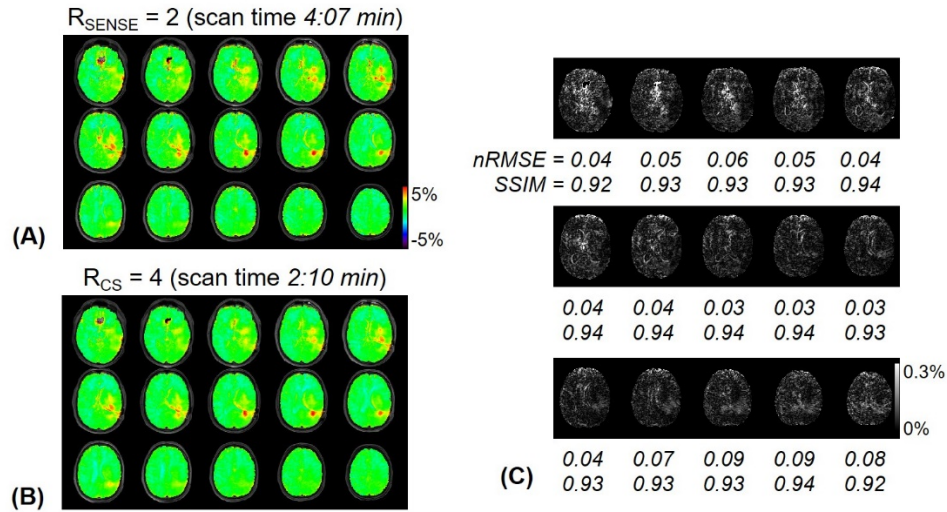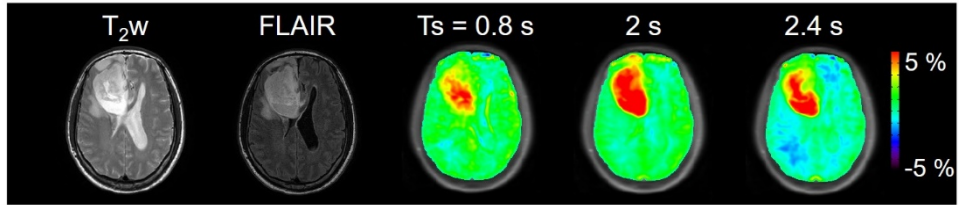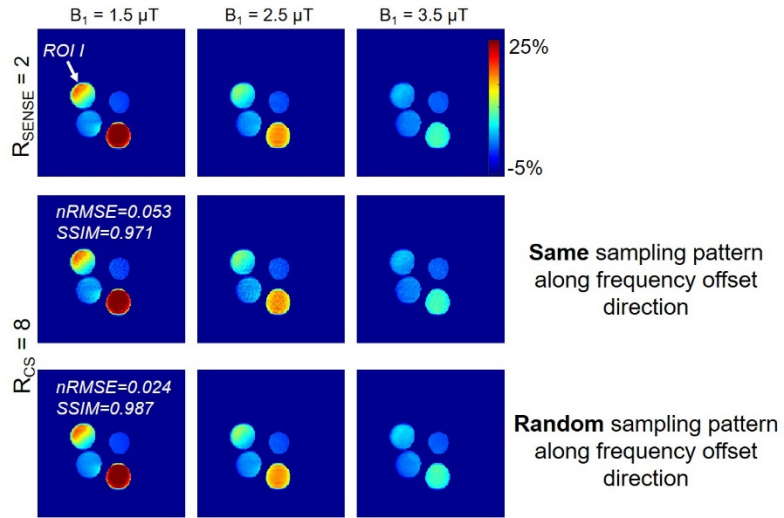**Supporting Information Figure S1.** A comparison of 3D APTw images (15 slices) from a healthy volunteer reconstructed with SENSE and CS using prospective acceleration factors of 2 and 4, respectively.
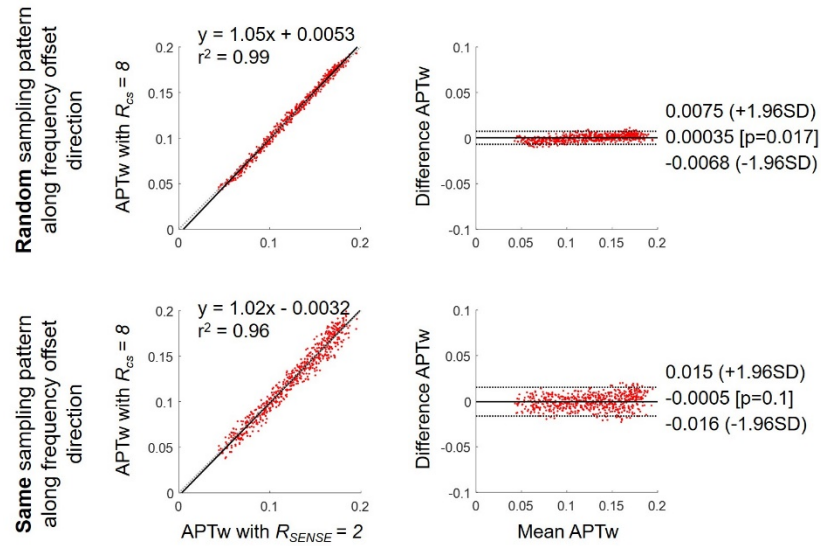
Supporting Information Figure S2. APTw images obtained for a patient with a glioblastoma using a RF saturation power of 2 µT and saturation duration of 2 sec, reconstructed by (A) SENSE (R_{SENSE} = 2) and (B) CS (R_{CS} = 4). (C) The corresponding error images (= |SENSE – CS|), nRMSE and SSIM values, from comparing the two reconstructions.

Supporting Information Figure S3. APTw images obtained for a patient with a glioblastoma using a RF saturation power of 2 µT and saturation durations of 0.8, 2, and 2.4 sec at 100% RF duty-cycle.

Supporting Information Figure S4. MTR$_{asym}$(2.5ppm) maps reconstructed by SENSE with R$_{SENSE}$ = 2 (top row) and CS with R$_{CS}$ = 8 (middle row: identical sampling pattern applied along a frequency offset direction and bottom row: random sampling pattern applied along a frequency offset direction).

Supporting Information Figure S5. Correlation and Bland-Altman plots of the MTR_{asym}(2.5ppm) signal at RF saturation powers of 1.5 µT, reconstructed from the reference standard (SENSE = 2) and CS factor 8 (top row: random sampling pattern applied along a frequency offset direction and bottom row: identical sampling pattern applied along a frequency offset direction). In the Bland-Altman plot, the mean bias is indicated by the solid black line and the 97% limits of agreement are indicated by dotted black lines.