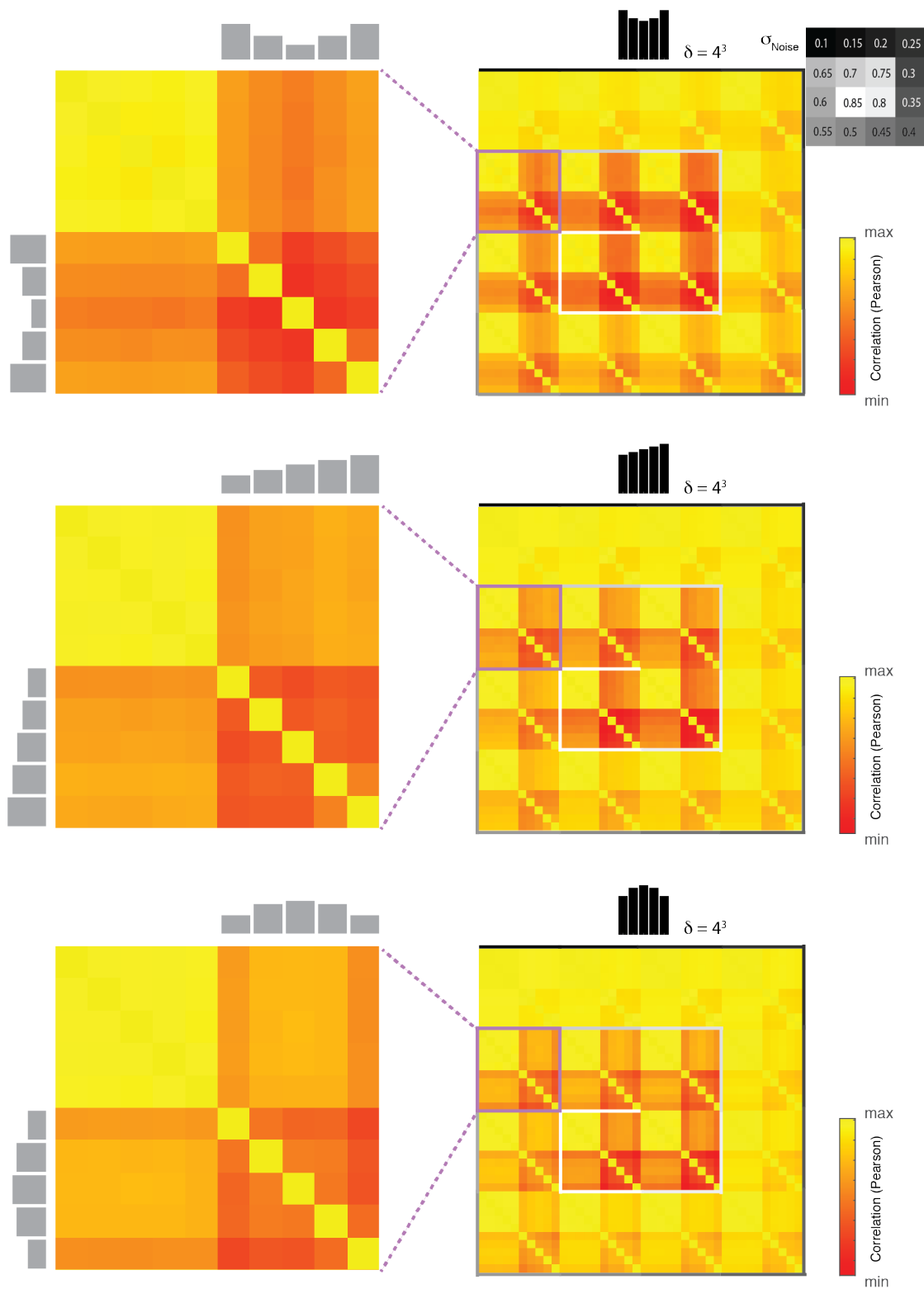# Supplementary Material

Supplementary Figure 1. *Signal-to-Noise effects on empirical correlation matrices.* The three shell-plots shown on the right-hand column correspond to the exact same shell-plots presented in Figures *4b* (Simulation 3), *5a* (Simulation 4), and *5b* (Simulation 5) for the

network density level $\delta = 4^3$. See figure caption 4 for details regarding the layout of each shell-plot. Crucially, all results reported here were obtained in the absence of data-demeaning. Highlighted within each shell-plot by a purple square is, in each case, the augmented LOSO matrix associated with the 12th simulated noise level (σ_{noise} = 0.65). Simulation results prescribing a positive-quadratic bias in signal strength across experimental conditions are shown in the top row, a linearly bias in the middle row, and a negative-quadratic bias in the bottom row. Each of the agLOSO matrices ensquared in purple in the right-hand column are reproduced after four-fold magnification in the left column. A good example of SNR-effects on RSA can be noted for the negative-quadratically biased case (top row). Note the vertical stripes in the upper-right quadrant of the agLOSO matrix shown in the left column. The correlation values associated with these stripes oscillate from high-to-low-to-high values. A similar tendency is discernible also in the bottom-left quadrant of this agLOSO matrix; however, the stripes are now horizontally oriented. This is the case because the 1st and 3rd quadrants of the agLOSO matrix are transposed versions of each other. The gray bar-plots beside each agLOSO matrix highlight the trend of these correlation-values, which qualitatively match that of the signal-strength associated with the five experimental conditions simulated here. Note the agreement observed between gray and black barplots witin each row. The black barplots shown at the top of each shell-plot indicate the form of signal bias prescribed for each simulation. SNR-effects qualitatively similar to those observed in the three agLOSO-matrices shown in the left column can be noted regardless of noise-level in the corresponding shell-plots shown immediately or the right. Note that SNR-effects consistent in nature with those observed in the positive-quadratic case are evident for the linear (middle row) and negative-quadratically biased cases (bottom row). These observations show that, while relatively subtle compared to the biases observed after data demeaning, signal imbalances across conditions generally influence RSA analyses even in the absence of data demeaning.

Glossary

Acronym	Definition	Further information
agLOSO matrix	augmented LOSO matrix	Square matrix constructed by concatenation of four (# of conditions) by (# of conditions) square matrices. The 1st and 3rd quadrants, which are transposed versions of each other, reflect across-subject similarities of the experimental conditions under investigation. The remaining two quadrants reflect within-population and within-subject similarities. See Results, sub-section 2.1 for further details.
CV	Cross-Validation	
cv	cross-validated	
cvLORO	Leave-One-Run-Out, cross-validated	
cvLOSO	Leave-One-Subject-Out, cross-validated	
cvLOSO-RSA	LOSO cross-validated RSA, distance measure unspecified	k-fold cross-validation scheme were the data from one run from one single subject is left out for validation and data from the remaining runs is used for training of, for example, a classifier
cvLOSO-RSA$_{corr}$	LOSO cross-validated RSA, Pearson correlation used as measure of pattern similarity	See Methods, sub-section D for further information as well as a precise step-by-step specification of this data analysis method here. Note: method is identical to that referred to as "LOPO" by other researchers in the literature.
cvLOSO-SVC	LOSO cross-validated Support-Vector Classification	See Methods, sub-section A for further information
eSM	empirical Similarity Matrix	Roughly equivalent to the concept of an RDM computed on empirical data, see note 2 for further information
GF	Gain Field	Set of positive real numbers in the interval [0, 1] encoding the gain factor associated with each of a set of measurement channels
LOPO	Leave-One-Person-Out (*)	Term used by some researchers in the literature to refer to the across-subject analysis method referred to here as cvLOSO-RSA$_{corr}$. See Methods, sub-section D for details
LORO	Leave-One-Run-Out	
LOSO	Leave-One-Subject-Out	See Methods, sub-section D for details
mSM	model Similarity Matrix	Roughly equivalent to the concept of an RDM derived from a quantitative or conceptual model, see note 2 for further information
MVPA	Multivariate Pattern Analysis	
RDM	Representational Dissimilarity Matrix	Roughly equivalent to the concepts of either eSM or mSM as used here. See note 2 for further information
RSA	Representational Similarity Analysis	
SNR	Signal-to-Noise Ratio	