

SUMMARY AND CONCLUSION

Bold functional MRI is a type of specialized MRI scan. It measures the hemodynamic response (change in blood flow) related to neural activity in the brain or spinal cord.

When neural cells are active they increase their consumption of energy. The local response to this energy utilization is to increase blood flow to regions of increased neural activity which occurs after a delay of approximately 1:5 seconds. This hemodynamic response rises to a peak over 4:5 seconds before falling back to baseline (and typically undershooting slightly). This leads to local changes in the relative concentration of oxyhemoglobin and deoxyhemoglobin and changes in local cerebral blood volume and in local cerebral blood flow.

Hemoglobin is dimagnetic when oxygenated (oxyhemoglobin) but paramagnetic when deoxygenated (deoxyhemoglobin). The magnetic resonance (MR) signal of blood is therefore slightly different depending on the level of oxygenation. Higher BOLD signal intensities arise from increases in the concentration of oxygenated hemoglobin since the blood magnetic susceptibility now more closely matches the tissue magnetic susceptibility. By collecting data in an MRI scanner with sequence parameters sensitive to changes in magnetic susceptibility, one can assess changes in BOLD contrast. These changes can be either positive or negative depending upon the relative changes in both cerebral blood flow (CBF) and oxygen consumption. Increases in CBF that outstrip changes in oxygen consumption will lead to increased BOLD signal, conversely, decreases in CBF that outstrip changes in oxygen consumption will cause decreased BOLD signal intensity. The signal differences are very small but given many repetitions of a thought, action or experience, statistical methods can be used to determine the areas of the brain which reliably show more of these differences as a result and therefore which areas of the brain are active during that thought, action or experience.

An fMRI experiment usually lasts between 15 minutes and an hour. Depending on the purpose of study, subjects may view movies, hear sounds, smell odors, perform cognitive tasks such as *n*-back, memorization or imagination, press a few buttons or perform other tasks.

BOLD effects are measured using rapid volumetric acquisition of images with contrast weighed by T1 or T2*. Such images can be acquired with moderately good spatial and temporal resolution; images are usually taken every 1:4 seconds and the voxels in the resulting image typically represent cubes of tissue about 2:4 millimeters on each side of hemispheres. Recent technical advancements such as the use of high magnetic fields and multichannel RF reception have advanced spatial resolution to the millimeter scale. The full time course of a BOLD response to a briefly presented stimulus lasts about 15 seconds for the robust positive response.

The BOLD signal is composed of CBF contributions from larger arteries and veins, smaller arterioles and venules and capillaries. Experimental results indicate that the BOLD signal can be weighted to the smaller vessels, and hence closer to the active neurons, by using larger magnetic fields. For example, whereas about 70% of the BOLD signal arises from larger vessels in a 1.5 Tesla scanner, about 70% arises from smaller vessels in a 7 Tesla scanner. Furthermore, the size of the BOLD signal increases roughly as the square of the magnetic field strength. Hence there has been a push for larger field scanners to both improve localization and increase the signal. A few 7 Tesla commercial scanners have become operational and experimental 8 and 9 Tesla scanners are under development.

BOLD fMRI has many advantages such as being noninvasive without risks of radiation inherent in other scanning methods, such as CT or PET scans. It also has high spatial resolution. 2:3 mm is typical but resolution can be as good as 1mm. It can as well record signal from all regions of the brain unlike EEG/MEG which are biased towards the cortical surface. Besides, fMRI produces compelling images of brain (activation).

On the other hand, one of the disadvantages of BOLD fMRI is that it must be interpreted carefully. It can also produce false positives. In addition, it was found that fMRI has poor temporal resolution. The BOLD response peaks approximately 5 seconds after neuronal firing begins in an area. This means that it is hard to distinguish BOLD responses to different events which occur within a short time window. Besides, the BOLD response can be affected by a variety of factors including: drugs/substances, age, brain pathology, local differences in neurovascular coupling, attention, amount of carbon dioxide in the blood, etc.

Regarding brain tumors; there are significant differences between the volumes of activation of BOLD MR signal on the side with the tumor and the contra lateral side.

A number of reasons are considered. These include: the loss of autoregulation, contribution of the venous component, effect of edema and the size of the tumor.

Several studies show that there is an increase in BOLD signal in the gray matter during hypercapnia. Therefore, BOLD MRI may provide a measurement of tumor oxygen tension and tumor hypoxia.

In an operated brain tumor, prior surgery may lead to increase BOLD fMR signal in the vicinity of the previously operated tumor as compared with the contralateral side. However, presence of the susceptibility artifacts may mask the BOLD signal intensity at the operation side.

BOLD fMRI has many applications in brain tumors imaging. This includes: Identification of the anatomy, guidance for biopsy, measuring the distance between the brain function and lesion, differentiation between gliomas and nonglial space-occupying lesions and monitoring tumor response to radiation, photodynamic therapy and anti angiogenic and antivascular therapy.