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Supplemental Data

Abstract Coding of Audiovisual Speech: Beyond Sensory Representation

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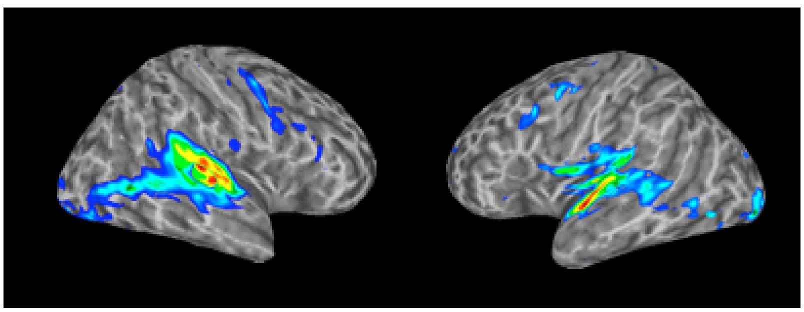
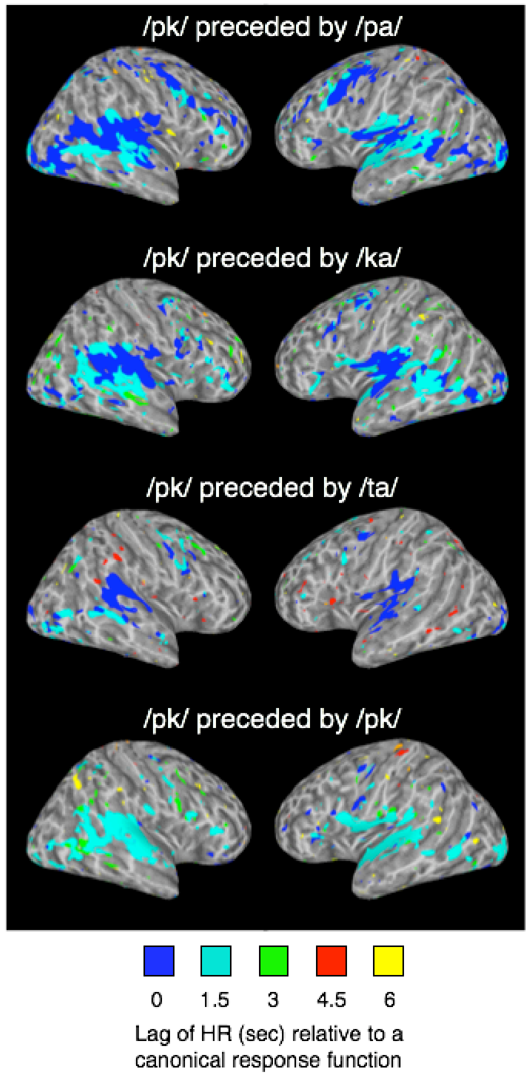
Figure S1. Brain Regions Showing Reliable Neural Activity for the Target Audiovisual Syllable /PK/, Collapsing over Preceding Context



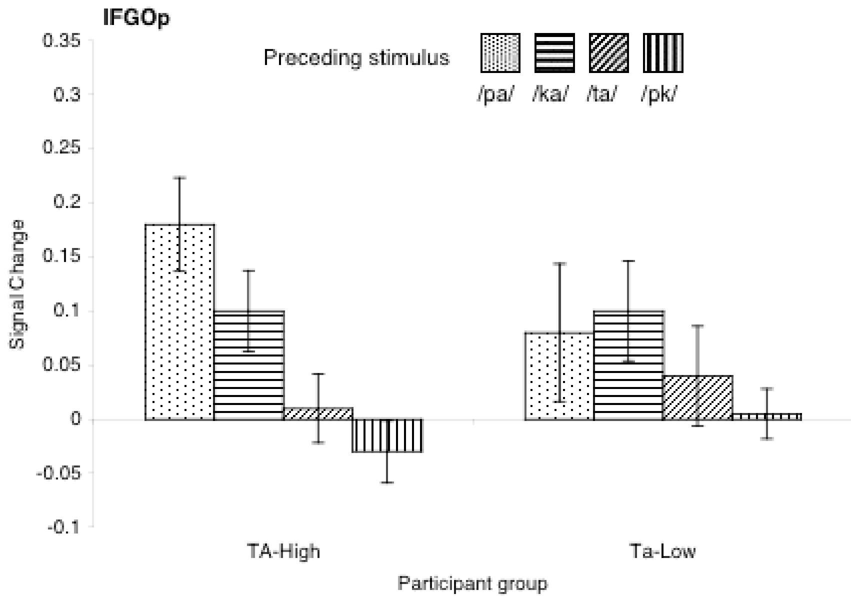
The hemodynamic response function for the target /PK/ was estimated using deconvolution for each voxel, and projected to a surface representation. Sensitivity to PK was operationalized as a systematic change in BOLD signal in a voxel (across participants) during target presentation. Individual voxel thresholded at $P < .001$, uncorrected for multiple comparisons.

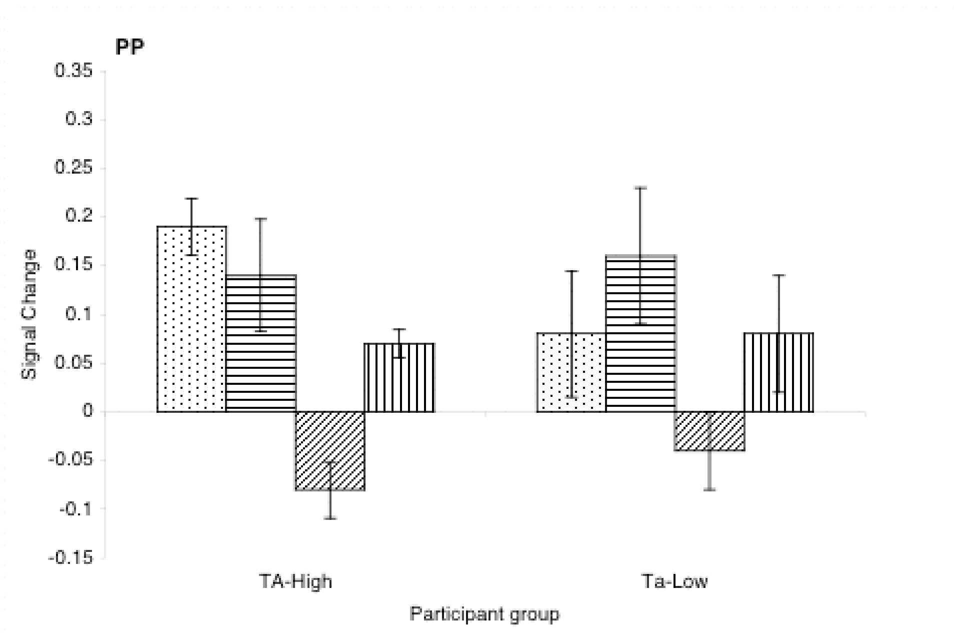
Figure S2. The Effects of Preceding Context on Extent and Delay of Activity for the Target /PK/



We employed a cross correlation function to identify voxels in which neural activity reliably correlated with a typical hemodynamic response function. The figure presents all voxels where the absolute value of the correlation exceeded .70 (p = .01; all visible voxels). The cross correlation function also established the relative delay at which this correlation was maximal (shown in colors of ascending warmness). Lag ‘0’ indicates a hemodynamic response peaking within ~ 4.5 seconds.

Figure S3. Repetition Patterns for TA-High and Ta-Low Perceivers in IFGOp and PP





Data for IFGOP and PP areas identified in the main analysis were re-analyzed by partitioning them on the basis of the classification to TA-Low and TA-High perceivers (note that 3 participants were not classified into either group, see Experimental Procedures). In IFGOp, TA-High perceivers demonstrated a strong abstract-repetition pattern whereas TA-Low perceivers demonstrated a weaker pattern, and less differentiation between the /pa/, /ka/ and /ta/ context conditions. In PP, a similar pattern was found for TA-High perceivers. The data for TA-Low perceivers shows greater variance. However, only 4 participants in this group demonstrated reliable activity in the region.

Establishing Probability for Finding an Abstract Repetition Pattern in at Least One Region of Interest

1. We define an abstract-level repetition pattern as holding for a given area when four comparisons are reliable (all contrasts needed to be reliable at $p < 0.05$, two-tailed t test and satisfy the directionality constraint):

a. pk after ta (pk/ta) shows reliably less activity than pk/pa,

b. pk/ta shows reliably less activity than pk/ka,

c. pk/pk shows reliably less activity than pk/pa,

d. pk/pk shows reliably less activity than pk/ka.

Because the four contrasts were not independent, we estimated the chance probability of finding an abstract-repetition pattern by performing Monte-Carlo simulations, for each ROI, that adjusted for the covariance structure of the four conditions in the region. Specifically, the following procedure was applied to each of the 17 ROIs. In the initial step, we computed the covariance matrix of the four conditions in the ROI. Using this covariance matrix we then carried out simulations (n = 100,000) where each simulation consisted of the following steps:

a. We sampled from a multivariate normal distribution (MVN) that was generated using the covariance matrix we had computed, so that the MVN had the same dependency structure as the empirical data. The sample obtained from the distribution had the same structure as the data in the region (i.e., 4 columns and as many rows as participants contributing data to each region). This sampling was performed using the 'mvrnorm' function of the R/S statistical languages, which produces samples from a simulated MVN distribution that is constrained by the covariance matrix of the variables (Ripley, 1987).

b. For these sampled 4 columns (simulating the 4 conditions) we examined if the four t tests of interest were reliable (i.e., tests a, b, c and d above)

c. If all four tests held, a counter was increased by 1.

The simulations revealed that in no region did the probability of finding an abstract-repetition pattern exceed $p = 0.00054$ (i.e., 54 times of 100,000).

Assuming a probability of $p = 0.00054$ for the chance occurrence of the pattern in any given test, we used the binomial test to determine if finding one or more ROIs showing an abstract repetition differs reliably from chance.

The binomial probability is given as

$$P_{(\text{k out of n})} = \frac{n!}{k!(n-k)!}(p^k)(q^{n-k})$$

where n is the number of opportunities for finding the result (number of search regions), k, is the number of times the result occurred, p is the probability of the result occurring on any particular test, and q is the probability that the result will not occur on any particular test.

The probability of finding an abstract repetition pattern in any single test (p) is 0.00054

The parameters are therefore:

$n = 17$

$k = 1$

$p = 0.00054$

$q = 1 - 0.00054$

The estimated probability is .0091, indicating a very low likelihood that one or more regions would manifest an abstract-repetition pattern by chance.

Supplemental References

Ripley, B.D. (1987). Stochastic Simulation (New York: Wiley).