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Human Vibrotactile Discrimination Thresholds for Simultaneous and Sequential Stimuli

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Abstract : Body machine interfaces (BMIs) afford users a non-invasive way coordinate movement. Vibrotactile stimulation has been incorporated into BMIs to allow feedback in real-time and guide movement control to benefit patients with cognitive deficits, such as stroke survivors. To advance research in this area, we examined vibrational discrimination thresholds at four body locations to determine suitable application sites for future multi-channel BMIs using vibration cues to guide movement planning and control. Twelve healthy adults had a pair of small vibrators (tactors) affixed to the skin at each location: forearm, shoulders, torso, and knee. A "standard" stimulus (186 Hz; 750 ms) and "probe" stimuli (11 levels ranging from 100 Hz to 235 Hz; 750 ms) were delivered. Probe and test stimulus pairs could occur sequentially or simultaneously (timing). Participants verbally indicated which stimulus felt more intense. Stimulus order was counterbalanced across tactors and body locations. Probabilities that probe stimuli felt more intense than the standard stimulus were computed and fit with a cumulative Gaussian function; the discrimination threshold was defined as one standard deviation of the underlying distribution. Threshold magnitudes depended on stimulus timing and location. Discrimination thresholds were better for stimuli applied sequentially vs. simultaneously at the torso as well as the knee. Thresholds were small (better) and relatively insensitive to timing differences for vibrations applied at the shoulder. BMI applications requiring multiple channels of simultaneous vibrotactile stimulation should therefore consider the shoulder as a deployment site for a vibrotactile BMI interface.

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