

# The Effect of Global Cerebral Vasodilation on Focal Activation Hemodynamics

B. Stefanovic<sup>1</sup>, J. M. Warnking<sup>2</sup>, K. M. Rylander<sup>3</sup>, B. Pike<sup>2</sup>

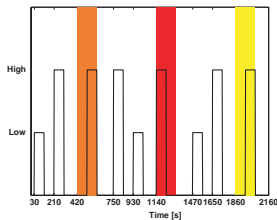
<sup>1</sup>LFMI, NINDS, NIH, Bethesda, MD, United States, <sup>2</sup>BIC, MNI, McGill University, Montreal, Quebec, Canada, <sup>3</sup>B, MNI, McGill University, M, Q, Canada

## Introduction

In view of its importance for the interpretation of BOLD fMRI studies and its significance for the understanding of the biophysical mechanism of BOLD, the effect of the baseline blood flow on the activation-induced BOLD response has attracted renewed interest. While small perturbations from resting CBF have typically supported an additive BOLD signal model [1,2], no consensus has been reached regarding the impact of baseline perfusion on either BOLD or CBF response to neuronal activation in the healthy human brain. In the present study, we investigated the effect of pronounced CO<sub>2</sub> induced dilation on both BOLD and CBF responses to stimulation.

## Methods

Interleaved 6-slice PASL and T2\*-weighted GRE sequences (4x4x5mm<sup>3</sup>; TR: 1.5s, TE: 22/50ms) were used to measure CBF and BOLD signals on a 1.5T Siemens Sonata. Twelve volunteers (7F, 5M; 27±1yrs) performed bilateral finger tapping while presented with a radial checkerboard alternating with rest and uniform grey baseline in 0.5/1.5/1 min off/on/off blocks. Three levels of hypercapnia (HC) were induced by administering mixtures of 0-10 % CO<sub>2</sub> and air in 1/3/2 min blocks. Two functional blocks preceded each hypercapnia block; with another functional block applied during either first or second half of the hypercapnic period, as illustrated. A reference grey matter region not participating in either motor or visual processing was used to correct the activation induced changes during hypercapnic periods for temporal instability in the hypercapnia induced responses.



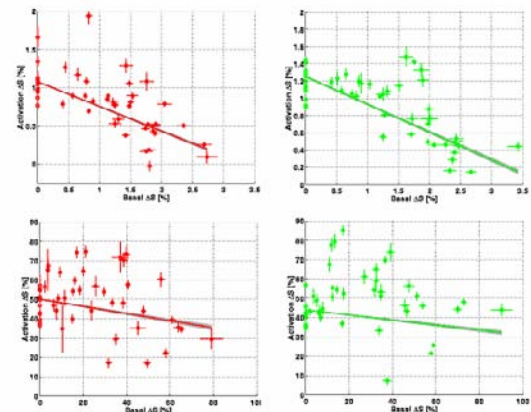
**Figure** Schematic of a sample experimental paradigm.

## Results

When controlling for inter-subject variability, the effect of hypercapnia on the activation-induced response was significant for both BOLD ( $p < 10^{-6}$ ) and CBF ( $p < 10^{-4}$ ). The linear fits to activation-induced responses as a function of hypercapnia-induced changes are shown in the Figure below. In view of the slope estimates ( $-0.32 \pm 0.01$  %/% for BOLD MC, VC;  $-0.18 \pm 0.02$  %/% for CBF MC and  $-0.13 \pm 0.01$  %/% for CBF VC) and given that activation induced markedly smaller percent signal changes than HC for BOLD, but not for CBF, only the effect of HC on BOLD bears practical significance on this range of basal vasodilation.

## Discussion

We observed a significant decline of activation-induced BOLD response magnitude with increasing basal flow levels, in accordance with the BOLD response models, whereby a significant drop in the basal dHb concentration decreases BOLD sensitivity to CBF increases. A very limited effect of the basal vasodilation on the relative CBF response is consistent with the existing literature [3] and testifies to the nature of CBF regulation following functional activation. The present findings indicate that the differences in global perfusion must be accounted for before conclusions regarding the activation- or region-specific BOLD response differences may be drawn. They are also suggestive of a hemodynamic scenario that results in functionally active regions being “silent” on BOLD fMRI maps.



**Figure** The activation induced response (MC: red, VC: green) as a function of the HC induced changes in BOLD (left) and CBF (right) in each subject.

[1] Corfield, NI, 13(6):1207-11, 2001.

[3] Brown, JCBFM, 23:829-837, 2003.

[2] Hoge, ISMRM, 1737, 1999.