The Difference Between Hands in the Perception of Stiffness of Virtual Elastic Objects

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During interaction with tissue in open surgery, the surgeon estimates its stiffness by slightly squeezing it. Since we lack stiffness sensors in our hands, the sensorimotor system relies on information about the amount of tissue deformation and the magnitude of the interaction forces to estimate stiffness. However, most of the clinical robot-assisted minimally invasive surgery (RAMIS) systems still don't provide the surgeon with force feedback. Therefore, the stiffness of the tissue can be misrepresented, and the surgeon may exert excessive force on it. Most studies on stiffness perception have focused on unimanual interaction with objects, but many daily interactions are performed with both hands. To provide the surgeons with force feedback, it can be beneficial to first achieve an understanding of how the sensorimotor system processes signals from both hands to estimate stiffness. Here, we studied stiffness perception during interaction with virtual elastic objects touched by different hands. Participants sequentially probed pairs of virtual elastic objects using two haptic devices and reported which object felt stiffer. They either touched both objects with the same hand or touched each object with a different hand. In the first experiment, when they continuously interacted with each object, we found that right-handed participants perceived objects touched with the left hand as harder than objects touched with the right hand. However, left-handed participants did not show any difference between hands. In the second experiment, to simulate realistic contact with objects, right-handed participants had to break contact with the elastic object several times before switching between objects. In this experiment, the differences in perception were heterogeneous. Most participants perceived objects touched with the left hand as harder, but some perceived them as softer than those touched with the right hand. These findings have substantial implications for bimanual haptic interfaces, specifically for the design of bimanual bilateral controllers for RAMIS systems.

About the speaker:
Shani Arusi holds a M.Sc. and B.Sc. in Biomedical Engineering from Ben-Gurion University of the Negev. Currently, Shani is a PhD student at the Biomedical Robotics lab under the supervision of Prof. Ilana Nisky from the Department of Biomedical Engineering. Shani Arusi is supported by a fellowship from the Kreitman school of advanced graduate studies and the Helmsley Charitable Trust through the Agricultural, Biological and Cognitive Robotics Initiative, both at Ben-Gurion University of the Negev. Shani's work has been done in collaboration with Dr. Raz Leib from UM School of Medicine and Health, Department Health and Sport Sciences, Technical University of Munich, Munich, Germany.