In stroke recovery, the activation of the primary motor cortex (M1) is critical for motor learning and has been found to be augmented by non-invasive brain stimulation (NIBS) recovery [1,2]. One form of interventional NIBS is transcranial direct current stimulation (tDCS), which involves the guided placement of electrodes on the scalp. Two methods to guide the somatotopic localization of the M1 area are 1) transcranial magnetic stimulation (TMS) and 2) the 10/20 International Electroencephalogram Coordinate System (10/20 EEG) [3]. The TMS M1 location, termed the motor hotspot, is derived by eliciting a motor evoked potential in a muscle corresponding to the area stimulated (e.g. the first dorsal interosseous muscle can be monitored when stimulating the hand knob of M1). In contrast, the 10/20 EEG identifies the location of M1 for the placement of scalp electrodes derived from four key individual anatomical landmarks with the nasion (lowest depression between the forehead and nose), in (lowest point of the skull from the back of the head) and the preauricular points of the right and left ears. EEG electrodes can record temporal brain activity in the form of event-related potentials (ERPs). The ERP represents a summation of neuronal activity and the location of the brain activity is inferred based on the type of task or stimuli (e.g. a motor task may infer activity in the M1 area). The coordinates for M1 include C3 (left hemisphere) and C4 (right hemisphere) areas regardless the possible cortical re-organization of M1 following a stroke.

Although the 10/20 EEG was originally designed to record brain activity, increasing investigations of tDCS in adults and children with stroke are reporting use of the 10/20 EEG to guide tDCS electrode placement. However, the reliability of the 10/20 EEG measurements to locate the C3 and C4 is unknown. The purpose of this study was to assess the inter-rater and intra-rater reliability of the 10/20 EEG to localize C3 and C4 to provide information about the error of this measure when used by a researcher with limited training in EEG measurements. These results may inform other investigators who design non-invasive brain stimulation research protocols where stimulation location is determined by the 10/20 EEG measurements. This research was approved by the Institutional Review Board at the University of Minnesota. A convenience sample of twenty-five adults without neurological conditions were recruited (mean age = 42.04, SD = 13.67). All participants provided written consent.

Two investigators unfamiliar with performing 10/20 EEG measurements were provided with two hours of training with a pediatric neurodiagnostic technician. Following training, independent measurements of participant’s heads were completed following the 10/20 EEG [4]. The C3 and C4 areas were localized and the distances between 1) left preauricular point and inion and 2) right preauricular point and inion were measured and recorded.

Keywords
Reliability, Non-invasive brain stimulation, Stroke, Neuroplasticity, Children

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Our study indicates that the 10/20 EEG can result in low SEM, when localizing C3 and C4, by different novice raters and on different days. Although limitations exist within this study design, there are limited reports of the reliability of the 10/20 EEG when used by different investigators and on different days.

The 10/20 EEG frequently guides electrode placement for tDCS although few studies report reliability of 10/20 EEG measurements. A lack of reporting reliability in 10/20 EEG measurements may be contributing to greater inter-individual variability following tDCS intervention. In addition, the 10/20 EEG does not take into consideration the influence of continued development of children following stroke when localizing the M1 area. The influence of development on reorganization of the motor cortex after stroke could limit the accuracy of the 10/20 EEG to locate the M1. As we consider not only reliability but also validity, other’s data suggests poor validity of the 10/20 EEG measurements to localize the motor cortex in adults without neurological condition [6,7]. Future studies incorporating neuroimaging may elucidate the validity of the use of 10/20 EEG to locate the M1 in children with stroke who may display reorganization of M1.

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