Investigation of the Autonomic Nervous System Control of Cardiovascular Variables using fMRI and Carotid Stimulation

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Several factors make difficult in humans the study of the central processing and control exerted by the autonomic nervous system (ANS) on the cardiovascular parameters. Non invasive neuroimaging using fMRI has the potential to identify the brain regions involved. This paper illustrates the results of a fMRI event-related protocol which uses the neck suction to deliver a peripheral input to the ANS network. A dual chamber MRI-compliant neck-suction system was designed and realized. ECG, respiration and peripheral pulse signals were collected using an MRI compliant biosignal acquisition system. An event-related design was employed to randomly administer 50 efficacious (-60 mmHg) and 30 non-efficacious (-10 mmHg) stimuli, with a duration of 8 s each. Six-hundred echo-planar imaging volumes (TR=2.08 ms) with BOLD contrast, covering the whole brain, were collected in each experiment (total duration 20 min). From each MRI experiment, RR intervals were obtained from the ECG and uniformly resampled at 10 Hz. A stimulus-response curve was obtained by averaging the heart period response to each stimulation, and it was used to verify that the neck suction stimulus reached the ANS, since it is known that the individual anatomical variability in the carotid baroreceptors position may result in non efficacious stimulation. Fifteen informed volunteers underwent fMRI at 3T during neck suction stimulation. Eight subjects responded to the stimulation, whereas in seven subjects the heart period did not show a significant increase during the suction. In the responder subjects, efficacious stimuli induced an increased activation in the left posterior cingulate cortex, temporal lobe, and insula, compared to the non-efficacious condition. Our data demonstrate that, in a given number of subjects, it is possible to investigate the ANS using fMRI event-related protocols, and identify the brain regions involved in the central processing and control of signals from carotid baroreceptors.