

## **Effect of vibrotactile stimulation on the response time to handle perturbation**

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**Background:** Falls from ladders are a major cause of disabling injuries among workers. Early detection of fall initiation may increase a person's ability to rapidly grasp a ladder with the hand and arrest the falling body. One of the fall detection medium is cutaneous sensation in the hand skin, sensing changes in contact pressure and alerting a person to respond to the fall initiation or perturbation. The objective of this study was to determine if vibrotactile stimulation applied to the upper extremity can enhance a person's cutaneous sensation and accelerate his/her muscular response to perturbation of the hand grip.

**Methods:** Eleven healthy young adults (age:  $25 \pm 5$  years) grasped an overhead handle with minimal effort at the beginning of a trial. A sudden upward load (20% of grip strength) was applied to the handle at a random time. Subjects were instructed to stop the handle from moving up as quickly as possible. Vibrotactile stimulation was applied to one of the 4 locations of the upper extremity (middle fingertip, thenar area, volar forearm, and dorsal forearm) using a vibration device that can generate stochastic resonance (C-3 Tactor, Engineering Acoustics, Inc., Casselberry, FL). The stimulation intensity was set at 50% of the sensory threshold. The muscle reaction times to handle perturbation were quantified as the time intervals between perturbation and increase in RMS EMG for 8 muscles (Flexor Digitorum Superficialis, Flexor Carpi Ulnaris, Extensor Digitorum Communis, Biceps Brachii, Triceps Brachii, Anterior Deltoid, Pectoralis Major, Latissimus Dorsi). The earliest reaction time among the 8 muscles was used for analysis. Four paired t-tests were used to determine the effect of stimulation on the earliest reaction times for the 4 stimulation locations.

**Results:** The earliest reaction time to handle perturbation significantly decreased by 9% ( $p=.008$ ) with the stimulation applied to the middle fingertip pad (from  $93 \pm 3$  ms to  $85 \pm 3$  ms). The earliest reaction time did not improve when vibrotactile stimulation was applied to other locations ( $p>.05$ ).

**Conclusion:** Vibrotactile stimulation at the fingertip demonstrated a potential to accelerate people's muscular response to handle perturbation. The present study's finding suggests that the use of vibrotactile stimulation can enhance a person's reaction time to handle perturbation and may help reduce fall injuries from ladders or scaffolds. Future studies may investigate the efficacy of vibrotactile stimulation on motor function of people with reduced sensation such as neuropathy and stroke.