Neuroimaging pain-related circuitries in the human brainstem with functional MRI

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The brainstem acts as a relay and processing station between spinal cord, cerebellum, and neocortex, and its importance in processing nociceptive signals and in chronic pain disorders has been confirmed in multiple animal and human studies. Apart from pain-related centers it also contains important nuclei of many functional systems in the central nervous system, including the visual, auditory, gustatory, vestibular, somatic, and visceral senses, as well as the autonomic nervous system. Despite this indisputable importance, the brainstem has been scarcely studied in human neuroimaging research. One reason for this lies in the anatomical characteristics of the brainstem, namely, its proneness to physiological noise driven by cardiac pulsatility, its proximity to the steep magnetic susceptibility gradient of the air-tissue boundary with the oral cavity, and the small size of its anatomical constituents. All these present inherent challenges to neuroimaging analysis and make the brainstem a difficult region to study. Nevertheless, the field of brainstem neuroimaging has significantly advanced in recent years, largely due to the development of new investigation and analysis tools that facilitate studying this critical brain structure. Specifically for pain research, studies have focused attention on sensory as well as modulatory - both inhibitory and facilitatory- processing.

The talks in this session will overview novel and state-of-the-art methods for brainstem-specific image acquisition, pre-processing and data analysis, MR-compatible pain stimulation methods, combined measurement of fMRI and autonomic signals, as well as experimental approaches to identify pain-modulatory and pain-related autonomic nuclei within the brainstem. Finally, we will present applications of functional imaging techniques to chronic pain populations such as migraine, trigeminal neuralgia, and temporomandibular disorder.

How to measure brainstem activity with fMRI
Florian Beissner, Somatosensory and Autonomic Therapy Research, Institute of Neuroradiology, Hannover Medical School, Hannover, Germany

Brainstem processing in migraine: can the gateway to chronic pain be down-regulated?
Vitaly Napadow, Martinos Center for Biomedical Imaging, MGH, Harvard Medical School, Boston, MA, United States

Altered brainstem anatomy and resting rhythm in chronic orofacial pain
Luke Henderson, University of Sydney, Sydney, Australia

Combining heart rate variability and ultrahigh field (7T) fMRI to reveal the brainstem circuitry supporting cardiovagal response to pain
Roberta Sclocco, Department of Electronics, Information and Bioengineering, Politecnico di Milano, Milano, Italy