3-E-32 Assessing Hand Grasp Representations in Children with Congenital Upper Limb Deficiencies

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The prediction of motor intent using surface electromyography (sEMG) has been extensively studied for upper limb prosthetic control. This approach utilizes pattern recognition algorithms that can be rapidly trained to recognize unique patterns of muscle excitation. These techniques have been primarily focused on the adult population and especially those with traumatic amputation, allowing them to more readily control the variety of grasping movements offered by modern dexterous prostheses. However, most pediatric prosthetic users have congenital limb deficiencies as opposed to acquired limb loss and their muscles will have never actuated a fully formed hand. It is currently unknown to what extent traditional adult amputee-based sEMG techniques will translate effectively to the pediatric population. Yet dexterous prosthetic hands have begun to emerge for pediatric users with little evidence to support their abilities to control the newly available dexterity. Together, these factors present a significant barrier to effectively translating dexterous devices to pediatric populations. Our work lays the foundation to address this gap in knowledge. sEMG data were collected from 9 participants with unilateral congenital below elbow deficiency ages 8-20 years as they attempted to perform a set of 11 hand grasp movements (including the rest state) with their missing limb. A Delsys Trigno Research System was used to capture the naturally occurring electrical activity of the children's forearm muscles with 4 to 7 sEMG electrodes adhered around both the participant's affected and typical limb. Utilizing conventional root mean squared and mean frequency characteristics we analyzed the sEMG data. We found that each time a participant attempted to move their missing limb to the specified hand grasp the characteristics provided sufficient information to distinguish muscle excitation patterns. The results also showed that participants had varying measures of within-grasp consistency across repetitions. Additionally, a typical pattern recognition algorithm and feature set were used to understand the extent to which participant-attempted hand grasps could be predicted. We found that participants were able to achieve average classification accuracies ranging from 57%-91% for their affected limbs and 74-98% for their typical limbs. Moreover, 7 participants achieved accuracies greater than 80% for 3-10 out of 11 hand grasp movements in their affected limbs and all participants had 4-11 grasps greater than 80% in their typical limbs. The low levels of classification accuracy seen in some participants are presumably associated with factors such as age and residual limb length. The work presented here begins to address the extent to which children born with upper limb deficiencies can actuate their affected muscles and provides a baseline of how traditional adult amputee-based sEMG pattern recognition techniques perform in this unique population.

3-E-33 Finger skin mechanoreceptors could explain deficits in grip force modulation in Parkinson disease.

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