Supplemental Online Material

From neural responses to population behavior: Neural focus group predicts population level media effects

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Supplemental Methods

Additional Participant Details

All participants were heavy smokers with the intention to quit. Participants were considered heavy smokers if they smoked at least 10 cigarettes per day, 7 days per week, for at least one year, and had urinary cotinine levels of at least 1000 ng/mL. In addition to enrollment in a cessation program, quitting intentions were assessed via scores >9 out of 10 on the Contemplation Ladder, a single-item measure of intentions to quit (Biener & Abrams, 1991), thus holding baseline intentions to quit relatively constant across this sample. Participants were ethnically diverse: 50% were Caucasian, 27% Hispanic, 20% African American, and 4% other, and socioeconomically diverse: participant mean annual income = $31,000 (range = $0-$200,000); 60% completed some form of college, and 28% received a bachelor's degree or higher. Participants were excluded if they were left-handed, did not speak English, were pregnant, claustrophobic, or had any other condition contraindicated for MRI. Participants were also excluded if they consumed more than 10 alcoholic drinks per week, or had any of the following conditions: dependence on substances other than nicotine, dependence on substances within one year of the scan date, neurological or psychiatric disorders, cardiovascular disease.

Self report projections of ad efficacy

Following the fMRI procedure, participants completed a survey in which they rank ordered their projected efficacy for each of the ads viewed during the scanner session. In addition to providing self-report rankings of ad efficacy, participants also rank ordered the ads from least favorite to most favorite, and evaluated each ad using a 10 item scale developed based on questions used to evaluate ads in other settings (e.g. the Legacy Media Tracking Survey: www.legacyforhealth.org/2141.aspx), and based on theoretical constructs of interest such as the power of internal motivation, and the power of social norms (e.g., "This ad motivates me to quit", "This ad highlights for me that people who care about me want me to quit"; see Table 1 for all scale items). This scale produced a high degree of internal reliability (Cronbach's alpha = .95). The average ratings of the individual ads were highly consistent across the three self report measures; the correlation between average ratings of the 10 ads, across participants, using the two rank ordering scales (most effective to least effective and most favorite to least favorite) was $r(8)=.94$, $p<.001$; and the correlations between the 10-item scale and each of the rank order scales, respectively, were $r(8)=.93, p<.001$, and $r(8)=.95, p<.001$.

Organization of the fMRI task

Within our fMRI study, the campaigns were presented in a counter-balanced, pseudo-randomized order, ensuring that ads from different campaigns followed one another across subjects. At the population level, individuals in a given market were exposed to exactly one of the three ad groups. The population data we have access to are naturalistic in that we obtained quit line call volume in regions after the campaigns were aired, and hence the campaigns were not rotated in markets. The content of the three ad campaigns was similar in that all promoted the National Cancer Institute's 1-800-QUIT-NOW call line. Across campaigns, the ads differed in the strategies used to persuade, but all followed a similar theme (e.g. we know it's hard to quit, but there are resources that can help you quit, call 1-800-QUIT-NOW).

fMRI Data Acquisition and Analysis

Acquisition. High-resolution structural T2-weighted echo-planar images (spin-echo; TR=5000ms; TE=34ms; matrix size 128x128; 34 axial slices; FOV = 192mm; 4mm thick) were acquired coplanar with the functional scans. One functional scan lasting 11.5 minutes (351 volumes) was acquired during the task (echo-planar T2*-weighted gradient-echo, TR=2000ms, TE=30ms, flip angle=90°, matrix size 64x64, 34 axial slices, FOV=192mm; 4mm thick).

Preprocessing. Images were brain-extracted using BET (FSL's Brain Extraction Tool) and realigned within runs using MCFLIRT (FSL's Motion Correction using FMRIB's Linear Image Registration Tool), then checked for residual motion and noise spikes using a custom automated diagnostic tool (thresholded at 2mm motion or 2% global signal change from one image to the next). In SPM8, all functional and anatomical images were reoriented to set the origin to the anterior commissure and the horizontal (*y*) axis parallel to the AC-PC line. Functional images were then corrected for slice acquisition timing differences within volumes, realigned within and between runs to correct for residual head motion, and coregistered to the matched-bandwidth structural scan using a 6-parameter rigid body transformation. The coregistered structural scan was then normalized into the Montreal Neurological Institute (MNI) standard stereotactic space and these parameters were applied to all functional images. Finally, the normalized functional images were smoothed (8mm FWHM Gaussian kernel).

Analysis. The task was modeled separately for each subject, using a block design in SPM5 (Wellcome Department of Cognitive Neurology, Institute for Neurology, London, UK). Initial analyses modeled ad exposure to each campaign compared to a fixation baseline. Corresponding random effects models averaged across results at the single subject level. All functional imaging results are reported in MNI coordinates. Average parameter estimates of activity in our MPFC ROI were extracted at the group level using Marsbar in order to compute a rank-ordered prediction of ad efficacy (where higher levels of neural activity in the *a priori* ROI were hypothesized to correspond to greater ad success). An outlier analysis was conducted, and data points falling greater than 2.5 standard deviations away from the mean for each ad group were excluded in comparing means parametrically (this included 3 data points out of 90 parameter estimates extracted); the ranking of means and substantive conclusions remain unchanged with or without inclusion of potential outliers.

Construction of control ROIs. In order to confirm that results in our primary region of interest were not due to uniformly increased neural activity during certain ad groups (for discriminant validity), we subsequently constructed control regions of interest in regions not hypothesized to respond differentially to the ad groups. In particular, using the wfu pickatlas and Marsbar, we constructed ROIs in primary visual cortex (BA 17), primary motor cortex (BAs 1,2,3), and right and left frontal eye fields (defined as 20mm cubes around 40,0,44 and -40,0,44, respectively, based on mean coordinates for this region reported in the Brede Database: http://neuro.imm.dtu.dk/services/jerne/brede/WOROI_434.html). As with our primary MPFC ROI, average parameter estimates of activity in our control ROIs were extracted at the group level using Marsbar in order to compute a rank-ordered prediction of ad efficacy. In response to an insightful reviewer who suggested that ventral striatum might also predict important outcomes (given it's prominent role in the decision neuroscience literature), we also constructed an anatomically defined ventral striatum ROI. Ventral striatum ROIs were structurally defined a priori using the Wake Forest University Pickatlas Tool (Maldjian, Laurienti, Kraft, & Burdette, 2003) based on the Automated Anatomical Labeling atlas (Tzourio-Mazoyer et al., 2002) and constrained in the following way: $-12<x<12$, $4<y<18$, and $-12<z<0$ (Eisenberger et al., 2010). We then used the Marsbar toolbox (http://marsbar.sourceforge.net) to extract mean parameter estimates.

Kendall's Tau Distance Based Metric for Ranking Data

In order to confirm the reliability of the rank ordering suggested by MPFC, we examined whether the average distance between orderings obtained in our data and the modal (and correct) ordering is smaller that the average distance that would be expected by chance. More specifically, our metric, based on Kendall's Tau, computes pairwise comparisons between each item that has been ranked, and further compares each observed ordering to the modal/correct ranking: $T_{UW}(\pi, \sigma) = \sum\sum I\{[\pi(i) - \pi(j)][\sigma(i) - \sigma(j)] < 0\}$. Here, π represents the mapping function from item *i* (out of a total of k items ordered) to the observed ranking for that item; e.g., $\pi(1)=2$ indicates that the first item is ranked second; σ represents the comparison ranking, for example, the modal ranking or the correct, population level ranking. I{} is the indicator function (Critchlow, Fligner, & Verducci, 1991; Lee & Yu, 2010; Shieh, 1998). An extension of this metric, weighted Kendall's Tau, proposed by Shieh (1998), allows different ranks to be assigned weights based on theoretical questions of interest: $T_w(\pi, \sigma) = \sum\sum w\pi 0(i)\, w\pi 0(j)\, I\{[\pi(i) - \pi(j)][\sigma(i) - \sigma(j)] < 0\}$. Given that we are most interested in selection of campaigns that are likely to be most effective in reducing smoking, we chose weights that preference correct selection of the best ad campaign w = [.6 .2 .2], reported in the main body of the manuscript. The unweighted metric w = [1 1 1] is also consistent with the hypothesis that the pairwise distances between our individual MPFC ratings, and the modal response is smaller than what would be expected by chance.

Supplemental Results

Figure S1. Whereas activity in the hypothesized medial prefrontal cortex region-of-interest, previously associated with persuasion-induced behavior change, mirrored the relative effectiveness of the three ad campaigns at the population level, neural activity in control regions of interest did not.

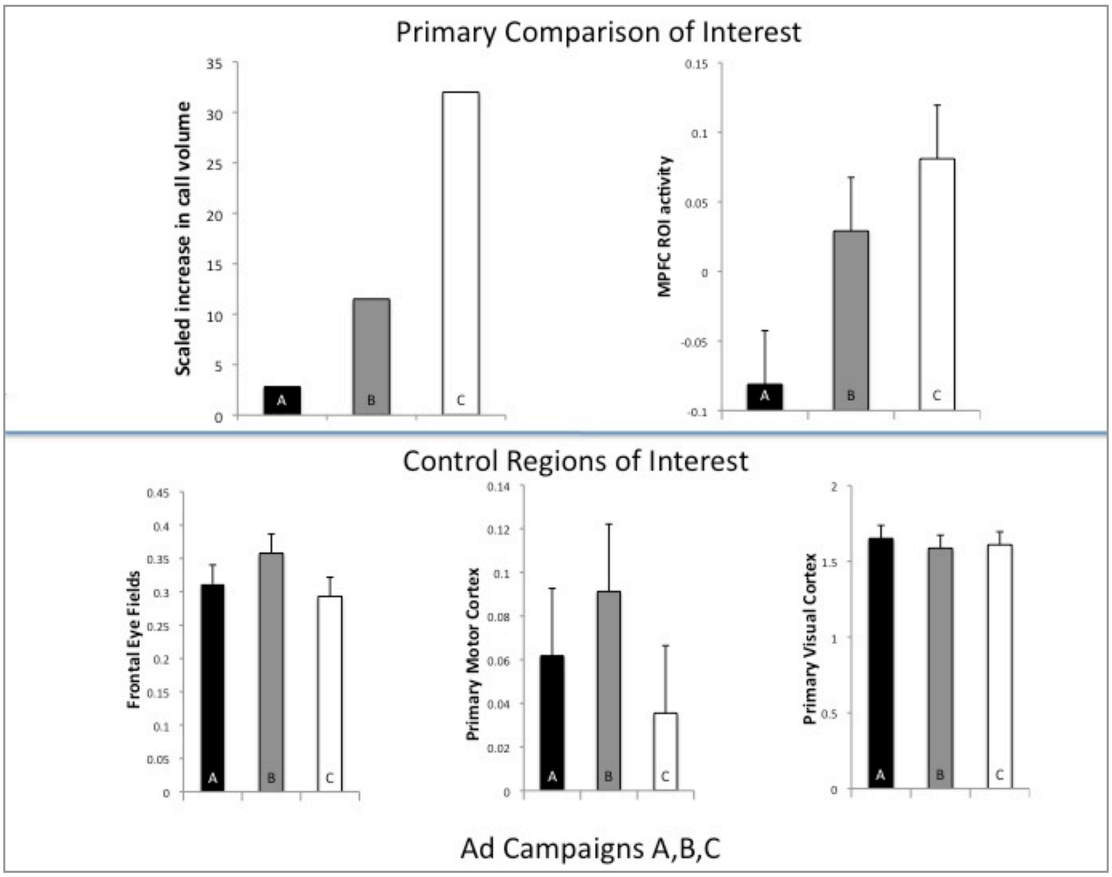
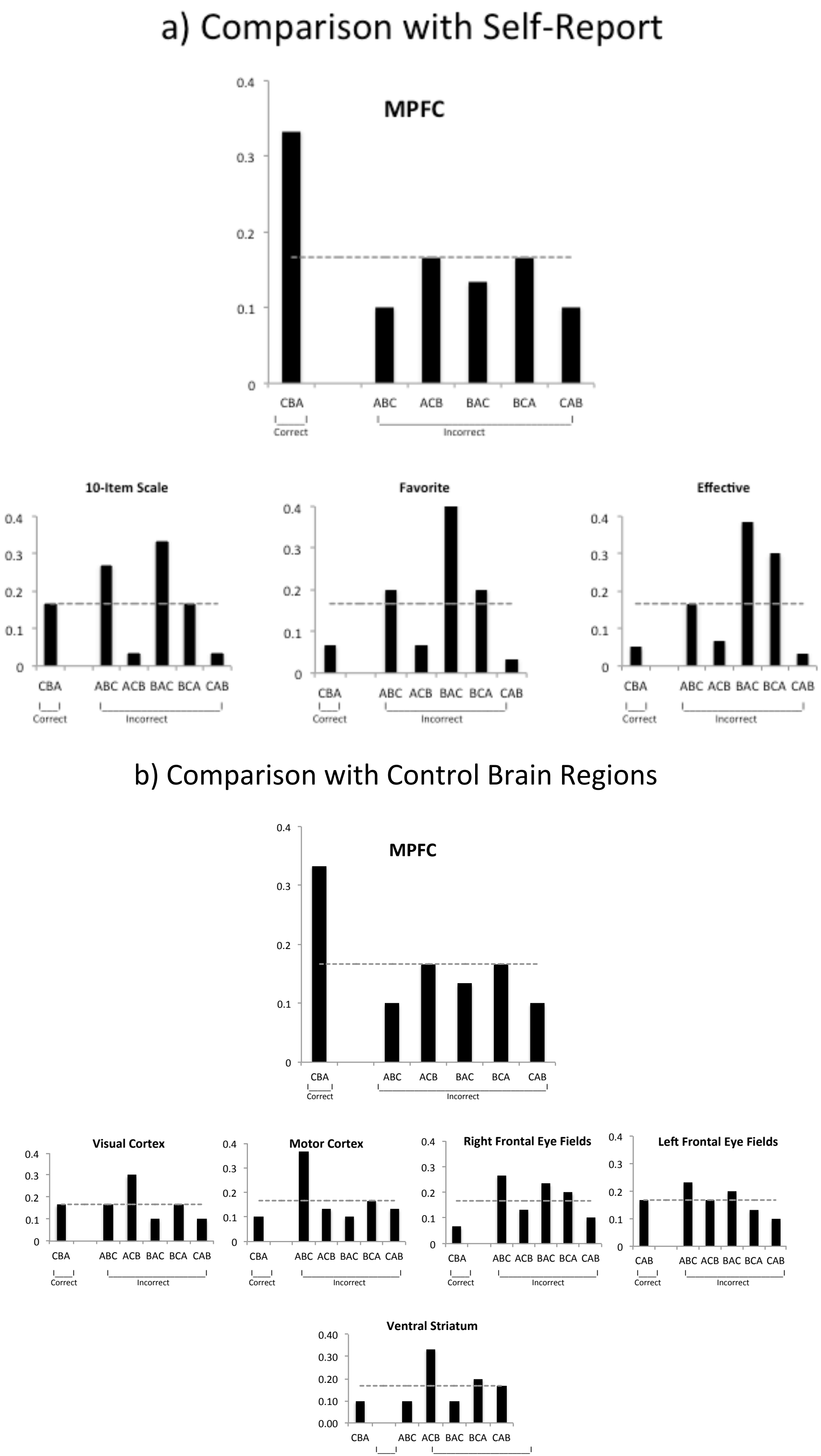


Figure S2. The proportion of cases in which each of the 6 possible orderings appeared for each type of measurement. Notably, participants' MPFC responses most frequently ordered the campaigns correctly, whereas other measurement types including (a) all three types of self-report, and (b) neural activity in control regions produced incorrect orderings as their most frequent outcome. Black bars indicate the proportion of cases suggesting each ordering permutation. Grey dashed lines indicate chance level.



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