

# Targeting modulates audiences' brain and behavioral responses to safe sex video ads

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## Abstract

Video ads promoting condom use are a key component of media campaigns to stem the HIV epidemic. Recent neuroimaging studies in the context of smoking cessation, point to personal relevance as one of the key variables that determine the effectiveness of public health messages. While minority men who have sex with men (MSM) are at the highest risk of HIV infection, most safe-sex ads feature predominantly Caucasian actors in heterosexual scenarios. We compared brain responses of 45 African American MSM to safe sex ads that were matched (i.e. 'Targeted') to participants' sexual orientation and race, and 'Untargeted' ads that were unmatched for these characteristics. Ad recall, perceived 'convincingness' and attitudes towards condom use were also assessed. We found that Targeted ads were better remembered than the Untargeted ads but perceived as equally convincing. Targeted ads engaged brain regions involved in self-referential processing and memory, including the amygdala, hippocampus, temporal and medial prefrontal cortices (MPFC) and the precuneus. Connectivity between MPFC and precuneus and middle temporal gyrus was stronger when viewing Targeted ads. Our results suggest that targeting may increase cognitive processing of safe sex ads and justify further prospective studies linking brain response to media public health interventions and clinical outcomes.

**Key words:** fMRI; African American men who have sex with men (AA MSM); safe sex ads; targeting; personal relevance

## Introduction

HIV/AIDS remains a major public health problem, with about 50,000 new HIV infections a year in the United States alone (CDC, 2012). Men who have sex with men (MSM), who constitute approximately 4% of the male population of the United States (Purcell et al., 2012), account for a disproportionately high number of new HIV infections among men (78%) and nearly 63% of all new HIV infections in 2010 (Centers for Disease Control and Prevention, 2014). Consequently, while the overall incidence of HIV has been stable, it increased by 12% over the same period among MSM (Centers for Disease Control and Prevention, 2014). Consistent use of condoms reduces the risk of HIV transmission

by about 80% (Weller and Davis, 2002). Therefore, promotion of condom use among MSM is one of the important prevention goals that serves two purposes: reducing the uninfected individual's risk of exposure to HIV and reducing the infected individual's likelihood of transmitting it to his partners (Shoptaw, 2013).

Televised public service announcements (PSAs) or video ads focused on audiences' perception of health risk and promoting desired behavioral changes are a key component of media campaigns to combat HIV (Snyder et al., 2004; Zimmerman et al., 2007). Despite extensive theoretical basis and investment in the production of such ads, their impact in the field has been

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modest at best (Donovan et al., 1991; Siska et al., 1992; Werb et al., 2011; LaCroix et al., 2014). Studies suggest several potential causes of such discrepancies between theory and practice. One such cause is that most data on PSA effectiveness comes from cross-sectional surveys that rely on self-report. Such measures account for less than half of the variability in predicting people's behavior (Nisbett and Wilson, 1977; Armitage and Conner, 2001; Florescu et al., 2009). Another reason might be that the individual variability in response to PSAs is neither taken into account by designers of mass media PSAs nor detected by existing means of evaluation. The latter premise suggests that greater understanding of the mechanisms of action of HIV prevention communications is required in order to increase their effectiveness in high-risk populations, such as MSM, that seem to be relatively insensitive to the current prevention efforts (LaCroix et al., 2014; French et al., 2014).

Targeting is a strategy designed to enhance the effectiveness of health communications by increasing an ad's personal relevance to a certain segment of its audience, such as making references to characteristics shared by a specific subgroup (Schmid et al., 2008). Emerging evidence suggests that targeting messages can increase their effectiveness in eliciting positive health behavior changes such as smoking cessation, increased compliance with cancer screening, and healthier diet (Brug et al., 1999; Kreuter et al., 2004; Lancaster and Stead, 2005). Recent neuroimaging studies in treatment-seeking smokers who viewed textual smoking cessation messages found that activation of the medial prefrontal cortex (MPFC) and the precuneus predicted smoking abstinence at 4-month follow-up and linked this activation to the messages' personal relevance (Chua et al., 2009; Chua et al., 2011). However, no prior study so far has extended the observed effect of personal relevance to video ads and non-treatment seeking audiences in any context, including HIV prevention (Dijkstra, 2005; Strecher, 2007; Schmid et al., 2008; Centers for Disease Control and Prevention, 2013). A growing body of neuroimaging work points to midline structures (frontal pole, medial prefrontal and posterior cingulate cortices and the precuneus) interacting with the limbic system and temporo-parietal cortex during self-referential processes (Whitfield-Gabrieli et al., 2011), prospective memory, as well as intent formation (Yoo et al., 2012; Momennejad and Haynes, 2013; Cona et al., 2015). These data enable hypothesis-driven evaluation of the brain response to public health or other video ads. Experimental evaluation of public health ads is particularly timely since most available PSAs and ads promoting safe sex, feature predominantly heterosexual scenarios and Caucasian actors, despite the fact that MSM and minorities are at the highest risk for unsafe sexual behaviors (Centers for Disease Control and Prevention, 2013).

The overall aim of the present study was to investigate targeting in the context of safe-sex ads in the US population at greatest risk for HIV infection and transmission, i.e. African American MSM (AA MSM), using objective neuroimaging methods. These methods have shown promise in the context of smoking cessation communications. We hypothesized that safe sex ads targeted for audiences' race and sexual orientation will be associated with greater activity in the brain regions processing self-relevance, memory and intent formation. Further, we anticipated that Targeted ads would produce better short-term cognitive outcomes such as recall and perceived convincingness. To test these hypotheses, we compared AA MSM audiences' response to safe-sex ads featuring AA actors and homosexual scenarios (Targeted) with ads featuring Caucasian actors and heterosexual scenarios (Untargeted), using

neuroimaging and measures of recall, perceived convincingness, and attitude change. Differences in brain connectivity while viewing Targeted and Untargeted ads were explored with a psychophysiological interaction (PPI) analysis (Friston et al., 1997; Gitelman et al., 2003).

## Material and methods

### Participants

Forty-five AA MSM (Mean  $\pm$  SD, 26.84  $\pm$  5.89 years old, 12.62  $\pm$  1.65 years of education, 21 HIV positive) were recruited through the University of Pennsylvania's HIV Prevention Research Division, and screened for HIV status, psychiatric, neurological or medical illnesses, as well as sexual orientation. Each gave written informed consent to participate in the study. The study protocol and consent form were approved by the University of Pennsylvania Institutional Review Board.

Inclusion criteria were (i) born and self-identified as male; (ii) between 18 and 49 years of age; (iii) sexually active with men in the past 90 days; (iv) self-identified as African American; 4) good physical health ascertained by history and physical examination, blood chemistry and urinalysis.

Exclusion criteria were (i) taking medications that could affect cerebral circulation or activity, such as beta-blockers, benzodiazepines or anti-epileptics; (ii) visual or auditory impairment that could affect the perception of video ads, i.e. color blindness, deafness or severe myopia; (iii) significant cardiovascular or cerebrovascular disease; (iv) history of clinically significant head trauma (e.g. prolonged loss of consciousness or depressed skull fracture); and (v) relative or absolute contraindications for MRI, e.g. indwelling metallic foreign bodies, implants and claustrophobia.

### Stimuli

We identified 71 HIV-related ads from public sources such as government-sponsored campaigns or commercials produced by condom manufacturers. From this pool of ads, we then selected four ads for the Targeted condition—featuring homosexual scenarios and AA actors (i.e. matched with the race and sexual orientation of participants), and four ads for the Untargeted condition—featuring heterosexual scenarios and Caucasian actors (i.e. did not match the race and sexual orientation of participants) to use in the fMRI Video Task. All ads shared a common theme—safe sex/condom use. Any references to particular organizations or manufacturer brand names were removed or digitally blurred. The length of ads in the two conditions was not different (Targeted: 0.37  $\pm$  0.01 minutes; Untargeted: 0.39  $\pm$  0.01 minutes;  $P = 0.74$ ). To control for the audio and visual effects of the ads, we ensured that the message sensation value (i.e. an aggregate measure of audio and visual format features of video messages) of these ads were not different ( $P = 0.17$ ) in the two conditions. The MSV rating procedure has been reported in detail in literature (Morgan, 2003; Strasser et al., 2009) and validated in multiple previous studies (Everett and Palmgreen, 1995; Kang et al., 2006; Langleben et al., 2009; Seelig et al., 2014).

### fMRI video task

Participants viewed a set of eight ads (four Targeted and four Untargeted videos) in a random order in a MRI scanner. Immediately after each ad, subjects were asked to answer two questions regarding their perception of the ad's convincingness (1) 'This video would convince ME to use condoms' and (2) 'This

video would convince OTHERS to use condoms', respectively on a scale of 1, = 'not at all convincing' to 4, = 'very convincing, using a single axis scroll wheel (FORP™, Current Design Inc., Philadelphia, PA). Each ad was preceded and followed by inter-stimulus interval (ISI) during which a homogenous black background with a grey fixation point ('+') was displayed. Stimuli were not repeated and total task duration was 6.83 min.

### Frame recognition test

Five minutes after the video task, subjects were given the Frame Recognition Test (FRT), a forced-choice recognition memory task designed to probe episodic memory of the videos they had watched in the scanner (Rossiter and Silberstein, 2001; Langleben et al., 2009; Seelig et al., 2014). The test contained a total of 48 still frames; 24 were targets that were extracted from the 8 ads used in the fMRI video task (three frames from each ad), and 24 were foils that were drawn from 8 safe sex ads (4 AA homosexual and 4 Caucasian heterosexual ads) not shown in this study. Three frames were extracted from each ad at equal time intervals from one another to ensure that they were representative of the full length of the ad. Frame stimuli were presented for 3 s each in a random order (Dale, 1999) that included a variable ISI (0.25 to 16.25 s) during which a fixation point was present. For each trial, participants were instructed to respond 'Yes' or 'No' to the question 'Have you seen this ad in the scanner?', using a hand-held single axis scroll wheel (FORP™, Current Design Inc., Philadelphia, PA). The question intentionally implied the ad as a whole though only a single frame was displayed. Stimuli were not repeated, and the total task run time was 4.36 min.

Both tasks were programmed using Presentation (Neurobehavioral Systems Inc., Albany, CA) stimulus presentation package. Stimuli were delivered through a rear projector system (Epson America, Inc., Long Beach, CA) that was viewed through a mirror mounted on the MRI scanner head coil. The video soundtrack was delivered through Silent Scan 2100 MRI-compatible headphones (Avotec Inc., Stuart, FL).

### Procedure

**Baseline assessments.** Participants were screened for demographics, sexual orientation, psychiatric disorders, fMRI eligibility and handedness (Oldfield, 1971). One hour before the fMRI session, participants provided urine samples for UDS (Reditest; Redwood Toxicology Labs), and completed questionnaires including Attitudes Towards Condom Use (ACU, a 17-item questionnaire, scoring from 1 = Strongly Disagree to 6 = Strongly Agree) (Sacco, 1991), Risk Assessment Battery (RAB, a 45-item questionnaire) (Navaline et al., 1994) and Quick Inventory of Depression Symptomatology (QIDS, a 16-item clinician-administered questionnaire, (Reilly et al., 2015)). The ACU was repeated after the MRI session.

Before the MRI session, participants were instructed to carefully watch all videos and to answer questions after each video. They were also informed that their memory of the videos would be tested after a delay and that their performance on this test was an integral part of the experiment. Participants performed the FRT approximately five minutes after the video task.

### Behavioral data analysis

Statistical analyses were performed using the IBM Statistical Package for the Social Sciences (IBM SPSS version 22). Independent t-tests were used to compare the difference in

baseline measures such as ACU, RAB, QIDS between HIV positive (HIV+) and HIV negative (HIV-) participants. A two-way repeated measures ANOVA was performed to examine the change of ACU before and after video exposure, using HIV status (HIV+ vs HIV-) as between-subject variable and Video (before vs after) as within-subject variable. Two-way repeated measures ANOVAs were performed to examine the targeting effect on convincingness rating and FRT performance, using HIV status (HIV+ vs. HIV-) as a between-subject variable and Targeting (Targeted vs. Untargeted) as a within-subject variable.

### fMRI data acquisition

MRI data were collected on the University of Pennsylvania's Siemens Trio (Erlangen, Germany) 3 Tesla whole body system using a 32-channel head coil. A BOLD fMRI gradient-echo echo-planar sequence was acquired with the following parameters: TR = 3000 ms, TE = 32 ms, flip angle = 90 degrees, matrix = 64 × 64, FOV = 192 × 192 mm, slice thickness/gap = 3.0/0 mm, 46 slices. After BOLD fMRI, a 5-min magnetization prepared, rapid acquisition gradient echo T1-weighted image (MPRAGE, TR = 1620 ms, TE = 3.87 ms, FOV 250 mm, Matrix 192 × 256, effective voxel resolution of 1x1x1 mm) was acquired covering the whole brain, for spatial normalization and anatomical overlay of functional data (Lancaster et al., 2000).

### fMRI data preprocessing

fMRI data were preprocessed and analyzed using FEAT (fMRI Expert Analysis Tool, v6.0), part of FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl). Images were slice time-corrected, motion-corrected to the median image using tri-linear interpolation with six degrees of freedom (Jenkinson et al., 2002), high-pass filtered (100 s), spatially smoothed (5 mm FWHM, isotropic) and scaled using mean-based intensity normalization. The anatomical and median functional volumes were co-registered and then transformed into standard space (T1 MNI template) using tri-linear interpolation (Jenkinson and Smith, 2001; Jenkinson et al., 2002). BET (Brain Extraction Tool) (Smith, 2002) was used to remove non-brain areas. Coordinates were converted to Talairach space (Talairach, 1988) for tables and figures to facilitate comparison with prior literature.

### Subject-level analysis

Subject-level time series statistical analysis was carried out using FILM (FMRIB's Improved Linear Model) with local autocorrelation correction (Woolrich et al., 2001). Targeted and Untargeted videos were modeled using a canonical hemodynamic response function for all subjects based on the order of stimuli presentation for each subject. Six rigid body movement parameters from the motion correction were modeled as nuisance variables. Second level analysis was performed on the contrast images generated from the subject level analysis including: Targeted > Untargeted, Untargeted > Targeted. QIDS scores reflecting individual's self-reported depressive symptomatology were entered as covariates of no interest. Group statistical maps were thresholded at  $z = 3.2$ . To control for Type 1 error, group maps were cluster corrected for multiple comparisons at  $P < 0.05$ , using the family-wise error rate based on Gaussian random field (GRF) theory.



## Psychophysiological interaction (PPI) analysis

PPI analysis was conducted to examine the differences in connectivity while viewing Targeted and Untargeted ads (Friston et al., 1997; Gitelman et al., 2003). A MPFC cluster from the Targeted vs Untargeted contrast was selected as the seed region of interest (ROI), based on prior work by several groups pointing to the key role of this region in the processing of health ads and messages (Falk et al., 2010; Chua et al., 2011; Wang et al., 2013). We converted the seed ROI from MNI space to the native space for each participant, using FLIRT, and extracted the de-convolved time course of MPFC. PPI regressor was then generated by multiplying the physiological regressor (i.e. time-course of MPFC) and the psychological regressor (i.e. Targeted > Untargeted). For each participant, a new design matrix with both the physiological and the psychological regressors added to the original design matrix was constructed and estimated, which produced individual statistical maps for the PPI effect. The individual PPI maps were then entered into a group-level one-sample *t*-test. Group statistical maps were thresholded at  $z = 2.3$  and corrected for multiple comparisons at  $P < 0.05$ .

## Results

Fifteen (33.3%) participants reported having 1 sexual partner, 13 (28.9%) had 2–3 partners and 17 (37.8%) had 4 or more partners in the past 90 days. Comparing HIV+ and HIV– AA MSM at baseline, there were no differences in the Attitudes Towards

Condom Use (ACU),  $t = 0.69$ ,  $P = 0.49$ , Cohen's  $d = 0.22$ ), Risk Assessment Battery (RAB,  $t = -0.96$ ,  $P = 0.34$ , Cohen's  $d = -0.29$ ) and Quick Inventory of Depressive Symptomatology (QIDS scores:  $t = 0.51$ ,  $P = 0.61$ , Cohen's  $d = 0.86$ ). Two-way repeated measures ANOVA revealed a significant effect of Video ( $F(1, 40) = 14.43$ ,  $P < 0.0001$ ,  $\eta^2 = 0.27$ ) but not of HIV status ( $F(1, 40) = 0.51$ ,  $P = 0.48$ ,  $\eta^2 = 0.01$ ) on condom use attitudes, and there was no interaction ( $F(1, 40) = 0.002$ ,  $p = 0.96$ ,  $\eta^2 < 0.001$ ). Targeting ( $F(1, 43) = 46.49$ ,  $P < 0.001$ ,  $\eta^2 = 0.52$ ) but not HIV status ( $F(1, 43) = 0.03$ ,  $P = 0.87$ ,  $\eta^2 = 0.00$ ) had a significant effect on frame recognition performance, and no interaction ( $F(1, 43) = 0.22$ ,  $P = 0.65$ ,  $\eta^2 = 0.01$ ) (Figure 1, a). Neither targeting ( $F(1, 42) = 3.06$ ,  $P = 0.09$ ,  $\eta^2 = 0.07$ ) nor HIV status ( $F(1, 42) = 2.81$ ,  $P = 0.10$ ,  $\eta^2 = 0.06$ ) had an effect on Convince Me ratings, and there was no interaction ( $F(1, 42) = 0.51$ ,  $P = 0.48$ ,  $\eta^2 = 0.01$ ). There was an effect of HIV status ( $F(1, 43) = 4.55$ ,  $P = 0.04$ ,  $\eta^2 = 0.10$ ) but not targeting ( $F(1, 43) = 1.96$ ,  $P = 0.17$ ,  $\eta^2 = 0.04$ ) on Convince Others ratings, but no interaction ( $F(1, 43) = 0.74$ ,  $P = 0.40$ ,  $\eta^2 = 0.02$ ) (Figure 1, b). HIV+ participants rated Convince Others higher than the HIV– participants did.

Compared to Untargeted videos, Targeted videos evoked more brain activation in the bilateral superior temporal and occipital lobes, precuneus, medial prefrontal gyrus, amygdala, hippocampus and parahippocampus and less brain activation in the bilateral middle occipital and middle frontal gyri (Figure 2; Table 1). There was no correlation between percent BOLD signal change in the medial prefrontal gyrus and the change in frame recognition performance.

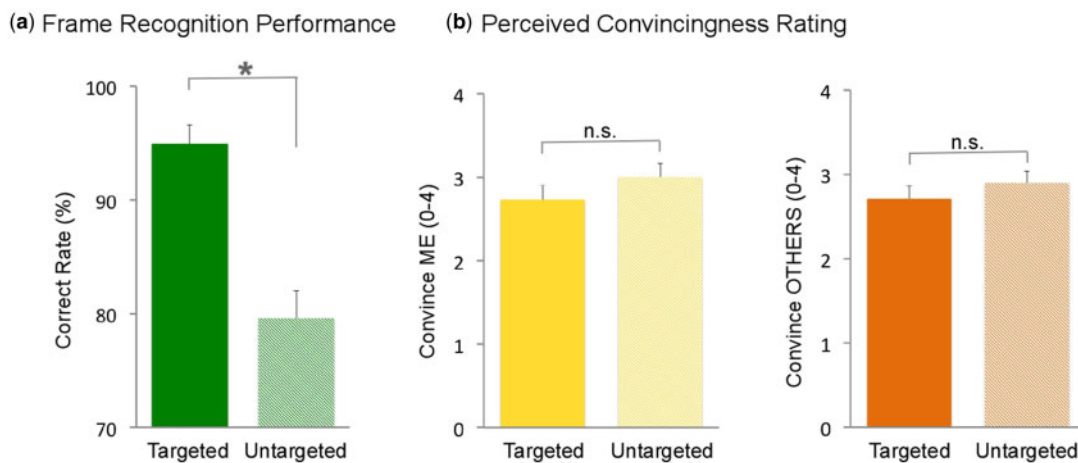


Fig. 1. (a) Targeted ads were better remembered than Untargeted ads. (b) Targeted and Untargeted ads were perceived as equally convincing.

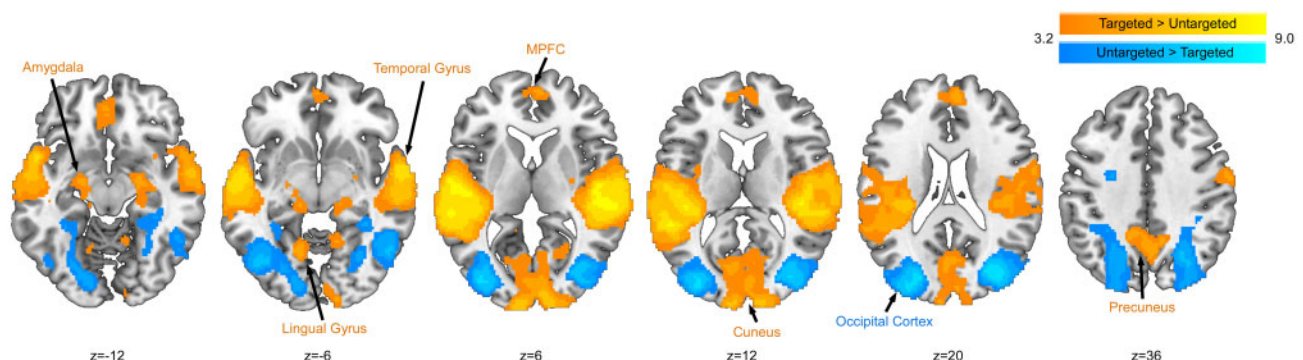


Fig. 2. Targeted ads evoked greater brain activation in bilateral superior temporal and occipital lobes, precuneus, medial prefrontal gyrus, amygdala and hippocampus (orange-yellow scale), while evoking less brain activation in the bilateral middle occipital and middle frontal (not shown) gyri (blue-green scale).

PPI analysis revealed that Targeted videos evoked greater connectivity between the medial prefrontal gyrus (the seed ROI) and precuneus and middle temporal gyrus (Figure 3; Table 2), than Untargeted videos. There were no correlations between percent BOLD signal in precuneus with recall ( $P = 0.331$ ) or convincingness (Convincing Me  $P = 0.641$ , Convincing Others  $P = 0.559$ ).

## Discussion

Safe sex ads that targeted AA MSM on race and sexual orientation were better recalled and engaged brain regions associated with self-referential processes and memory. Message recall is

**Table 1.** Location and magnitude of the differences in the brain response to Targeted > Untargeted ads

Region <sup>a</sup>	Hem	Size	Z-MAX <sup>b</sup>	X <sup>c</sup>	Y <sup>c</sup>	Z <sup>c</sup>
<b>Superior temporal gyrus (BA 22, 38)</b>	Left	7800	8.96	-58	-6	1
Middle temporal gyrus (BA21)			8.46	-58	-29	1
Transverse temporal gyrus (BA 41)			7.91	-41	-26	14
Insula (BA 13)			4.61	-33	-17	20
Precentral gyrus (BA 6)			4.22	-62	0	21
<b>Superior temporal gyrus (BA 22, 38)</b>	Right	6412	8.76	46	-23	6
Insula (BA 13)			8.3	46	-13	8
Transverse temporal gyrus (BA 41)			7.93	40	-25	13
Middle temporal gyrus (BA22)			7.53	52	-36	8
Inferior frontal gyrus (BA 47, 13)			4.6	44	15	-10
<b>Cuneus (BA 17, 18, 23, 30)</b>	Left	5194	6.75	-9	-98	4
Cingulate gyrus (BA 31)			5.98	2	-60	28
Lingual gyrus (BA 19)			5.82	-16	-60	-4
Precuneus (BA 31)			5.4	2	-67	24
Posterior cingulate (BA 30)			4.2	20	-62	7
<b>Medial frontal gyrus (BA 9, 10)</b>	Right	846	5.05	5	49	23
Anterior cingulate (BA 32)			4.83	-5	42	-7
<b>Precentral gyrus (BA 4, 6)</b>	Right	482	5.85	50	-6	45
<b>Amygdala</b>	Right	473	5.28	20	-8	-10
Parahippocampal gyrus (BA 28)			4.09	22	-23	-9
Putamen			4.02	25	-11	5
<b>Postcentral gyrus (BA 1, 2, 3, 6)</b>	Left	465	4.93	-50	-11	51
<b>Amygdala</b>	Left	423	5.02	-20	-10	-10
Thalamus			4.88	-14	-27	0
Hippocampus			3.35	-29	-21	-13

Location of the clusters and the global and local maxima of BOLD fMRI signal change. Please refer to Figure 2 to visualize the full extent of each cluster.

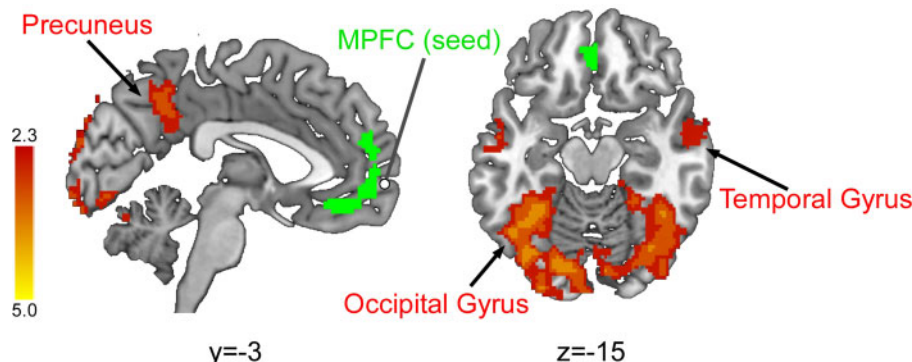
<sup>a</sup> $z \geq 3.2$  and (corrected) cluster significance  $P < 0.05$ .

<sup>b</sup>Z-MAX values represent peak activation for the cluster.

<sup>c</sup>Talairach (1988) coordinates.

an accepted intermediate outcome in communication research. Knapp et al. (1981) first proposed the 'memorable message' as a meaningful unit of communication that affects behavior and guides the sense-making process (Knapp et al., 1981). Smith and Ellis (2001) demonstrated that memorable messages can guide subsequent behaviors if they are recalled during self-assessment (Smith and Ellis, 2001). More recently, Leas and colleagues (2015) reported that recall of anti-tobacco ads predicted smoking cessation at follow-up (Leas et al., 2015). From the standpoint of brain activation, we found that targeted ads engaged the medial prefrontal cortex (MPFC). This region has been linked to the processing of persuasive messages in multiple media modalities from text to video ads, and across disease categories such as smoking cessation and sunburn protection (Falk et al., 2010; Chua et al., 2011; Wang et al., 2013). MPFC was also hypothesized to reflect future behavior change. For example, MPFC activation during the viewing of anti-smoking videos predicts future urine cotinine levels (Wang et al., 2013; Wang et al., 2015). The role that the MPFC plays in both processing and predicting subsequent behavioral outcomes is thought to stem from its involvement in both the evaluation of incoming information (Wang et al., 2013) and the formation of intent (den Ouden et al., 2005; Bull et al., 1999; Nansel et al., 2002; Shields et al., 2013). In addition to the MPFC, targeted ads produced greater activation in the brain regions involved in learning, memory and language processing (i.e. amygdala, hippocampus, bilateral superior and middle temporal gyrus (STG)) and in processing self-referential information (i.e. precuneus). Although targeted ads increased MPFC activation and were better remembered, the effect of targeting on recall performance was not explained by increased MPFC activation, suggesting that further research is required to link the brain fMRI features of targeting with behavioral outcomes. Links between brain response and Argument Strength (an ad variable that overlaps with targeting) and subsequent behavioral change have been demonstrated with smoking cessation ads (Wang et al., 2013).

Targeted ads induced stronger connectivity between the MPFC, precuneus and STG. This finding is consistent with those reported in the 'natural vision' experiments, where participants viewing emotionally salient films showed changes in connectivity in the MPFC, anterior cingulate cortex (ACC), STG and the posterior cingulate cortex (PCC) (Hasson et al., 2008; Guo et al., 2016). Our findings are also congruent with the role of precuneus in the processing of self-relevant information (Murray et al., 2015) and the role of the postromedial PFC in the encoding



**Fig. 3.** Compared to untargeted ads, targeted ads were associated with greater connectivity (red-yellow scale) between the seed region in the medial prefrontal gyrus (MPFC, in green) and clusters with peak activation in the precuneus and in the left middle temporal gyrus, extending to the occipital cortex.

**Table 2.** Location and magnitude of brain regions connected with MPFC in responses to Targeted vs. Untargeted ads. PPI connectivity using MPFC as a seed region

Region <sup>a</sup>	Hem	Size	Z-MAX <sup>b</sup>	X <sup>c</sup>	Y <sup>c</sup>	Z <sup>c</sup>
<b>Middle temporal gyrus (BA 39)</b>	Left	15249	4.99	-54	-68	18
Superior temporal gyrus (BA22)			4.49	-54	-19	0
Supramarginal gyrus (BA 40)			4.38	-64	-48	29
Lingual gyrus (BA 17)			4.32	-11	-99	-12
Middle occipital gyrus (BA 19)			4.31	-47	-74	-9
<b>Precuneus (BA 7, 31)</b>	Left	693	3.76	-9	-54	34

Location of the clusters and the global and local maxima of BOLD fMRI signal change. Please refer to Figure 3 to visualize the full extent of each cluster.

<sup>a</sup> $z \geq 2.3$  and (corrected) cluster significance  $P < 0.05$ .

<sup>b</sup>Z-MAX values represent peak activation for the cluster.

<sup>c</sup>Talairach (1988) coordinates.

and retrieval of delayed intentions (den Ouden et al., 2005; Momennejad and Haynes, 2013; Wang et al., 2013). The MPFC is commonly co-activated with the PCC and STG during 'mentalizing' or 'theory of mind' paradigms, i.e. making inferences about the mental states of self and others (Van Overwalle and Baetens, 2009). A meta-analysis of 1840 studies (Laird et al., 2011), linked medial prefrontal and posterior cingulate/precuneus connectivity to theory of mind and 'social cognition' tasks as well as episodic recall, imagined scenes, and delayed discounting tasks. Based on this literature, an association between targeting and greater MPFC-PCC/precuneus and MPFC-STG connectivity suggests greater mentalizing while viewing targeted ads. This hypothesis would require replication and confirmation in future studies. Increased 'mentalizing' while viewing Targeted ads could be ascribed to greater engagement and perhaps introspection. This interpretation is consistent with previous reports of more mentalizing during race-congruent vs. race-incongruent stimuli (Adams et al., 2010; Liew et al., 2011). Together these findings offer testable hypotheses about mechanisms by which targeting makes ads more effective (Bull et al., 1999; Nansel et al., 2002; Shields et al., 2013).

Our convincingness results were not fully consistent with the recall and neuroimaging results. While Targeted ads were better recalled, they were not rated as more convincing than the Untargeted ones. This divergence could be due simply to the subjective and variable nature of the convincingness measure resulting in a false negative finding in this relatively small sample ( $N = 45$ ). Another interpretation is that a subjective outcome such as convincingness is more likely to be susceptible to a '3<sup>rd</sup> person effect' (i.e. the tendency of respondents to underestimate persuasiveness to themselves rather than to others (Davison, 1983; Lansky et al., 2010; Molina and Ramirez-Valles, 2013; Overstreet et al., 2013) than objective outcomes such as recall performance and brain fMRI response. Previous studies indicate that members of disadvantaged or stigmatized social groups tend to adopt (i.e. internalize) the prevailing negative perception of themselves and act accordingly. This concept, first proposed by Clark and Clark (Clark and Clark, 1939), has been extended to sexual orientation and to HIV status (Quinn et al., 2015). Thus, absence of targeting effect on convincingness could be due to unconscious bias among AA MSM towards their own sexual or racial group, cancelling the effects of targeting that would otherwise favor ones' own sexual orientation and race. Also, the fact that HIV+ participants rated all ads regardless of targeting as more convincing to others, suggests that HIV+ participants engaged in more self-referential processing.

Alternatively, it could also suggest that HIV- participants were less concerned about the serious consequences of unprotected sex, underscoring the need to target the prevention efforts on HIV- AA MSM (Nemeroff et al., 2008; van Koningsbruggen et al., 2009).

Our findings should be interpreted with a number of caveats. Being an initial proof of concept study, we tested targeting as a within-subjects factor in a single category of highest risk participants. Race and sexual orientation are major, but not the only common characteristics that define this important subgroup. Also, information about the ethnicity of participants' partners could have helped interpret the self-reported convincingness ratings. Future studies with a larger sample could manipulate additional sociodemographic variables and determine whether our findings generalize to other demographic categories. Additional modifications of our design should include Caucasian MSM as a control group. While our results suggest potential neuropsychological pathways for targeting to exert its effects, determining whether brain response to ads can predict their effectiveness and thus be used in the ad evaluation and design requires further studies linking brain activity to clinical outcomes. Selecting ads from a limited pool of previously released ads from multiple sources, results in greater heterogeneity in their cinematography than would occur with ads made specifically for research. Future studies may benefit from such purpose-produced ads, which would allow a more nuanced manipulation of the personal relevance variables, potentially even enabling tailoring rather than targeting. Such research-driven ads would allow a greater range and better control over the physical ad characteristics as well as ensure their novelty to the audience.

In conclusion, our findings support customizing safe sex ads by sexual orientation and ethnicity to target the AA MSM population, and warrant a prospective confirmation of the effects of targeting of a broader range of media on the long-term behavioral and biological outcomes in HIV prevention.

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