Quality Assurance for functional Magnetic Resonance Imaging

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Introduction

There are no generally accepted guidelines for carrying out QA on functional imaging scanners, and only a few publications on the subject (1,2). Signal-to-noise ratio (SNR) and stability are clearly important. Short-term stability dictates the length of acquisitions necessary to accumulate sufficient statistical power in cognitive tasks. Long-term stability affects the ability to compare findings from different sessions, although sophisticated analysis (3) can minimise the confounding effects. We present the findings of a QA programme spanning three years.

Methods

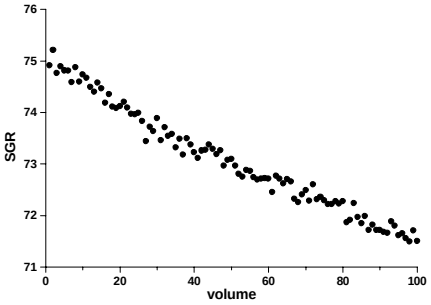
Each month, the standard GRE-EPI sequence for human fMRI studies was run on the manufacturer's head phantom. Parameters were TR/TE/flip angle=4000/40/90, 100 volumes (14 prior to 2003), 40×5mm slices, 64×128 matrix and 240×480 FOV leading to 3.75mm pixels. Raw data were reconstructed offline, and QA measures were calculated using in-house software. For each volume, the mean signal S was calculated over the central 20% of the phantom in each direction. Ghost level G was defined to be the standard deviation of the image intensity in the regions of ghosting (outside the phantom, in the phase-encoding direction). Noise level N was defined to be the standard deviation of the background noise, avoiding the phantom and ghost regions. S, S:G ratio (SGR) and SNR for each volume and for each month were subject to statistical analysis.

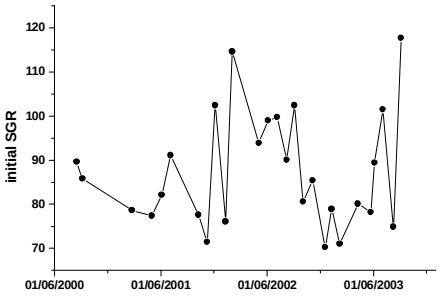
Results and discussion

During fMRI runs of 100 volumes, mean signal and noise levels both dropped by 0.1-0.3% of their initial values, such that SNR was maintained (at approximately 420). Ghosting increased markedly during fMRI runs, such that SGR dropped by 4-8% (left figure). Long term month-to-month variation (std. dev.) in initial mean signal was 0.7% about a mean value of 3800 units. Long-term SNR variation was 2% about a mean value of 450. SGR displayed more variation, with a standard deviation of 16% about a mean value of 90 (right figure). These values are comparable to Ref. 2. There was no association between scanner servicing and fMRI QA performance. EPI sequences are prone to ghost artefacts. Performance is optimised immediately after self-calibration of the scanner for each run, and falls during the subsequent acquisition, likely due to gradient heating and drift in centre frequency.

Conclusion

Signal, noise and ghosting levels each fMRI QA signal and SNR consistent within respectively over years. Ghost much larger particularly drifted during run. The initial levels were 0.7% and 2% a period of three artefacts had a variation (16%).





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References 1. Weisskoff MRM 1996, 36:643-645; 2. Simmons MRM 1999, 41:1274-1278;
3. www.fil.ion.ucl.ac.uk/spm