sensitivity of superficial spinal oxytocin circuits to modulate the first step of touch and pain processing. Our findings will provide a framework for the use of oxytocin for pain treatment and should inform us on how combined oxytocin administration and touch therapy can provide pain relief.

Transformation of neural coding for vibrotactile stimuli along the ascending somatosensory pathway

Kuo Sheng Lee 1, Dominica De Thomas Wagner 1, Mark Sanders 1, Daniel Huber 1

1 : Geneva University Hospitals and Geneva University

Perceiving substrate vibrations is a fundamental component of somatosensation. In mammals, action potentials fired by Pacinian corpuscle afferents are known to reliably time lock to the cycles of a vibration. This stands in contrast to coding in the somatosensory cortex, where we recently found that neurons represent vibration frequency with a rate code tuned to a preferred value. How and where along the ascending neuraxis is the temporal code of cyclically entrained action potentials found in the periphery, transformed into a rate code? Therefore, we probed the representation of vibrotactile stimuli with electrophysiological recordings and two-photon calcium imaging along all stages of the ascending somatosensory pathway in mice. Recordings from nerve fibers of primary sensory neurons in lightly anesthetized mice revealed that rapidly adapting mechanosensitive units innervating Pacinian corpuscles display phase-locked spiking for vibrations up to 2000 Hz. Electrophysiological recordings surprisingly revealed that the precise temporal code found in the periphery was maintained in the brainstem. The main transformation step was identified at the level of the thalamus, where we observed a significant loss of timing information accompanied with a further narrowing of the width of the tuning curves. By comparing the neural codes at different stages of the somatosensory pathway, we identified an important stepwise transformation of vibrotactile coding at the level of spiking patterns, as well as feature selectivity, occurring between brainstem and thalamus. These findings will now allow us to model the computational principles, while integrating the perceptual framework we recently described in mice and humans.

Voluntary control of cortical waves in primary somatosensory cortex

Anton Dogadov 1, Shulz Daniel E., Isabelle Ferezou, Valérie Ego-Stengel, Luc Estebanez

1 : NeuroPSI – Paris Saclay Institute of Neuroscience, Universit´e Paris Saclay, CNRS

In the cerebral cortex, activity measured at a mesoscopic (0.1 to 1 mm) scale is characterized by both spontaneous and task-related dynamical waves of synchronized neuronal activity ranging from spreading stationary depolarizations to traveling waves that can follow complex trajectories throughout the cortical network. In the primary somatosensory cortex, these waves are thought to participate in touch information propagation and processing, but their exact functional implication remains poorly understood. To test whether cortical waves in primary somatosensory cortex can be actively generated and controlled, we have implemented an instrumental learning task for head-fixed mice, based on the online processing of wide-field Ca-imaging signals.

Transgenic mice expressing GCaMP6f in excitatory cortical neurons (Ai-95 x EMX-Cre) were implanted with a 6-mm optical window covering the left primary somatosensory cortex. During training, the waves that traveled from an arbitrary source to a target cortical location opened an opportunity for the mice to obtain a reward upon licking a water spout. Our experiments show that mice can be trained to voluntarily control the emergence of specific waves of activity, but they were commonly associated with body movement. Five mice involved in task learned to increase their number of reward opportunities. This methodological framework provides a unique opportunity to better understand how neuronal assemblies can orchestrate the flow of information within primary somatosensory cortex while an animal is actively performing a task.

The role of the somatosensory system in the generation and perception of emotions: a transcranial alternated stimulation (tACS) study

Michelle Giraud 1, Luigi Tamè 2, Amir-Homayoun Javadi 2, Carmen Lenatti 2, Elena Nava 1
1 : Università degli Studi di Milano-Bicocca = University of Milano-Bicocca; 2 : University of Kent, Canterbury, UK

Emotional experiences deeply impact our bodily states, such as when we feel 'fear', our body feels cold and goosebumps, and when we feel 'anger', we close our fists and feel our face burning. Recent behavioural studies have shown that emotions can be mapped onto specific body portions, suggesting that emotions are represented in the somatosensory system. However, what is the role of the somatosensory system in the processing of emotions and, more specifically, in the generation of feelings of emotions? To answer this question, we applied transcranial alternated current stimulation (tACS) to the somatosensory cortex of healthy adult participants at different frequencies while they saw emotional pictures taken from the IAPS database. We found that modulation of cortical excitability of S1 influenced subjective emotional ratings, particularly Affecting Valence and making the participants rating more pleasant; instead, we didn't find a clear effect on Arousal (measured through the skin conductance response). Our results suggest a dissociation between the two dimensions of emotions: Arousal and Valence, with the latest being the only one affected by tACS applied on S1 at different frequencies. This is compatible with previous studies suggesting different neural substrates for Valence and Arousal, in which the Orbitofrontal cortex process valance and the amygdala preferentially processes arousal. Our findings suggest that the somatosensory system plays a crucial role in generating emotions.

Effects of skin moisturization on various aspects of touch: differences with age and skin site

Mariama Dione 1, Roger Watkins 1, **Jean-Marc Aimonetti** 1, Roland Jourdain 2, Rochelle Ackerley 1
1 : Laboratoire de Neurosciences Cognitives (UMR7291), CNRS - Aix Marseille Université, France; 2 : L'Oréal Recherche & Innovation, L'OREAL, Paris, France

The human body is encompassed by a thin layer of tissue, the skin, which is heterogenous and highly specialized to protect the body and encode interactions with the external world. There is a fundamental scientific drive to understand its function, coupled with the need to preserve skin as we age, which impacts on our physiological and psychological well-being. In the present study, we aimed to define differences in touch perception between age groups and with skin cream application. We investigated touch on the finger, the forearm and cheek in younger (20-28 years, n = 22) and older (65-75 years, n = 22) females. We measured skin hydration, touch detection, finger spatial discrimination, forearm tactile pleasantness together with electrodermal activity, and perceptual ratings about cream use, skin dryness, and cosmetic habits. Glabrous finger skin became drier and touch performance was impaired with age, but these aspects were preserved in hairy skin. Skin moisturization immediately increased hydration levels, but did not significantly change touch perception. We also found that touch appreciation increased with age. We conclude that reduced finger capacity may impact self-evaluation of the skin and that long-term skin care strategies should focus on hydrating the hand to preserve touch capacities.

Short oral presentations #5 (6th July, 9:45-10:05)

Imaging skin deformation during pincer grasp.

Sophie Du Bois De Dunilac 1, David Córdova Bulens 1, Stephen Redmond 1
1 : University College Dublin, Ireland

Tactile feedback is crucial for dexterous manipulation, but the underlying mechanisms are not well understood due to the complex interplay between predictive and feedback control in setting our grip force (GF) in response to varying load forces (LF). The GF-LF relationship has been investigated for decades using instrumented objects that measure forces, but these instrumented objects do not measure tactile feedback. Recent developments in skin strain imaging have provided a proxy measurement of tactile feedback during the manipulation of such instrumented objects. However, these instrumented objects only image a single finger, providing an incomplete picture of cutaneous tactile feedback. To address this limitation, we present a novel instrumented object capable of imaging both the index finger and thumb in a pincer grasp with high contrast. Our pilot study aims to investigate the beginning of grip and lift phases using a size-weight illusion paradigm which renders visual cues and anticipatory scaling of GF unreliable. Without the ability to reliably predict the GF, we expect any subsequent GF adjustments to be informed by tactile feedback, including cutaneous sensation from the finger and thumb. We anticipate that our device will

provide a more comprehensive understanding of the role of tactile feedback in GF adaptation. Our pilot study's findings may help establish a causal link between partial slips and grip force adaptation, shedding light on the underlying mechanisms of dexterous manipulation.

Turning vibrations into textures: Texture rendering and causality for low bandwidth vibrotactile displays

Rebecca Friesen 1

1 : Texas A&M University

When we stroke a textured surface, we elicit signature vibrations that allow us to distinguish that particular texture from thousands of others. These vibrations also change with stroking speed; as your hand moves faster over a surface, the texture's constant spatial pattern will induce higher frequency vibrations. The properties of real texture-induced vibrations and human perception inform the design of haptic texture displays, which can create the illusion of texture by applying vibrations to the hand during movement. Applied vibrations with different spectral content can produce many texture sensations, but only when they also vary with changing hand speed. Vibrations which lack any causal link between hand speed and sensation will not be attributed to texture at all; rather, you have created a "buzzing device" display. An obvious way to render convincing causality for texture displays is to modulate temporal frequency with hand speed, such that spatial frequency remains constant. However, this poses serious challenges for many small vibrotactile devices, which have limited bandwidth. We are exploring alternative methods of modulating vibrations as a function of hand speed, including amplitude modulation and changing amplitude ratios of multiple distinct frequencies. Our results suggest we can render the sensation of smoothly increasing temporal frequency by manipulating amplitudes of two single frequency values. Linking this perceived change in frequency to finger speed increases ratings of realism and pleasantness of haptic texture displays, compared to unmodulated vibrations.These results have broad applications for improving texture rendering for wearable displays for virtual and augmented reality.

Short oral presentations #6 (6th July, 16:00-16:30)

The attitude of parents to parent-child touch: barriers of tactile contact with children with special needs (qualitative research)

Eva Dydenkova 1, Ekaterina Zhukova 1, Anton Varlamov 1

1 : Moscow affective touch laboratory, Russia

It is difficult to overestimate the importance of caring touch in parent-child relationships (Carozza, 2021). Simple instincts (Eisenberger, 2012) and the heritage of human culture (Andersen, 2011) usually provide some degree of affective contact in the family. However, we know little about parental attitudes towards touching a child with special needs. At the same time they need more than others the therapeutic effect of a gentle touch (Longa, 2021; Provenzi, 2020; Devine; 2020). Probably the presence of tactile parent-child interaction is supported by a subjective feeling of pleasantness of this process for both the child and the parent (Proskurnina, 2021). But what if the mother-child dyad encounters psychological and physiological barriers that can displace tactile contact? The aim of this study was to clarify parental attitudes towards touching a child with special needs (children with ASD, premature babies, adopted children (N=85)), as well as the features of the experience of this tactile contact, as a result of which to identify possible barriers of caring touch in families with difficult circumstances. 85 semi-structured interviews were conducted with parents of children with ASD, parents of premature infants, foster mothers and blood mothers of normally developing children. The general attitude of parents towards touching children with special needs is clearly positive. At the same time, some barriers to tactile contact were identified, such as infant indifference to attention, “foreign” smell, social pressure “do not teach to handle”, fear of sexualization of contact, neglect of the importance of touch, loss of “tactile” continuity, etc.

The antidepressive efficacy of affective-touch-based massage therapy: Findings from controlled studies.

Bruno Müller-Oerlinghausen 1, 2, Michael Eggart 3, 4

1 : Charité - UniversitätsMedizin = Charité - University Hospital [Berlin]; 2 : Brandenburg Medical School Theodor Fontane ,DFaculty of Medicine and Psychology; 3 : Brandenburg Medical School Theodor Fontane, Faculty of Health Sciences; 4 : Faculty Social Work,health and Nursing, Ravensburg-Weingarten University of Applied Sciences

In our view, depression is not primarily a “mood disorder” with “accompanying somatic symptoms”, but it is characterized by basic bodily symptoms such as muscular contractions, lowered skin temperature, various forms of pain , intestinal dysfunction etc. as well as blunted heartbeat perception accuracy. According to recent research these manifold physical symptoms might be described as a disturbance of interoception (i.e., an abnormal sense of the bodily self) which is accompanied by anhedonia. In terms of phenomenology, the animate body is transformed into a piece of flesh, i.e. a resistant corpse (Fuchs, Merleau-Ponty and others). Against this background, it can be assumed that specific manual treatments might be effective in depressed patients, particularly since affective touch corresponds to an interoceptive modality. . Interestingly depressed patients often seek help in massage therapy. – We shall present the findings from three RCTs in depressed in-and outpatients, as well as in

females with psychosomatic back pain and depression ,in which antidepressive efficacy of various forms of psychoactive massage therapy has been demonstrated . (See also Poster by GM Kiebgis et al.) Potential mechanisms will be discussed, such as oxytocinergic effects, activation of CT afferents, vagal stimulation, and restoration of interoceptive functioning.

Response to CT-fiber targeted stimulation in preterm children

Yvonne Friedrich, Püschel Isabella, Hans Proquitte, Jörg Reichert, Ilona Croy 1
1 : Friedrich-Schiller-Universität Jena

Touch is an important component of care for preterm infants and has been shown to have positive effects on mother-infant bonding and infant development. In term-born infants, CT targeted touch causes an autonomic response, characterized by a decrease of sympathetic and an increase of parasympathetic activation. We investigate whether the maturity of the CT fiber system in premature infants is sufficient to elicit the same response. In two observational studies, we tested whether (a) mothers intuitively use stroking velocities that are suited to target C-tactile fibers, (b) preterm infant heart rate declines in response to C-tactile optimal stroking, and whether (c) this decline is more pronounced in stroking as in static touch. Furthermore, we recorded infant behavior during stroking using a specifically developed coding system for preterm stress. Our results show that mothers use stroking velocities within the CT optimal range and preterm babies showed a significant but delayed decrease of heart rate to stroking. Analysis of the behavioral data is ongoing and will be shown at the conference. The study is part of the EraNet Neuron project “Pretouch”.

Short oral presentations #7 (7th July, 9:45-10:30)

A functional framework for multisensory and interactive mediated social touch experiences

Merle Fairhurst 1, 2, Irene Valori 1
1 : Centre for Tactile Internet with Human-in-the-Loop (CeTI), Technische Universität Dresden; 2 : 6G life, Technische Universität Dresden

In an increasingly digital world, for work, education or entertainment, we are spending more time interacting with others through screens. These social interactions are therefore typically limited to audiovisual sensory content and devoid of touch. A recent manifesto has suggested that mediated social touch is in a moment of crisis. The authors call for renewed efforts to create technologies that better capture both the social and sensory aspects of social touch and to determine when to use them. We suggest that current conceptualisations and indeed existing technology generally focus on only one functional aspect of social touch namely that of copresence, with haptic devices producing short, vibrotactile stimuli. And yet, thanks to a rich body of electrophysiological and cognitive neuroscience research it is now well established that social affective touch is a multimodal experience tuned and perhaps dominated by top-down modulation. By discussing the many functions that social touch plays from facilitating feelings of connectedness to promoting trust, we put forward the positive proposal that we need to avoid the “replication” red herring and instead look for new ways to create the feeling of touch for our digital interactions. Specifically, we detail how multisensory approaches as well as enhancing the interactive nature of the touch experience would improve mediated touch technologies. Importantly, we stress that these novel approaches could be used to not only further empirical research into the complexity of what makes social touch so special but also improve our experiences of the social digital world.

Towards consensual and non-intrusive mediated social touch

Dasha Kolesnyk 1, Angelika Mader 1, Marieke Van Doorn 1
1 : University of Twente

Informed consents for social touch technology do not ensure that the users psychologically consent to every single touch. Sometimes a touch through technology can be unwanted or unexpected, and therefore experienced as intrusive. This is more likely the case when the social touch technology does not allow for a pre-contact communication. Examples of pre-contact in face-to-face communication include, for instance, coming closer or extending one's arm towards the touch recipient. However, a pair of touch bracelets does not warn the receiver about the touch until it arrives. This can result in an experience of intrusion and violation of personal boundaries. We conducted several user studies to understand deeper the antecedents of experience of intrusiveness in mediated social touch. Based on the findings, we propose a taxonomy of situations when touch can be experienced as intrusive and discuss ways to preempt this at the technology design phase.

The physical and mental health benefits of affective touch: A comparative systematic review and multivariate meta analysis

Julian Packheiser 1, Helena Hartmann 2, Kelly Fredriksen 1, Valeria Gazzola 1, Christian Keysers 1, Frédéric Michon 1
1 : Netherlands Institute for Neuroscience; 2 : University of Essen

Receiving touch is of critical importance for human well-being. Several studies show that affective touch can improve mental and physical well-being. Here, we conduct a systematic review as well as a large-scale multivariate multilevel meta-analysis

encompassing 154 studies (183 cohorts, 10847 participants and 700 effect sizes) to identify critical moderating factors and inform factors to target for interventions. We find that affective touch has comparable and medium-sized (g ~0.5) effects on both mental and physical health. Affective touch was especially effective in regulating cortisol levels and increasing weight in newborns, as well as in reducing pain, feelings of depression and anxiety for adults and children. Touch interventions involving objects or robots resulted in similar physical health but lower mental health benefits than human interactions – a difference likely mediated by missing skin-to-skin contact. Clinical cohorts profited more strongly in mental health domains but showed comparable physical health benefits as healthy individuals. Familiarity between the touch dyad was inconsequential in children and adults but critical in newborns. Massages did not show increased health benefits compared to other kinds of touch interventions. The number of sessions positively correlated with increased mental and physical health benefits while session duration did not show significant effects. We believe that leveraging the factors that we find to influence the efficacy of affective touch will help maximize the benefits of future social touch intervention and focus research in this field.

Report on 20 years of experience in osteopathy, a touch-based therapy commonly used to treat musculoskeletal pain, and functional anxiety-related disorders

Mattheiu Boulat 1

1 : Osteopath, Valence, France

Social distancing during covid-19 pandemic has highlighted the importance of touch in healthcare and touch-based therapies have continued to be increasingly used, however recent research and recommendations in physiotherapy has set a trend of devaluing hands-on treatments. Despite a lack of independent research using appropriate methodologies, contemporary osteopathy has begun to refine its explanatory models. These are now more aligned to evidence-informed practice through emerging neuroscience research and narrative explanations of health and disease leading to a more enactive patient-centred approach. Touch-based therapies differ from conventional treatments in various ways, such as the amount of time spent with the patient, physical touch, and attention combined with meaningful co-created dialogue.These factors may contribute to positive modulatory effects on patients experiencing musculoskeletal pain and functional anxiety-related disorders. Bottom-up tactile induced analgesia combined with top-down influences derived from a consensual dialogue within an empathic human interaction are likely to be significantly involved in this process. Multi-sensorial afferences including complex mechanosensory derived signals are expected to lead to central co-firings of cortical and subcortical structures. These are likely to contribute in shaping the neurological substrate accounting for the uniqueness and meaningfulness of the encounter between patient and practitioner in an osteopathic treatment setting.

Affective touch reduces immediate chronic pain experience in Parkinson's Disease; A longitudinal intervention study

Larissa Meijer 1, Carla Ruis 1, 2, Maarten Van Der Smagt 1, Chris Dijkerman 1

1 : Utrecht University [Utrecht]; 2 : University Medical Center [Utrecht]

30-95% of Parkinson patients are suffering from chronic pain, which is generally treated with analgesia. However, the current treatment seems ineffective and can cause several side-effects. Therefore, finding new ways to reduce chronic pain is needed. Several experimental studies show that affective touch can reduce acute pain. However, little is known about the effect of affective touch on chronic pain. The aim of the current study is to investigate whether affective touch can reduce the chronic pain experience in Parkinson's Disease. In this longitudinal study, 18 participants underwent one week of pain registration, one week of affective touch and one week of non-affective touch. During the touch week participants received touch from their partners, twice a day for 15 minutes. Results show that both types of touch have a pain relieving effect on the chronic pain experience. Furthermore, affective touch has an additional immediate relieving effect and is perceived as more pleasant. This study shows that affective touch can reduce chronic pain experience in PD. As this effect was more pronounced immediately after receiving affective touch we argue that it might be implemented as a treatment to reduce sudden high levels of chronic pain experience. In addition to this, one participans was excluded from this larger sample as he might suffered from neuropathic pain and is reported as single case study. Interestingly, after two days of receiving affective touch, the participant started to feel less pain. After seven days his pain fully disappeared, which endured even after the study.

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