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TITLE: An fMRI compatible vibrotactile stimulator for the study of touch: basic science and clinical applications

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Tactile sensibility is mediated by a population of low threshold mechanoreceptors (LTM), innervated by large diameter nerve fibres, and found in both the hairy and glabrous skin of the body. Psychophysical studies investigating the response properties of LTM's in the glabrous skin of the hand have traditionally employed electromagnetic vibrators (EMV) delivering ranges of sinusoidal frequencies and amplitudes that preferentially excite each of the four main tactile channels, and have allowed researchers to derive tuning curves of LTM response functions Bolanowski et al, 1988). However, studies mapping the central projections and representations of LTM's into primary (SI) and secondary (SII) somatosensory cortices have largely depended on primate studies employing electrophysiological methods. With the advent of fMRI, visual and auditory sensory systems were readily investigated in humans, as stimulus presentation was not a large issue in the high magnetic field environments of scanners. The precise study of tactile systems, using highly controlled vibrotactile stimuli having the same properties as EMV's within the MRI environment has been more challenging. Although a number of groups have built pneumatic, hydraulic and piezo-electric devices, none of these devices - to our knowledge - has all of the properties required to match the psychophysical data collected with EMV's. We will present fMRI data collected with a purpose designed piezo-electric tactile stimulator (PTS) that matches the capabilities of EVM's, offering precise control of frequency (DC - 1000Hz) and, importantly, amplitude - the latter being measured with an in-built optical displacement transducer (McGlone et al 2002). Initial studies have allowed us to map digit representation in human SI/SII at 3T (McGlone et al., , and more recently the PTS has been employed to study cortical mechanisms underlying persistent pain. Tactile stimulation of the hand of patients with chronic orofacial pain (TMJD) evoked patterns of somatosensory cortical activity that differed from those observed in age- and gender-matched control subjects (Nebel et al., 2008). Moreover, the cortical response to the PTS stimulation was altered by the concurrent delivery of noxious experimental stimuli – demonstrating the usefulness of the PTS in studying CNS tactile-pain regulatory mechanisms (Nebel et al., 2007).

Bolanowski, Gescheider, Verillo, and Checkosky, (1988). Four channels mediate the mechanical aspects of touch. *J. Acoust. Soc. Am.* 84: 1680–1694.
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Nebel, Folger, and Essick. 37th annual meeting of the Society for Neuroscience, San Diego, CA, 3-7 November 2007; Abstract #825.7.