Key points:

1. To test whether brain activity could forecast time allocation at market scale, we combined neuroimaging with a behavioral task to forecast engagement with videos in an internet attention market (i.e., youtube.com).
2. Whereas activity in brain regions implicated in anticipatory affect (NAcc, AIns) and value integration (MPFC, PCC) predicted individual choices to start and stop viewing videos, only activity in regions implicated in anticipatory affect at video onset (but not during video choice) forecast video view frequency and view percent on the internet.
3. While only brain activity at video onset forecast video view frequency, both brain activity at video onset and behavior forecast video view percent on the internet.
4. Together, these findings suggest brain activity can reveal “hidden information” capable of informing forecasts about time allocation in attention markets.

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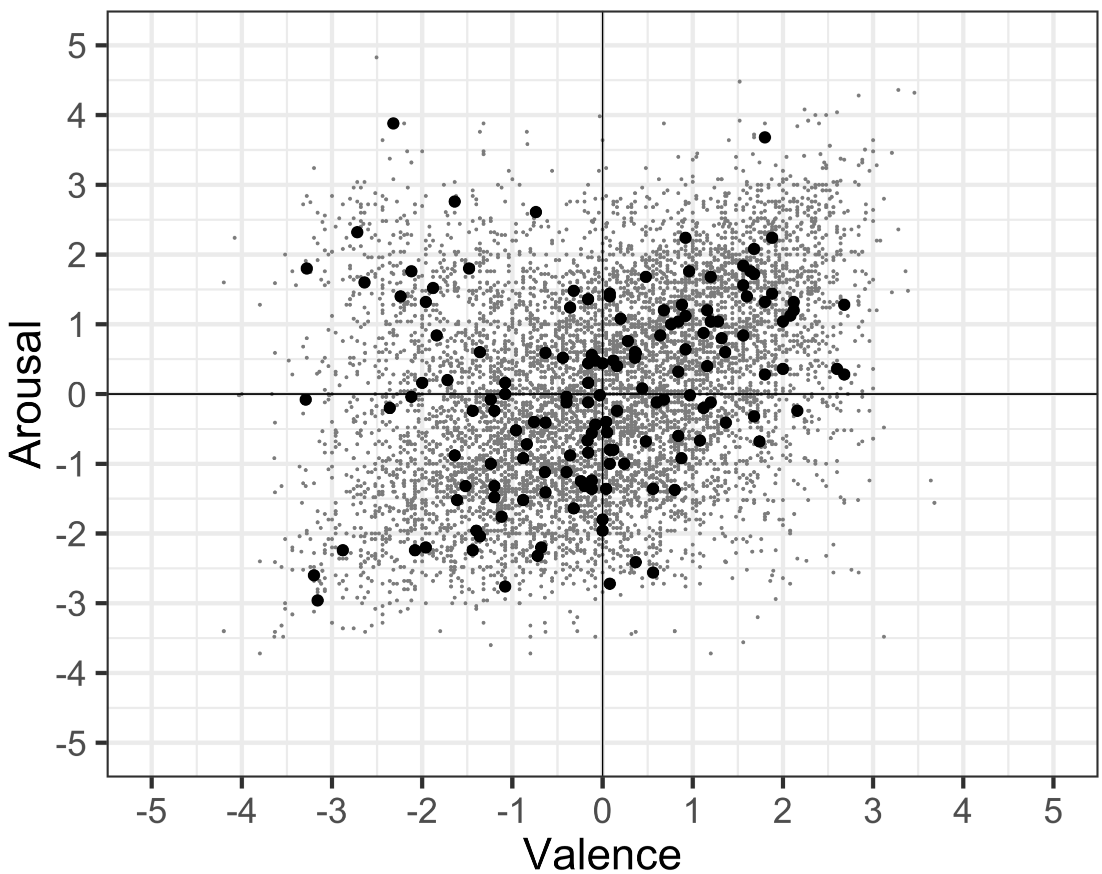
SI Appendix 1: Stimulus selection methods and results.

We initially identified three YouTube channels (National Geographic, Animal Planet, and Discovery) featuring relatively homogenous content and publicly available views and view duration data for all videos. We then used the YouTube Application Program Interface (API) to obtain metadata (including link, views, video posting date, YouTube labeled category, description, video thumbnail link, total duration) for all videos shorter than 3 minutes posted on the selected YouTube channels, yielding a total of 11124 videos. Next, two raters categorized the content in the video thumbnails as containing one human face, one place, one nonhuman animal, or something else. Of the videos, we selected 2950 videos for which both raters categorized the thumbnail as depicting one human face, or one place. These 2950 thumbnails were then presented to Amazon Mechanical Turk (MTurk) workers, each of whom rated 25 thumbnails on six-point Likert scales to indicate: (1) how clear the thumbnails were; (2) experienced affective valence; (3) experienced affective arousal; and (4) whether they would want to watch the video. At least 5 of each of these four ratings were obtained for each video thumbnail and averaged.

We then used selenium (seleniumhq.org) to dynamically access javascript elements embedded in the YouTube pages and extract daily view count, daily view duration, shares, likes, and dislikes for each of the 2950 thumbnailed videos. For stimulus selection, we were able to match aggregate data from Youtube statistics to 1377 of the 2950 rated videos we randomly sampled. This video database was split between videos that had thumbnails containing faces and those that had thumbnails containing places. For these videos, we randomly sampled sets of videos 32 at a time for 500 iterations. Rated positive arousal, negative arousal, and view duration metrics were normalized prior to sampling. For each random sample, we calculated the sum of standard deviations of all three metrics and picked the random sample out of 500 iterations that had the largest total standard deviation across all three metrics. Since this process was applied to video thumbnails containing both faces and places, it yielded 64 sampled videos that had high variation in positive arousal and negative arousal ratings for their thumbnails (Figure S1), as well as in average view duration. The goal of this process was thus to sample the initial stimulus set down to a group of videos with high variation across all three metrics.

For prediction of aggregate outcomes, we used in-lab self-reports of valence and arousal after viewing videos associated with the thumbnails, rather than the thumbnail ratings collected in the MTurk sample. In the selected subsample of videos, positive arousal correlated 0.058 with aggregate view frequency and 0.020 with aggregate view percentage, whereas negative arousal correlated -0.053 with aggregate view frequency and -0.087 with aggregate view percentage. In the full video sample with MTurk ratings, positive arousal correlated 0.067 with aggregate view frequency and 0.049 with aggregate view percentage, whereas negative arousal correlated 0.044 with aggregate view frequency and 0.092 with aggregate average view duration. We verified the representativeness of the final subsample of videos by comparing the statistical properties of the subsample with the population (SI Appendix 2).

Figure S1. Affective ratings of pilot video thumbnails. In an online pilot study, video metadata was collected for 2950 videos on YouTube. Video thumbnails for these videos were then rated with respect to affective valence and arousal by 5 MTurk workers each. Large black points represent MTurk affective ratings for the 32 videos selected for use in the neuroimaging study, whereas gray points represent affective ratings for unselected videos.



SI Appendix 2: Aggregate view percent outliers

Two data points In Figure 3 appear as influential in the bivariate relationship between average AIns activity and Aggregate View Percent. This may be due in part to the videos in question being outliers with respect to AIns activity, or outliers with respect to aggregate view percent. With respect to AIns activity, the points on the horizontal axis already represent averages across all participants after removing volume acquisitions that exceeded 4 standard deviations of the average AIns activity, suggesting that they are not driven by a small number of influential AIns responses.

To address the possibility that the two influential videos were not representative of the population of videos, we tested whether the subsample of videos used as stimuli in the FMRI experiment (*N*=32) was representative of the full population of videos for which we collected aggregate data (*N*=1377). We compared the first four statistical moments of the distribution of aggregate view percent in the subsample of selected videos with the full population of videos. All four statistical moments were comparable between the 32 selected videos and the population of videos (Table S1).

Table S1. Statistical moments for distribution of aggregate view percent for internet market versus experimental sample

	Mean	Standard Deviation	Skewness	Kurtosis
Internet	0.695	0.491	0.352	0.255
Experiment	0.684	0.481	0.345	0.251

Table S2. Predicting individual view percent across different neural activity timescales. Statistics are standardized coefficients and standard errors. Class. acc. represents leave-one-subject-out cross-validated classification accuracy applying a median split to view percent. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

	Choice	Self-report	Onset	Average	Offset
Constant	0.498 (0.035)***	0.504 (0.033)***	0.503 (0.033)***	0.503 (0.032)***	0.502 (0.003)***
Choice (yes/no)	0.118 (0.009)***	-	0.067 (0.009)***	0.064 (0.009)***	0.069 (0.009)***
Positive arousal	-	0.186 (0.008)***	0.159 (0.010)***	0.155 (0.009)***	0.163 (0.009)***
Negative arousal	-	-0.007 (0.008)	-0.004 (0.008)	-0.003 (0.008)	-0.005 (0.008)
NAcc	-	-	0.039 (0.011)***	0.053 (0.012)***	-0.003 (0.012)
AIns	-	-	-0.047 (0.012)***	-0.065 (0.013)***	-0.018 (0.013)
MPFC	-	-	0.013 (0.010)	0.041 (0.009)***	-0.002 (0.011)
PCC	-	-	-0.025 (0.010)*	-0.012 (0.010)	0.023 (0.011)*
Pseudo R^2	0.40	0.53	0.58	0.58	0.57
Akaike Inf. Crit.	552	248	189	166	201
Class. Acc.	0.661	0.731	0.742	0.751	0.734
CV RMSE	0.347	0.310	0.301	0.299	0.302

SI Appendix 3. Eye tracking methods and results.

Eye-tracking data was acquired using an SR Research EyeLink 2000 eye tracker with remote optics installed, using a custom MR-safe infrared source with a single high-power infrared light emitting diode epoxied to a non-metallic heat sink. Data was sampled at 1000 Hz with pupil and corneal thresholds set to optimize data quality for each participant, using an elliptical pupil size detector. Stimuli were displayed on a 47" liquid crystal display from Resonance Technology at 1920 by 1080 pixel resolution. The visual distance was 256.1 cm from screen to mirror 2, 6 cm from mirror 2 to mirror 1, and 15 cm from eye to mirror 1. The total horizontal field of view at this distance was about 20 degrees. Eye-tracker calibration was conducted using a custom in-house calibration script. As we planned to only conduct analyses based on blink rates, we did not perform any drift correction between trials or runs. Raw eye-tracking data was loaded into R using the edf R package for preprocessing and analysis. Blink rates were computed for trials with valid eye tracking data by identifying blinks as periods of missing data for a duration between 100 to 2000 ms and dividing the total number of blinks by the total trial duration in seconds. Blink rates were then standard-normalized within each participant across all trials. Blink rate data was missing from 327 trials (25.6%). Data loss resulted from eye-tracking data having been collected from only 30 of the 40 participants, due to equipment malfunction, data corruption, or idiosyncratic issues (such as heavy eye makeup) that forced termination of the eye-tracking protocol before the beginning of the video choice task at the time of data collection.

For valid trials, blink rates were significantly negatively associated with individual view percent. Specifically, a one-standard-deviation increase in blink rates was associated with a 4.2% reduction in view percent for a video (β=-0.042, t=-3.93, $p<0.001$). This was consistent for skipping as well, where blink rates were significantly positively associated with skipping (β=0.275, z=2.82, $p<0.005$). A one standard deviation increase in blink rates was still associated with a 3.2% decrease in view percent when controlling for positive and negative arousal, and video choice task decision about the video (β=-0.032, t=-3.65, $p<0.001$). Adding blink rates increased variance explained in view percent by 1.2% above and beyond positive and negative arousal, and video choice task decision, bringing total variance explained to 54.% including random effects before inclusion of information derived from FMRI activity.

We also tested whether average blink rates could forecast aggregate view frequency and duration. Blink rates were not significantly associated with aggregate view frequency. There was a trend towards a negative association between blink rates and aggregate view percent (β=-0.038, p=0.07), but this association was not significant after controlling for choice, self-report, and neuroimaging data (β=-0.008, p=0.16), and a full model including blink rate did not perform significantly better than the model without blink rate (adjusted $R^{2=}$0.531, AIC=-62, CV RMSE=0.100).

Overall, consistent with research linking blink rates to working memory load and attentional capture, higher blink rates were associated with lower engagement in individuals. This finding may suggest that blink rates are able to capture unique variance in explaining view percent by indexing low attentional capture by the videos that were eventually skipped. While blink rate measures could explain some variation in individual video view duration, they did not generalize to forecast aggregate measures.

Other peripheral physiological measures might also improve neuroforecasting, potentially as a function of their association with the neural activity described in this report. For instance, ElectroEncephaloGraphy (or EEG) has been used to forecast aggregate preferences among commercial goods (1), social media mentions (2), and movie ticket sales (3), but the ability of EEG measures to forecast aggregate behavior has not been directly compared against more conventional behavioral and self-report measures. Nonetheless, other peripheral measures may correlate with neural responses observed in this study. Research designs that assess multiple measures as well as individual and aggregate choices are needed to directly compare the efficacy of different measures in forecasting population outcomes (4).

Table S3. Forecasting aggregate view frequency (log views / day) with video *average* activity. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.15)***
Choice (yes/no)	0.705 (0.75)			0.306 (0.19)
Positive arousal		-0.020 (0.16)		-0.239 (0.22)
Negative arousal		0.223 (0.16)		0.303 (0.17)†
NAcc (mean)			0.142 (0.18)	0.077 (0.18)
AIns (mean)			-0.208 (0.21)	-0.230 (0.21)
MPFC (mean)			-0.180 (0.18)	-0.175 (0.18)
PCC (mean)			0.053 (0.20)	0.014 (0.20)
Adjusted R^2	-0.004	0.005	-0.057	-0.001
Akaike Inf. Crit.	83	84	87	88
Class. Acc.	0.531	0.438	0.530	0.469
CV RMSE	0.870	0.854	0.950	0.986

Table S4. Forecasting aggregate view duration (percent watched) with video *average* activity. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.01)***
View duration (%)	0.071 (0.02)***			0.096 (0.02)***
Positive arousal		0.025 (0.02)		-0.039 (0.02)†
Negative arousal		-0.006 (0.02)		-0.008 (0.02)
NAcc (mean)			0.047 (0.02)*	0.024 (0.02)
AIns (mean)			-0.066 (0.02)*	-0.035 (0.02)
MPFC (mean)			-0.039 (0.02)†	-0.046 (0.02)*
PCC (mean)			0.015 (0.02)	0.030 (0.02)
Adjusted R^2	0.354	-0.024	0.206	0.524
AIC	-57	-42	-48	-62
Class. Acc.	0.656	0.344	0.560	0.750
CV RMSE	0.097	0.122	0.120	0.102

Table S5. Forecasting aggregate view frequency (log views / day) with video *offset* activity. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.15)***
Choice (yes/no)	0.705 (0.75)			0.254 (0.20)
Positive arousal		-0.020 (0.16)		-0.177 (0.22)
Negative arousal		0.223 (0.16)		0.253 (0.19)
NAcc (offset)			0.064 (0.29)	0.019 (0.30)
AIns (offset)			0.082 (0.29)	0.005 (0.31)
MPFC (offset)			0.024 (0.20)	0.025 (0.20)
PCC (offset)			-0.212 (0.19)	-0.139 (0.20)
Adjusted R^2	-0.004	0.005	-0.090	-0.101
AIC	83	84	88	91
Class. Acc.	0.531	0.438	0.220	0.406
CV RMSE	0.870	0.854	0.990	1.052

Table S6. Forecasting aggregate view duration (percent watched) with video *offset* activity. Statistics are standardized coefficients and standard error. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.01)***
View duration (%)	0.071 (0.02)***			0.098 (0.02)***
Positive arousal		0.025 (0.02)		-0.046 (0.04)*
Negative arousal		-0.006 (0.02)		-0.003 (0.02)
NAcc (offset)			0.085 (0.04)*	0.071 (0.03)*
AIns (offset)			-0.064 (0.04)†	-0.043 (0.03)
MPFC (offset)			-0.041 (0.02)	-0.029 (0.02)
PCC (offset)			0.027 (0.02)	0.013 (0.02)
Adjusted R^2	0.354	-0.024	0.125	0.505
AIC	-57	-42	-45	-61
Class. Acc.	0.656	0.344	0.440	0.625
CV RMSE	0.097	0.122	0.120	0.101

Table S7. Forecasting aggregate view frequency (log views/day), robustness check substituting engagement ratings. Statistics are standardized coefficients and standard errors. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.13)***	2.770 (0.13)***
Choice (yes/no)	0.141 (0.15)			0.164 (0.16)
Engagement (Self)		-0.177 (0.29)		-0.239 (0.32)
Engagement (Other)		0.392 (0.29)		0.370 (0.30)
NAcc (onset)			0.653 (0.18)***	0.552 (0.19)**
AIns (onset)			-0.540 (0.22)*	-0.372 (0.25)
MPFC (onset)			-0.026 (0.16)	-0.048 (0.17)
PCC (onset)			0.295 (0.18)	0.283 (0.18)
Adjusted R^2	-0.004	0.032	0.279	0.271
Akaike Inf. Crit.	83	83	75	78
Class. Acc.	0.531	0.469	0.688	0.625
CV RMSE	0.870	0.882	0.790	0.845

Table S8. Forecasting aggregate view percent (percent watched), robustness check substituting engagement ratings. Statistics are standardized coefficients and standard errors. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.01)***
View percent	0.071 (0.02)***			0.112 (0.02)***
Engagement (Self)		-0.046 (0.04)		-0.121 (0.03)***
Engagement (Other)		0.081 (0.04)*		0.063 (0.03)*
NAcc (onset)			0.055 (0.03)*	0.035 (0.02)†
AIns (onset)			-0.081 (0.03)*	-0.054 (0.03)*
MPFC (onset)			-0.017 (0.02)	-0.009 (0.02)
PCC (onset)			0.017 (0.03)	0.026 (0.02)
Adjusted R^2	0.354	0.112	0.158	0.637
Akaike Inf. Crit.	-57	-46	-46	-71
Class. Acc.	0.656	0.406	0.594	0.750
CV RMSE	0.097	0.115	0.120	0.080

Table S9. Forecasting video frequency (log views / day), substituting neural data from the video choice task. FMRI data extracted from presentation of thumbnail, lagged for the hemodynamic response (i.e., volumes 3-4; lag=6 sec). Statistics are standardized coefficients and standard error. Significance: $^{\dagger}p<0.10$ (ns trend), $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$ (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	2.770 (0.15)***	2.770 (0.15)***	2.910 (0.17)***	2.770 (0.15)***
Choice (yes/no)	0.705 (0.75)			0.119 (0.20)
Positive arousal		-0.020 (0.16)		-0.076 (0.20)
Negative arousal		0.223 (0.16)		0.253 (0.17)
NAcc			-0.475 (0.26)†	-0.392 (0.29)
AIns			0.206 (0.20)	0.106 (0.22)
MPFC			0.087 (0.21)	0.082 (0.21)
Adjusted R^2	-0.004	0.005	0.053	0.037
AIC	83	84	83	86
Class. Acc.	0.531	0.438	0.560	0.530
CV RMSE	0.870	0.854	0.890	0.94

Table S10. Forecasting video duration (percent watched), substituting neural data from the video choice task. FMRI data extracted from presentation of thumbnail, lagged for the hemodynamic response (i.e., volumes 3-4; lag=6 sec). Statistics are standardized coefficients and standard error. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***
Choice (yes/no)	0.071 (0.02)***			0.106 (0.02)***
Positive arousal		0.025 (0.02)		-0.050 (0.02)†
Negative arousal		-0.006 (0.02)		-0.001 (0.02)
NAcc			0.005 (0.04)	-0.018 (0.03)
AIns			-0.029 (0.03)	-0.005 (0.02)
MPFC			-0.004 (0.03)	-0.009 (0.02)
Adjusted R^2	0.354	-0.024	-0.045	0.369
AIC	-57	-42	-40	-54
Class. Acc.	0.656	0.344	0.310	0.620
CV RMSE	0.097	0.122	0.130	0.110

SI Appendix 4: Exploratory whole brain analysis

We conducted an exploratory whole brain analysis to verify our focus on the predicted volumes of interest for forecasting aggregate data and to highlight other brain regions which might be relevant for future inquiry. After preprocessing as described in the Methods, high-pass filtered data (admitting frequencies more than 1 cycle / 360 sec) for all four scans were concatenated for each participant. We then generated stick regressors by identifying volumes that corresponded to the onset and offset of videos as well as the four self-report ratings, and also block regressors indicating when participants were watching videos. These regressors were then convolved with a single gamma function to generate regressors for first-level regression analysis. Six additional parametrically-modulated regressors of interest were generated by multiplying the height of the indicator regressors for the three different parts of the videos (video onsets, blocks, and offsets) by the two different video aggregate metrics (i.e., view frequency and view percent) and then convolving the resulting regressors with single gamma functions.

To most closely reproduce our volume of interest analyses, we conducted six first-level analyses for each participant, each including one of the six parametrically-modulated regressors, as well as the same thirteen covariates of no interest (video onset, average, offset, the four ratings, and six motion parameters). We then conducted second-level analyses to generate statistical parametric maps of the coefficients of each parametrically modulated regressor of interest across the entire sample (Table S11-S12). Overall, whole brain results were consistent with our original bivariate volume of interest findings, with NAcc activity at video onset forecasting view frequency, and AIns activity at video onset negatively forecasting view percent. Interestingly, beyond these regions implicated in anticipatory affect, activity in visual and auditory regions also appeared to forecast aggregate viewership, as well as (albeit less robustly) the posterior cingulate cortex, dorsolateral prefrontal cortex, and inferior parietal lobule. Further multivariate analyses using feature elimination techniques will be necessary, however, to determine the degree of redundancy of activity in these regions with activity in our affective volumes of interest in forecasting aggregate time allocation metrics.

Table S11. Exploratory whole brain analysis forecasting aggregate view frequency. Video onset, average, and offset gamma-convolved boxcar regressors parametrically modulated by aggregate view frequency (k=4; p<0.001 uncorrected; predicted VOI targets *italicized*).

Contrast Region	Volume (voxels)	Peak Z-score	Peak coordinate (Talairach)		
			x	*y*	*z*
Onset x view frequency					
R superior temporal gyrus, middle temporal gyrus, posterior insula	407	5.514	45	–14	3
L superior temporal gyrus, posterior insula	282	6.754	–43	–22	8
L inferior middle occipital gyrus	83	4.585	–36	–74	–6
R inferior/middle occipital gyrus	83	4.300	33	–80	–6
R lingual gyrus	37	4.495	10	–80	0
L posterior cingulate, cuneus	13	3.818	–7	–60	6
R inferior parietal lobule	13	–4.232	54	–40	37
R middle occipital gyrus	9	3.490	28	–60	6
L middle occipital gyrus	9	4.304	–25	–60	6
R posterior cingulate, cuneus	7	3.806	16	–60	11
L nucleus accumbens	*6*	*3.872*	*–7*	*1*	*–6*
L fusiform gyrus	4	3.630	–25	–74	–17
R putamen	4	3.780	25	1	–3
R thalamus	4	3.892	22	–25	0
Average x view frequency					

R inferior occipital gyrus, middle occipital gyrus, lingual gyrus, fusiform gyrus	104	5.344	30	–74	–9
R superior temporal gyrus	46	4.356	45	–40	11
L fusiform gyrus	39	4.159	–40	–54	–17
R midde occipital gyrus, posterior middle temporal gyrus	32	3.906	48	–72	–3
R superior temporal gyrus	24	3.897	51	–19	6
L posterior superior temporal gyrus	22	4.091	–65	–34	6
R superior temporal gyrus	13	4.309	57	–5	3
L fusiform gyrus	9	4.291	–51	–66	–12
L fusiform gyrus	7	3.610	–40	–57	–12
L superior temporal gyrus	7	3.963	–45	–51	17
R fusiform gyrus	6	3.745	42	–51	–15
L middle occipital gyrus	6	3.841	–45	–74	–9
L superior temporal gyrus	6	3.557	–48	–40	6
L middle temporal gyrus	6	4.061	–54	–54	8
L fusiform gyrus	5	3.802	–36	–77	–17
L anterior superior temporal gyrus	5	3.728	–54	4	–3
L superior temporal gyrus	5	3.823	–54	–14	8
R superior temporal gyrus	5	3.739	62	–16	8
Middle cingulate cortex	5	–3.622	1	–22	35
L parahippocampal gyrus	4	–3.674	–25	–48	–6
Offset x view frequency					
L superior temporal gyrus	101	4.484	–45	–40	6
R superior temporal gyrus	58	4.165	60	–14	0
R superior temporal gyrus	21	4.213	42	–40	11

L fusiform gyrus	15	4.523	–36	–37	–15
L lingual gyrus	11	3.799	–4	–80	–3
L posterior middle temporal gyrus	11	4.014	–45	–66	26
L superior temporal gyrus	9	3.863	–62	–28	8
L caudate tail	9	4.009	–28	–37	8
Posterior cingulate cortex	8	4.411	–1	–60	23
R fusiform gyrus	6	3.922	39	–40	–23
L lingual gyrus	6	3.820	–16	–80	–15
L middle temporal gyrus	6	4.268	–54	–14	–6
R lingual gyrus	5	3.689	13	–83	–3
R superior temporal gyrus	5	3.664	39	–31	6
R anterior insula	5	–3.634	42	15	11
L superior temporal gyrus	4	3.627	–54	–5	0
L superior temporal gyrus	4	3.955	–60	–2	8
R superior temporal gyrus	4	3.401	60	–34	6
L superior temporal gyrus	4	4.101	–60	–19	8
R middle frontal gyrus	4	–3.717	36	33	23

Table S12. Exploratory whole brain analysis forecasting aggregate view duration. Video onset, average, and offset gamma-convolved boxcar regressors parametrically modulated by aggregate view percent (k=4; p<0.001 uncorrected; predicted VOI targets *italicized*).

Contrast Region	Volume (voxels)	Peak Z-score	Peak coordinate (Talairach)		
			x	*y*	*z*
Onset x view duration					
L superior temporal gyrus	208	4.983	–54	–11	6
R superior temporal gyrus	195	4.671	44	–19	6
R inferior parietal lobule	96	–4.770	33	–45	40
Posterior cingulate gyrus	65	–4.496	4	–40	37
Precuneus	37	–4.157	13	–69	26
R middle frontal gyrus	35	–4.457	33	4	55
Superior parietal lobule	34	–4.519	–10	–69	49
R lateral prefrontal cortex	28	–4.391	45	36	14
L dorsolateral prefrontal cortex	27	–4.013	–33	39	23
R parahippocampal gyrus	24	–4.463	25	–40	–9
Posterior cingulate cortex	20	–4.579	–10	–34	37
R dorsolateral prefrontal cortex	14	–3.844	30	50	23
L insula	7	–3.764	–36	–5	11
R inferior parietal lobule	7	–3.542	60	–40	37
L inferior parietal lobule	6	–3.616	–54	–45	35
L inferior parietal lobule	6	–3.698	–39	–43	37

L anterior insula	*5*	*–3.709*	*–30*	*12*	*9*
R inferior frontal gyrus	4	–3.940	19	12	–15
R dorsolateral prefrontal gyrus	4	–3.567	45	33	23
Average x view duration					
R superior temporal gyrus, middle temporal gyrus	1110	5.647	51	–16	0
L fusiform gyrus	807	5.383	–45	–57	–17
R fusiform gyrus	39	4.673	30	–74	–21
R precentral gyrus	29	4.275	48	1	35
R posterior parahippocampal gyrus	28	–4.450	25	–40	–6
R parahippocampal gyrus	7	4.194	19	–2	–9
L cerebellar declive	5	3.670	–33	–72	–20
L posterior parahippocampal gyrus	5	–3.695	–19	–40	–9
L inferior parietal lobule	5	3.857	–48	–37	43
L temporal pole	4	3.499	–42	15	–26
R inferior occipital gyrus	4	3.760	42	–74	–6
R inferior parietal lobule	4	3.750	48	–31	43
L inferior parietal lobule	4	3.567	–57	–31	43
Offset x view duration					
L superior temporal gyrus	11	–4.415	–51	–20	11
L precentral gyrus	11	–4.120	–42	–8	52
R posterior insula	5	4.133	33	–11	23

Table S13. Forecasting aggregate view frequency (log views / day) with video *onset* activity, with interactions modeling previous choice to watch the video. Statistics are standardized coefficients and standard error. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	2.770 (0.15)***	2.770 (0.15)***	2.751 (0.14)***	2.754 (0.14)***
Choice (yes/no)	0.141 (0.15)		0.119 (0.17)	0.165 (0.22)
Positive arousal		-0.020 (0.16)		-0.094 (0.24)
Negative arousal		0.223 (0.16)		0.095 (0.02)
NAcc (onset)			0.628 (0.20)**	0.601 (0.22)*
Choice (yes/no) * NAcc (onset)			0.151 (0.23)	0.103 (0.26)
AIns (onset)			-0.441 (0.28)	-0.465 (0.31)
Choice (yes/no) * AIns (onset)			-0.181 (0.30)	-0.133 (0.33)
MPFC (onset)			-0.014 (0.21)	0.009 (0.23)
Choice (yes/no) * MPFC (onset)			0.054 (0.25)	0.034 (0.26)
PCC (onset)			0.271 (0.23)	0.239 (0.25)
Choice (yes/no) * PCC (onset)			-0.034 (0.30)	-0.043 (0.31)
Adjusted R^2	-0.004	0.005	0.165	0.094
Akaike Inf. Crit.	83	84	83	87
Class. Acc.	0.531	0.438	0.531	0.500

CV RMSE	0.870	0.854	1.111	1.183

Table S14. Forecasting aggregate view duration (percent watched) with video *onset* activity, with interactions modeling previous choice to watch the video. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	0.684 (0.02)***	0.684 (0.02)***	0.691 (0.02)***	0.687 (0.02)***
Choice (yes/no)			-0.027 (0.02)	-0.035 (0.02)
View duration (%)	0.071 (0.02)***			0.088 (0.03)***
Positive arousal		0.025 (0.02)		-0.034 (0.03)
Negative arousal		-0.006 (0.02)		-0.007 (0.02)
NAcc (onset)			-0.057 (0.02)*	0.046 (0.02)†
Choice (yes/no) * NAcc (onset)			-0.047 (0.03)	-0.031 (0.03)
AIns (onset)			-0.083 (0.04)*	-0.059 (0.03)†
Choice (yes/no) * AIns (onset)			-0.012 (0.04)	-0.001 (0.04)
MPFC (onset)			-0.054 (0.03)†	-0.031 (0.03)
Choice (yes/no) * MPFC (onset)			-0.014 (0.03)	0.005 (0.03)
PCC (onset)			0.046 (0.03)	-0.034 (0.03)
Choice (yes/no) * PCC (onset)			0.063 (0.04)	0.014 (0.04)
Adjusted R^2	0.354	-0.024	0.218	0.474

Akaike Inf. Crit.	-57	-42	-45	-57
Class. Acc.	0.656	0.344	0.594	0.625
CV RMSE	0.097	0.122	0.135	0.116

Table S15. Forecasting aggregate view frequency (log views / day) with video *onset* activity, robustness checks. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Behavior & ratings	Brain	Brain 2	Combined	Combined 2
Constant	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.13)***	2.770 (0.13)***	2.770 (0.13)***	2.770 (0.13)***
Choice (yes/no)	0.141 (0.15)		0.251 (0.18)			0.180 (0.18)	0.206 (0.17)
Positive arousal		-0.020 (0.16)	-0.175 (0.19)			-0.118 (0.22)	-0.191 (0.20)
Negative arousal		0.223 (0.16)	0.281 (0.16)†			0.121 (0.16)	0.167 (0.15)
NAcc (onset)				0.653 (0.18)***	0.617 (0.18)**	0.604 (0.19)**	0.569 (0.19)**
AIns (onset)				-0.540 (0.22)*	-0.338 (0.18)†	-0.545 (0.25)*	-0.381 (0.20)†
MPFC (onset)				-0.026 (0.16)		0.010 (0.18)	
PCC (onset)				0.295 (0.18)		0.257 (0.20)	
Adjusted R^2	-0.004	0.005	0.034	0.279	0.255	0.231	0.229
AIC	83	84	84	75	74	79	78
Class. Acc.	0.531	0.438	0.469	0.688	0.781	0.625	0.688
CV RMSE	0.870	0.854	0.871	0.790	0.765	0.875	0.832

Table S16. Forecasting aggregate view duration (percent watched) with video *onset* activity, robustness checks. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Behavior & ratings	Brain	Brain 2	Combined	Combined 2
Constant	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.01)***	0.684 (0.01)***
View duration (%)	0.071 (0.02)***		0.107 (0.02)***			0.098 (0.02)***	0.097 (0.02)***
Positive arousal		0.025 (0.02)	-0.051 (0.02)*			-0.057 (0.02)*	-0.064 (0.02)**
Negative arousal		-0.006 (0.02)	-0.002 (0.02)			-0.007 (0.02)	-0.003 (0.02)
NAcc (onset)				0.055 (0.03)*	0.053 (0.03)*	0.044 (0.02)†	0.041 (0.02)†
AIns (onset)				-0.081 (0.03)*	-0.079 (0.03)**	-0.070 (0.03)*	-0.061 (0.02)*
MPFC (onset)				-0.017 (0.02)		-0.012 (0.02)	
PCC (onset)				0.017 (0.03)		0.027 (0.02)	
Adjusted R^2	0.354	-0.024	0.421	0.158	0.196	0.509	0.517
Akaike Inf. Crit.	-57	-42	-59	-46	-50	-61	-63
Class. Acc.	0.656	0.344	0.594	0.594	0.594	0.688	0.688
CV RMSE	0.097	0.122	0.097	0.120	0.112	0.097	0.095

SI Appendix 5: Analyses controlling for prior video familiarity

After the scan, participants completed a questionnaire that included an open-ended question inquiring about familiarity with any of the videos in the experiment. Of the 40 participants, 7 reported some familiarity with videos from specific show series (e.g., Mythbusters; with 3 noting that they had not seen the scenes used as stimuli in the experiment). Thus, we repeated the regression analyses testing the critical forecasting predictions (Table 1) after excluding data from those 7 participants. Results are presented below in Table S17 and Table S18, and are comparable to results reported in the full sample.

Table S17. Forecasting aggregate view frequency (log views / day) with video *onset* activity in unfamiliar participants only. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	2.770 (0.15)***	2.770 (0.15)***	2.770 (0.13)***	2.770 (0.14)***
Choice (yes/no)	0.159 (0.15)			0.249 (0.18)
Positive arousal		-0.025 (0.16)		-0.172 (0.23)
Negative arousal		0.209 (0.16)		0.127 (0.16)
NAcc (onset)			0.592 (0.19)**	0.546 (0.20)*
AIns (onset)			-0.393 (0.26)	-0.418 (0.29)
MPFC (onset)			-0.014 (0.20)	0.011 (0.21)
PCC (onset)			0.168 (0.19)	0.164 (0.20)
Adjusted R^2	0.004	-0.005	0.175	0.148
Akaike Inf. Crit.	83	84	79	83
Class. Acc.	0.563	0.375	0.656	0.688
CV RMSE	0.862	0.862	0.821	0.926

Table S18. Forecasting aggregate view duration (percent watched) with video *onset* activity in unfamiliar participants only. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.02)***	0.684 (0.01)***
View duration (%)	0.068 (0.02)*			0.108 (0.02)***
Positive arousal		0.021 (0.06)		-0.076 (0.02)**
Negative arousal		-0.004 (0.02)		-0.003 (0.02)
NAcc (onset)			0.058 (0.03)*	0.057 (0.02)*
AIns (onset)			-0.079 (0.04)*	-0.085 (0.03)**
MPFC (onset)			-0.020 (0.03)	-0.001 (0.02)
PCC (onset)			0.018 (0.03)	-0.025 (0.02)
Adjusted R^2	0.321	-0.036	0.156	0.550
Akaike Inf. Crit.	-56	-41	-46	-64
Class. Acc.	0.656	0.344	0.563	0.750
CV RMSE	0.100	0.122	0.124	0.092

Table S19. Forecasting *ranked* aggregate view frequency with video onset activity. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	16.500 (1.63)***	16.500 (1.66)***	16.500 (1.34)***	16.500 (1.36)***
Choice (yes/no)	2.401 (1.66)			2.208 (1.85)
Positive arousal		0.462 (1.77)		-0.270 (2.31)
Negative arousal		2.268 (1.76)		0.826 (1.68)
NAcc (onset)			8.080 (1.88)***	7.476 (2.01)**
AIns (onset)			-5.162 (2.38)*	-4.794 (2.59)†
MPFC (onset)			-1.227 (1.77)	-1.121 (1.90)
PCC (onset)			2.634 (1.89)	2.629 (2.06)
Adjusted R^2	0.034	0.004	0.343	0.326
Akaike Inf. Crit.	237	239	227	230
Class. Acc.	0.531	0.438	0.688	0.625
CV RMSE	15.409	15.212	16.338	16.568

Table S20. Forecasting *ranked* aggregate view duration with video onset activity. Statistics are standardized coefficients and standard error. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

	Behavior	Ratings	Brain	Combined
Constant	16.500 (1.36)***	16.500 (1.66)***	16.500 (1.58)***	16.500 (1.29)***
View duration (%)	5.556 (1.38)***			7.079 (1.89)***
Positive arousal		2.442 (1.76)		-2.164 (2.07)
Negative arousal		-0.372 (1.76)		-1.323 (1.48)
NAcc (onset)			5.402 (2.21)*	4.445 (1.91)*
AIns (onset)			-4.410 (2.80)	-2.838 (2.43)
MPFC (onset)			-1.675 (2.08)	-1.793 (1.76)
PCC (onset)			0.562 (2.22)	2.007 (1.92)
Adjusted R^2	0.329	-0.001	0.094	0.397
Akaike Inf. Crit.	225	239	237	227
Class. Acc.	0.656	0.344	0.594	0.688
CV RMSE	15.965	15.190	15.796	16.682

SI Appendix 6: Neuroimaging acquisition and analysis.

Brain images were acquired using a 3T General Electric (GE) Discovery 750 scanner with a 32-channel head coil. Whole-brain coverage was achieved with forty-six 2.9-mm thick axial slices (in-plane resolution=2.9mm isotropic, no gap, interleaved acquisition, matrix size 80x80) extending from the mid pons to the top of the skull. Functional scans were collected with a T2*-weighted gradient-echo pulse sequence (TR=2s, TE=24ms, flip angle=77°). A high-resolution T1-weighted anatomical image was acquired using GE's BRAVO sequence (TR=7.2ms, TE=2.8ms, flip angle=12°, 181 slices, 0.9mm isotropic, matrix size 256x256).

FMRI preprocessing was conducted using Analysis of Functional Neural Images software (5). The first six and last four volume acquisitions constituted lead-in and lead-out periods, and were omitted from analysis. Brain images were corrected for variation in slice-timing using sinc-interpolation, corrected for motion using six-parameter affine transformations to realign each volume to the volume acquired with closest temporal proximity to the anatomical scan, and spatially smoothed with a Gaussian 4 mm full-width at half-maximum kernel (6). The resulting images were normalized to percent signal change within voxel and high-pass filtered at 1/360 Hz so as not to alias low-frequency signals over the course of each video. Anatomical images were coregistered to the most temporally proximal functional volume (one anatomical scan needed to be manually coregistered), and spatially normalized by warping to the "Colin" brain template in Talairach space.

For volume-of-interest (VOI) analyses, we used NAcc and AIns masks publicly available with AFNI software (5), generated by Rutvik Desai using Destrieux, Desikan-Killiany, and Freesurfer parcellations in Talairach space. For the MPFC VOIs, we centered 8-mm-diameter spheres on foci identified in meta-analyses of incentive valuation at Talairach coordinates x=±4, y=45, z=0 (7). A PCC mask was generated using the Harvard-Oxford Cortical Atlas in FSL in MNI space by limiting regional match probability at over 50%, and then warping onto Talairach space. All VOIs were warped from Talairach to subject native space by inverting the warps derived from spatial normalization. Preprocessed data were averaged within each VOI, and activity time series were extracted for computing neural activity metrics. Trials with activity exceeding 3 standard deviations from the mean were excluded from analysis.

Figure S2. Bivariate plots of individual choice regression variables, including neural onset variables. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

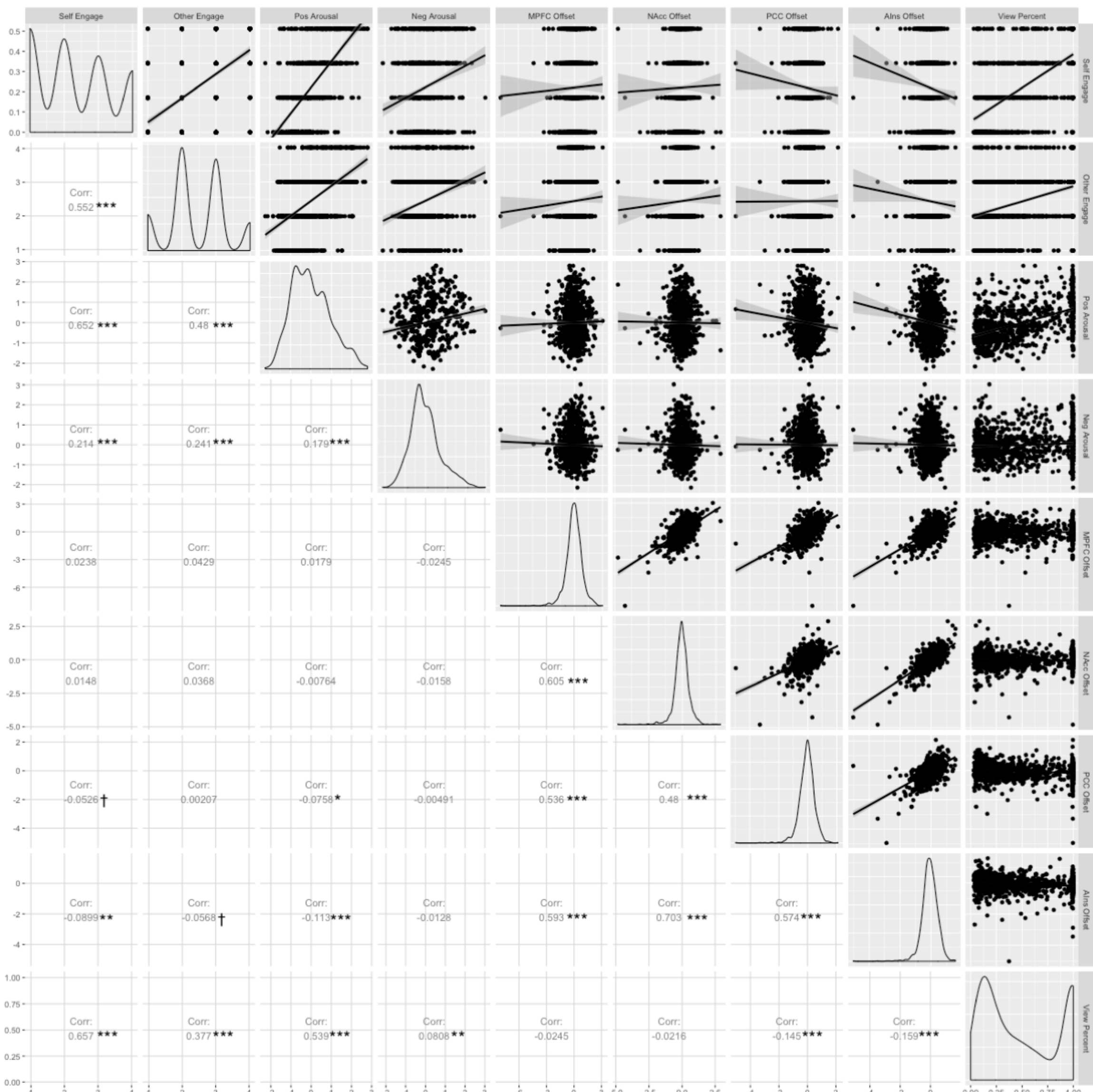


Figure S3. Bivariate plots of individual choice regression variables, including neural average variables. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

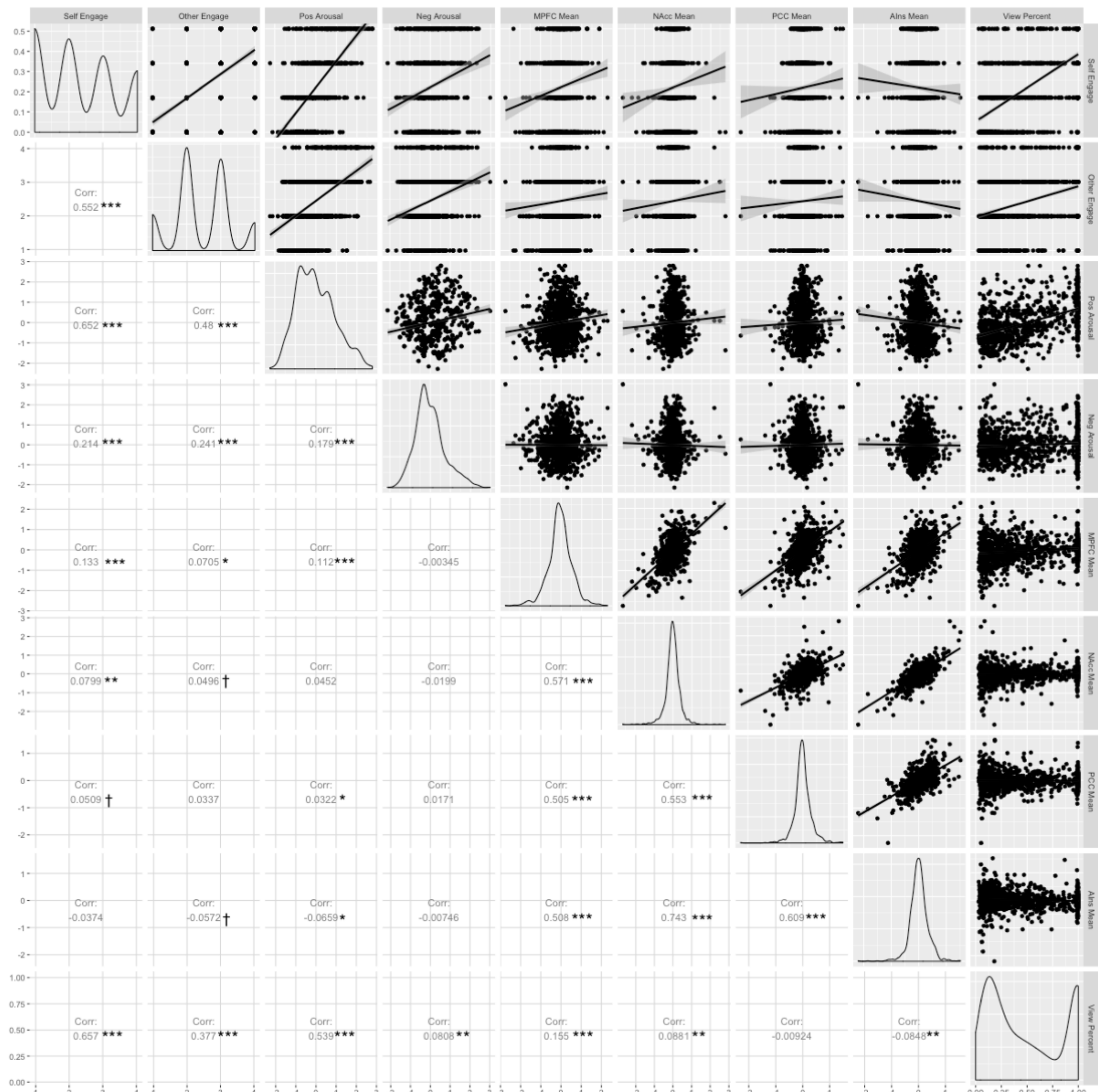


Figure S4. Bivariate plots of individual choice regression variables, including neural offset variables. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

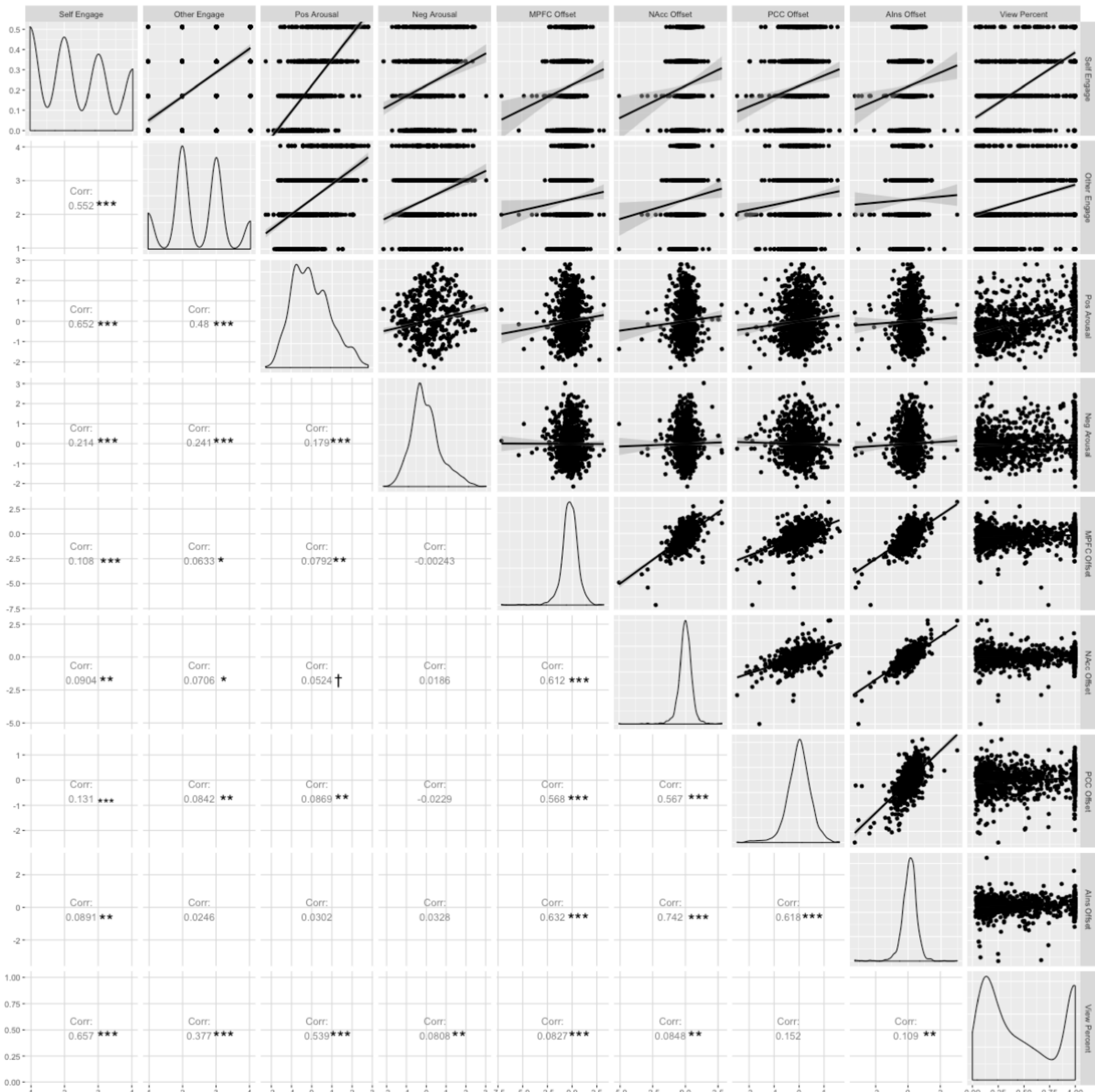


Figure S5. Bivariate plots of aggregate view frequency regression variables, including neural onset variables. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

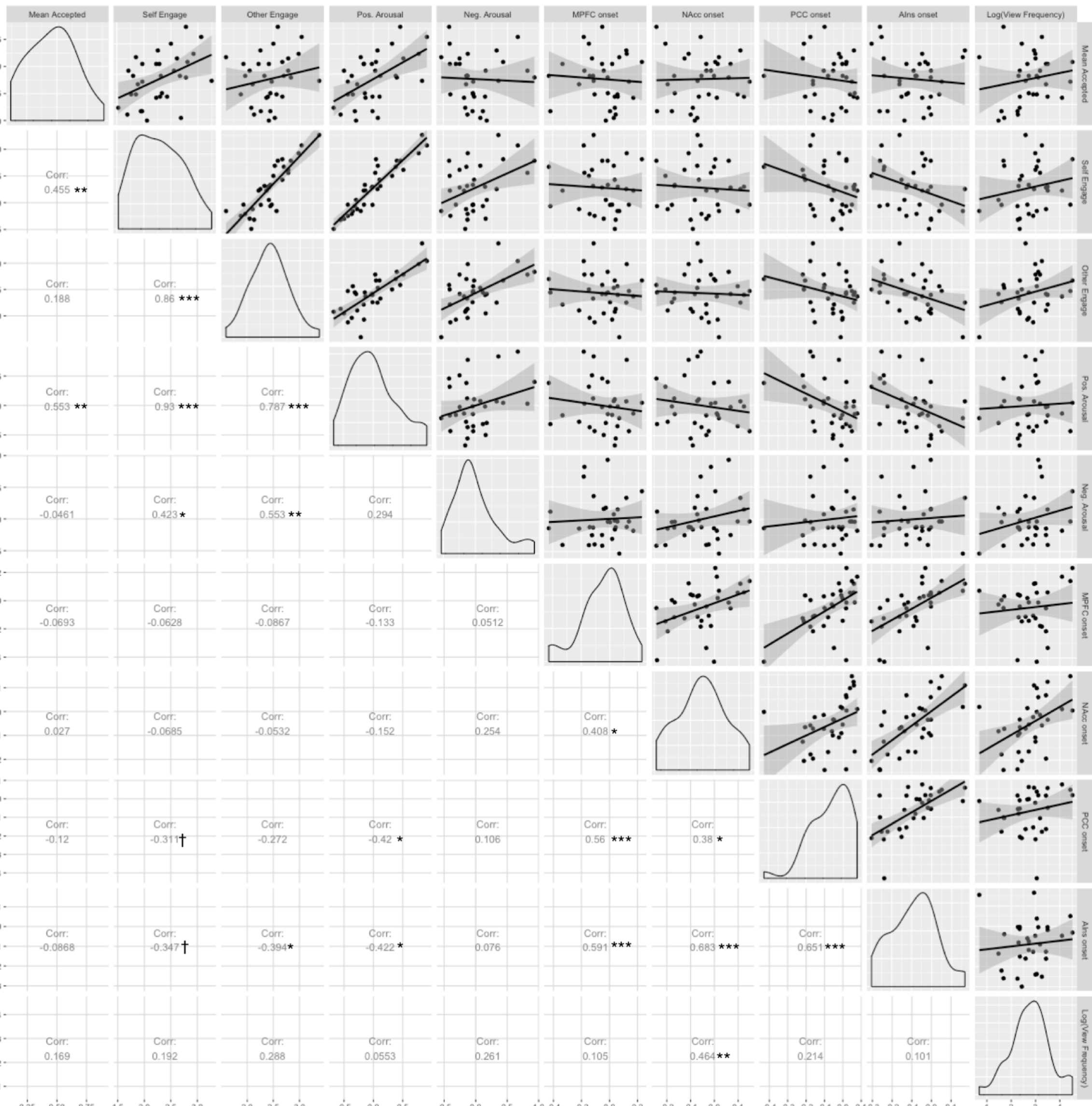


Figure S6. Bivariate plots of aggregate view percent regression variables, including neural onset variables. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

Figure S7. Bivariate plots of aggregate view frequency regression variables, including neural average variables. Significance: †p<0.10 (ns trend), *p<0.05, **p<0.01, ***p<0.001 (two-tailed).

Figure S8. Bivariate plots of aggregate view percent regression variables, including neural average variables. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

Figure S9. Bivariate plots of aggregate view frequency regression variables, including neural offset variables. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

Figure S10. Bivariate plots of aggregate view percent regression variables, including neural offset variables. Significance: †*p*<0.10 (ns trend), **p*<0.05, ***p*<0.01, ****p*<0.001 (two-tailed).

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