

# Effects of fMRI acoustic scanner noise on neural processing networks during task performance and rest

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**Introduction.** – Acoustic MR-scanner noise that is produced during gradient switching affects task-evoked neural activation patterns in the brain, which constitutes a confound in the context of fMRI [1]. Sparse clustered volume acquisition methods exist that deal with these interactions [2,3]. In recent years, ‘resting state’ measurements have gained popularity [4]. So far, the effects of scanner noise in such analyses have not been studied, hence the current experiment.

**Materials & Methods.** – Eleven subjects consented to participate in an fMRI session that consisted of four different types of runs. These included *passive* runs in which subjects remained at ‘rest’ (without any stimulus or task), as well as *active* runs in which a diverse series of sound fragments was presented and subjects performed a basic auditory memorization task (note: every fifth trial contained silence). During both the passive and active runs, dynamic series of  $T_2^*$ -sensitive EPI-images were obtained (3-T Philips Intera), either by means of *continuous* acquisitions (2.0-s TR) or by *sparse* clustered volumes (10.0-s TR). All image volumes were preprocessed, including motion correction, coregistration, normalization, smoothing (5-mm FWHM), logarithmic transformation, and subtraction of various confounds (baseline, polynomial drift, residual motion, and global mean). Data from corresponding runs were concatenated across subjects, reduced to 24 principal components, and decomposed into maximally independent components [5].

**Results.** – The figure shows two selected components, corresponding with the central auditory system (top) and default mode network (bottom). In the left column, the spatial distribution of the component strength is displayed by means of color coded cross-sectional maps. Importantly, for all four types of runs, similar components could be extracted. Still, the auditory component was much weaker in the passive runs than in the active runs. For sparse clustered volumes the difference was larger than for continuous acquisitions (weaker activity during passive runs and stronger activity during active runs). The opposite was true for the default mode network, which was strongest during the passive runs, especially with continuous scanning. In the middle column the components’ mean time courses of all four runs are shown; the right column contains the corresponding power spectra. In the active runs, the periodicity of the sound presentations (i.e.: silence every fifth trial) was clearly detectable in the auditory system using sparse imaging, but was considerably weaker using continuous acquisitions. For the default mode network, the periodicity was detectable (with opposite sign) using sparse clustered volumes, but not at all using continuous acquisitions. Moreover, differences were observed in the overall shape of the spectrum, which appeared more or less flat for the sparse clustered volumes, but gradually dropped off towards higher frequencies for the continuous acquisitions (the initial slope at low frequencies is caused by baseline and drift removal during preprocessing). Various other components (not shown) displayed related trends.

**Conclusions.** – Most independent components were similarly detectable irrespective of the acquisition method and stimulus/task paradigm. However, in agreement with literature, activation levels in response to sound presentations in the central auditory system decreased in the presence of background scanner noise [1-3], and concurrent task-related deactivation of the default mode network was similarly affected [6,7]. During resting state, scanner acoustic noise also influenced the components. Both the central auditory system and the default mode network were more extensive during continuous scanning, suggesting that background noise may generally serve to drive coherent fluctuations. Trends in the power spectra suggest that these fluctuations are slow [8].

**References.** – [1] Langers et al. *Magn.Res.Med.* (2005) 53(1): 49-60. [2] Hall et al. *Hum.Brain.Mapp.* (1999) 7(3): 213-23; [3] Edmister et al. *Hum.Brain.Mapp.* (1999) 7(2): 89-97; [4] Damoiseaux et al. *PNAS* (2006) 103(37): 13848-53; [5] Calhoun et al. *Hum.Brain.Mapp.* (2001) 14(3): 140-51; [6] Raichle et al. *NeuroImage* (2007) 37(4): 1083-90; [7] Gaab et al. *Hum.Brain.Mapp.* (2008) 29(7): 858-67; [8] Cordes et al. *AJNR.* (2001) 22(7): 1326-33.

