# TV commercial and rTMS: can brain lateralization give us information about consumer preference?

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DOI: http://dx.doi.org/10.7358/neur-2017-021-leba federica.leanza@unicatt.it

ABSTRACT

*The current research aimed at investigating the brain lateralization effect in response to TV advertising of different commercial sectors. This study explored the effects of dorsolateral prefrontal cortex (DLPFC) stimulation on subjective evaluation (semantic differential), in response to some consumer goods. We adopted rTMS (low-frequency 1Hz on left and right DLPFC) to modulate the consumers' (N= thirty-three) response during the vision of five commercials. After three hours from the first evaluation of TV commercials without stimulation, rTMS was delivered in brain frontal areas (F3 and F4 areas) before the vision of each stimulus. Following the stimulation, subjects evaluated advertising a second time by using the same semantic differential. An increase of TV commercials preference occurred in subjects who were inhibited on right DLPFC; while a decrease of advertising preference was shown in subjects who were inhibited on left DLPFC. These results reveal the important role of DLPFC for emotions' elaboration. In particular, the left and right DLPFC seem to be related respectively to positive and negative evaluation of emotional stimuli.*

*Keywords: rTMS; DLPFC; TV commercial; Preference*

## 1. Introduction

According to a recent study conducted by Ebiquity (Rigby, 2015) of over 4.500 advertising campaigns between 2008 and 2014, TV commercial is again the most effective form of advertising. Unlike the past, today the interest of advertising creators is to produce commercials not only brand and company's representative but also exciting and engaging commercials, in addition to useful and informative. Indeed, TV commercial is generally broadcast for a short time where it can get consumers' attention and try to influence their behavior.

The evaluation of advertising has been done for years through conventional marketing research methods as focus group and questionnaires to easily understand consumers' opinions and reactions (Ariely & Berns, 2010), but today the marketers are more skeptical by using only verbal measures to test the commercials' effectiveness. Also, it is necessary to consider that emotions are an important aspect of consumer behavior and the people cannot always fully explain their preference when explicitly asked (Calvert & Brammer, 2012). For this reason, in addition to conventional methods, the effectiveness of different marketing strategies may be evaluated by monitoring brain activity or autonomic measures (heart rate, skin conductance, facial expressions) (Poels & Dewitte, 2006) which result from consumers watching of different advertisements and products (Astolfi et al., 2009; Ohme, Reykowska, Wiener & Choromanska, 2010).

In the literature, the recent interdisciplinary field that combines psychology, neuroscience and economics is the consumer neuroscience. This new discipline studies how the brain is psychologically affected by marketing strategies and, in particular, advertising (Lee, Broderick & Chamberlain, 2007; Madan, 2010). The main goals of consumer neuroscience research are the discovery of the changes which make the commercial stimuli more persuasive (Ohme et al., 2010). Also, it explains how different presentations of marketing stimuli can affect the way in which the consumer reacts. The consumer's physical responses give us information about the process of preference-formation and choice (Kenning & Plassmann, 2008).Most of consumer research was focused on investigating memory (Rossiter, Silberstein, Harris & Nield, 2002; Silberstein, Harris, Nield & Pipingas, 2000), attention (Smith & Gevins, 2004), to assess predictive value of obtained results in the light of marketing theories and emotional process (Balconi, Stumpo & Leanza, 2014).

About emotional processes in consumer neuroscience, studies demonstrate that emotional signals can be revealed from physiological data like heart rate, skin conductance and brain activity (Partala, Jokiniemi & Surakka, 2000; Takahashi, 2004). In addition, the literature on psychology reveals that human emotions are related to their preferences (Aurup, 2011; Nie, Wang, Shi

& Lu, 2011). Custòdio (2010) demonstrated that advertisement, which received high preference scores, had more emotional neural circuits activated compared to advertisements that received worse scores. In order to investigate the prefrontal contribution to choice and preference, functional magnetic resonance imaging (fMRI) has been used (Lebreton, Jorge, Michel, Thirion & Pessiglione, 2009; Levy, Lazzaro, Rutledge & Glimcher, 2011; Tusche, Bode & Haynes, 2010). In particular, a number of studies have documented the important role of orbitofrontal cortex in the emotional valuation process (Balconi, Falbo & Conte, 2012; Balconi & Scioli, 2012; Kringelbach, 2005; Kable & Glimcher, 2009). About this, research mentioned that a stronger activation exists in the left hemisphere associated with TV commercials that consumers like (Vecchiato et al., 2011). Also Davidson, Schwartz, Saron, Bennett, and Goleman (1979) demonstrated brain asymmetry, following research on frontal electroencephalographic (EEG). They proposed that the left frontal cortex (PFC) is involved in a system facilitating approach behavior (positive evaluated stimuli), whereas the right (PFC) is involved in a system facilitating withdrawal behavior (negative evaluated stimuli). Therefore, emotion will be associated with a right or a left asymmetry depending on the extent to whom it is accompanied by approach or withdrawal behavior (Davidson, 2004, 1993). Certainly, these asymmetries are ubiquitous and involved, both in trait predispositions to respond to emotional stimuli related to moderating function of the frontal cortex, and in changes in emotional state, which can be treated as a marker of emotional intensity (Coan & Allen, 2003). Considering EEG analysis as a measure of emotive valence, studies showed that the model of emotional frontal asymmetry can be used to analyze TV advertisements. Other recent studies indicated that the ventromedial prefrontal cortex (VMPFC) is an important substrate for preference judgments (Bartra, McGuire & Kable, 2013; Levy & Glimcher, 2012; McClure, Li, Tomlin, Cypert, Montague & Montague, 2004; Paulus & Frank, 2003). Several recent studies have used cognitive measures to explore subjective responses to stimuli, for example Rossiter and colleagues (2001) analyzed memory and information processing data and showed that preferred visual scenes were better recognized and produced most rapid activation of the left frontal cortices. Focusing on TMS technique, Balconi and Ferrari (2012) found an increased facilitation of the retrieval of positive emotional words under stimulation of the left DLPFC; on the contrary, the memory performance concerning the negative information was not influenced by left frontal stimulation.

More specifically, studies have observed increased activity in the left dorsolateral prefrontal cortex (L-DLPFC) while participants viewed pleasing images (Cela-Conde et al., 2009, 2004; Cupchik, Vartanian, Crawley & Mikulis (2009); Lengger, Fischmeister, Leder & Bauer, 2007; Varrtanian &

Goel, 2004; Vessel, Starr & Rubin, 2012). In addition, it was demonstrated that DLPFC is a key structure in reward, being critical for processing emotional information related to reward (Balconi, Finocchiaro & Canavesio, 2014; Bechara & Martin 2004). However, little is known about individual differences in reward mechanisms mediated by prefrontal system, and about the neural substrates of such individual differences which may support choice and preference (Balconi & Mazza, 2009a; Coan, Allen & McKnight, 2006; Lilienfeld, Wood & Garb, 2000; Wallace, 1966). Indeed the motivational and personality components in choice may modulate the subject's responsiveness to specific emotional features of a good (Balconi et al. 2012; Balconi & Mazza 2009b; Everhart & Harrison, 2000; Heller 1993; Mardaga, Laloyaux & Hansenne, 2006). The concept of reward mechanism was considered a marker of emotional value computation, supported by the prefrontal cortex: primarily it may help to analyze the preference formation and, secondly, it is directly related to emotional significance of a good.

In the current research, TMS paradigm was applied on left and right DLPFC to analyze the contribution of frontal regions on emotional information during the vision of different TV commercials. Specifically, the current study analyzed the role of the prefrontal network (DLPFC) on TV commercial effectiveness with specific focus on the cortical lateralization effect (prefrontal left/right hemisphere) when subjects watched video advertisements of several different commercial sectors. Considering that neuroimaging evidence shows a positive correlation between activity in prefrontal regions and visual appreciation (e.g. Cela-Conde et al., 2004) and the proposed valence model explains the relationship between emotional information processing and a frontal left/right hemispheric lateralization effect (Davidson, MacGrego, Stuhr & Gidron, 1999; Balconi, Brambilla & Falbo, 2009), we expected that TMS paradigm may be used to decrease/increase the cortical excitability of one cortical site in order to enhance/reduce the preference response to different emotional stimuli. High-frequency electrical stimulation is known to induce long-term potential, whereas low-frequency stimulation induces long-term depression (Miniussi et al., 2008; Miniussi, Ruzzoli & Walsh, 2010). In the current study, after a first evaluation of the stimuli, a TMS paradigm was used to estimate the TV commercial effectiveness by inhibiting the left (seventeen subjects) and right hemisphere (sixteen subjects); this phase was followed by second evaluation of TV commercials. On the basis of the valence hypothesis, we supposed that repetitive TMS (rTMS) on the left and right DLPFC would produce respectively higher and lower emotional engagement for the positively and negatively evaluated stimuli. Specifically, we expected more positive judgments of stimuli after the inhibition of RDLPFC and more negative judgments after the inhibition of LDLPFC, by comparing with initial evaluation of stimuli.

## 2. Method

### *2.1 Sample*

Fifteen males and eighteen females (21-31 years) took part to the experiment. We included young healthy subjects who were all right-handed, with normal or corrected-to-normal visual acuity. Exclusion criteria were personal or immediate family history of psychopathology. No neurological or psychiatric pathologies were observed in any of the participants during the study. All participants gave informed written consent for participation and the research was approved by the Ethical Committee of the institution where the work was carried out (Ethics Committee of the Catholic University of Milan, Department of Psychology). The study conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki) printed in the British Medical Journal (18 July 1964).

### *2.2 Stimuli*

The research participants watched five TV commercials concerning products of several different commercial sectors and each video stimulus was associated with a name: Food, Pharmaceutical, Electronic, Finance and Clothing. The video advertisements were interspersed with a 5-second black screen display. Examples of images in the video advertisements are given below (Fig.1).

### *2.3 Procedure*

Participants seated comfortably in a moderately lit room with the monitor screen positioned approximately 100cm in front of their eyes. In the first phase, the short videos (25s) were presented in randomized order (separated by a 5s inter-stimulus interval during which a black screen was displayed) in the centre of the computer monitor. Consecutive stimuli were always different. After each stimulus presentation, the participant was required to evaluate it in terms of some characteristics (emotional, novelty, beauty, usefulness, attractiveness) to rate the overall preference of the video on a seven-point scale preference. Evaluations were indicated using a mouse that allowed to choose the scores, without any time limitation. Second phase started three hours after the first phase; one more time, the same short videos (25s) were presented in randomized order. TMS was delivered before of each stimulus presentation and right after the participant was required to evaluate it on a seven-point scale for the second time.


*Figure 1. Some examples of the five commercial videos: "Food" (Barilla Commercial); "Pharmaceutical" (Enterogermina Commercial); "Electronic" (Samsung Commercial); "Finance" (Che Banca Commercial); "Clothing" (Calzedonia Commercial)*

### 2.4 *Transcranial magnetic stimulation*

rTMS was delivered using a Magstim Super Rapid2 magnetic simulator with a figure-of-eight coil (double wings of 70-mm diameter). We applied rTMS (1 Hz frequency, train duration 10s) at 100% of the motor threshold on left DLPFC (F3) for seventeen subjects and on right DLPFC (F4) for sixteen subjects immediately after each stimulus presentation. Single-pulse TMS was applied at increasing intensities to determinate individual motor threshold by standard procedure (Rossini et al., 1994). Motor threshold was defined as the lowest TMS intensity capable of evoking a muscle twitch in the controlateral hand in eight or ten consecutive trials. The approximate locations of the left and right DLPFC were automatically identified on the subject's scalp using the SofTaxic navigator system (The Magstim Company LTD, Dyfed, Wales), which uses a set of digitized skull landmarks (nasion, inion, and two preauricular points), and approximately 50 scalp points entered with a Fastarack Polhemus digiter system and an averaged stereotaxic magnetic

resonance imaging (MRI) brain atlas in Talairach space (Talairach and Tournoux, 1998). The Talairach coordinates of cortical sites underlying the coil locations were estimated on the basis of an MRI-constructed stereotaxic template (accuracy approx. 1 mm, Talairach space). This scan procedure suggested that TMS was applied over the left or right DLPFC. For the left and right DLPFC, TMS coil was placed with an angle of approximately 45° from the nasion-inion line.

## 3. Results

### 3.1 *Preference rating and stimulus evaluation*

Separated analyses were carried out for the two stimulated groups in left DLPFC (F3) and right DLPFC (F4).A set of distinct ANOVAs were applied to differential semantic adjectives and each analysis had two independent within-subjects factors: time of evaluation (pre- stimulation and post-stimulation) (2) and commercial category (5). Error associated with in homogeneity of variance was controlled by decreasing the degrees of freedom using the Greenhouse-Geiser epsilon. Post-hoc comparisons (contrast analysis for ANOVA, with Bonferroni corrections for multiple comparisons) were carried out where relevant. Moreover, paired-samples t-tests were applied to each stimulus to compare pre-stimulation and post-stimulation evaluation.

### 3.2 *Stimulation in right DLPFC (F4)*

For the usefulness (informative) adjective, significant interaction effect was found for time of evaluation and commercial category ($F(3.032) = 3.658$, $p = 0.019$; Fig.2). For the attractiveness adjective, paired-sample T-test indicated that food TV commercial scores were significantly higher post-stimulation (M=5.076, SD=.9931) than pre-stimulation evaluation (M=4.58, SD=1.458), $t(32) = -2.358$, $p<.025$ (Fig.3). For the emotional adjective, paired-sample T-test indicated that clothing TV commercial scores were significantly higher post-stimulation (M=4.758, SD= 1.22) than pre-stimulation evaluation (M=4.15, SD=1.69), $t(32)=-2.261$, $p<0.31$ (Fig.4).

*3.3 Stimulation in left DLPFC (F3).*

For the beauty adjective, significant effect was found for time of evaluation ($F(1) = 5.839$, $p = 0.028$; Fig.5).

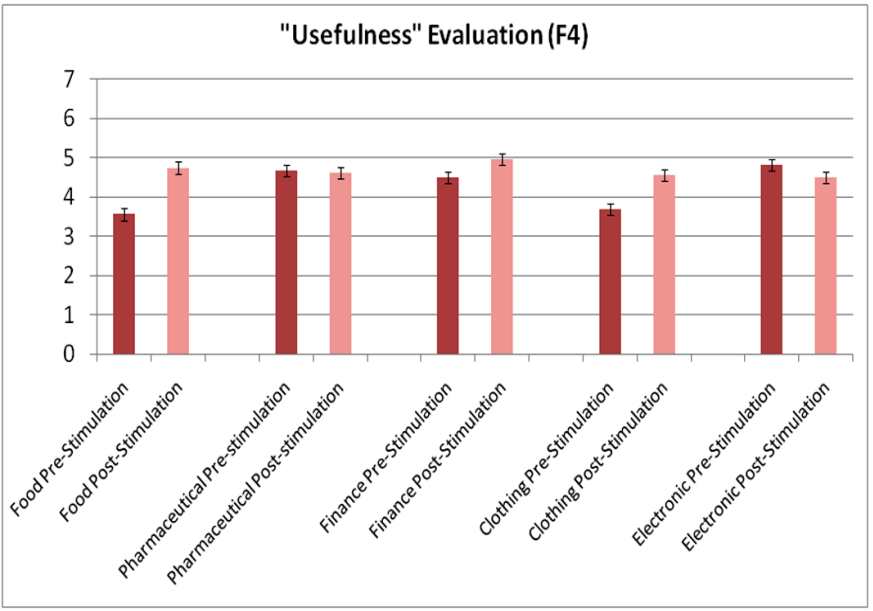


*Figure 2. "Usefulness" Evaluation Pre-stimulation and Post-stimulation of right DLPFC based on all TV commercials*

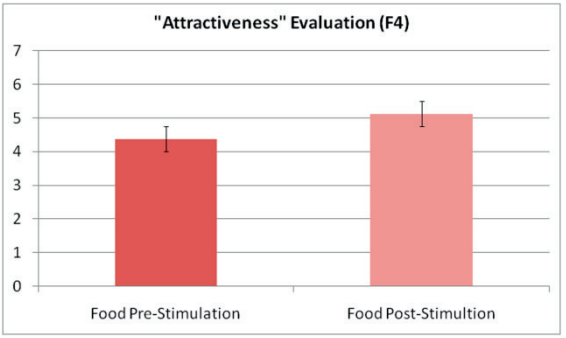


*Figure 3. "Attractiveness" Evaluation Pre-stimulation and Post-stimulation of right DLPFC - Food commercial*

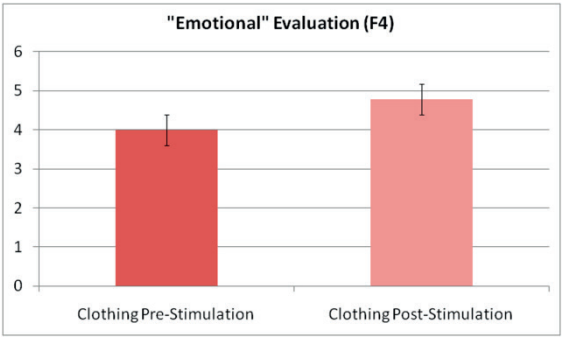


*Figure 4. "Emotional" Evaluation Pre-stimulation and Post-stimulation of right DLPFC - Clothing commercial*

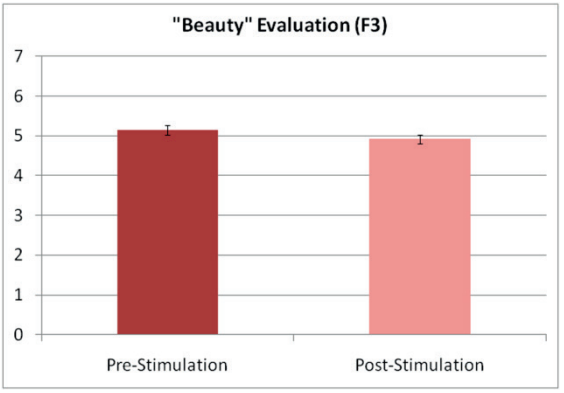


*Figure 5. "Beauty" Evaluation Pre-stimulation and Post-stimulation of left DLPFC based on all TV commercials*

## 4. Discussion

In the current study, we tested the effect of lateralized hemispheric stimulation (DLPFC) during the vision of stimuli that were created to be informative and to emotionally involve the subject. The main result of this research is related to the important role of DLPFC for emotions' elaboration. This is evident for a direct link between subject's preference in the evaluation of the stimuli and brain activity. Specifically, the appreciation for the stimuli increases by inhibiting the right DLPFC. In fact, subjects evaluated all stimuli as more informative (utility) after stimulation compared to starting evaluations. In particular the food TV commercial, that aimed to show the good quality of promoted product and the pleasure to share it, resulted more attractive and desirable compared to previous evaluation without stimulation. Moreover, the clothing TV commercial, created with the intention to involve and excite by promoting the fit of the product thank to physical beauty of actors, resulted more exciting following the inhibition of the right DLPFC. Differently, the appreciation for the stimuli decreases by inhibiting the left DLPFC during the watching of all stimuli that resulted less pleasant.

One possible explanation for this finding is that the left hemisphere selectively attends more to positive stimuli and, conversely the right hemisphere supports increased attention to negative stimuli. With respect of the cortical contribution of the two left/right frontal areas, the present results allowed us to confirm a significant role by the frontal network in elaboration of emotional information. The specificity of the left hemisphere for positive-approach emotions was demonstrated and discussed in previous research (Balconi & Mazza, 2010; Balconi & Lucchiari, 2005; Davidson, 1995). In fact, neuroimaging, ERPs, and EEG studies concluded in favor of the existence of two different frontal cortical networks, one deputed to process withdrawal, negative emotions (the right hemisphere) and one deputed to process approach, positive emotions (the left hemisphere) (Balconi et al., 2009). Other studies suggest that the role of the left DLPFC in esthetic appreciation is to engage an "esthetic orientation" toward the presented stimuli (Cupchik, Vartanian, Crawley & Mikulis, 2009). This research allows us to extend this confirmed theory for emotional TV commercials and the contribution by DLPFC was confirmed by the relationship it has with the subjective evaluation measures. In addition, to strength this supposition, it should be underlined that greater left than right side activation was found for commercial products rated as more positive, emotionally significant and preferred. Thus, positive emotional stimuli are able to induce a more intense response by the left hemisphere.

This left-localized effect, associated with approach responses, might also be explained in terms of reward system processing, which is prefrontally

localized and generally more prominent in the left hemisphere (Balconi et al., 2012). We found that left and right DLPFC are related respectively to positive and negative evaluation of products. Bechara and Damasio (2005) demonstrated that left DLPFC supports the reward system that results more activated when people are involved by positive stimuli. Several studies have reported that frontal and temporal regions are important in reward processing (Min et al., 2003; Potts & Tucker, 2001), and an association between the left frontal regions and positive evaluated stimuli has been demonstrated in several studies (Kawasaki, & Yamaguchi, 2012; Nie et al., 2011). Our results are broadly consistent with neurophysiological evidence. In the human behavior, the reward can be of different natures for example social reward or drugs. In addition, certain concrete objects, like cars (Erk, Martin & Walter, 2005) or money (Breiter, Aharon, Kahneman, Dale & Shizgal, 2001) can be rewarding. Following these results, TV commercial should aim to produce an activation of reward system so that it was memorized and promoted product was purchased.

It is evident that this relationship between stimulation of brain activity and product evaluation was also characterized by a lateralization effect that is a clear emotional valence effect. Previous studies have suggested that the lateralization effect may be explained by the valence and the approach-withdrawal models, and there is a considerable body of evidence supporting these different hypotheses (Schaefer & Rotte, 2007).

This research demonstrates how the brain lateralization is linked with consumer preference. Each promoted product can stimulate reward mechanism, making more desirability the promoted product, exciting consumer and valorizing the characters in TV commercial to increment the social reward sensation. The right and left brain stimulation showed respectively a lower and higher subjects' preference for TV commercial watching.

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