SHORT TR RESTING STATE DATA ACQUIRED WITH A SIMULTANEOUS MULTISLICE MULTI-ECHO SEQUENCE AT 7T, A COMPARISON WITH MULTI-ECHO

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Target audience: MR physicists

Purpose

In this study, we have implemented a simultaneous multislice[1] (SMS) multi-echo (ME) sequence to investigate the potential improvement in sensitivity at 7T for resting state (RS) fMRI. In addition we explore the potential benefits of two different echo weighting schemes. For task fMRI ME acquisition weighting schemes at 7 T have previously been compared[2]. However, RS BOLD signal characteristics might impose different constraints on the echo combination. Specifically, a TE-based weighting scheme will treat the BOLD noise as signal, and all other noise as noise, this is compared to simple echo summation (averaging) which was previously found optimal for 7T. A ME SMS sequence has previously been compared to a single echo SMS sequence in terms of physiological noise correction and sensitivity[3], where the former benefits from the extraction of artifactual regressors from the early echoes and the latter has more time points (degrees of freedom). Here, we looked at temporal signal characteristics of a ME SMS sequence and a matched ME protocol. We also investigated the RS networks (RSNs) obtained from an Independent Component Analysis (ICA).

Methods

RS data (eyes open, 5 min. both acquisitions) were collected for 4 subjects (with informed consent) at a 7T Siemens scanner (Siemens Healthcare, Erlangen, Germany) equipped with a 32 channel head coil (Nova Medical, Wilmington, MA, USA). Acquisition parameters are summarized in Table 1. The sequences are matched in terms of spatial resolution and FOV. Reconstruction of SMS data is done offline in Matlab using a SENSE/GRAPPA reconstruction[4].

Table 1. Acquisition Parameters

	TR (s)	TEs (ms)	In plane GRAPPA	SMS factor	Excitation FA (Ernst/grey matter)	BW (Hz/Px)	Slice gap	Res.(mm)
ME	2.22	11,23	3	-	40	2520	%17	3.5 isotropic
ME SMS	0.74	36,48		3				

ICA was carried out with Melodic (v3.10, http://www.fmrib.ox. ac.uk/fsl/) with 30 components. The following preprocessing steps were applied: spatial smoothing (5 mm kernel), drift removal, MCFLIRT motion correction. Sensitivity maps were calculated from raw time series to investigate temporal stability of the sequences. To compare protocols with different TR, sensitivity maps were obtained by dividing the temporal mean image by the standard deviation over time and correcting by dividing by the square root of the TR.

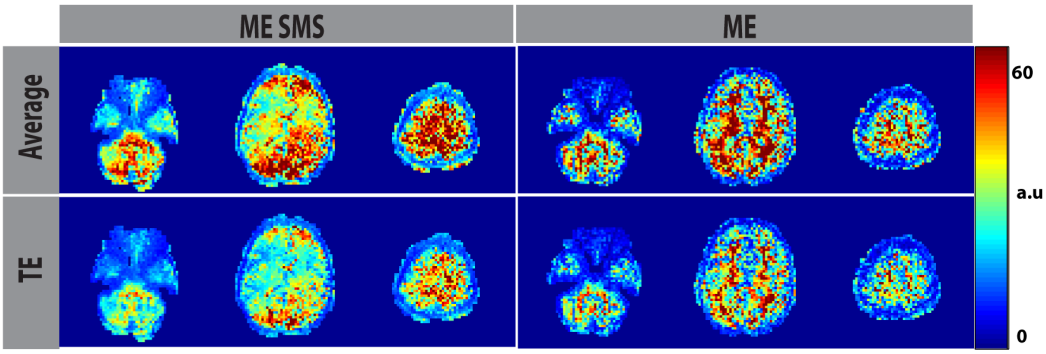

Figure 1. Sensitivity maps for a single subject. Note the improved sensitivity for ME SMS compared to ME

Results & Discussion

Figure 1 shows sensitivity maps of a single subject clearly demonstrating the improved sensitivity for SMS acquisition compared to ME. The ICA corresponding to the DMN (Figure 2) is similar for both sequences. The increased sensitivity of ME SMS appears to give a stronger representation of the IC in frontal inferior regions. As expected averaging the echoes gives higher image sensitivity than TE weighting, but in practice there is little difference between the resultant ICAs. At standard spatial resolutions where the echo train length can be kept short by the use of parallel imaging techniques, ME SMS offers a considerable improvement in sensitivity while retaining the advantages of multi-echo techniques of high sensitivity, low distortion, and the potential to acquire data over a broad range of T2* values.

Conclusion

We have implemented a high temporal resolution (0.74s) ME SMS sequence and showed that SMS acquisition improves sensitivity compared a standard ME sequence. Combining echoes by averaging might be more favorable than TE weighting at 7T for RS fMRI data.

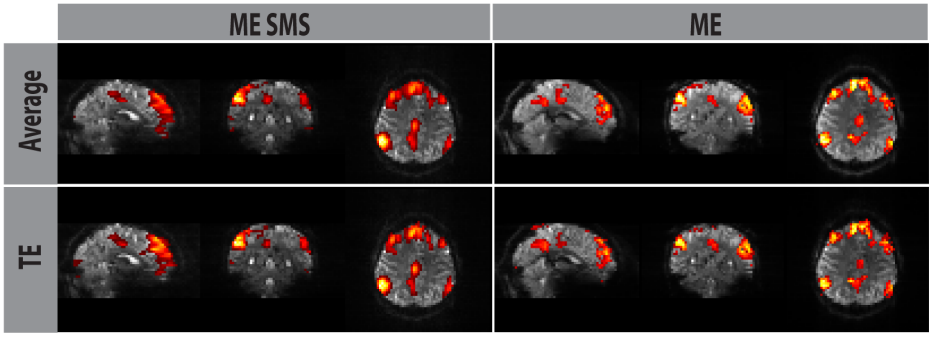

Figure 2. Default Mode Network for a single subject, similar for all cases.

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References

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