***Figure S1****.* ***Illustration of the various phase distributions of the significant sensor-time-frequency points from one participant.*** *The scalp topographies express the t statistic (slow breathing vs. fast breathing) at given time-frequency points. Significant sensors are highlighted in red. For both the slow- (top panel) and fast-breathing (bottom panel) conditions, each circular histogram depicts the phase distribution from one of the significant sensor-time-frequency points (white circle).*

***Figure S2****.* ***Illustration of the merit of phase-difference histograms in detecting consistent******phase dynamics embedded in simulated data sets.*** *Dataset 1 was generated from a combination of 25000 phase samples randomly selected from –π/4 to π/4 and the other 25000 samples with the opposite angles. Dataset 2 was generated by rotating Dataset 1 by π. The circular histograms depict a bimodal pattern of the phase distributions in Dataset 1 (left top panel) and Dataset 2 (middle top panel), but the pattern disappears when the phase data are pooled together (right top panel). The horizontal histograms depict the distributions of absolute phase differences, which were obtained by calculating phase distance in each pair of phase samples in Dataset 1 (left bottom panel) and Dataset 2 (middle bottom panel). By contrast, after pooling absolute phase differences from Datasets 1 and 2, the phase-difference distribution (right bottom panel) retains the bimodal pattern embedded in each data set. Although in real data, phase distributions are not limited to any specific mode as shown in Fig. S1, this simplified simulation aims to elucidate how phase differences are more suitable than phase histograms for detecting the presence of a consistent pattern revealed from a pool of data sets (each data set can be viewed as a set of phase samples across trials at a given sensor-time-frequency point) because this measure assesses the relation between phase samples in a relative manner.*

******

******

***Figure S3****.* ***Distinct phase patterns driven by slow and fast breathing within individual participants.*** *The horizontal histograms depict the distributions of absolute phase differences collapsed across all data points in the significant cluster window from the remaining 14 participants during the slow- (top panel) and fast-breathing (bottom panel) conditions. The linear regression lines are shown in red. \*\*p < 0.01. \*\*\*p < 0.001.*

***Figure S4****.* ***Replication of the distribution of absolute phase differences during the slow-breathing condition using independent data.*** *Although the results statistics of our subsequent findings during the slow-breathing condition are irrelevant to the criteria for defining the significant cluster window shown in Fig. 1a, to further prevent circular inference,* i.e.*, the same dataset for both region-of-interest (ROI) definition and subsequent ROI analysis, we used an independent data set within the reported significant window to reproduce the findings. These slow-breathing data were derived before the group-level data-selection step (Fig. 1f) and therefore can be regarded as independent because they were not chosen to contrast with the fast-breathing data. For the same sub1 and sub 2 shown in Fig. 5b, there was an increasing number of trial pairs whose phases were moving from each other (t-test on the slope of the regression line, t(18) ≥ 8.68, p < 0.001). The same results were obtained for the remaining 12 participants (ts ≥ 3.58, ps ≤ 0.002), except for one participant whose distribution did not significantly change according to the phase difference (t(18) = 1.07, p = 0.30). \*\*\*p < 0.001.*