Title: Mouthmetrics: A tool for assessing bulbar motor involvement using a low-cost, 3D depth sensing technology.

Additional authors (in order): Richburg, B.D.; Markan, S.; Berry, J.D.

Institution name, city, state, country of additional authors:
MGH Institute of Health Professions, Boston MA USA (Richburg, B.D.)
Eudelic Systems LLC, Framingham MA USA (Markan, S.)
Massachusetts General Hospital, Boston MA USA (Berry, J.)

Background: Currently, there is no standardized diagnostic procedure for evaluating bulbar motor impairment due to ALS, and adequate markers of speech motor involvement have not been identified. Although recent findings suggest that changes in jaw, lip, and tongue performance are among the best markers of bulbar motor involvement (Rong et al., 2016), technology and cost have been a barrier to clinical implementation. To address these limitations, we tested the accuracy of a bulbar assessment system that is based on newly-developed, low-cost, and widely available 3D depth sensing camera technology. This technology is becoming a standard component of consumer-grade laptops and cell phones, and is capable of recording lip and jaw movement in 3D during speech and chewing.

Hypothesis. Our hypothesis is that the accuracy of lip and jaw tracking using the 3D depth sensing camera will be adequate for detecting clinically meaningful differences in bulbar motor impairment.

Methods: For this validation study, we investigated speech movements in 10 participants by comparing the results of a speech motor assessment using the Intel® RealSense™ 3D camera (model SR300) and a 3D electromagnetic articulography (NDI Wave). To elicit lip and jaw movements, each participant repeated four different syllable sequences (“puh”, “tuh”, “kuh” and “puhtuhkuh”) as fast and precise as possible on one breath. Custom algorithms were used to automatically extract measures of speech motor performance (i.e., repetition count, repetition rate, speed and extent of movement).

Results and Discussion: Measures of repetition rate, duration, and average velocity were comparable across systems. The accuracy of depth sensing camera for measuring range of movement and maximum speed was less than that of the Articulograph. The current findings suggest that with additional development the device has the potential to address three important translational needs in person with ALS: improved early detection of bulbar motor involvement, improved options for the remote monitoring of bulbar motor decline, and improved objective outcome measures for ongoing experimental drug trials.