**MRI Microscopy of Human Motor Neurons Progress Report**

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**Introduction**

A key feature of human behavior is spoken language, but the neural structures that permit humans to learn vocal culture while other apes cannot have yet to be described. A popular hypothesis is that humans have evolved a direct corticobulbar connection originating from the frontal lobes and ending in the nucleus ambiguus, the hindbrain motor nucleus that controls the intralaryngeal muscles (Jürgens, 2002). It is further hypothesized that this direct connection allows for more fine control of this structure, in a manner analogous to the way direct frontal innervation of spinal motor nuclei allows for fine motor control of the hands in apes. While there is not conclusive evidence that this ambiguo-frontal tract exists, it’s potential existence has been reported in the literature for so long that it is now often cited as a conclusion, and not as a possibility. We propose to use high-field, diffusion weighted MRI to establish the existence, or nonexistence, of this hypothesized connection.

**Experimental**

The test sample was an human hindbrain from an 89 year old male who passed in 2004, with no history of language-related complications or other neurological contraindications.The whole brain was preserved in formalin until the time of this research project. The hindbrain was excised by cutting at the caudal medulla and rostral midbrain, with the cerebellum removed at the brachium pontis as close as possible to the main axis of the brain stem. The hindbrain was soaked in neutral buffered formalin for 7 days before it was to be scanned, with the solution replaced three times at an interval of 2 days. After shipment and prior to scanning, the hindbrain was placed in fluorinert and any excess water pipetted off.

In February 2015, the brain stem was scanned in a 17.6T Bruker Avance III spectrometer, with a micro 2.5 gradient set and a custom-built receive coil. When submitted to a 2D diffusion weighted sequence at a Gmax of 1500 mT/m, the system failed silently and continued to appear to be running but was no longer applying any of the necessary gradient changes. By the time the error was discovered, it was too late to run the brainstem in the magnet again, keeping in mind that flight arrangements had already been made and the brainstem was only allowed to stay in Florida as long as a Berkeley researcher was there to supervise.

**Results and Discussion**

Subsequent investigation showed that the Z gradient, which was in the slice encoding direction, had overheated (due to surpassing of the duty cycle limitations due the demands by the high resolution DWI) shortly into the first day of scanning. This caused a safety shutdown of the entire gradient set at the magnet, which for an unknown reason was not relayed to the Bruker controller driving the scanner. In the months since this event, Dr. Colon has reported that another sample has been successfully run with the similar parameters, but with the time between individual components of the scan lengthened to give the gradients time to cool between acquisitions hence reducing the duty cycle to reasonable levels for the micro 2.5 gradient set.

**Conclusions**

We are confident that future work on this scanner will yield data of sufficient resolution and quality to successfully evaluate hypotheses about hindbrain phonatory motor neuron connectivity in humans and nonhuman apes.

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**References**

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