Understanding the physical relations governing the noise navigator
Supporting Information

1 MRI measurments

The thermal noise variance modulation depth measured over the respiratory cycle for all three volunteers for all five coil positions is show in Table S1. The mean thermal noise variance modulation depth over all three volunteers agrees with the simulated effective resistance values.

15 cm coil diameter	left chest (%)	middle chest (%)	right chest (%)	middle back (%)	stationary coil (%)
Simulation	5.6	4.2	5.8	2.9	39.7
Volunteer 1	5.2	3.5	6.2	2.4	39.5
Volunteer 2	4.9	3.8	7.3	1.4	33.2
Volunteer 3	7.0	2.2	4.8	1.5	42.2
Volunteer mean (SD)	5.7 (1.1)	3.2 (0.8)	6.1 (1.3)	1.8 (0.5)	38.3 (4.6)

Table S1: The simulated effective resistance and measured thermal noise variance modulation depth (in %) for a 15 cm diameter loop coil on different positions with respect to the body.

The measured thermal noise variance curves as a function of the respiratory cycle of the two volunteers that were not shown in the main body of the manuscript are depicted in Figure S1.

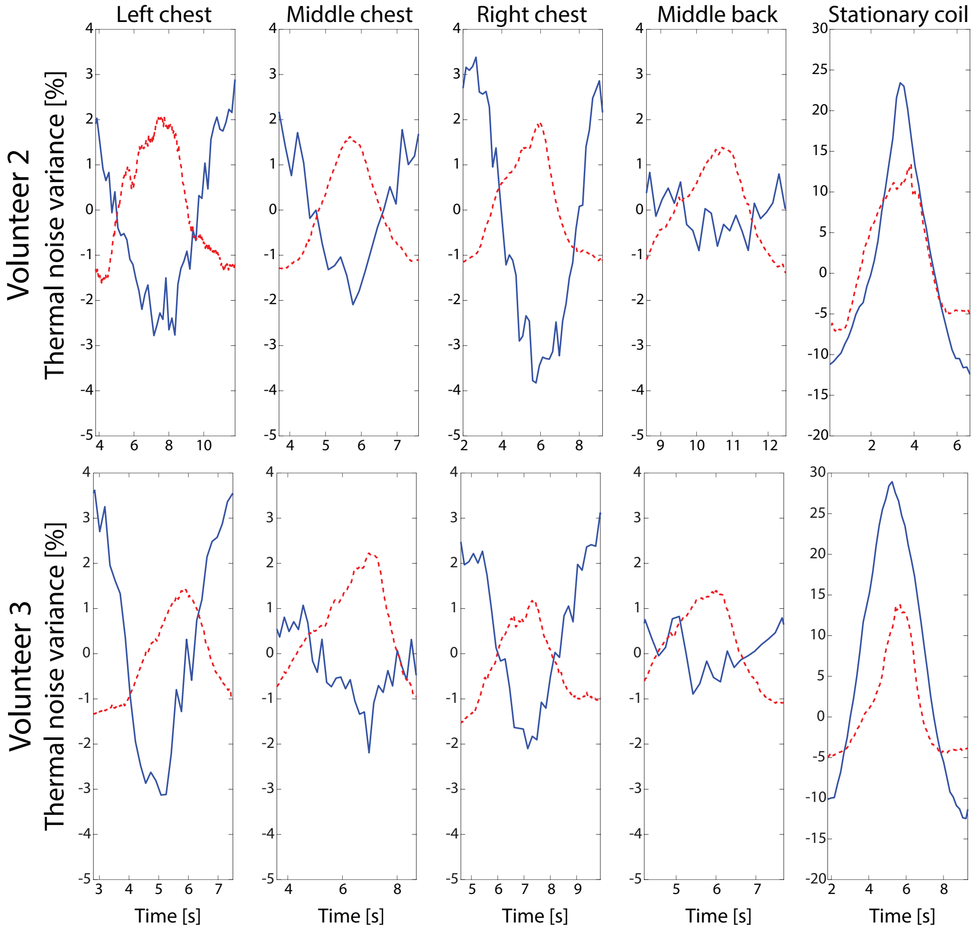

Figure S1: The thermal noise variance modulation over the respiratory cycle at multiple positions for a single coil. The upper row shows volunteer 2 and the bottome row volunteer 3. The red dashed line is the respiratory bellows signal, whereas the blue solid line indicates the thermal noise variance.

2 Network analyzer measurements

As the simulated effective resistance cannot directly be observed at an MRI scanner, but only through the thermal noise variance, additional measurements were performed to validated the simulations. Breathing experiments on four healthy volunteers were performed with a custom built 10 cm diameter loop coil (including matching circuitry) and a network analyzer. With a network analyzer the reflection coefficient of the coil was measured at 128 MHz outside the MRI scanner. Note that this measurement is an active measurement, identical to the simulation setup. The noise measurements on an MRI scanner represent the electromagnetic reciprocal case and the breathing induced modulation in the real part of the effective impedance Z_{eff} (i.e. R_{eff}) will be the same. The only difference is the measurement principle of Z_{eff}.

From the measured reflection coefficient, the real part of the effective impedance (i.e. effective resistance) could directly be calculated.

$$R_{eff} = \frac{1 - \Gamma_r^2 - \Gamma_i^2}{1 + \Gamma_r^2 - 2\Gamma_r + \Gamma_i^2} Z_0$$

where the subscripts r and i indicate the real and imaginary part of the reflection coefficient respectively. Z_0 is the reference impedance, this was equal to 50 Ω for the performed measurements.

In Table S2, the measured effective resistance modulation depths of the four subjects are shown. The mean over all volunteers (bottom row) is in line with the simulations (second row).

10 cm coil diameter	left chest (%)	middle chest (%)	right chest (%)	middle back (%)	stationary coil (%)
Simulation	7.7	3.5	6.8	1.6	50.1
Volunteer 1	7.2	4.3	6.7	2.5	50.2
Volunteer 2	8.6	3.1	6.4	2.8	42.1
Volunteer 3	9.1	2.4	6.2	1.4	43.1
Volunteer 4	8.1	3.2	7.0	1.5	46.2
Volunteer mean (SD)	8.2 (0.8)	3.4 (1.1)	6.6 (0.4)	2.0 (0.7)	45.4 (3.7)

Table S2: The simulated and measured effective resistance modulation depth (in %). The mean effective resistane modulation depth agrees with the simulated values.

The measured effective resistance as a function of the respiratory cycle for volunteer 1 is shown in Figure S2.

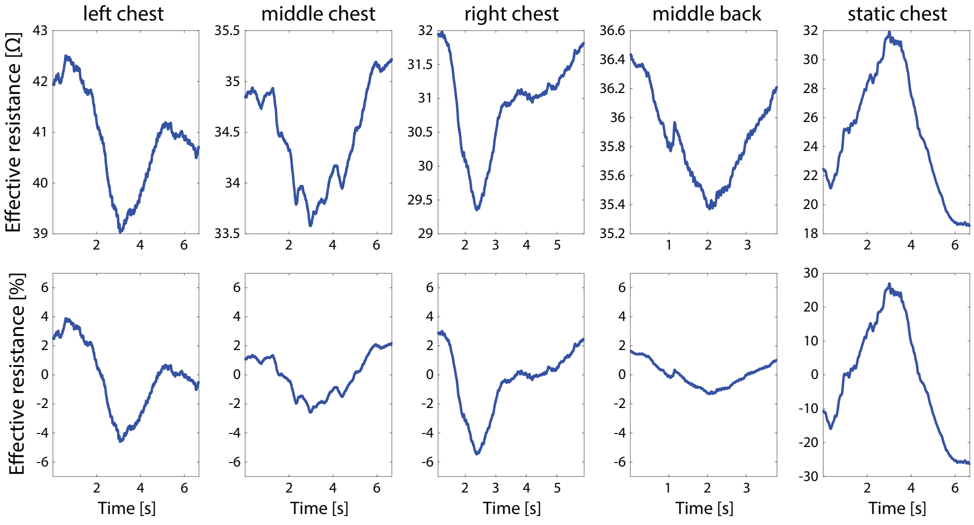

Figure S2: The measured effective resistance (upper row) and effective resistance modulation (bottom row) measured with a network analyzer for a representative volunteer.