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### **Supplemental Information**

### **Entrainment of Arteriole Vasomotor Fluctuations**

#### by Neural Activity Is a Basis of Blood-Oxygenation-

### Level-Dependent "Resting-State" Connectivity

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#### **Supplemental Data**

#### **Captions for Supplemental Figures**

# Figure S1, related to figure 1. Illustration of amplitude modulated neuronal activity and the envelope extracted from that activity.

The signal is synthesized as  $(1 + m_1\eta_1(t)) \cdot \cos[2\pi (1+m_2\eta_2(t)) f_\gamma t]$  where  $\eta_1(t)$  and  $\eta_2(t)$  are time series formed by filtering Gaussian noise, with unity variance, through a 13-th order 0.1 - 0.2 Hz band pass filter,  $f_\gamma = 55$  Hz, and the modulation depths are  $m_1 = 0.2$  and  $m_2 = 0.001$ . The spectrum was computed with a bandwidth of 0.5 Hz. The modulation of the g-band signal exists as side-bands surrounding the peak near  $f_\gamma$ ; the low-frequency components of the envelope appear after demodulation of the signal. The spectrum of the envelope was computed with a bandwidth of 0.05 Hz.

# Figure S2, related to figure 2: The coherence between power in the $\gamma$ -band and the diameter of an arteriole (Fig. 2c,d) as a function of the fraction of time that mice whisked during the epoch.

We used 100 s rather than 600 s epochs for this data only to accentuate differences in whisking. The animals (2 mice) were not involved in an active sensory task per se. Whisking was assessed via the signal from EMG electrodes in the mystacial pad. A regression shows that there is no systematic trend, i.e.,  $|C| = 0.56 \pm 0.02 + (0.057 \pm 0.240) \bullet F$ , where *F* is the fraction of time whisking. The distribution across top shows the probability of whisking for different fractions; the colors indicate the animal and the black line is the combined distribution.

#### Figure S3, related to figure 2: Successive epoch from one mouse.

(A-F) We show the spectrogram of the LFP and the time series of the power in the  $\gamma$ -band and the diameter of an arteriole (Fig. 2c,d) for each of six epoch recorded across three days.

# Figure S4, related to figure 5: Coherence at low frequency of vessels in C57/BL6J mice and I/LnJ mice regardless of the rostro-caudal and lateral functional distances.

A. Coherence at low frequency of transhemispheric vessel pairs

The red and grey dots show the low-frequency coherences between transhemispheric arteries respectively in C57/BL6J and I/Lnj mice. The light and dark blue dots are the low-frequency coherences between veins respectively in C57/BL6J and I/Lnj mice. The right panel shows the distribution of the low-frequency coherence for the different of vessel pairs.

**B.** Same as panel A for intrahemispheric vessel pair.

# Figure S5, related to figure 5: The coherence between the $\gamma$ -band power across pairs of LFP electrodes.

**A.** Schematic of the set-up. Each hemisphere had two bipolar electrodes spaced 2.0 mm apart, arranged as mirrored pairs across the midline that were separated by 6.0 mm, for a total of eight wires plus reference.

**B.** The coherence between  $\gamma$ -bands averaged for both mirrored and diagonal transhemispheric pairs as well as the intrahemispheric pair. Note the significantly higher coherence for the mirrored pair at all frequencies; the bars are the average values.

**C.** Compendium of seven trials across three animals for the magnitude of the coherence at 0.1 Hz.

# Figure S6, methodology related to figures 2 through 4: Two-photon imaging combined with optogenetic stimulation.

**A.** Optical set-up for two-photon imaging and Channelrhodopsin-2 wide field stimulation. The divergent beam of the blue fiber-coupled laser (Obis 445 nm) is adjusted by a pair of lenses before entering the collection pathway via a dichroic mirror. The telescope formed by the 200 mm lens and the Zeiss 20X objective (NA 1.0) provide wide field illumination of the thinned-skulled window.

**B.** Optical set-up for two-photon imaging and Halorhodopsin focal illumination. The collimated beam of an orange laser (Bob Laser 599 nm) was introduced in the collection path via a dichroic mirror. A beam expander is formed by a 50 mm lens and the 200 mm lens of the collection pathway. The Zeiss 20X objective (NA 1.0) provides focal illumination of smooth muscle arteries.







Figure S3, related to Figure 2. Mateo, Knutsen, Tsai, Shih & Kleinfeld 2017







TPLSM excitation / channelrhodopsin (field illumination) excitation / fluorescence detection pathway

TPLSM excitation / halorhodopsin (focal illumination) excitation / fluorescence detection pathway

