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Talk Title:
Implicit contributions of visual information to online control of manual movement

Abstract:
Humans control various interactions with the external world heavily relies on visual information. We need to control our movements in real time, considering motions of the external world and self-body, to access external objects. Here, I will introduce two types of implicit visuomotor processing crucial for skillful interactions with the external world.
One is the impact of visual information on the stretch reflex which quickly generate motor command from somatosensory information. While the modulation of the stretch reflex depending on the motor task and dynamical environments has been widely acknowledged, the influence of visual information on the stretch reflexes remains poorly understood. We investigated as to whether visual information is involved in regulating stretch reflex under the hypothesis that the estimation of the body state plays a pivotal role in the stretch reflex organization. Experiments with manipulations of visual feedback and visual target suggested that the uncertainty of hand state estimated from visual feedback plays a critical role in modulating stretch reflex, which contributes to physical interaction with environments.
Another mechanism by which vision contributes to real-time motor control is a direct influence of visual motion on reaching movement. Beyond the rapid and automatic reaching adjustment for target shifts, reaching movements are also impacted by background motion, called manual following response (MFR). Its mechanism has been controversial for many years, but we have recently shown that (1) the initial component of the MFR cannot be attributed to an illusory target shift induced by visual motion (MIPS: motion induced position shift), and (2) the MFR is modulated by postural and visual-world stabilities. These results support the hypothesis that the illusory body motion estimated from visual motion triggers a compensatory manual response during reaching. This idea is further supported by a synthetic modelling. A convolutional neural network (CNN) that was trained to estimate self-motion from natural visual sequences captured by a head-

mounted camera, exhibited several visual stimulus specificities akin to those of the MFR. Remarkably, the CNN acquired hierarchical visual analyses of pattern motion and optic flow, similar to those processed in the brain. This analysis may suggest the possibility that the visual motion analysis is not fully self-organized but is shaped by estimating self-motion through interactions with the environment. To understand skillful dynamic interactions with environments, it would be worth investigating hidden sensorimotor mechanisms embedded in the brain.

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Biographical information:

Dr. Gomi is a Senior Distinguished Research Scientist and Group Leader of Sensory and Motor Research Group at NTT Communication Science Laboratories. He received B.E. and M.E., and Ph.D degrees in Mechanical Engineering from Waseda University. He was affiliated at ATR from 1989 to 1994, where he explored computational models of biological motor control, robot learning mechanisms (demonstration learning). He was an Adjunct Lecturer of Waseda Univ. (1995 - 2001), and Adjunct Associate Professor (2000 - 2003) and Adjunct Professor (2003 - 2004) of Univ. Tokyo Institute of Technology, and was involved in CRESTs (1996 – 2003, 2010 - 2015) and ERATO (2005 - 2010) projects of Japan Science Technology, and ‘Correspondence and Fusion of Artificial Intelligence and Brain Science’ Project (2016-2020). He served as a president of Japanese Neural Network Society (2021 - 2023). His current research interests include computational and neural mechanisms of implicit sensorimotor control and interaction among sensory, motor, and perception, and development of tactile interfaces.