changed the level of BOLD signal intensity expected to 1%, the required minimum SNR decreases by a factor of 2, to 82. In a separate publication, we also showed how the BOLD sensitivity maps could be used to determine if the actual measured BOLD signal intensity change was detectable in the amygdala.[3]

What is the practical implication for real fMRI data? In Fig 1, 2 different anatomic levels of a postsurgical fMRI patient study are shown. In the first row, the mask was generated by the SIM method[1] by setting the threshold so that the tissue surrounding the brain in the raw BOLD EPI data was suppressed; signal intensity was 240. In the second row, the mask was generated by the SNR-based method,[2] with the parameters described above and an expected BOLD signal intensity change of 1% (SNR $>$ 82). Note the large differences in the mask in the region where the sinus susceptibility artifact exists, as well as near the surgical site. The third row demonstrates a very different mask based on a 0.5% BOLD signal intensity change (SNR $>$ 164). The lower level of BOLD change may be expected in patients with disease. The lower 2 rows are based on SNR, statistical confidence, and BOLD signal intensity changes, whereas the first row is based on the SIM, a number that has very little meaning.[1]

I am encouraged that the authors are concerned about the impact of image quality, artifacts, and signal intensity voids on the interpretation of clinical fMRI and have done some excellent work to illuminate this problem. We should, however, proceed carefully when developing a method to demonstrate confidence in the activation maps. Using an arbitrary method may "mask" the clinical utility of BOLD imaging.

Todd Parrish
Department of Radiology
Northwestern University Medical School
Chicago, Ill

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Reply:

We thank Dr. Parrish for his comments on the relationship of susceptibility and signal intensity–to-noise ratio (SNR) for confidence levels in clinical functional MR imaging (fMRI). We welcome the discussion of these issues and laud him for his comprehensive investigation of the effects of temporal SNR on blood oxygen-level dependent (BOLD) time course analyses.[1]

The statements and example of a signal intensity map (SIM) that Parrish includes in his letter, however, do not match our experience. In our study, each SIM threshold was individually matched to the patient's echo-planar imaging (EPI) data, thus eliminating the possibility for errors incurred by use of an arbitrary threshold applied across all datasets.[2] In our experience, as demonstrated by the examples for SIM formation in Figs 1–3 of our article, SIM is sensitive to regions of signal intensity loss produced by magnetic susceptibility effects when conventional echo-planar BOLD imaging is used. In all of our cases, EPI susceptibility effects in regions of frontal and basilar sinuses were delineated by the SIM. The intent of our report was to evaluate the SIM as an indication of susceptibility-induced artifact upon the interpretation of clinical fMRI mapping. These susceptibility-induced artifacts are substantially stable during the course of a fMRI time series acquisition. Therefore, within this limited assessment, the static SIM provides an adequate means for evaluation. A version of the SIM is relatively easy to produce on a clinical system and thus offers widespread utility to fMRI users.

Parrish et al[1] have applied the temporal nature of the fMRI acquisition to further evaluation of BOLD sensitivity. We appreciate the importance of their report and encourage fMRI users to become familiar with the significance of their findings. Temporal SNR measurements provide information about the BOLD signal intensity stability that is not contained within a static SIM, and indeed it is our practice to produce both types of signal intensity evaluation maps for our fMRI studies.

We regret any misunderstanding that might have led Dr. Parrish to question our report on the utility of a SIM. We are gratified by the forum for discussion of these issues, particularly when the opportunity leads toward increased awareness of limitations and capabilities for clinical fMRI.

Chad Moritz
Roberta Strigel
Howard Rowley
Victor Haughton
Department of Radiology
University of Wisconsin
Madison, Wisc

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Erratum

Due to a translation error, Chung Hwan Baek's name was misspelled in the published list of authors for the article "Nodular Fasciitis in the Head and Neck: CT and MR Imaging Findings" in the November/December 2005 issue. The correct author list should be:

Sung Tae Kim, Hyung-Jin Kim, Sun-Won Park, Chung Hwan Baek, Hong Sik Byun, and Young Mo Kim. (*AJNR Am J Neuroradiol* 2005; 26:2617–23.)