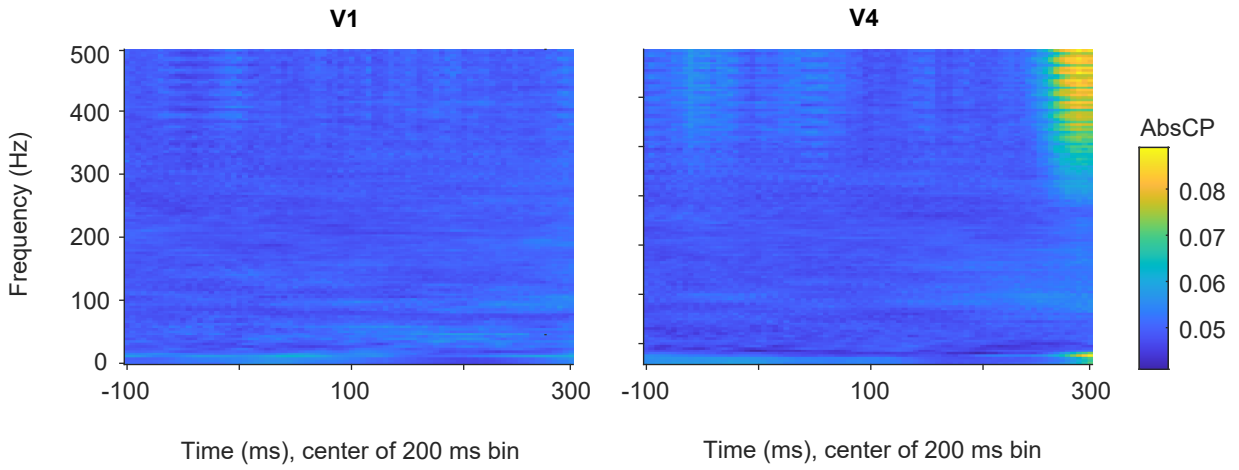
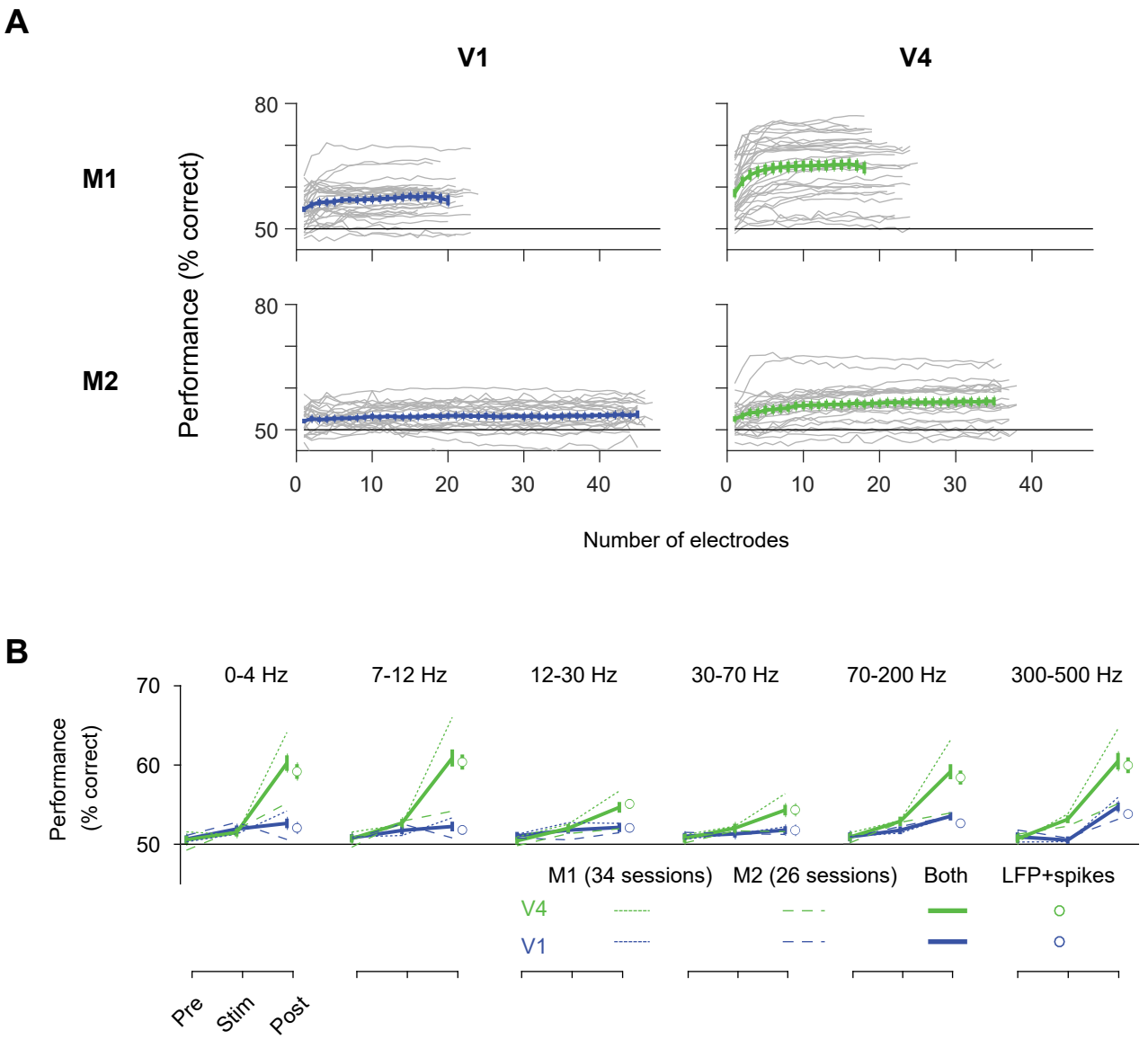


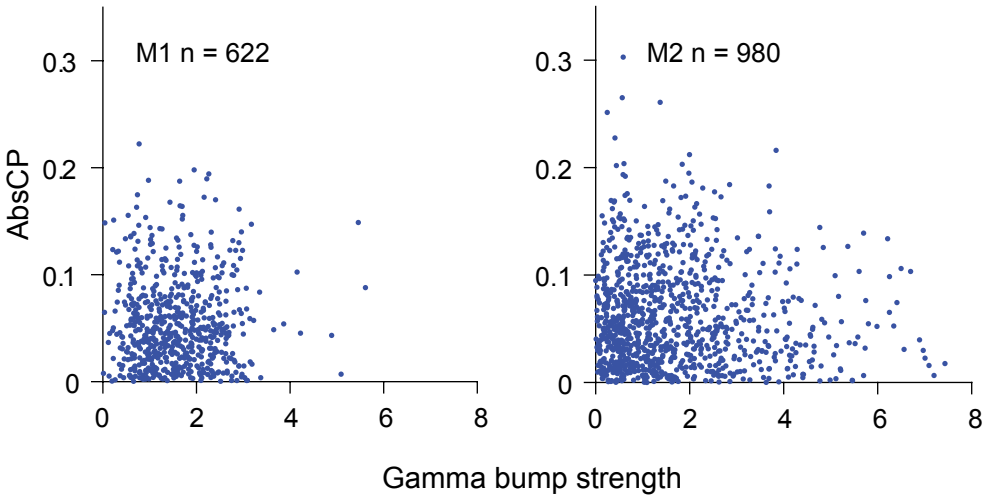
Supplementary Figure 1 – Choice signals in the induced LFP

The analyses in the main text were performed on the raw LFP, which includes both a transient evoked potential locked to stimulus onset, and ongoing and induced signals. To test the importance of the stimulus-evoked LFP component to our findings, we calculated absCP using power in the induced LFP. Specifically, for each electrode we calculated the evoked LFP as the average signal across all trials. We then subtracted this signal from the LFP measured on each trial, and calculated power and choice information as described in the main text. This figure shows the resultant absCP values for V1 (left) and V4 (right), as a function of time and frequency. These results can be compared to those presented in Figure 4 of the main text. We note three primary features: (1) All of the basic features evident in the raw signal are also apparent in the induced signal: choice signals are stronger in V4 than V1, are strongest in the post-stimulus epoch, and are notably weaker in the gamma range than in low or high frequency components of the LFP. This similarity in outcome for the raw and induced signal might be expected since choice signals are strongest near the end of the trial, when the stimulus-locked LFP transient is minimal. (2) The absCP values are weaker in the induced signal than in the raw LFP. (3) The weak choice signal apparent in in the high frequency components of the raw LFP during the stimulus epoch are absent in the induced signal.



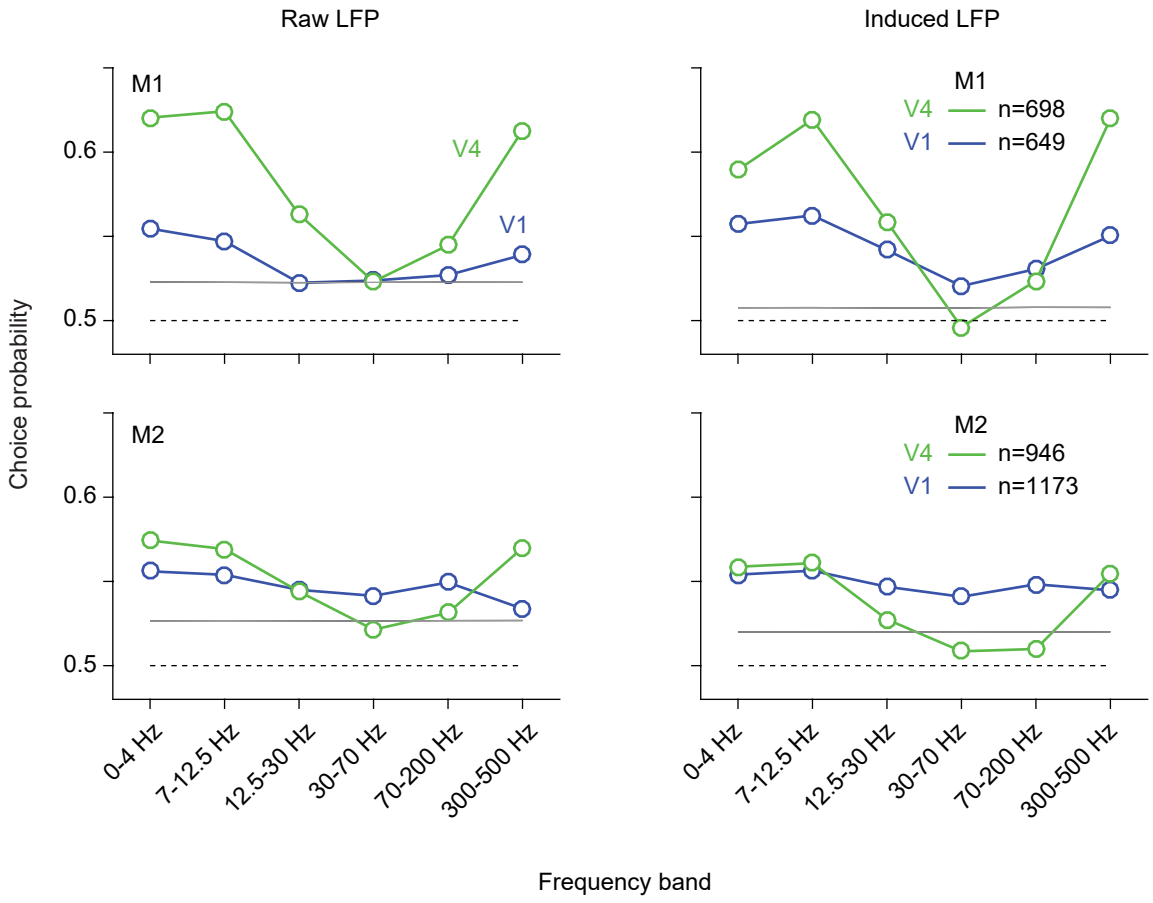
Supplementary Figure 2 – Choice signals decoded using linear discriminant analysis

(A) Predictive performance for choice using LFP power in the 300-500 Hz range for V1 (left) and V4 (right). Performance is shown separately for M1 (top) and M2 (bottom). Performance is shown as a function of the number of electrodes considered in the decoding. Thin gray lines show the performance for each session (up to the maximum number of electrodes available for that session). Colored lines show the average across sessions. Note that peak performance is reached for a small number of electrodes. (B) Performance as a function of frequency band, epoch, and area, for the full set of available electrodes, following the conventions of Figure 7 in the main text. Open symbol shows the performance of LDA applied to LFP power and spiking activity, both measured in the post-stimulus epoch. Methods: We performed identical preprocessing steps to those used for logistic regression (Figure 7). We then performed LDA using LFP power as well as LFP power and simultaneously available spiking activity. Performance was measured using 10 fold cross-validation. Model fitting was performed, on average, with 143±7 and 106±6 trials in M1 and M2, respectively. We varied the strength of regularization to test LDA performance as a function of the number of predictors. That is, the performance vs population size plots all involved using the full set of predictor variables, but the contribution of some variables was set to zero because of regularization.



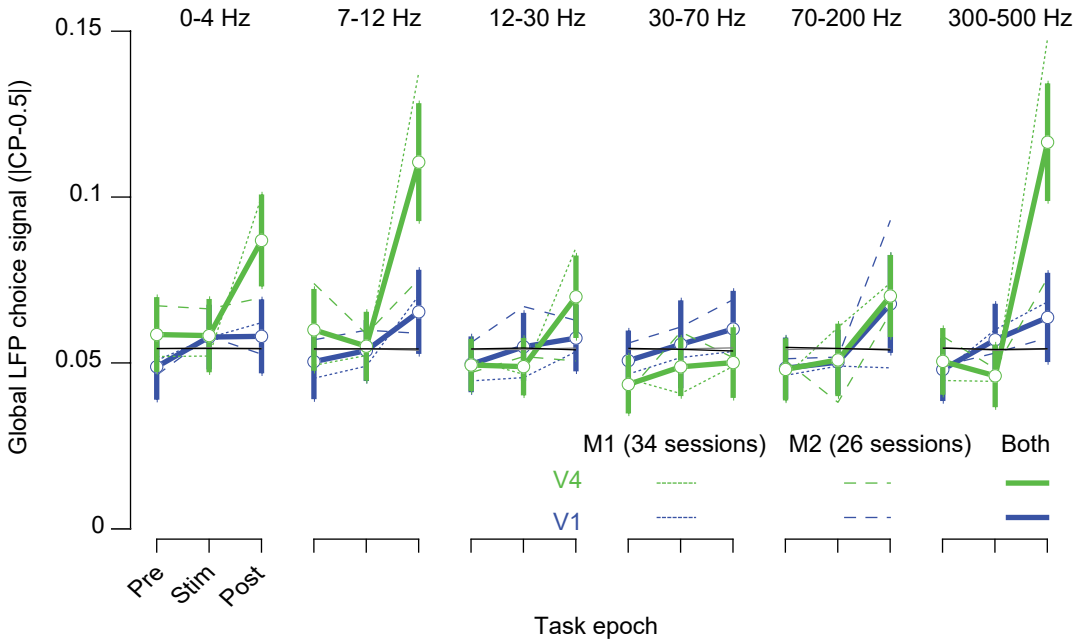
Supplementary Figure 3 – Choice signals in the LFP gamma 'bump'

In the average power spectra of V1 LFPs for M1, we observed a distinct bump in the gamma range in the stimulus and post-stimulus epochs (Figure 2). This is entirely expected given that our task involved large, high contrast stimuli (Jia et al., 2011, 2013; Ray and Maunsell, 2011). In M2, we also observed a distinct bump in V1 LFPs, but at a higher frequency range. In both animals, LFPs recorded on many but not all electrodes had a clear bump (with a shape and frequency range consistent with the average). In previous work (Jia et al., 2011), we showed that broadband power in the gamma range has distinct properties from power in the spectral bump. We therefore tested whether power in the bump contained choice information. Supplementary Figure 3 shows the strength of choice signals in the spectral bump for M1 (left) and M2 (right), in the post-stimulus epoch. There was no correlation between the mean bump strength and the magnitude of abs CP (r=0.02 in M1, r=-0.05 in M2). In addition, the average absCP based on bump power (0.055±0.002 in M1, 0.061±0.002 in M2) was similar to the values presented in the main text (Figure 4). Since there was no obvious spectral bump in V4, we could not conduct a similar analysis there. We conclude that the power in the spectral bump does not contain strong choice information. Methods: We adopted the approach of Jia et al. (2011) to quantify bump power on each electrode. Briefly, we fit the average power spectrum (across all trials and electrodes) with a decaying exponential function and defined the bump frequency range as the range in which the average spectra were consistently different from this fit (43-66 Hz in M1, 70-125 Hz in M2). We then quantified the bump power on each electrode and trial as the deviation between the exponential fit for that electrode and observed spectra in the defined range. We only considered electrodes with average bump power greater than 0 for further analysis, excluding electrodes which only had broadband power in the identified range.



Supplementary Figure 4 – Similarity of choice signals in different frequency bands

To assess the similarity of choice signals in different frequency bands, we performed the following analysis on responses measured in the post-stimulus epoch. First, for each electrode, we defined the sign of choice probability (i.e. whether horizontal or vertical trials involved more power) such that the first frequency band (0-4 Hz) had a choice probability value greater than 0.5. We then adopted this sign convention for the remaining frequency bands. Finally, we averaged the choice probability values across electrodes. This figure shows the resultant average choice probability values for the raw (left) and induced (right) LFP, for monkey 1 (top) and 2 (bottom), as a function of frequency. SEM are smaller than the symbols indicating the mean values. Chance performance is shown by the dashed black line. The upper bound of the 95th percent confidence interval for the shuffled data are shown in gray and black for V1 and V4, respectively (lines overlap). Choice signals are evident in most frequency bands, except gamma frequencies. Choice probabilities are consistently greater than 0.5, indicating that choice signals have a similar relationship to choice across a broad range of frequencies.



Supplementary Figure 5 – Choice signals in the global induced LFP

We calculated the global induced LFP by first, for each electrode, subtracting the trial-averaged LFP response (the evoked response) from the LFP recorded on each trial. Then, for each trial, we averaged the resultant LFPs (induced LFPs) across electrodes. Finally, we calculated the power of the global induced LFP on each trial and measured its relation to choice. This figures shows the absCP in the global induced LFP as a function of frequency, brain area, and trial epoch. The choice signal evident in the global induced LFP is similar to that evident in the global LFP, shown in Figure 11 of the main text.