

## The mere green effect: An fMRI study of pro-environmental advertisements

I. Stephanie Vezich, Benjamin C. Gunter & Matthew D. Lieberman

**To cite this article:** I. Stephanie Vezich, Benjamin C. Gunter & Matthew D. Lieberman (2016): The mere green effect: An fMRI study of pro-environmental advertisements, Social Neuroscience, DOI: [10.1080/17470919.2016.1182587](https://doi.org/10.1080/17470919.2016.1182587)

**To link to this article:** <http://dx.doi.org/10.1080/17470919.2016.1182587>



Accepted author version posted online: 09 May 2016.  
Published online: 10 May 2016.



Submit your article to this journal [↗](#)



Article views: 8



View related articles [↗](#)



View Crossmark data [↗](#)

# The mere green effect: An fMRI study of pro-environmental advertisements

I. Stephanie Vezich, Benjamin C. Gunter and Matthew D. Lieberman

Department of Psychology, University of California, Los Angeles (UCLA), Los Angeles, CA, USA

## ABSTRACT

Self-report evidence suggests that consumers prefer green products (i.e., pro-environmental) to standard products, but this is not reflected in purchase behaviors. To understand this disconnect, we exposed participants in a magnetic resonance imaging (MRI) scanner to green and standard ads. After viewing each ad, participants rated liking and perceived sustainability. Ratings were more favorable for green ads than for control ads, but the functional MRI data suggested an opposite pattern—participants showed greater activation in regions associated with personal value and reward (ventromedial prefrontal cortex and ventral striatum) in response to control ads relative to green ads. In addition, participants showed greater activity in these regions to the extent that they reported liking control ads, but there was no such trend for green ads. In line with a neuroeconomic account, we suggest that activity in these regions may be indexing a value signal computed during message exposure that may influence downstream purchase decisions, in contrast to self-reported evaluations that may reflect social desirability concerns absent at the point of purchase.

## ARTICLE HISTORY

Received 5 August 2015  
Revised 11 February 2016  
Published online  
13 May 2016

## KEYWORDS

Persuasion; green marketing; advertising; fMRI

## 1. Introduction

Imagine a typical ad for a soft drink. You might imagine the copy to highlight the beverage's refreshing taste and thirst quenching ability. What if, instead, the benefits of the product itself were replaced by claims that the drink is 100% natural and the can is recyclable? Of course, all soft drinks share these traits, but by placing them front and center, the creators of these "green" ads hope to capitalize on many consumers' reported desires to purchase sustainable products (Hartmann & Apaolaza-Ibañez, 2008; Hartmann, Apaolaza-Ibañez, & Forcada-Sainz, 2005; Phillips, 1999).

Despite these reported desires, sales of green products have not matched firms' enthusiasm (Eurobarometer, 2008; Rex & Baumann, 2007). There has been little investigation on mechanism to explain why, although some have suggested that self-presentation concerns salient during a survey or focus group are largely absent at the actual point of purchase, when other considerations such as price and quality may be more important (Griskevicius, Tybur, & Van den Bergh, 2010; Milfont, 2008). Beyond the desire to appear prosocial, consumers who participate in focus groups and surveys may wish to avoid appearing cynical about a company's green marketing while privately harboring suspicion about the validity of the company's claims. Building on these

ideas, in the current study, we argue that despite favorable self-reported attitudes toward green-marketed products, consumers are in fact spontaneously (and perhaps below conscious awareness) integrating *both* the costs and the benefits of green products when forming judgments about them, and it may be this more nuanced value computation that aligns with downstream purchase behavior. We use functional magnetic resonance imaging (fMRI) to investigate this potential disconnect in processing green ads in comparison to yoked control ads.

## 2. Conceptual background

### 2.1 Self-report evidence strongly suggests a preference for green products

Across many surveys, people report more favorable attitudes for green products than for standard ones. Gallup polls indicate that 75% of Americans consider themselves to be environmentalists, and 80% believe that we will need to change our lifestyles to protect the environment (Goldman, 1991; Mackoy, Calantone, & Droge, 1995; Osterhus, 1997; Ottman, 1996). Fifty percent of Americans report looking for eco-labels when shopping and say they would change brands to be more sustainable (Phillips, 1999). In terms of impact on pricing, American and Chinese consumers report

willingness to pay roughly 5% more for sustainable products (Chang, 2011).

Experimental work also supports the claim that people report a preference for green products. For example, regardless of whether an ad employs emotional or cognitive arguments about a product's green features, it significantly improves consumers' self-reported attitudes relative to a matched non-green ad (Hartmann & Apaolaza-Ibáñez, 2008). Other research unpacks the positive attitudes people form in response to green messaging, finding that a "warm glow" in particular predicts intent to purchase (Hartmann & Apaolaza-Ibáñez, 2012). This suggests a social desirability component that may well be contributing to positive attitudes about green products in survey research.

Based largely on such promising findings, there has been a growth of green companies, and existing firms have started to focus on publicizing green elements of their products (Gillespie, 2008). In fact, some estimates indicate that 40% of household products have at some point been introduced with environmental messages (Humphrey, 1992; Osterhus, 1997).

## 2.2 Less support for real-world effectiveness

Although marketers have understandably taken consumers' self-reported attitudes about green products to heart, it is unclear whether this has been the most effective strategy—despite reported overwhelming support for green products, "mass consumer markets for green products in most categories have yet to develop" (Prakash, 2002). Indeed, actual sales of green-marketed products have been much lower than companies expected from the results of attitudinal surveys (Rex & Baumann, 2007); for example, 75% of respondents in one survey reported that they would buy green products, but only 17% had actually made a green purchase (Eurobarometer, 2008). While 30% of respondents in public opinion surveys report being willing to pay a premium for green energy services, green energy market share remains lower than this (Eurobarometer, 2003, 2005; Gan, Eskeland, & Kolshus, 2007; Zarnikau, 2003). Particularly unsettling, studies in both the United States and United Kingdom find that a whole suite of self-report measures explains less than 10% of the variance in actual green purchasing behavior (Derksen & Gartrell, 1993; Schlegelmilch, Bohlen, & Diamantopoulos, 1996). Thus, consumers' self-reports account for very little of the purchases they actually make.

In terms of financial behavior, an analysis of corporate stock prices indicates that when a firm announces

news about green marketing efforts, market value for the average firm actually *decreases* by about 3.14% (Mathur & Mathur, 2000). Although there have, of course, been green product marketing successes, such as the Toyota Prius and energy efficient washing machines (whose market share grew from 9% to 25% between 2001 and 2004), they appear to depend on variables unrelated to the sustainability of the product itself, such as celebrity endorsements, cost savings, and personal health and convenience factors (Ottman, Stafford, & Hartman, 2006). Finally, although there have been great efforts to promote eco-labeling standards, the market share of eco-labeled products remains low (Rex & Baumann, 2007). Thus, we see that while people report preferences for green products, the evidence from actual behavior suggests that they prefer to purchase standard products.

## 2.3 Why self-report does not tell the whole story

Although the attitude–behavior link is tenuous in many domains, it appears to be particularly weak in the realm of sustainability; this trend has been observed across a number of studies, but there has been little work to explain why (Davari & Strutton, 2014; Gill, Crosby, & Taylor, 1986; Luchs et al., 2011; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008; Oskamp et al., 1991; Smith, Haugtvedt, & Petty, 1994). In the current experiment, we suggest one possibility: That competing value signals are spontaneously assessed during green ad processing and become salient at the point of purchase, but are largely absent in self-report contexts and thus not captured in standard intentions measures. That is, when individuals are exposed to green marketing, they automatically weigh the benefits of the green product (e.g., helping the environment, potentially looking prosocial in front of others) against the costs (e.g., higher price point, perceived lower quality, skepticism of green claims, belief that individual purchases do not significantly help the environment; Chang, 2011; Griskevicius et al., 2010; Luchs, Naylor, Irwin, & Raghunathan, 2010) to compute a value signal. In a survey context, social desirability concerns may be more salient and override this signal to guide responses, but in a shopping context where real costs are made salient, the value signal may be accessed to guide purchase behavior.

Neuroimaging tools such as fMRI may be a useful complement to traditional tools when trying to understand the relationship between consumer self-report and subsequent consumer behavior (Smidts et al., 2014). In previous studies of persuasive messaging, fMRI has proven valuable for multiple reasons. First,

imaging methods often circumvent participants' inability or unwillingness to report attitudes that are predictive of subsequent behaviors (Nisbett & Wilson, 1977; Nolan et al., 2008; Wicker, 1969). Second, fMRI studies have demonstrated a power to significantly predict persuasion-related outcomes over and above self-report (Berns & Moore, 2012; Cooper, Thompson, O'Donnell, & Falk, *in press*; Falk, Berkman, Mann, Harrison, & Lieberman, 2010; Falk, Berkman, Whalen, & Lieberman, 2011; Falk et al., 2015). In particular, activity in ventral striatum (Berns & Moore, 2012; Knutson, Rick, Wimmer, Prelec, & Loewenstein, 2007) and a subregion of ventromedial prefrontal cortex (VMPFC; Cooper et al., *in press*; Falk et al., 2010, 2011, 2015) have been shown to be better predictors of subsequent behavior than self-report. Finally, and perhaps most unique, imaging methods allow the researcher to interrogate multiple psychological processes at once without interrupting the participant—in other words, fMRI researchers are able to assess aspects of participants' spontaneous cognitive, affective and social processes during the viewing of an advertisement, rather than retrospectively after the advertisement is finished.

In this particular case, we chose to combine naturalistic viewing of real ads with self-reported responses following each ad. In doing so, our goal was to see whether the self-report data track with neural activity in ventral striatum and VMPFC, regions typically associated with assessing personal value, or if, as expected, there may be discrepancies between participants' conscious responses and their activity in relevant brain regions. In addition, we chose especially tight controls for our target green products: matched brand control products. Because brand associations, knowledge, etc. may be very different for markedly eco-friendly brands like Seventh Generation than for more general brands like Clorox, we restricted our ads to general brands that had examples of both standard ads and eco-friendly ads. This approach allowed us to investigate the "mere green effect," that is, how processing and evaluation of a message for the same product varies based on the presence or absence of green cues.

### 3. Method

#### 3.1 Participants

Twenty-four right-handed women<sup>1</sup> were recruited through a community database. Three participants were excluded from final analyses due to poor co-

registration, leaving 21 participants in final analyses ( $M_{\text{age}} = 32.26$ ;  $SD_{\text{age}} = 4.82$ ). Potential participants were screened and excluded if they were claustrophobic, pregnant or breastfeeding; had any metal in their bodies or were currently taking psychoactive medication.

#### 3.2 Materials

Twenty-one green print ads were selected from greenwashingindex.com, a site promoted by EnviroMedia Social Marketing in partnership with the University of Oregon School of Journalism and Communication. We included ads from greenwashingindex.com's database if they were characterized by the following: (1) had reasonably high image quality and (2) advertised a product or service that has a clear non-green counterpart (e.g., Clorox's Greenworks line vs. their standard bleach) or advertised the same product or service that has green and non-green ads (e.g., some bottled water ads highlight their recyclable bottles while others highlight the taste and other non-eco features of the water). These ads were matched with 21 yoked controls that advertised the same brand but either referred to a non-green line of products or services, or referred to the same product or service but did not reference green features (ads available upon request from the authors).

#### 3.3 Procedure

The study followed a two-cell (ad type: green vs. control) alternating block design, with seven trials per block. On each trial, participants viewed an ad for 4 s and then responded to two questions: (1) "How much do you like this ad?" and (2) "How sustainable do you think this company is?" Each question was asked on a scale of 1 (dislike or unsustainable) to 4 (like or sustainable), corresponding to the four buttons on the button box, and participants were given up to 5 s to answer each question. Questions and trials were separated by a jittered fixation ranging from 500 to 1500 ms.

#### 3.4 Data acquisition and analysis

Imaging data were acquired using a Siemens Trio 3 Tesla head-only MRI scanner (Siemens Medical Solutions USA, Inc., Malvern, PA, USA). Head motion

<sup>1</sup>Women exclusively were recruited because another task in the same scanning session was interested in women's perceptions of female-targeted advertising.

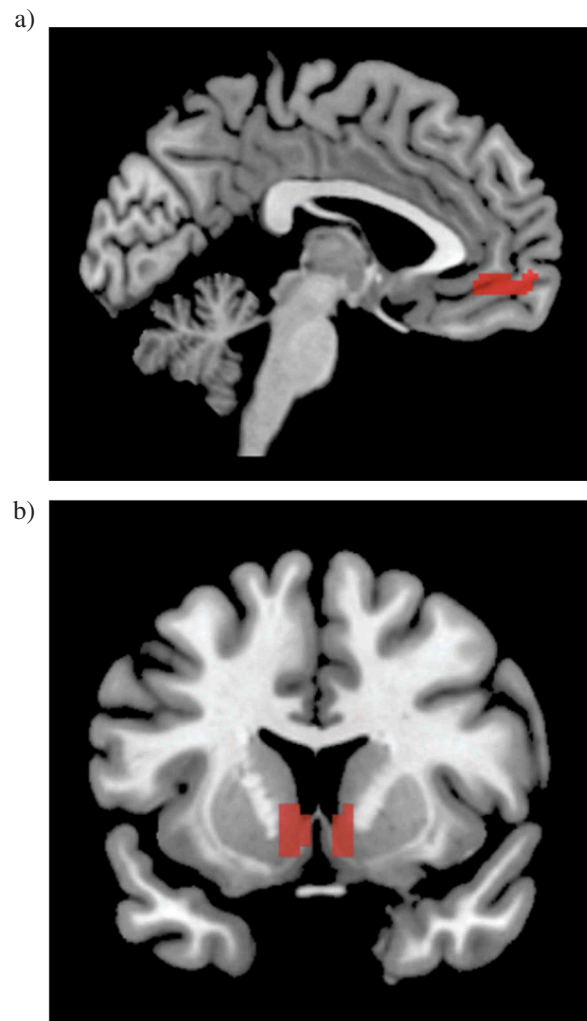
was minimized using foam padding and surgical tape; goggles were also fixed in place using surgical tape connecting to the head coil and scanner bed. A matched-bandwidth structural scan (spin-echo; repetition time [TR] = 5000 ms; echo time [TE] = 34 ms; matrix size =  $128 \times 128$ ; 36 axial slices; field of view [FOV] = 20 cm; 3-mm thick; voxel size =  $1.6 \times 1.6 \times 3.0$  mm) and a magnetization-prepared rapid-acquisition gradient echo (MPRAGE) structural scan (TR = 2170 ms; TE = 4.33 ms; matrix size =  $256 \times 256$ ; 192 sagittal slices; FOV = 25.6 cm; 1-mm thick; voxel size =  $1.0 \text{ mm} \times 1.0 \text{ mm} \times 1.0 \text{ mm}$ ) were acquired. One functional run was recorded (echo-planar T2\*-weighted gradient-echo, TR = 2000 ms, TE = 25 ms, flip angle =  $90^\circ$ , matrix size =  $64 \times 64$ , 36 slices, FOV = 20 cm, 3-mm thick; voxel size =  $3.1 \times 3.1 \times 3.0$  mm).

The fMRI data were analyzed using Statistical Parametric Mapping (SPM8). Images were realigned to correct for motion, co-registered to the MPRAGE, normalized into Montreal Neurological Institute space, and smoothed with an 8-mm Gaussian kernel full-width half-maximum. The task was modeled for participants at the single-subject level, comparing activity while watching green messages to activity while watching control messages. A random effects model was constructed, averaging over these single subject results at the group level.

### 3.5 Regions of interest

In addition to whole-brain analyses, we had two regions of interest (ROI) that we were interested in interrogating. The first of these regions was a cluster overlapping Brodmann area (BA) 10/11 in VMPFC (see Figure 1(a); volume =  $1232 \text{ mm}^3$ ; center of mass =  $[-5.83 \ 50.3 \ -8.27]$ ; min/max coordinates =  $[-12:0 \ 40:62 \ -14:-2]$ ) that has been used in several past studies to predict behavior change over and above self-reported predictions of behavior change and has also been associated with assessments of personal value (Cooper, Tompson, O'Donnell, & Falk, *in press*; Falk, Berkman, & Lieberman, 2012; Falk et al., 2011, 2015). Although the current study does not assess behavior, past work would suggest that activity in this region may align with message-consistent future behavior. We used the same ROI definition as described in Falk et al. (2011) and extracted average activity using MarsBaR (Brett, Anton, Valabregue, & Poline, 2002).

The second ROI was in ventral striatum. This region is generally associated with reward and valuation processes (Cooper & Knutson, 2008; Knutson, Adams, Fong, & Hommer, 2001; Knutson, Taylor, Kaufman, Peterson, & Glover, 2005; Knutson et al., 2007). Thus, it is a natural



**Figure 1.** Ventromedial prefrontal cortex and ventral striatum regions of interest.

region to examine correspondence (or lack thereof) with self-reports of liking. Ventral striatum has also been used to predict future behavior in past work (Berns & Moore, 2012). This ROI was constructed using Wake Forest University PickAtlas and then restricted to the ventral and medial halves of the mask to constrain our search to the most canonical portion of ventral striatum (see Figure 1(b); Maldjian, Laurienti, Kraft, & Burdette, 2003; volume =  $2208 \text{ mm}^3$ ; center of mass =  $[-1.06 \ 12.1 \ -5.57]$ ; min/max coordinates =  $[-10:10 \ 6:18 \ -12:0]$ ).

## 4. Results

### 4.1 Behavioral

Consistent with prior research, participants reported liking green ads more on average ( $M = 2.91$ ,  $SD = .59$ ) than control ads ( $M = 2.78$ ,  $SD = .59$ ),  $t(20) = 2.50$ ,  $p = .020$ . Additionally, they reported thinking that the green ads were more sustainable ( $M = 2.64$ ,  $SD = .64$ ) than control



ads ( $M = 2.32$ ,  $SD = .65$ ),  $t(20) = 5.55$ ,  $p < .001$ , suggesting that the green ads were perceived differently from the control ads, as expected. Although we did not ask participants to rate the ads on other dimensions known to influence attitudes, it is possible that factors besides the contrast between green and standard advertising influenced their ratings. To rule out this possibility, we asked an independent sample of 30 Amazon Mechanical Turk workers to rate each ad on three dimensions shown to influence attitudes in past research: (a) credibility, (b) self-relevance, and (c) source characteristics such as authority and attractiveness (Petty, Wegener, & Fabrigar, 1997; Wathen & Burkell, 2002; Wood, 2000). There were no significant differences between green and control ads (all  $ps > .25$ ), providing greater confidence that our observed effects are a function of the distinction between green and standard ads.

#### 4.2 fMRI responses to green vs. control ads

Next, we wanted to examine whether brain regions that have been associated with personal value and message-consistent behavior (i.e., VMPFC and ventral striatum) in prior studies would show differential responses to the green and control ads. Both regions showed marginally significant effects of advertisement type; however, the activity was the reverse of what was observed in self-report.

There was marginally greater ventral striatum activity during the presentation of control ads relative to the presentation of green ads ( $M = .098$ ,  $SD = .24$ ),  $t(20) = 1.84$ ,  $p = .080$ . Similarly, we observed marginally greater VMPFC activity during the presentation of control ads relative to the presentation of green ads ( $M = .18$ ,  $SD = .48$ ),  $t(20) = 1.70$ ,  $p = .10$ .

A whole-brain search showed the same pattern for ventral striatum, with greater activation during presentation of control ads relative to presentation of green ads (Figure 2; see Table 1(a) for full list of activations). In contrast, we did not find greater activity in VMPFC during control relative to green images in whole-brain activity. No activity in any voxels emerged as more significant during green ads relative to control (i.e., the opposite contrast) even at an extremely liberal statistical threshold ( $p < .01$ ,  $k = 0$ ). Together, the behavioral and neuroimaging results suggest a disjunction between self-report and other unreported responses that may relate to message-consistent behavior (or the lack thereof).



**Figure 2.** Ventral striatum activity associated with viewing control ads relative to green ads. Results threshold at  $p < .005$ ,  $k = 10$ .

**Table 1.** Full list of activations (a) during viewing of control ads relative to green ads and (b) associated with increasing levels of liking while rating control ads.

Region	BA	x	y	z	t	k
(a)						
Middle occipital gyrus	19	-48	-79	-2	5.25	73
Cerebellum	-	-39	-49	-35	4.45	58
Ventral striatum	-	15	17	-11	4.26	19
dACC	32	-6	35	22	4.14	73
Postcentral gyrus	22	-66	-22	19	3.96	12
Thalamus	-	12	-10	13	3.96	91
Superior temporal gyrus	41	-51	-31	16	3.68	20
Inferior parietal lobule	2	66	-31	34	3.62	45
Postcentral gyrus	2	-54	-31	52	3.57	32
Tuber	-	-48	-64	-32	3.18	10
(b)						
Ventral striatum	-	12	20	-8	4.87	26
Midbrain	-	0	-37	-23	4.64	64
Insula	48	45	-25	13	4.61	22
DLPFC	8	-21	26	49	4.53	102
VMPFC	11	-3	50	-11	4.53	109
Cerebellum	30	-6	-40	-5	4.27	53
Precuneus	-	-15	-46	40	3.95	70
Lingual gyrus	18	21	-67	-11	3.86	42
Middle temporal gyrus	21	63	-16	-14	3.65	11
Premotor cortex	6	33	-10	67	3.65	25
SMA	-	-3	-16	49	3.47	10

dACC: dorsal anterior cingulate cortex; DLPFC: dorsolateral prefrontal cortex; SMA: supplementary motor area; VMPFC: ventromedial prefrontal cortex.

#### 4.3 Relating neural responses to self-reported liking

To further investigate the dissociation between self-reported liking and neural activity, we conducted a parametric modulation analysis to see whether activity in our a priori ROIs tracked with self-reported liking scores in each advertisement. We looked at this separately for green and control ads to determine whether

the correlation between self-report and neural activity was stronger during control advertisements when social desirability pressures were absent. For this analysis, we examined neural activity during the portion of each trial when participants were making their judgments of liking for the preceding advertisement.

We found that for control ads, activity in VMPFC tracked with self-reported liking,  $t(20) = 3.37$ ,  $p = .0030$ . That is, when people said they liked an ad more, they also showed more activity in VMPFC. However, there was no significant relationship between self-reported liking and VMPFC activity for green images,  $t(20) = -1.03$ ,  $p = .31$ . Importantly, this difference between these effects was also significant; the parametric modulation was stronger for control ads relative to green ads,  $t(20) = 2.12$ ,  $p = .046$ .

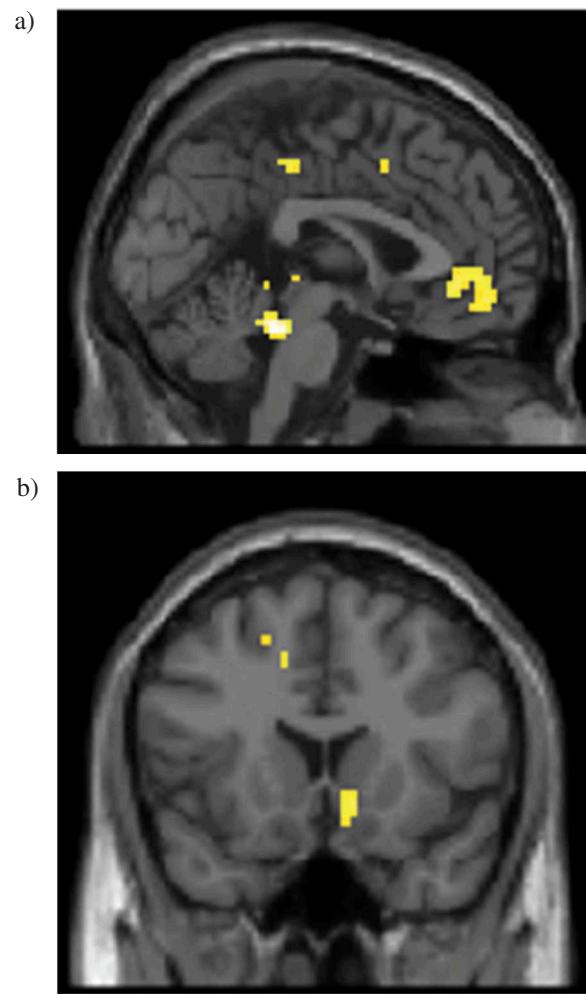
A similar but weaker trend was found for ventral striatum. The parametric effect of liking scores on ventral striatum activity was marginally different from 0 for the control images,  $t(20) = 1.85$ ,  $p = .080$ , and the effect was not significantly different from 0 for the green images,  $t(20) = 1.16$ ,  $p = .26$ . However, the difference between the two effects was not significant,  $t(20) = .28$ ,  $p = .78$ .

Whole-brain results followed a similar pattern. We found that for control ads, there was a significant relationship between increases in self-reported liking and activation in both the ventral striatum and VMPFC (Figure 3; see Table 1(b) for full list of activations). However, there was no such relationship for green ads.

## 5. Discussion

While decades of research suggest that people self-report preferring green to standard products, actual purchase behaviors have not shown such a clear pattern. As an initial investigation of potential reasons for this disconnect, we exposed participants to both green and standard ads for the same products in the fMRI scanner. We found that individuals reported liking green ads more than standard ads, consistent with prior research. However, the fMRI data revealed that participants actually showed greater activity in regions associated with personal value and reward during standard ads relative to green ads. Additionally, while self-reported liking tracked linearly with activity in these regions for control ads—suggesting consistency between self-reported preferences and private preferences—there was no such relationship for the green ads.

Past research has implicated the VMPFC and ventral striatum in processes related to computation of personal value (Hare, Malmaud, & Rangel, 2011; Knutson



**Figure 3.** VMPFC ( $p < .005$ ,  $k = 43$ ) and ventral striatum ( $p < .005$ ,  $k = 10$ ) activity associated with increasing levels of liking while rating control ads.

et al., 2007)—consistent with this account, we suggest that engagement of these regions during consideration of green ads may reflect computation of a value signal that may influence downstream purchase decisions. In contrast, self-reported evaluations may reflect social desirability concerns that are not present at the point of purchase, thus leading to a disconnect between self-reported attitudes and behaviors. Although we did not probe participants on the influence of particular costs in their purchase decision-making processes (and it would be valuable for researchers to consider doing so in the future), we suggest a few possible costs that may lead to lower computed value. For instance, it could be that consumers associate green products with negative attributes like higher prices and lower quality for the individual. While they may be hesitant to admit these concerns out loud—or past surveys may not have asked specifically about these concerns—such factors remain an important part of consumers' evaluations

and may guide their purchase behaviors. An alternative, or perhaps additional, reason is that consumers do not actually believe that buying these products helps the environment. For example, they could be skeptical of the sustainability claims in the ad or they may believe that individual behaviors are only a drop in the bucket relative to institutional sustainability efforts.

Another clear avenue for future investigation would be to use the neural signal associated with evaluating green and standard products as a predictor of actual purchase behavior, as it is possible that although these green and control ads were evaluated differently, they may not have produced meaningful differences in purchase behavior. Past work has shown the promise of this “brain-as-predictor” approach for several real-world behaviors such as smoking cessation and music purchases (Berkman & Falk, 2013; Berns & Moore, 2012). Similarly, researchers could use this method to see how well such “neural focus groups” predict green product purchases weeks or months down the line. This approach would also allow us to understand the relationship between neural responses and purchase behavior with respect to the particular ads in question; although the past literature discussed suggests that green ads have not been successful in general, the current data do not allow us to speak to the effectiveness of the ads in the current stimulus set.

Our study also illustrates how self-report measures may be differentially useful depending on the context. We find that for relatively uncontroversial standard ads for products such as soft drinks and household cleaners, there is a consistency between self-reported responses and activity in brain regions that are important in personal valuation. It may be that with social desirability concerns absent, spontaneously computed value can guide these self-report responses without being overriden. Therefore, in these contexts, self-report measures may be sufficient to gauge attitudes about particular messages. However, we did not see a clear relationship between self-reported responses and neural activity in these regions for the green ads, suggesting the need for methods that circumvent the fallibility of self-report in those contexts.

This work provides the first evidence for differences in neural response when evaluating green ads relative to control ads and suggests a potential mechanism underlying the disconnect between reported preferences for green products versus less clear purchase behavior, namely, spontaneously computed value. While past work showed an inconsistency between self-reported preferences for green products on the one hand and lackluster sales for green products on the other, there has not been a reliable measure

developed that can better predict purchase behavior (Eurobarometer, 2003, 2005; Gan et al., 2007; Prakash, 2002; Rex & Baumann, 2007; Zarnikau, 2003), although it is promising that recent scale development can predict willingness to pay and likelihood to purchase (Haws, Winterich, & Naylor, 2014). Our current study did not include purchase behaviors and thus cannot make claims about predictive power; however, it is encouraging that our results suggest a more positive response to control relative to green ads, in line with past sales data. It is our hope that future work may address this predictive question and further test the idea of computed value in the VMPFC and ventral striatum as a potential mechanism guiding purchase behaviors.

This type of research would have important implications both for theory and for marketing practitioners. It would advance persuasion theory by helping us understand what kinds of neural activation patterns support a strong versus a weak attitude-behavior link. On the practical side, certain costs associated with buying green products may be relatively easier to address with a shift in marketing strategy (e.g., including testimonials to counteract concerns about quality), while others may be more difficult if not impossible (e.g., changing the belief that personal behaviors have no impact on the environment); it would be helpful to know which of these has greater impact on downstream behavior. Thus, we propose that this research is of interest to a variety of stakeholders and holds potential for better designing and testing of green messages to encourage shifts in consumer behavior.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## References

- Berkman, E. T., & Falk, E. B. (2013). Beyond brain mapping: Using neural measures to predict real-world outcomes. *Current Directions in Psychological Science*, 22(1), 45–50. doi:10.1177/0963721412469394
- Berns, G. S., & Moore, S. E. (2012). A neural predictor of cultural popularity. *Journal of Consumer Psychology*, 22(1), 154–160. doi:10.1016/j.jcps.2011.05.001
- Brett, M., Anton, J. L., Valabregue, R., & Poline, J. B. (2002). Region of interest analysis using the MarsBar toolbox for SPM 99. *Neuroimage*, 16(2), S497.
- Chang, C. (2011). Feeling ambivalent about going green. *Journal of Advertising*, 40(4), 19–32. doi:10.2753/JOA0091-3367400402
- Cooper, J. C., & Knutson, B. (2008). Valence and salience contribute to nucleus accumbens activation. *Neuroimage*, 39(1), 538–547. doi:10.1016/j.neuroimage.2007.08.009



- Cooper, N., Tompson, S., O'Donnell, M. B., & Falk, E. B. (in press). Brain activity in self- and value-related regions in response to online antismoking messages predicts behavior change. *Journal of Media Psychology*, 27(3), 93–108. doi:10.1027/1864-1105/a000146
- Davari, A., & Strutton, D. (2014). Marketing mix strategies for closing the gap between green consumers' pro-environmental beliefs and behaviors. *Journal of Strategic Marketing*, 22, 563–586. doi:10.1080/0965254X.2014.914059
- Derksen, L., & Gartrell, J. (1993). The social context of recycling. *American Sociological Review*, 58, 434–442. doi:10.2307/2095910
- Eurobarometer. (2003). *Energy: Issues, options and technologies, science and society*. Luxembourg: The European Opinion Research Group (EORG) for the Directorate-General for Research.
- Eurobarometer. (2005). *Attitudes towards energy*. Luxembourg: The European Commission for the Directorate-General for Research.
- Eurobarometer. (2008). *Attitudes of European citizens towards the environment report*. Brussels: Directorate General Communication.
- Falk, E. B., Berkman, E. T., Mann, T., Harrison, B., & Lieberman, M. D. (2010). Predicting persuasion-induced behavior change from the brain. *The Journal of Neuroscience*, 30(25), 8421–8424. doi:10.1523/JNEUROSCI.0063-10.2010
- Falk, E. B., Berkman, E. T., & Lieberman, M. D. (2012). From neural responses to population behavior: Neural focus group predicts population level media effects. *Psychological Science*, 23, 439–445.
- Falk, E. B., Berkman, E. T., Whalen, D., & Lieberman, M. D. (2011). Neural activity during health messaging predicts reductions in smoking above and beyond self-report. *Health Psychology*, 30(2), 177–185. doi:10.1037/a0022259
- Falk, E. B., O'Donnell, M. B., Cascio, C. N., Tinney, F., Kang, Y., Lieberman, M. D., ... Strecher, V. J. (2015). Self-affirmation alters the brain's response to health messages and subsequent behavior change. *Proceedings of the National Academy of Sciences*, 112(7), 1977–1982. doi:10.1073/pnas.1500247112
- Gan, L., Eskeland, G. S., & Kolshus, H. H. (2007). Green electricity market development: Lessons from Europe and the US. *Energy Policy*, 35(1), 144–155. doi:10.1016/j.enpol.2005.10.008
- Gill, J. D., Crosby, L. A., & Taylor, J. R. (1986). Ecological concern, attitudes and social norms in voting behavior. *Public Opinion Quarterly*, 50, 537–554. doi:10.1086/269002
- Gillespie, E. (2008). Stemming the tide of 'greenwash'. *Consumer Policy Review*, 18(3), 79–83.
- Goldman, D. (1991, February 4). Shoppers still don't see green. *Adweek*, p. 12.
- Griskevicius, V., Tybur, J. M., & Van den Bergh, B. (2010). Going green to be seen: Status, reputation, and conspicuous conservation. *Journal of Personality and Social Psychology*, 98(3), 392–404. doi:10.1037/a0017346
- Hare, T. A., Malmaud, J., & Rangel, A. (2011). Focusing attention on the health aspects of foods changes value signals in vmPFC and improves dietary choice. *The Journal of Neuroscience*, 31, 11077–11087. doi:10.1523/JNEUROSCI.6383-10.2011
- Hartmann, P., & Apaolaza-Ibáñez, V. (2008). Virtual nature experiences as emotional benefits in green product consumption: The moderating role of environmental attitudes. *Environment and Behavior*, 40(6), 818–842. doi:10.1177/0013916507309870
- Hartmann, P., & Apaolaza-Ibáñez, V. (2012). Consumer attitude and purchase intention toward green energy brands: The roles of psychological benefits and environmental concern. *Journal of Business Research*, 65(9), 1254–1263. doi:10.1016/j.jbusres.2011.11.001
- Hartmann, P., Apaolaza-Ibáñez, V., & Forcada-Sainz, F. J. (2005). Green branding effects on attitude: Functional versus emotional positioning strategies. *Marketing Intelligence & Planning*, 23(1), 9–29. doi:10.1108/02634500510577447
- Haws, K., Winterich, K. P., & Naylor, R. W. (2014). Seeing the world through GREEN-tinted glasses: Green consumption values and responses to environmentally friendly products. *Journal of Consumer Psychology*, 24(3), 336–354. doi:10.1016/j.jcps.2013.11.002
- Humphrey, H. H. (1992). Foreword. In J. Ottman (Eds.), *Green marketing*. Lincolnwood, IL: NTC Business Books.
- Knutson, B., Adams, C. M., Fong, G. W., & Hommer, D. (2001). Anticipation of increasing monetary reward selectively recruits nucleus accumbens. *The Journal of Neuroscience*, 21(16), RC159.
- Knutson, B., Rick, S., Wimmer, G. E., Prelec, D., & Loewenstein, G. (2007). Neural predictors of purchases. *Neuron*, 53(1), 147–156. doi:10.1016/j.neuron.2006.11.010
- Knutson, B., Taylor, J., Kaufman, M., Peterson, R., & Glover, G. (2005). Distributed neural representation of expected value. *The Journal of Neuroscience*, 25(19), 4806–4812. doi:10.1523/JNEUROSCI.0642-05.2005
- Luchs, M., Naylor, R. W., Irwin, J. R., & Raghunathan, R. (2010). The sustainability liability: Potential negative effects of ethicality on product preference. *Journal of Marketing*, 74, 18–31. doi:10.1509/jmkg.74.5.18
- Luchs, M., Naylor, R. W., Rose, R. L., Catlin, J. R., Gau, R., Kapitan, S., ... Weaver, T. (2011). Toward a sustainable marketplace: Expanding options and benefits for consumers. *Journal of Research for Consumers*, 19, 1–12.
- Mackoy, R. D., Calantone, R., & Droge, C. (1995). Environmental marketing: Bridging the divide between the consumption culture and environmentalism. In M. J. Polonsky & A. T. Mintu-Wimsatt (Eds.), *Environmental marketing* (pp. 37–54). Binghamton, NY: The Haworth Press.
- Maldjian, J. A., Laurienti, P. J., Kraft, R. A., & Burdette, J. H. (2003). An automated method for neuroanatomic and cytoarchitectonic atlas-based interrogation of fMRI data sets. *Neuroimage*, 19(3), 1233–1239. doi:10.1016/S1053-8119(03)00169-1
- Mathur, L. K., & Mathur, I. (2000). An analysis of the wealth effects of green marketing strategies. *Journal of Business Research*, 50(2), 193–200.
- Milfont, T. L. (2008). The effects of social desirability on self-reported environmental attitudes and ecological behaviour. *The Environmentalist*, 29(3), 263–269. doi:10.1007/s10669-008-9192-2
- Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. *Psychological Review*, 84(3), 231–259. doi:10.1037/0033-295X.84.3.231
- Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is under-detected. *Personality and Social Psychology Bulletin*, 34(7), 913–923. doi:10.1177/0146167208316691

- Oskamp, S., Harrington, M. J., Edwards, T. C., Sherwood, D. L., Okuda, S. M., & Swanson, D. C. (1991). Factors influencing household recycling behavior. *Environment and Behavior*, 23(4), 494–519. doi:[10.1177/0013916591234005](https://doi.org/10.1177/0013916591234005)
- Osterhus, T. L. (1997). Pro-social consumer influence strategies: When and how do they work? *Journal of Marketing*, 61(4), 16–29. doi:[10.2307/1252084](https://doi.org/10.2307/1252084)
- Ottman, J. (1996). Green consumers not consumed by eco-anxiety. *Marketing News*, 30, 13.
- Ottman, J., Stafford, E. R., & Hartman, C. L. (2006). Avoiding green marketing myopia: Ways to improve consumer appeal for environmentally preferable products. *Environment: Science and Policy for Sustainable Development*, 48(5), 22–36. doi:[10.3200/ENVT.48.5.22-36](https://doi.org/10.3200/ENVT.48.5.22-36)
- Petty, R. E., Wegener, D. T., & Fabrigar, L. R. (1997). Attitudes and attitude change. *Annual Review of Psychology*, 48, 609–647. doi:[10.1146/annurev.psych.48.1.609](https://doi.org/10.1146/annurev.psych.48.1.609)
- Phillips, L. E. (1999). Green attitudes. *American Demographics*, 21, 46–47.
- Prakash, A. (2002). Green marketing, public policy and managerial strategies. *Business Strategy and the Environment*, 11(5), 285–297. doi:[10.1002/\(ISSN\)1099-0836](https://doi.org/10.1002/(ISSN)1099-0836)
- Rex, E., & Baumann, H. (2007). Beyond ecolabels: What green marketing can learn from conventional marketing. *Journal of Cleaner Production*, 15(6), 567–576. doi:[10.1016/j.jclepro.2006.05.013](https://doi.org/10.1016/j.jclepro.2006.05.013)
- Schlegelmilch, B. B., Bohlen, G. M., & Diamantopoulos, A. (1996). The link between green purchasing decisions and measures of environmental consciousness. *European Journal of Marketing*, 30(5), 35–55. doi:[10.1108/03090569610118740](https://doi.org/10.1108/03090569610118740)
- Smidts, A., Hsu, M., Sanfey, A. G., Boksem, M. A. S., Ebstein, R. B., Huettel, S. A., ... Yoon, C. (2014). Advancing consumer neuroscience. *Marketing Letters*, 25(3), 257–267. doi:[10.1007/s11002-014-9306-1](https://doi.org/10.1007/s11002-014-9306-1)
- Smith, S. M., Haugtvedt, C. P., & Petty, R. E. (1994). Attitudes and recycling: Does the measurement of affect enhance behavioral prediction? *Psychology & Marketing*, 11(4), 359–374. doi:[10.1002/\(ISSN\)1520-6793](https://doi.org/10.1002/(ISSN)1520-6793)
- Wathen, C. N., & Burkell, J. (2002). Believe it or not: Factors influencing credibility on the web. *Journal of the American Society for Information Science and Technology*, 53(2), 134–144. doi:[10.1002/\(ISSN\)1532-2890](https://doi.org/10.1002/(ISSN)1532-2890)
- Wicker, A. W. (1969). Attitudes versus actions: The relationship of verbal and overt behavioral responses to attitude objects. *Journal of Social Issues*, 25(4), 41–78. doi:[10.1111/josi.1969.25.issue-4](https://doi.org/10.1111/josi.1969.25.issue-4)
- Wood, W. (2000). Attitude change: Persuasion and social influence. *Annual Review of Psychology*, 51, 539–570. doi:[10.1146/annurev.psych.51.1.539](https://doi.org/10.1146/annurev.psych.51.1.539)
- Zarnikau, J. (2003). Consumer demand for “green power” and energy efficiency. *Energy Policy*, 31(15), 1661–1672. doi:[10.1016/S0301-4215\(02\)00232-X](https://doi.org/10.1016/S0301-4215(02)00232-X)