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Muscle Synergies, Assistive Devices and the Control of Movement

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Our proposal originated through a mutual interest in the neural coalitions involved in the control of real-time movements and evolved into questions concerning how best to design optimal interfaces for assistive devices.

The paradox is that while we can learn to control individual motor units, most real-world coordinated movements always require the successful specification of many degrees of freedom in real-time. Nearly all the research to date has focused on limb movements, a class of movements that are typically defined by clear antagonist-agonist muscles pairs and a fixed target (e.g., reach an object, produce a given level of force, etc.). But what if one focused instead on the intrinsic muscles of the head and face? Unlike their limb counterparts, many of these muscles are routinely activated independently (e.g., winking) yet are also routinely activated in complex harmonies, sometimes cyclic (e.g., speaking, chewing, coughing, laughing, etc.) and sometimes not (e.g., swallowing, yawning, blinking, sneezing, etc.).

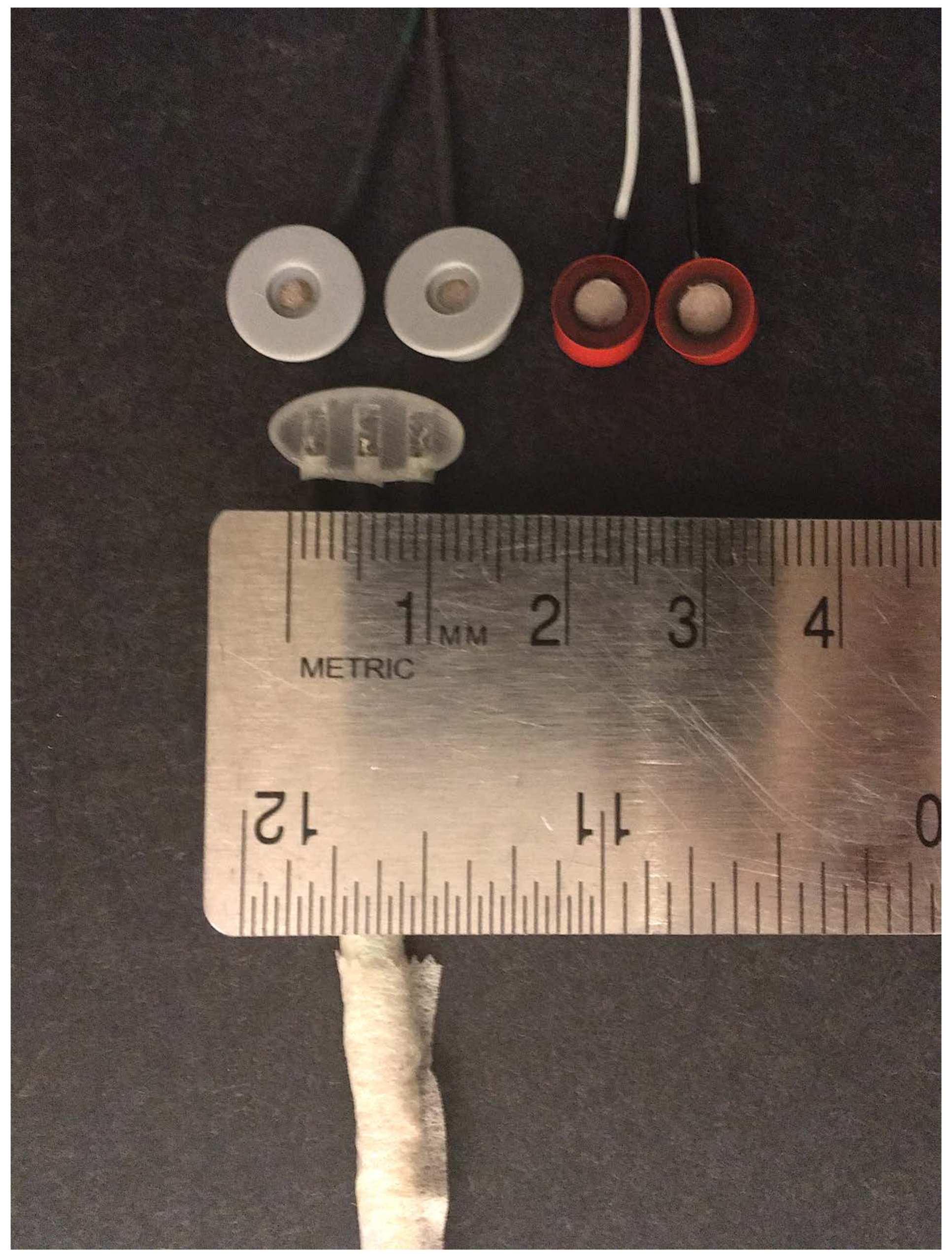
Individuals with disabilities that presently limit them to operating assistive devices with their mouth or tongue also prevent them from doing something that able-bodied persons take for granted; namely, talking and perambulating. Based on our exquisite control over the muscles of the face, the idea was to design a series of experiments to explore the possibility that people could be easily taught to use slight increases in the differential activation of the 4 intrinsic muscles of the lips to control the direction and speed of an assistive device while simultaneously holding a conversation.

To test this idea required us to first design a surface biosensor that was simple, small, lightweight and with an inherently high signal-to-noise ratio. Figure 1 displays three types of biosensors. The top two are commercially available but are too large to provide a signal both sensitive and specific, as well as not interfere with normal lip movements. The bottom sensor directly next to the ruler is a prototype designed by us, 3D printed locally and incorporates three independent Ag/AgCl pellets that allowed for construction of a branched electrode, one designed specifically to reduce cross-talk and that can be used with conventional EMG equipment (van Vugt & van Dijk, 2001).

The Covid19 pandemic has prevented us from working with research participants to collect data this past spring and summer but we know that the electrode works (See Figure 2) and our plan is to begin running subjects, if at all possible, before the end of the fall term.

Van Vugt, J.P.P and van Dijk, J.G. (2001). A convenient method to reduce crosstalk in surface EMG. *Clinical Neurophysiology*, 112(4), 583-92.

Figure 1



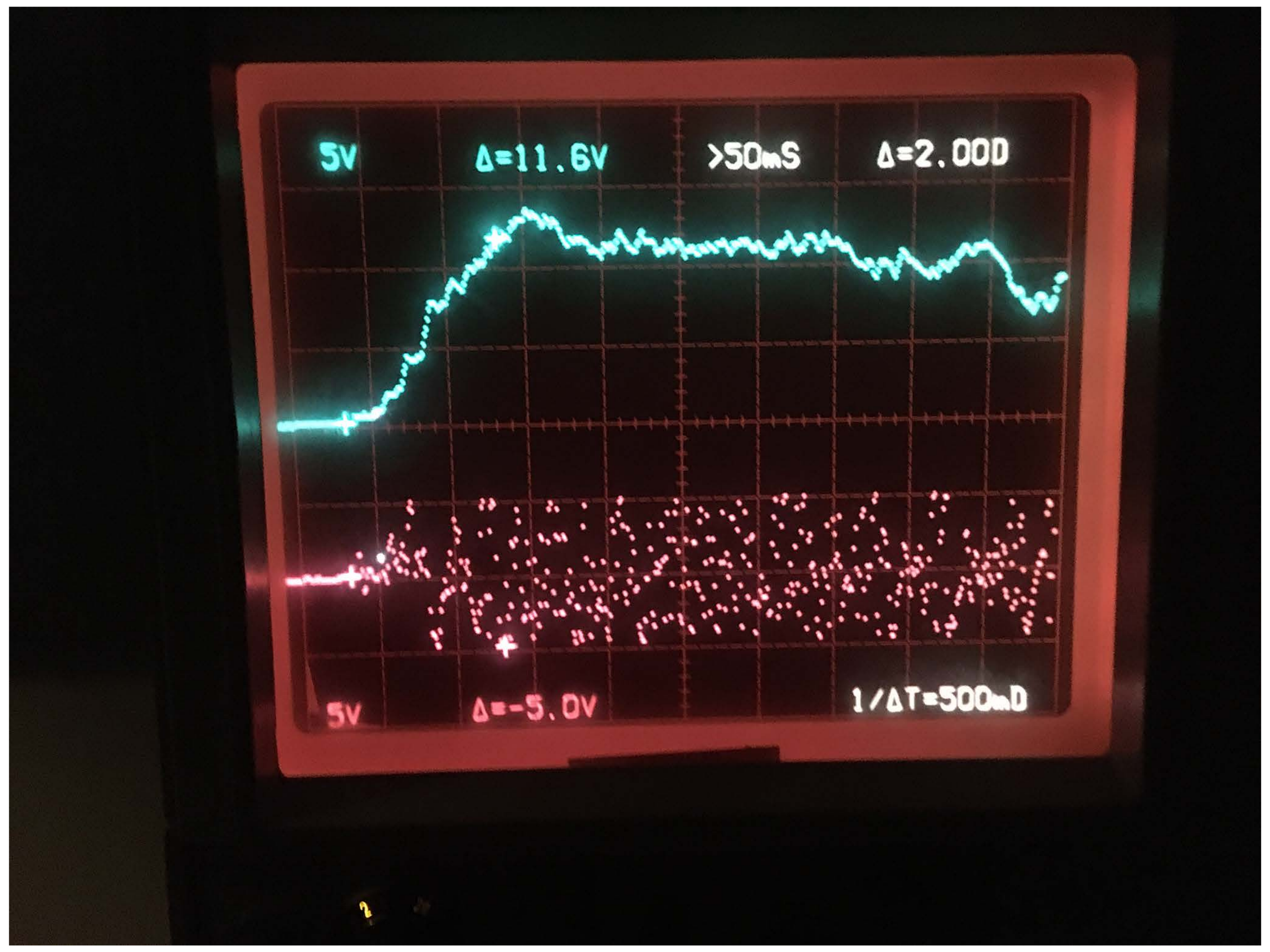


Figure 2