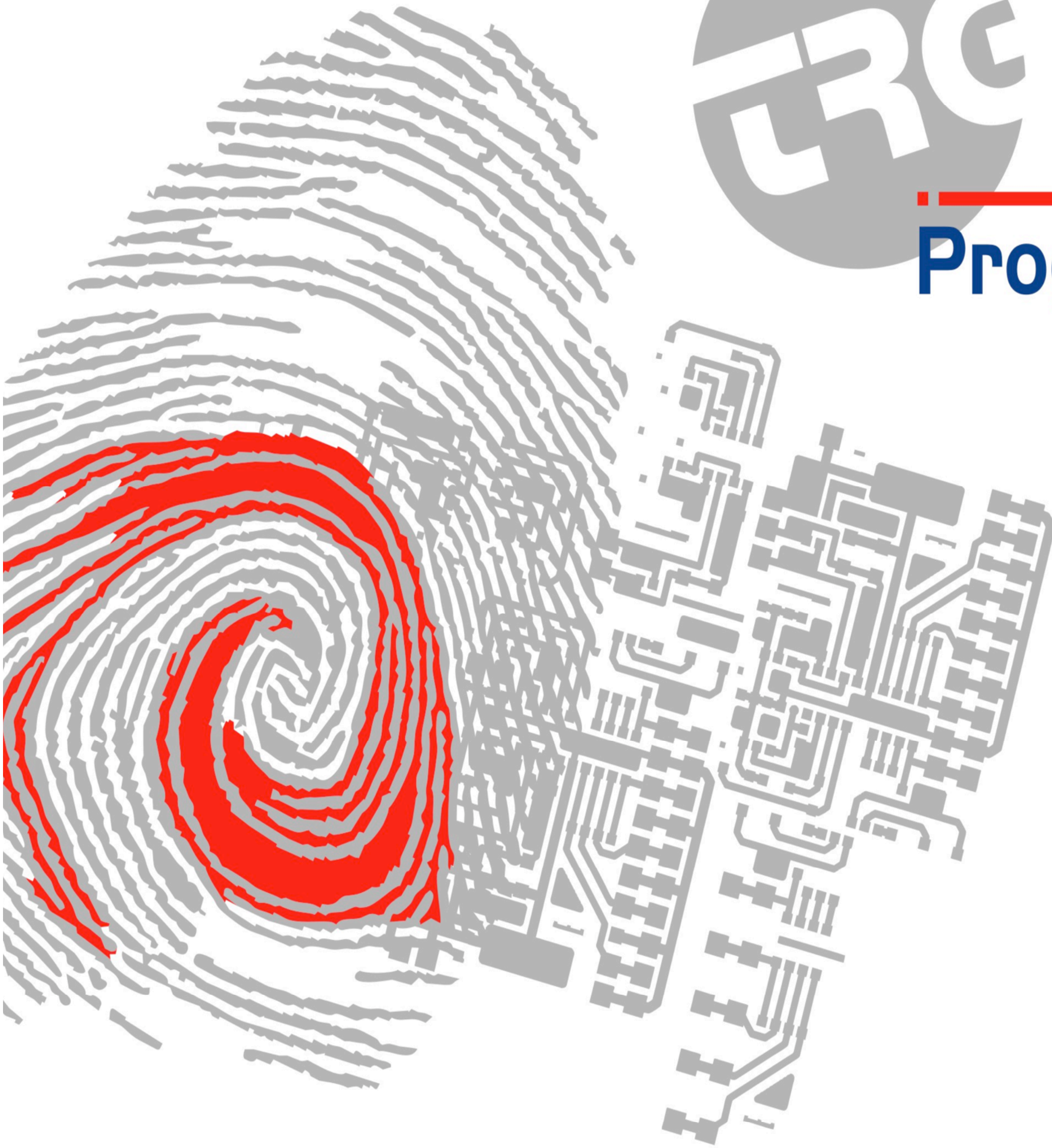
TRC 2011

Program



Meeting organization: Mounia Ziat, Sliman Bensmaia, and Masashi Nakatani. Email: mziat@nmu.edu

TRG 2011 Meeting (Seattle) – Thursday 03 November 2011

7:45am – 8:55am	**Registration**
Session 1	**Chair: Sliman Bensmaia**
8:55am – 9:25am	**Junji Watanabe**, *"Phonological analysis of onomatopoeias for expressing tactile sensations"* NTT Communication Science Laboratories, Japan
9:25am – 9:45am	**Soledad Ballesteros** *"Haptic memory and aging: Behavioral and brain activity results"* UNED, Spain
9:45am – 10:00am	**Mounia Ziat** *"Tactile suppression of displacement: ERP results"* Northern Michigan University, USA
10:00am – 10:15am	**Break**
Session 2	**Chair: Karon McLean**
10:15am – 10:45am	**Stephen Helms Tillery** *"Postural effects on tactile physiology and perception"* Arizona State University, USA
10:45am – 11:15am	**Sliman Bensmaia**, *"Behavioral Demonstration of a Somatosensory Prosthesis"* University of Chicago, USA
11:15am – 11:45am	**Lee Miller**, *"Toward Artificial Proprioception: Closing the BMI Loop Through Cortical Stimulation"* Northwestern University, USA
11:45am – 12:15am	**Doug Weber**, *"Feeling, wired: primary afferent microstimulation to restore tactile and proprioceptive feedback"* University of Pittsburgh, USA
12:15pm – 1:30pm	**Lunch**
Session 3	**Chair: Mounia Ziat**
1:30pm – 2:00pm	**Karon McLean**, *"Affective Communication through Touch"* University of British Columbia, Canada
2:00pm – 2:30 pm	**Richard Ladner**, *"Tactile Graphics - Accessing Diagrams and Figures in Science by Blind Students"* University of Washington, USA

2:30pm – 2:45pm	**Tomaso Vecchi**, *“Spatial biases in representing peripersonal space in blind individuals”* University of Pavia, Italy.
2:45pm – 3:00pm	**Dianne Pawluk**, *“Haptic Perceptual Organization: Object Differentiation”* Virginia Commonwealth University, USA
3:00pm – 3:15pm	**Farley Norman**, *“Blindness enhances tactile acuity and haptic 3-D shape discrimination”* Western Kentucky University, USA.
3:15pm – 3:30pm	**Break**
Session 4	**Chair: Tomaso Vecchi**
3:30pm – 3:45pm	**Krista Overvliet**, *“Perceptual grouping in haptic search: the influence of the Gestalt laws of proximity and similarity”* University of Leuven, Belgium
3:45pm – 4:00pm	**Huiyuan Cao**, *“Active control of tactile in remote communication by virtue of digital media”* Université de Technologie de Compiègne, France
4:00pm – 4:15pm	**Claus Christian Carbon**, *“Haptic exploration and aesthetic appreciation”* University of Bamberg, Germany
4:15pm – 4:30pm	**Burak Güçlü**, *“Temporal summation is independent of frequency in the Pacinian (P) tactile channel”* Bogazici University, Turkey
4:30pm – 4:45pm	**Danielle Rager**, *“Spline regression models for real-time decoding of primary afferent activity”* University of Pittsburgh, USA
4:45pm – 5:00pm	**Concluding remarks**

Phonological analysis of onomatopoeias for expressing tactile sensations

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Analyzing the words for expressing sensations is one of the methods used in psychological analysis and classification of sensation. We performed psychophysical experiments to investigate the relationship between tactile sensation categories and phonemes of onomatopoeias used for expressing the sensations. The results indicated that there are unique associations between certain tactile properties and phonemes of the onomatopoeias.

Haptic memory and aging: Behavioral and brain activity results

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Previous studies showed that visual (Ballesteros, Reales, & Mayas, 2007), haptic and cross-modal behavioral repetition priming (Ballesteros et al., 2009) of familiar objects were spared in healthy older adults. In contrast, explicit recognition was highly impaired in Alzheimer´s disease patients despite of the spared implicit memory (Ballesteros & Reales, 2004). Further studies investigated the neurophysiological signals (event-related potentials, ERPs and brain oscillations) of implicit and explicit memory for objects explored by touch. In two electrophysiological studies, we recorded EEGs in groups of healthy young and older adults while performing an implicit speeded symmetry/asymmetry detection task (Sebastián & Ballesteros, submitted) and an "old/new" haptic recognition task (Sebastián, Reales & Ballesteros, 2011). The results showed similar behavioral haptic priming in both age groups. In contrast, aging affected ERP repetition priming and oscillatory theta, alpha and beta responses. In the recognition task, behavioral performance and the ERP old/new effect were similar in both age groups. In contrast, older adults showed greater alpha and beta desyncronization with stimulus repetition. These results suggest that despite similar behavioral performance, young and older adults recruited different neural resources to perform the implicit and explicit memory tasks.

Tactile suppression of displacement: ERP results

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Similar to saccadic suppression of image displacement in vision, tactile suppression of displacement is a phenomenon where, in certain conditions of direction and amplitude of displacement, people fail to detect that a tactile feature changes location, for instance when touched with the index and then with the middle finger. We used ERPs to examine neural activities during trials in which subjects did not detect the displacement of a Braille dot (i.e., responded 'same location' when the dot changed location) and during trials in which they did detect the displacement (i.e., responded 'not same location' when the dot changed location or 'same location' when the dot didn't change location). Preliminary results supports the predictive strategy, i.e. there is sufficient information in the first stimulus to predict the occurrence of the second.

Postural effects on tactile physiology and perception

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One of the key skills used in manipulative tasks is the ability to identify an object based on somatosensory inputs. This skill is likely based on a computation which combines input from tactile and proprioceptive signal streams. Understanding the interaction of these two streams is complex because the movements which drive proprioceptive channels also drive some classes of tactile receptors, and the systems exhibit substantial convergence between the periphery and central representations. We have developed a series of experiments which allow us to examine the contributions of these two streams to the firing of neurons in the somatosensory cortex. We use a robot-enhanced virtual reality environment to separate movement from tactile contact. Using this system, we have found that many neurons which respond to tactile contact also encode posture or movement of the hand, so that postural state impacts the firing rates of neurons driven primarily by touch. We have also found many that S1 neurons which encode surface texture are also tuned to the orientation of the grasped surface. Together with our recent psychophysical results, this points towards the mechanisms of the integrative processes which underlie stereognosis, and have implications for the provision of somatosensory information for neuroprosthetic systems.

Behavioral Demonstration of a Somatosensory Prosthesis

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Providing informative and high-resolution haptic feedback to individuals with upper limb prostheses is a critical challenge that must be solved for the next generation of highly dexterous neuroprosthetic limbs. Able-bodied humans can adeptly control their native upper limbs, easily accomplishing the activities of daily living (ADL) and mastering complex manual skills. Upper-limb amputees and individuals with congenital upper-limb deficiencies want to interact with their surroundings with this same level of ease. However, a significant obstacle is posed by the lack of rich sensory feedback from today's prostheses. Although vibrotactile motors and sensory substitution devices can be used to convey gross sensations, a direct neural interface (to the peripheral nerves, spinal cord, or brain) is required to provide detailed and intuitive sensory feedback.
In this study, we implement a somatosensory prosthesis that consists of converting force output from sensors on a prosthetic finger (from the Modular Prosthetic Limb or MPL, developed by Johns Hopkins Applied Physics Laboratory) into a pattern of electrical stimulation applied to the brain. Specifically, we train Rhesus macaques to detect and discriminate mechanical indentations applied to their skin. Then, we repeat the task, but rather than applying the mechanical stimulus to the animal's finger, we apply it to the prosthetic finger. Sensor output from the prosthetic finger is transformed in real-time by our sensory encoding algorithm into a train of electrical pulses delivered through an electrode implanted in the hand representation in primary somatosensory cortex. The algorithm was developed by characterizing, in behavioral experiments, the function that relates applied force to pulse train intensity of matching perceptual magnitude. We show that we can produce tactile sensations of graded magnitude through electrical stimulation of somatosensory neurons.

Toward Artificial Proprioception: Closing the BMI Loop Through Cortical Stimulation

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A major issue to be addressed in the development of Brain Machine Interfaces (BMIs) is the need for somatosensory feedback. Patients suffering from lost proprioception make movements that are slow, poorly coordinated, and require great concentration. Existing BMIs rely exclusively on visual feedback, which may account in part, for their relatively limited performance. We have done a series of multi-electrode recording experiments designed to study the way limb movements are encoded by neurons in the primary somatosensory cortex (S1). By recording the activity of groups of neurons in area 2, we are able to infer not only the direction of limb movement, but whether the movement was passively imposed or was actively generated by the monkey. We are hoping to use this simple encoding model in an effort to induce "artificial perturbations" of the monkey's limb. Such a system might ultimately be used to convey continuous feedback to a BMI user.

Feeling, wired: primary afferent microstimulation to restore tactile and proprioceptive feedback

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Over the last 2 decades, advances in microsystems engineering have enabled the development of neural prostheses that interface directly with neurons in the brain, spinal cord and peripheral nerves. These so-called "neural interfaces" serve as bi-directional communication channels, allowing information to be read-out by decoding signals recorded from neurons or written-in via patterned electrical stimulation of neurons. We are exploiting these technologies for two purposes: 1) to advance our understanding of how the nervous system senses and controls limb motion, and 2) to develop advanced prosthetic devices that interface directly with the nervous system for control. My talk will focus on research in my lab that is aimed at understanding how somatosensory neurons encode information about touch, force, limb position and motion. By recording and decoding the output of these neurons, we can provide limb-state feedback for controlling functional electrical stimulation (FES) systems to reanimate paralyzed limbs. Conversely, patterned stimulation of somatosensory neurons can be used to provide amputees with touch and proprioception for prosthetic limbs. Such feedback will be essential for users of the dexterous prosthetic limbs developed recently by the DARPA-funded Revolutionizing Prosthetics Program. Ultimately, these bidirectional neural interfaces will make the prosthesis feel and function like a native limb.

Affective Communication through Touch

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Generally, I'm interested in how people communicate through the sense of touch, and how haptic information transfer interacts with perception in other modalities. My group has recently been studying two very different kinds of haptic communication. One is *abstract* information, delivered one-way to your hand encoded in complex vibrations, or in non-consciously perceived rhythms that guide motion. We've found that humans are better at this than you might expect - depending on how the sensations are created; and the medium has potential for low-effort, background communication. In the second kind, which I'll focus on this talk, we're examining haptically communicated *affect*: what's behind feels that we like or don't like - can this be predicted or quantified? How do we communicate emotion haptically, to people or animals, and is this an essential part of emotional communication more generally? We've built a touch-sensitive, animatronic Creature as an experimental platform, which we are using for basic study of emotion and in a therapeutic setting; and extending to smaller, handheld formats.

Tactile Graphics - Accessing Diagrams and Figures in Science by Blind Students

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More and more blind students desire to study in scientific fields. Technology based on speech, such as text-to-speech and screen readers has made access to the text in science books and articles more accessible than ever. In addition, there is technology to automatically translate mathematical formulas in the form of an image to math markup languages such as MathML and LaTex. All these technologies open doors for blind students to enter science fields. However, there are some remaining problems. One key problem is how to make the diagrams and figures more accessible to blind students. Audio-description of diagrams can work in some instances and there have been attempts to use some forms of sonification to show information in an audio fashion. If you think of the finger as an "eye ball" with very low resolution and narrow field of view than a tactile image can potentially be "seen" by a blind person. However, there are limits. Natural images, that have been enhanced to maximize readability do not seem to be understandable by the fingers. Within the limits of tactile perception seem to be many scientific diagrams and graphs that are more abstract. Take for example, an embossed image of a parabola, along with the x- and y-axes. This embossed image with surrounding text embossed in Braille can be understood by using the fingers. In this talk, we will give examples of tactile images (in 2 + epsilon dimensions) that can be understood. Colors are be represented by textures and text is read either in Braille or by speech using simple QR-codes (a kind of barcode that succinctly represents text) and a self-voicing barcode reader on a smartphone. In addition, we suggest some open problems in neuroscience to understand the human limits of tactile image perception.

Spatial biases in representing peripersonal space in blind individuals

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Individuals typically show a leftward bias – known as pseudoneglect – in bisecting physical lines as well as numerical intervals, possibly reflecting a right hemisphere dominance in spatial representation. We found that congenitally blind individuals showed a similar leftward bias when required to haptically bisect a series of rods. Moreover, they showed a leftward bias in bisecting numerical intervals, supporting the view that blindness does not prevent to represent numbers in a spatial format, the so-called "mental number line". These findings suggest that pseudoneglect operates at a mental representational level and indicate that the right hemisphere dominance in spatial processing, resulting in an overestimation of the left side of space, develops even in the absence of any visual input.

Haptic Perceptual Organization: Object Differentiation

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When manually examining objects, a critical question arises as to how tactile/haptic perceptual processing progresses from initial unconnected, sparsely distributed tactile inputs at the fingertips to percepts of the physical world that are typically accurate, unambiguous and complete. We propose that haptic perceptual organization is derived from integrating cutaneous inputs from two or more discrete contacts on the hand, together with kinesthetic inputs that provide information about hand configuration and applied force. We expect haptic perceptual organization to be similar to visual perceptual organization inasmuch as some of the same object properties are being extracted. However, there are important differences as well. First, haptics inherently processes all three spatial dimensions directly, as opposed to vision, which derives our 3D world from its projection(s) upon 2D surfaces. Second, we expect serial temporal processing to be a critical component in the synthesis of an object percept as relatively little information is obtained during any one instance in time (cf. vision). Third, contact between the observer/actor and the object/environment, together with contact forces, are both inherent and unavoidable. In this presentation, I will describe the results of initial work on the haptic segmentation of 3D objects from their supporting surfaces (i.e., the haptic figure-ground problem) and on 3D haptic grouping. Our approach is grounded in and directly guided by current knowledge concerning the nature of haptic processing and I will provide a conceptual framework based on it.

Blindness enhances tactile acuity and haptic 3-D shape discrimination

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This study compared the sensory and perceptual abilities of the blind and sighted. The participants were required to perform two tasks: tactile grating orientation discrimination and haptic 3-D shape discrimination. The results indicated that the blind outperformed their sighted counterparts (individually matched for both age and sex) for both tactile tasks. The improvements in tactile acuity that accompanied blindness occurred for all blind groups (congenital, early, & late). However, the improvements in haptic shape discrimination only occurred for the early-onset and late-onset blindness groups; the performance of the congenitally blind was no better than that of the sighted controls. The results of the current study demonstrate that blindness does lead to an enhancement of tactile abilities, but they also suggest that early visual experience may play a role in facilitating haptic 3-D shape discrimination.

Perceptual grouping in haptic search: the influence of the Gestalt laws of proximity and similarity

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In this study we investigate whether the Gestalt principles of perceptual organization also apply in the haptic modality by using a haptic search paradigm. We focus on two of these principles: grouping by proximity and grouping by similarity. We used a haptic search paradigm and expected that distractors were rejected faster when they could be grouped according to certain grouping principles. In a first experiment we tested grouping by similarity (defined by item orientation) and grouping by proximity (defined by physical distance), and found an effect for similarity but not for proximity. In a second experiment we again tested grouping by similarity and proximity, but now proximity was defined by somatotopic distance. Participants could either use two fingers of one hand or two single fingers of both hands. Interestingly, we found an interaction between similarity and proximity: using two single fingers of both hands was faster than using two fingers of one hand, but this effect was only present when grouping by similarity did not occur. We discuss the results in the light of grouping principles.

Active control of tactile in remote communication by virtue of digital media.

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We aim at enhancing the remote, synchronous, multi-users, verbal communication by using tactile which may also support the blind people and vision handicapped people, borrowing ideas from articles (1), (2). An experiment is designed as follows: 3 separated agents are demanded to reach an agreement in task of sorting a sequence out of order by verbal communication on skype, similarly implemented in (3). In their conversation, they use MIT (Tactile Interaction Device), sending the tactile signal for expressing the listeners' desire of speaking toward speaker who inform his/her speaking and choose the next speaker with MIT as well. Under the premise of successfully checking its learnability, we try to confirm that the additive tactile would let up TRP (Transition-Relevance Places) and equalize the occasion of speaking therefore increase participation in the official experiment. It benefits from their instant tactile communication and deeper feeling of being listened and focused on. Broadly speaking, tactile supplementation could promote an active control in turn-taking as it proposed in article (4),(5). In other words, It can be helpful to the performance of the conversation. Thus, we could find the new possibility for organizing and spatializing the remote communication in digital media.

REFERENCE:

(1) Kirsten.H and Brigitte.R, 2009, Auditory and auditory-tactile processing in congenitally blind humans Volume 258, Issues 1-2, December 2009, Pages 165-174. Multisensory integration in auditory and auditory-related areas of cortex

(2) Basdogan, C., Ho, C., Srinivasan, M.A., Slater, M., 2000, An Experimental Study on the Role of Touch Shared Virtual Environments to appear in ACM Human Computer Interactions.

(3) Elena Cosereanu. The role of negotiation and corrective feedback in the acquisition of second languages. The situation of tasks of interaction in synchronous communication studied in the case of French as a foreign language.

(4) Andrew Chan, Karon Maclean, Joanna McGrenere, Designing haptic icons to support collaborative turn-taking, Int. J. Human-Computer Studies 66 (2008) 333-355.

(5) Andrew Chan, Karon MacLean, Joanna McGrenere, Learning and Identifying Haptic Icons under Workload, whc, pp.432-439, First Joint Eurohaptics Conference and Symposium on Haptic Interfaces for Virtual Environment and Teleoperator Systems (WHC'05), 2005

Haptic exploration and aesthetic appreciation

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The question about what we appreciate or prefer and why, was examined by using a variety of approaches in the visual domain. Clearly, the aesthetics of objects is neither logically nor empirically limited to the visual sense – haptic perception might trigger in many cases very strong experiences which modulate or even generate the formation of preferences. Systematic research of underlying features is however nearly entirely missing. Consequently, we report three series of experiments testing a) low-level features (shape and complexity), b) familiarization effects (mere exposure paradigm) and c) context – dependent effects (scenario-based touching) in relation with aesthetic judgments. Our findings revealed similarities to the preference formation in the visual domain and provide valuable hints for future research and applied scientific fields.

Temporal summation is independent of frequency in the Pacinian (P) tactile channel

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Abstract: Classical temporal summation model states that for stimuli with longer durations, more neural impulses are integrated, which results in lower psychophysical detection thresholds. Similar improvement would also be expected if the frequency of a vibrotactile stimulus is increased at constant duration. In psychophysical experiments on 6 subjects, sinusoidal mechanical vibrations were applied on the fingertip (contactor radius: 2 mm) at different frequencies (150, 250, 350, 500 Hz) and durations (10, 1000 ms) specifically targeting the Pacinian (P) tactile channel. The thresholds followed the typical U-shaped sensitivity curve of the P channel, and were significantly elevated for the 10-ms stimuli as compared to the 1000-ms stimuli. This duration-based difference (~6.6 dB) was almost constant as a function of frequency, but significantly lower than the model-predicted difference of 13.1 dB. Furthermore, the model predicted continuously decreasing thresholds as a function of frequency and did not produce the U-curve. The results support the classical model for the duration-based threshold differences as being independent of frequency, but the model may be incompatible with the general frequency dependence of the thresholds.

Spline regression models for real-time decoding of primary afferent activity

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Firing rates of primary afferent neurons have been successfully used to predict limb kinematics such as joint angle or limb endpoint coordinates. Neuroprostheses that use functional electrical stimulation to animate paralyzed extremities can use this limb state information as feedback, allowing the prostheses to compensate for limb fatigue or unexpected perturbations through closed-loop control. Different decoding methods have been used to extract kinematic information from firing activity with varying degrees of accuracy. Linear regression has been used successfully to predict kinematics; but while simple and fast to implement, linear regression does not make efficient use of neural data. My talk will focus on a spline decoding algorithm in which kinematics are modeled as a spline function of each neuron's firing rate. The resulting kinematic model is a linear combination of the spline fit for each neuron. Spline regression models provide more accurate kinematic predictions than linear regression models. In addition, spline regression models are faster and simpler to train than machine-learning-based decoding approaches like fuzzy neural networks, and they provide globally optimal solutions instead of locally optimal solutions. This makes spline regression models well suited for real-time decoding applications in neuroprosthetics.