UNIVERSIDADE TÉCNICA DE LISBOA

INSTITUTO SUPERIOR DE ECONOMIA E GESTÃO

DOUTORAMENTO EM GESTÃO

NEUROSCIENCE IN MARKETING

AN FMRI-BASED PERSPECTIVE ON BRANDS

JOSÉ PAULO NEVES CORREIA MARQUES DOS SANTOS

Orientação: Doutor Luiz Abel Magro Moutinho
Júri:
Presidente: Reitor da Universidade Técnica de Lisboa
Vogais: Doutor Luiz Abel Magro Moutinho
Doutora Amanda Jayne Broderick
Doutora Maria Margarida de Melo Coelho Duarte
Doutor Paulo de Neville da Cunha Sepúlveda e Lencastre
Doutora Patrícia Margarida Piedade Figueiredo

Março / 2011

ERRATUM

(empty list so far)

ABBREVIATIONS, UNITS AND ACRONYMS

AGL	Artificial Grammar Learning
AIC	An information criterion (Akaike)
ANN	Artificial neural networks
aMPFC	Anterior medial prefrontal cortex
arMFC	Anterior rostral medial frontal cortex
BC	Before Christ
BOLD	Blood-oxygen-level Dependent
ca.	Circa (Latin); approximately
cf.	Confer (Latin); compare
cont.	Continued
Coord.	Coordinates
dMPFC	Dorso medial prefrontal cortex
DN	Default network
dof	Degrees of freedom
doi	Digital object identifier
EPI	Echo-planar imaging
ESRC	Economic and Social Research Council
et al.	Et alii (Latin); and others
etc.	Et cetera (Latin); and the rest
EV	Explanatory variables
FEAT	FMRIB Expert Analysis Tool
fMRI	Functional Magnetic Resonance Imaging
FMRIB	Functional Magnetic Resonance Imaging of the Brain
fNIRS-DOT	Functional Near-Infrared Spectroscopy – Diffuse Optical Tomography
fov	Field of view
FSL	FMRIB Software Library
GLM	General Linear Modelling
HRF	Hemodynamic response function
Hz	Hertz (frequency; occurrences per second)
IAPS	International Affective Picture System
IC	Independent component
IFG	Inferior frontal gyrus
IGT	Iowa Gambling Task
IQR	Interquartile range
ISI	Inter-stimulus interval
MEG	Magnetoencephalography
MELODIC	Multivariate Exploratory Linear Optimized Decomposition into Independent Components
MNI152	Montreal Neurological Institute standard brain with 152 subjects
MO	Market orientation
ms	Milliseconds
MTL	Medial temporal lobe
NBO	Non-biological actors
NEW	Non-emotional words

oMFC	Orbital medial frontal cortex
PAD	Pleasure – Arousal – Dominance scale
PCC	Posterior cingulate cortex
PICA	Probabilistic independent component analysis
prMFC	Posterior rostral medial frontal cortex
rTMS	Repetitive Transcranial Magnetic Stimulation
s	Second
s/he	She or he
SD	Standard deviation
SI	Primary somatosensory cortex
SII	Secondary somatosensory cortex
SAM	Self-assessment manikin
S-O-R	Stimulus – Organism – Response
T	Tesla
TE	Echo time
TMS	Transcranial Magnetic Stimulation
ToM	Theory of Mind
TPJ	Temporo-parietal junction
TR	Repetition time
vmPFC	Ventro-medial prefrontal cortex

ABSTRACT

Although somewhat outdated, the American Marketing Association definition of brand still is largely accepted. In this case, brands are signs for product differentiation.

The present research, instead, finds brands and their logos as meaningful signs that belong to the human communicative lexicon. Logos are ideograms, i.e. graphic representations that convey meanings. These meanings are transferred from one mind to other minds through brands, establishing communication between humans, and which is also used to self-monitoring in a self-reflexive process, i.e., reading the reactions of others to the ideographic messages once sent to them. Brands are intimately connected to meta-representational processes, whether they are seen as the repository of human attributes, whether themselves are perceived as interlocutors, in a quasi-human level.

It also finds that the human emotion system is used to perceive, interpret, and classify brands. Founding in the neuro-based model of emotions developed by Damásio, the present research reveals that brands systematically recruits the emotion system when stimulate brains, which leads to posit that brands are felt in order to be perceived.

It is also largely relying in the brain structures that support emotion processing, but also based in other regions that support self-relatedness processing, that is trained an artificial neural network that yields predictions of subjects' choices at a level much higher than mere chance. This procedure allows a coarse but promising consumers' "mind reading".

Key words: Brands; Neuroscience; Semiotics; Ideograms; Meanings; Theory of Mind.

RESUMO

Apesar de algo ultrapassada, a definição de marca da American Marketing Association ainda é largamente aceite. Assim, as marcas são sinais usados na diferenciação de produtos. A investigação presente, pelo contrário, sugere que as marcas e os seus logótipos são sinais com significado que pertencem ao léxico comunicativo humano. Os logótipos são ideogramas, i.e. representações gráficas que transmitem significados. Tais significados transferem-se de uma mente para outra através das marcas, estabelecendo uma comunicação entre humanos, e que também é usada na auto-monitorização num processo auto-reflexivo, i.e. lendo as reacções que os outros têm às mensagens ideográficas que lhes foram enviadas. As marcas estão intimamente ligadas aos processos meta-representacionais, seja por elas serem consideradas um repositório de atributos humanos, seja por elas próprias serem consideradas como interlocutores, a um nível quase-humano.

Este estudo também constata que o sistema emocional humano é usado para perceber, interpretar, e classificar as marcas. Baseado no modelo neuronal das emoções de Damásio, verifica-se que as marcas recrutam sistematicamente o sistema das emoções sempre que elas estimulam um cérebro, o que leva a avançar que as marcas são sentidas de forma a serem percebidas.

É com base em estruturas cerebrais que sustentam o processamento das emoções, mas também com base em outras regiões ligadas a processamentos da auto-reflexão, que é treinada uma rede neuronal artificial, da qual resultam previsões das escolhas dos sujeitos participantes, as quais estão a um nível muito superior ao mero acaso. Este procedimento permite uma “leitura da mente” algo grosseira, mas muito promissora.

INDEX

LIST OF TABLES

LIST OF FIGURES

PREFACE

Qualitative and Quantitative methods are not usually seen together in the same research. Social Sciences and Natural Sciences (or Exact) tend to mutually repel, each one with its credos and rituals. Compartmentalising knowledge only results in creating difficulties to its progress. The approach of the present thesis is markedly no-dogmatic and shamelessly incorporates methods and knowledge from both sides. Ultimately, its aim is to know more about humans.

As it will emerge along the dissertation, brands are inherently and intrinsically human. The last two decades witnessed the emergence of human facets in brands in a series of ideographic studies. In fact, brands were not created two centuries ago and brands are not only product differentiators. Such a way of thinking is clearly limited, amputating brands in the most they are. Brands are crucial for self construction, maintenance, and repairing. Brands are also used to mark belongingness to social groups and avoidance too. Brands are used also to self-monitoring in a self-reflexive process. Hence, brands are vital for psychosocial homeostasis, a concept with 40 years that here is recovered and that wisely translates what brands are in fact.

Probably brands are as old as writing is. Brands belong to the human communicational system. When the Native American paints his totem in the shield, he is spreading his brand, sending clear messages with meanings about himself: what he is and what he is not. Very importantly, he would not be the same without such brand.

Brands are not a western creation. It may be advanced that:

> “[27] So Man created brand in his own image, in the image of Man he created him;”
> (adapted from Genesis)

Original Contributions

The main original contributions of this research are:

- A different framework to understand what brands are in fact. There is an alteration from the traditional American Marketing Association definition, which conceive brands as product markers, allowing to make a distinction from the competing products, to the proposed framework, where brands belong to the human communicative lexicon, much like in logographic / ideographic language systems, and which integrates the Semiotic perspective that brands (Signs) are different because convey different meanings (Objects).
- It is revealed that the human emotion processing neural mechanism is largely used to perceive and classify brands. In fact, brands are felt in order to be perceived.
- There is a significant participation of the Social Brain when brands' logos stimulate the brain. There is a consistent participation of brain structures connected to Theory of Mind, which is interpreted as a "doing mind" with brands, whether brands are perceived as repository of other humans attitudes (humans mediators), whether brands are themselves the target of meta-representations, in this case are brought into a quasi-human level.
- Qualitative research in general and Grounded Theory in particular are not usually seen in traditional positivist realms, like Neuroscience is. Grounded Theory is a master girder along this research in a markedly post-positivist approach. The compelling pertinence in theory construction, the systematic challenging of the interpretations, and the founding of all construction in

empiric data bring robustness and purpose to any research, which counteracts the insistence on narrowing questions into an atomic and meaningless level.

- It is experimented a new approach to interpret MELODIC independent components (ICs) outputs by the means of a GLM. The GLM links ICs to the paradigms' manipulations through the conventional explanatory variables (EVs). This strategy allows selecting specific ICs with statistical criteria (and not based in the suppositions of the researcher) and makes the usually large output sets much easier to analyse and interpret.
- It is experimented the application of artificial neural networks (ANNs) to the analysis of Functional Magnetic Resonance Imaging (fMRI) data, developing an initial procedure. This procedure is found to yield predictions of subjects' options much higher than the chance level, allowing to a coarse but promising "mind reading".

Publications

Parts of this thesis have been presented and published in several scientific conferences with competing papers:

- Santos, José Paulo; Brandão, Sofia; Seixas, Daniela (2007). "Neuromarketing: valence assessments of commercial brands. A functional magnetic resonance imaging (fMRI) study", 9th International Forum on the Sciences, Techniques and Art Applied to Marketing. Academy and Profession (November 29-30th, 2007), at Universidad Complutense de Madrid, Spain.
- Santos, José Paulo; Brandão, Sofia; Seixas, Daniela (2008). "Neuromarketing: how Neuroscience can help get into the minds of the consumers. A study on

commercial brands", XVIII Luso-Spanish Conference on Management (February, 07-08th, 2008), at the Faculty of Economics of University of Porto, Portugal.

- Santos, José Paulo; Brandão, Sofia; Seixas, Daniela; Moutinho, Luiz (2008). "Neural Correlates of Emotional and Symbolic Brands' Content", 2008 Conference on Neuroeconomics (May, 15-16th, 2008), at the Copenhagen Business School, Copenhagen, Denmark.
- Santos, José Paulo; Brandão, Sofia; Seixas, Daniela; Moutinho, Luiz (2009). "*Habeo ergo sum*: neural correlates for self-concept nourishing with brands' symbolic meanings", 38th EMAC Conference (May 26-29th, 2009), at Audencia – École de Management, Nantes, France.
- Santos, José Paulo; Moutinho, Luiz; Seixas, Daniela; Brandão, Sofia (2010). "Perceiving brands after logos perception: an event-related fMRI study", 6th Thought Leaders International Conference on Brand Management (April 18-20th, 2010), at Università della Svizzera italiana, Lugano, Switzerland.

ACKNOWLEDGMENTS

To José Diogo, José Guilherme and Cláudia Sofia, and of course José Queiroz and Maria Ermelinda, for love, care, support, kept the universe stable and a truly deadline.

But I am just one in the team: to Daniela Seixas, Sofia Brandão, and Luiz Moutinho without whom it would never be possible.

I. APPROACHING THE THEME, BOUNDING THE RESEARCH, AND OPTIONS

The 2008 call from the Economic and Social Research Council (ESRC) "Understanding Individual Behaviour: Exploratory Networks (UIBEN)" summarises the actual level of comprehension of human behaviour:

> The ESRC in collaboration with the BBSRC and MRC invites applications for innovative exploratory networks (ENs) in the area of 'Understanding Individual Behaviour' (UIB). Many of the major challenges facing UK society depend on improving understanding on why people behave as they do and how to maximise the effectiveness with which individuals can take control of their own lives. The leading edge is to bring together the different groups of scientists from very different perspectives into a meaningful scientific endeavour which adds value via its interdisciplinary approach. The complexity of analysing human behaviour, as well as the challenges of cross-disciplinary working, both within and between the biological, physical, biomedical and social sciences, means achieving this aim will be especially demanding. (ESRC, 2008, retrieved 2008-08-07 http://www.esrc.ac.uk/ESRCInfoCentre/opportunities/current_funding_ opportunities/UIB.aspx?ComponentId=26866&SourcePageId=5964)

In fact the mechanisms and computations that output human behaviour still are a mystery, and this state of the art directly touches Marketing discipline because Marketing is essentially human behavioural responses. Markets do not exist in nature.

Markets are a human creation where individuals practise exchange and exchange is a cascade of behavioural initiatives and responses. It is worth to note that the ESRC call requires the participation of scientists from diverse fields to embark upon a new multidisciplinary approach. It recognises the complexity of human, and consequently, consumer, behaviour, and it is possible to infer that the conventional approaches were not sufficient. It is time to involve Biology, Physics, and Biomedicine together with Social Sciences to struggle to better understand human behaviour. The present work shares the concern of ESRC and clearly adopts the proposed strategy.

Neuroscience in Marketing

The use of neuroscientific knowledge to investigate Marketing issues has been postulated by several researchers and practitioners (Ambler, 2008; Hubert & Kenning, 2008; N. Lee, Broderick, & Chamberlain, 2007; D. Penn, 2008; Plassmann, Ambler, Braeutigam, & Kenning, 2007; Zaltman, 2003). Even recently such visions were disclosed in an high impact journal (Ariely & Berns, 2010). In spite of this, not many empirical articles have been published in peer reviewed journals, contrarily to the flourishing field of Neuroeconomics that already have a society (The Society for NeuroEconomics; http://www.neuroeconomics.org), a scientific annual meeting, and substantial articles and books (Glimcher, 2003; Glimcher, Camerer, Fehr, & Poldrack, 2009; Politser, 2008). Aiming to contribute with cutting-edge research to Neuroscience applied to Marketing, the main object of the research along this work will be commercial brands, represented by their logos, to target a neuroscientific approach to consumer brands' perception.

But, why so big expectancies rely on Neuroscience? Maybe because actual methods are not providing satisfactory answers... (Senior, Smyth, Cooke, Shaw, & Peel, 2007). Although the evolution in statistical analysis, much of the market research still extensively depends on consumers opinions. It is known that humans give socially desirable responses (Steenkamp, de Jong, & Baumgartner, 2010; Tourangeau & Yan, 2007), especially when the questions investigate delicate themes like drugs (Makkai & McAllister, 1992), or emotions (Chamberlain & Broderick, 2007). In the end, the researcher is working more with pretence than reality, more with papers that actors would like to perform than those they effectively can or are able to perform. If the study is contaminated with such biases, its utility and applicability will become very limited. Acknowledging this problem, some researchers developed other methods that could surpass this bias by limiting verbalisations, like the image-based in-depth personal interview that Zaltman (2003) patented under the name ZMET - Zaltman Metaphor Elicitation Technique (Zaltman, 1995). For example, this method was used to understand the perceptions that consumers have about advertising (Coulter, Zaltman, & Coulter, 2001), and the results obtained with the characterisation of mountain bike consumers are strikingly pertinent, drawing a cognitive map that undresses this consumer tribe (Christensen & Olson, 2002). However, consumers' brains, particularly the cognitive processes that occur in the brain and generate behaviours, still are a black box. The faith on Neuroscience is that it would help shed some light into that black box, and thus helps researchers and marketers to better understand consumers.

The following study conducted by Plassmann and colleagues may illustrate how neuroscientific knowledge can inform about specific marketing issues (Plassmann, O'Doherty, Shiv, & Rangel, 2008). A sample of consumers was scanned in a Functional

Magnetic Resonance Imaging (fMRI) device while they tasted a set of wines and rated them on pleasantness. The only things they knew about the wines were the grapes they were made from (all Cabernet Sauvignon), and their prices. In fact, the task was being manipulated because the researchers did not delivered five different wines (as consumers thought), but only three. In two of them the price was increased / decreased. Wine 1 was delivered at its market price ($5), and inflated ($45), wine 2 was delivered at its market price ($90), and deflated ($10), and wine 3 was delivered at its market price ($35). The ratings exhibited a clear linear correlation with price. Eight weeks after the scanning session, participants had to rate again the wines, now without the price information. They could not significantly distinguish wine 1 at $5 from $45, neither wine 2 at $90 and $10. Amazingly, wine 1 ($5 and $45, but participants did not know the price now) was the higher rated. This inverse correlation between price and wine liking is confirmed in blind tests made with non-experts (Goldstein, et al., 2008). The positive correlation between price and quality is known for long (Rao & Monroe, 1989), and participants produced behavioural responses that were culturally aligned. The comparison between high priced wines (wine 1 at $45, and wine 2 at $90) versus low priced wines (wine 1 at $5, and wine 2 at $10) revealed activation in a brain region named ventro medial prefrontal cortex and a deactivation in the dorso lateral prefrontal cortex. This pattern suggests that the participants' decision processes were emotion-based and that they forwent their rational capabilities. In fact, participants were common wine appreciators, not professionals. Thus, they did not use the necessary deliberative knowledge to independently rate the wines, and hence, they used their emotional cognition. It is worth to say that the experienced pleasantness price-based did not correlate with the primary gustatory cortex, which is a proof that the participants were responding according to some information other than the sensorial. For Marketing, this is a clear lesson that intrinsic qualities of a product can be perfectly negligible, and extrinsic properties, like price, can override functionalities during the decision process. In fact, Neuroscience acknowledges that people have extreme difficulties in representing absolute values. Common judgements are relative-valued, which turns them permeable to manipulations as the described in this study, when the brain tries to integrate several sources of information under uncertainty and produce accordingly behaviours (Seymour & McClure, 2008).

In summary, the neuroscientific knowledge and methods can and should be used to aid researchers understand better how consumers behave, and specifically how consumers relate to brands (Perrachione & Perrachione, 2008). To this same conclusion arrived Chamberlain and Broderick (2007), stressing that physiological measures concur to a better description of a construct so complex as emotions are. This strategy is then fully in line with the proposals and aims of ESRC considered in the beginning of this chapter.

Functional Magnetic Resonance Imaging (fMRI)

Many neuroscientific studies have been using Functional Magnetic Resonance Imaging (fMRI) to investigate brain function, and it was found to be useful in market research (Kenning, Plassmann, & Ahlert, 2007). This Neuroimaging technique was elected due to a set of advantages, where being ethically acceptable apply it to healthy participants figures on the top (Seixas & Ayres Basto, 2008): it does not uses radioactive chemicals, nor ionizing radiation, nor has the invasiveness of introducing electrodes through the skull. It just makes use of a strong magnetic field and radio electromagnetic pulses that never have been proved to cause harm to humans. Other advantages include the spatial resolution and a wealth of knowledge constructed along the years of neuropsychological studies using fMRI, which is crucial to guarantee the nomological validity of eventual findings. A set of disadvantages are important to be mentioned to fully understand the outputs of this tool. The most important is the fact that the fMRI scanner is located inside a hospital, which means that healthy participants will perform in the trials under the hospital environment. The extent of the influence of such environment is unknown, notwithstanding the adoption of practices that aim to reduce such an influence like the use of current wearing apparel by team elements and a fifteen minutes lounge talk, previous to the scanning sections, to ensure anxiety reduction. It is worth to say that not all participants are acceptable in the experiments: due to impositions of the Ethics Committee only adults are allowed to the scanner; due to fMRI's limitations, participants should not suffer from claustrophobia, nor have metal particles in the body; and due to neuroscientific considerations, they should not be under the effect of psychotropic drugs, nor be left handed (to guarantee the same brain lateralisation for all participants). Other major disadvantages of fMRI are the noise (intrinsic to the fMRI scanner operation) and the very limited interaction with participants. These disadvantages limit the use of sound, touch, taste, and smell stimuli. For that reason only visual stimuli will be used.

FMRI basics.

Some basics of fMRI should be considered to fully interpret and understand the results (some books make a very complete draw of this tool (Huettel, Song, & McCarthy, 2004; Jezzard, Matthews, & Smith, 2001), and Blow (2009) updates with the last improvements). FMRI measures the BOLD signal (Blood-Oxygen-Level Dependent signal). Thus, it does not measures directly neural activity but, supposedly, the rate of oxygen consumption: it is assumed that when a group of neurons increase firing rate, they start to consume more oxygen. Oxygen is supplied by the blood stream, linked to haemoglobin molecule. Deoxihaemoglobin (haemoglobin without oxygen) is paramagnetic (is attracted to magnetic fields), but oxyhaemoglobin is diamagnetic (creates a magnetic field opposed to an external magnetic field), which means that, when oxyhaemoglobin delivers the oxygen molecule that is carrying, it transforms into deoxihaemoglobin and simultaneously changes its magnetic character. This change interferes with magnetic field, and this interference can be measured by radiofrequency pulses in three dimensional volumes.

As there is a difference in time between the neurons firing rate increase and the extra supply of oxygen, the BOLD signal is lagged, and usually the peak occurs about 4 to 6 seconds after the stimulus onset. This feature is very important when interpreting the results.

It results from this mechanism that if researchers aim to test if a certain group of neurons participate in a process, they must design a paradigm that puts those neurons into, at least, two different firing rates. This is a very important methodological issue, as it results that only relative questions can be addressed with this tool. If this contrast between two different levels does not exist there will only exist a constant firing pattern in time, impossible to resolve with fMRI. In simple block designs, two levels of functioning are usually induced by the paradigm: stimulus and baseline. More complex paradigms use several classes of stimulus and a baseline, hoping that certain brain structures fire differently under each different stimulus. By subtracting pairs (stimulus 1 - stimulus 2, or stimulus *n* - baseline) there is an activation (increase in BOLD signal) if the result is positive, which means that the target neurons increased the firing rate with the stimulus onset; or a deactivation (increase in BOLD signal under the baseline condition) if the result is negative, although this mechanism is not completely understood (Logothetis, 2008; Wade, 2002). More complex analysis allows the emergence of linear, parabolic, exponential, logarithmic, etc. parametric tendencies in multi stimuli paradigms.

It is worth to emphasise that activation / deactivation and excitatory / inhibitory impulses are not the same thing, although all concern neurons. So a neuron fire, it needs to receive excitatory impulses from other neurons over a certain threshold. However, some neurons send inhibitory impulses that counteract the excitatory ones, blocking the excitatory chain. It is important to retain that if a neuron sends an excitatory impulse, or if another one sends an inhibitory impulse, both are working, both are firing, thus both are consuming more oxygen, and then both increase the BOLD signal. This means that both excitatory and inhibitory neurons produce activations in the fMRI outputs (Sotero & Trujillo-Barreto, 2007).

There are two more limitations of fMRI that extensively condition the design of the research paradigms. Normally a full brain scan takes 2 to 3 seconds to accomplish. Within this time window multiple processes initiate, evolve, and terminate. Hence, fMRI is good to reveal the brain structures that participate in a process, but, actually, it is not capable to disclose sequences within psychological processes. Another point is that BOLD signal is laden with magnetic noise (an example of the output signal is drawn in Figure 1). For this reason it is necessary to repeat enough times the same stimulus and baseline so the signal statistically emerges from noise. Murphy and Garavan (2005) estimated the ideal number of repetitions for event-relate fMRI studies.

Balancing all these pros and cons, the result is clearly positive for fMRI and this technique was chose to address a specific Marketing issue: how humans perceive brands. One of the aims of this thesis is to draw cognitive maps of assorted brands' perception with the help of fMRI. This perception will be made up by consumers. Hence, it will be the images of the brands, as consumers construct them in their brains, which will be acquired. This research stresses therefore the shift into the consumer perspective on brands, as consumers own the epicentre of equity building along their relation with brands (Escalas, 2004; Keller, 1993; Lassar, Mittal, & Sharma, 1995; Leone, et al., 2006). Based upon the activated brain structures it is intended to identify the processes that support brands' perception and infer the characteristic brands' dimensions. The purpose of the present research is not study a particular brand, rather find eventual neural markers that could be used to attribute certain characteristics to brands, but with neuroscientific validity, hence surpassing the verbalisation pertained to conventional methods like questionnaires, focus groups, or interviews.

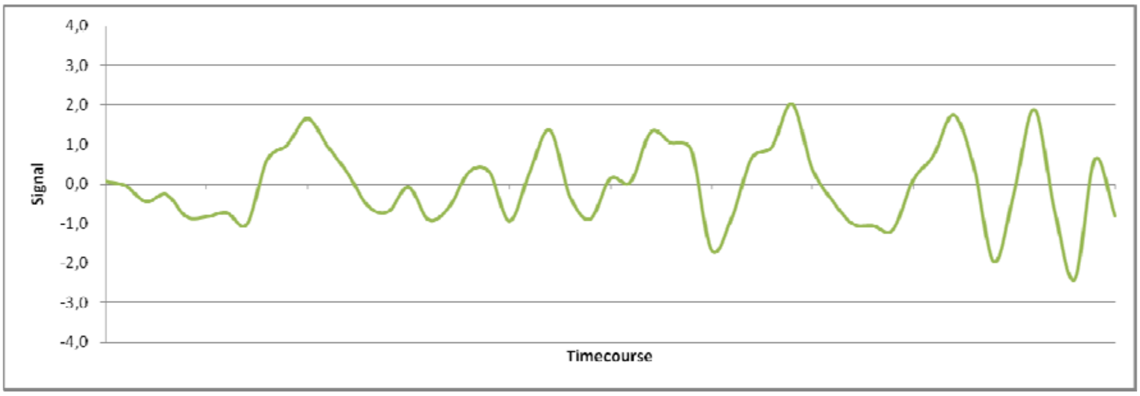


Figure 1 – Example of the BOLD signal output during fMRI experiments. The data used refers to 50 acquisitions, which in this case is 150 seconds.

General Linear Modelling (GLM) analysis of fMRI data.

The scanner outputs a dataset with the BOLD signal along the sequence of brain acquisitions (let say “photos” in timely sequence). However, this timecourse is not for all the brain. The brain is divided in voxels (think about voxels like digital photos’ pixels, but with thickness). If the unit voxel is 2 mm × 2 mm × 2 mm, it would expect to have about 200,000 voxels in the whole brain (which is about 1,600 m^3).

As the paradigm is manipulated and stimuli onset and duration is controlled, the idea is to, for each voxel at a time, consider every type of stimulus an independent variable, the BOLD signal is the dependent variable and then fit a GLM. Likewise, it is possible to make statistical inferences over the independent variables’ coefficients (β, betas) and then conclude about an eventual activation, or deactivation, or no significant difference in the contrast. An example illustrates the procedure.

The orange line in Figure 2 represents the stimulus manipulation with the respective onsets and extinctions. However, the BOLD signal is lagged about 4-6 seconds and also the hemodynamic response does not happen in right angles, but is smooth. The first step is then to transform onsets and extinctions in a hemodynamic response function (HRF) convolution, like the blue line in Figure 2.

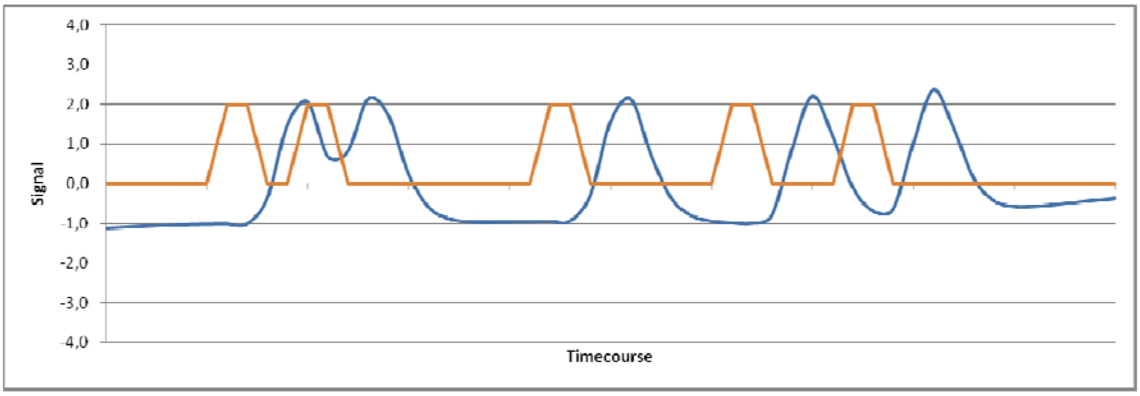


Figure 2 – The orange line represents stimulus onsets and extinctions. The blue line is the resulting hemodynamic response function convolution, which already includes the delay in BOLD signal.

This procedure has to be extended to all independent variables. In Figure 3, the HRF for two different stimuli are represented.

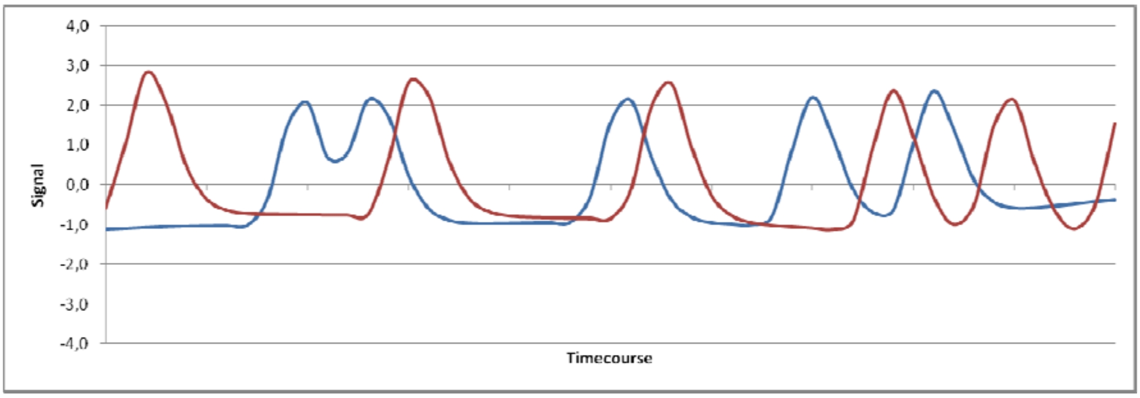


Figure 3 - Hemodynamic response function for two different stimuli.

The BOLD signal (dependent variable) may now be added to the graph (see Figure 4. It is possible to see that the BOLD signal line follows more the blue line than the red line. In fact the statistical *z* for this difference is 3.94. At this point it is necessary to define a threshold for significance. The value arbitrated is the default in the FSL software package: 2.30 for activations, and -2.30 for deactivations. As 3.94 > 2.30 it may be asserted that this voxel activates in the contrast Blue > Red.

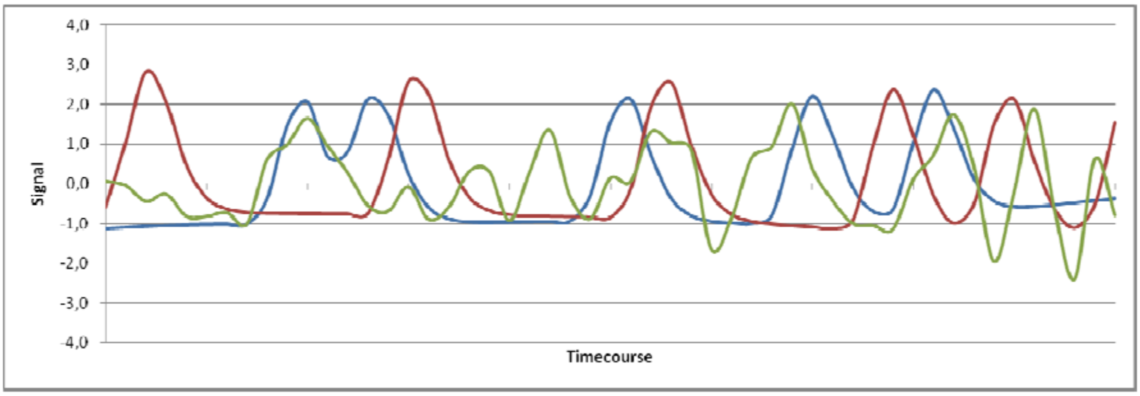


Figure 4 - Hemodynamic response function for two different stimuli (blue and red lines) together with the BOLD signal for the voxel (-6 × 50 × -8) (green line).

In Figure 5 there is a different example for another voxel. In this case the yellow line follows less the blue line than the red line. The statistical *z* for such difference is -4.43, and as it is inferior to the threshold (-2.30) it may be asserted that this voxel deactivates in the contrast Blue > Red.

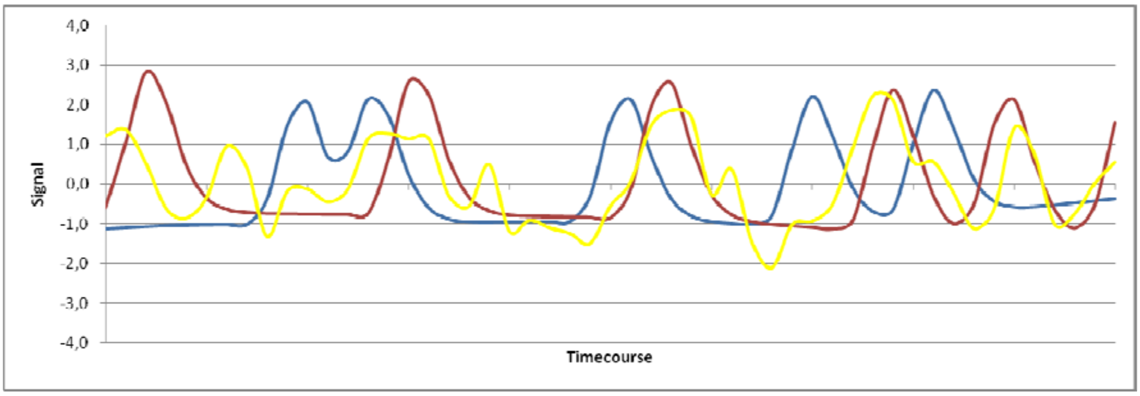


Figure 5 - Hemodynamic response function for two different stimuli (blue and red lines) together with the BOLD signal for the voxel (-2 × 88 × -8) (yellow line).

A further example is presented in Figure 6. In this case the BOLD curve does not follow preferentially any of the others, and the statistical *z* is -0.22. This voxel is not significant in the contrast Blue > Red. It may be the case that both stimulus recruit this voxel, or that none recruits it. In any case there is not a significant difference.

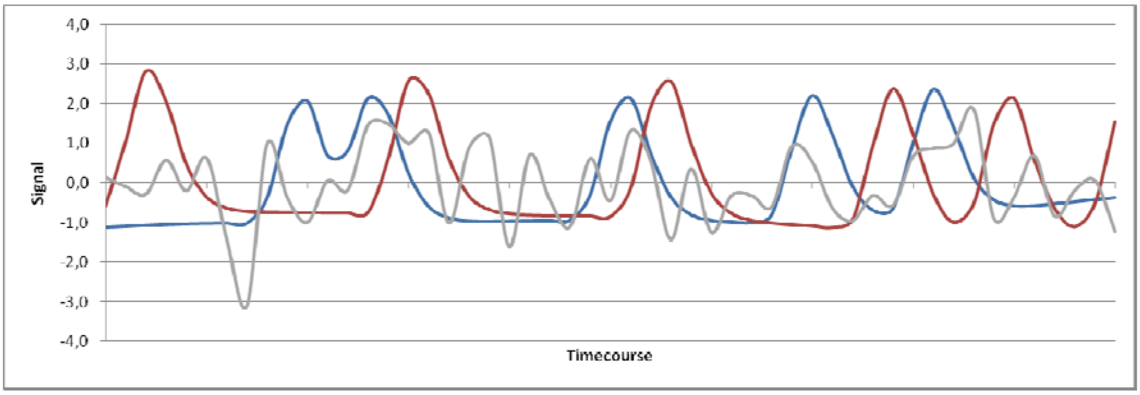


Figure 6 - Hemodynamic response function for two different stimuli (blue and red lines) together with the BOLD signal for the voxel (-38 × 14 × -8) (grey line).

After running this procedure for all the voxels in the brain, the output is a statistical parametric map with *z* values. This is why this kind of approach is named by mass-univariate analysis: a GLM analysis is applied in each voxel per se; interactions between voxels are not considered. To better visualise the relevant information, it is a common procedure to highlight activated voxels with colours ranging from red to yellow (normally corresponding to *z* from 2.30 to 3.90), and highlight deactivated voxels with colours from dark blue to light blue (normally corresponding to *z* from -2.30 to -3.90). Non significant voxels are not represented. To easily locate the voxels exhibiting activations or deactivations, usually these colour codes are presented over an anatomical acquisition of the brain, as depicted in Figure 7. Along the present work the brain coordinate system and the brain template that will always be used as reference is the MNI152, adopted by the International Consortium for Brain Mapping (details of the construction of this coordinate system and brain template can be found in Collins (1994) and Brett (1999)).

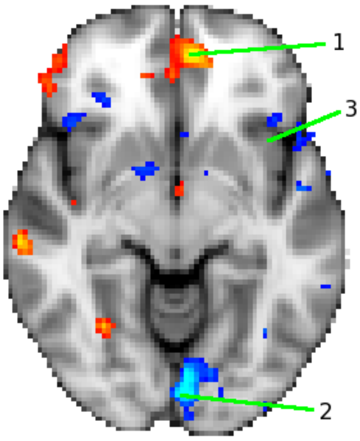


Figure 7 – Example of a statistical parametric map for the slice *z* = -08 (in this case, *z* is the vertical axis of the coordinate system, not a statistical *z*). The points 1, 2, and 3 refer to the partial timecourses represented respectively in Figure 4, Figure 5, and Figure 6. The respective coordinates in the MNI152 coordinate system are: for point 1 (-6 × 50 × -8), for point 2 (-2 × -88 × -8), and for point 3 (-38 × 14 × -8).

The identification of the anatomical brain structures that include the activated or deactivated voxels is made with the help of digital atlases. Along the present work two probabilistic atlases will be used: the *Harvard-Oxford Cortical Structural Atlas* and the *Harvard-Oxford Subcortical Structural Atlas* provided by the Harvard Centre for Morphometric Analysis (www.cma.mgh.harvard.edu), which are part of FSL View v3.0.2, part of FSL 4.1.2. Maintaining the same slice example (*z* = -08), Figure 8 provides an image of the segmentation of these atlases; neighbouring brain structures are individualised with different colours.

Figure 8 – Example of the segmentation of the brain structures considered in the adopted atlases in the slice z = -08.

It is possible then to filter the results of the activations / deactivations with these atlases to conclude about the brain structures that participate in each process. The same previous example is depicted in Figure 9 for the clusters with activations and in Figure 10 for deactivations.

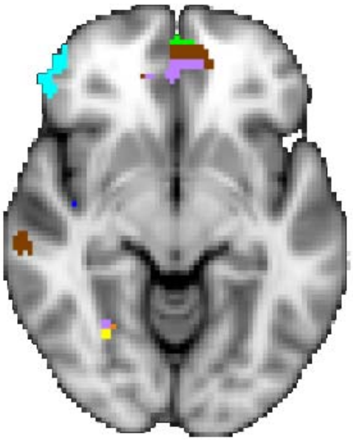


Figure 9 - Example of the activations in Figure 7 (z = -08), now depicted in false colours to highlight the participation of different brain structures.

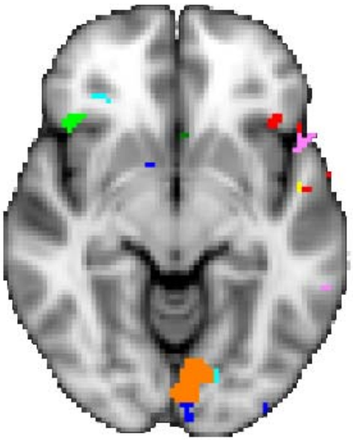


Figure 10 - Example of the deactivations in Figure 7 (*z* = -08), now depicted in false colours to highlight the participation of different brain structures.

An important issue in using brain templates and standard brains is their usefulness in group analysis. The procedure described so far applies for the analysis at the individual level, which may be interesting for Psychology. However, for Marketing, the most appealing are collective movements, which mean that the systematic search of patterns of activation across individuals is emphasised. Due to inter-individual morphological variations, comparing brains is a challenging task, and resorting to standard brains is a suitable solution, acknowledging that in the adaptation process valuable information will be lost and that such process is always approximate.

Multivariate analysis of fMRI data.

The analysis in a voxel by voxel basis puts methodological problems. Acknowledging that fMRI is being used to unveil neural systems that support psychological processes, the separate analysis of each element without considering the effect of the remaining will ever be successful? Probably not, because the advantage of a system is being more than the sum of the parts, and if psychological processes rely on complex systems (e.g. integrating multisensory information and individual own goals into the decision process), this strategy for data analysis maybe will never accomplish its objective.

It has been proposed multivariate methods to analyse fMRI data (Haynes & Rees, 2006; Norman, Polyn, Detre, & Haxby, 2006; Pereira, Mitchell, & Botvinick, 2009), which consider not only the timecourse signal of each voxel individually, but also the activity in the other voxels through the brain. Of course this introduces extensive amounts of computations, which is not easily solved. Due to this reason, most of the multivariate approaches have been focusing on well defined parts of the brain (regions of interest) and there investigate if particular voxels within that region hold critical information for the decision process (Etzel, Gazzola, & Keysers, 2009). For example, Hanson, Matsuka, and Haxby (2004) used an artificial neural network classifier to investigate the role of the ventral temporal lobe (fusiform and parahippocampal gyri) in object recognition (faces, houses, cats, bottles, scissors, shoes, and chairs). They found that there are not specific places for each object category, but correctly classifying objects relies in combinatorial participations of some voxels in this brain region. This means that a certain voxel may hold critical information to correctly classify houses and cats, but does not participates in houses classification, and that another voxel participates in cats and houses classification, but not in faces. This way, with a finite limited number of inputs, through combination, it is theoretically possible to generate an infinite number of categorical concepts, much like when a finite limited number of words can produce an infinite number of statements (also because words can be infinitely sequenced). It is worth to note that mass-univariate methods would not unveil this schema because such methods look strictly for particular places that correlate with one category. Mass-univariate methods would then produce spurious results and are not adequate to reveal combinatorial-based systems.

Multivariate analysis over fMRI data was also used to understand the construction of value in a neuroeconomic task. Clithero, Carter, and Huettel (2009) found that the left posterior parietal cortex (and secondarily the posterior cingulate) hold important information to correctly classify above chance if participants were making a probabilistic or an intertemporal valuation, which was not evident in the analysis of activations across voxels. Hence, also for complex behaviours like in economic tasks, multivariate analysis may be more informative than current mass-univariate methods.

In spite of this, the very large majority of the works published using fMRI relies in mass-univariate analysis and not in multivariate methods. This is because multivariate methods are seen as essentially exploratory and less confirmatory, and mainly because their development is delayed face to GLM, and also because much of the methods still lack agreement within the scientific community. In the present work both methods will be used. Besides the conventional GLM-based mass-univariate analysis, two multivariate methods will be used: Probabilistic Independent Component Analysis (PICA) and the correspondent extension for group analysis Tensor-PICA as implemented in MELODIC (Multivariate Exploratory Linear Optimized Decomposition into Independent Components) as part of FSL (FMRIB Software Library), and also Artificial Neural Networks (ANN).

While GLM-based fMRI data analysis previously necessitate the design of a model, which is formalised in the independent variables, multivariate methods, and specifically MELODIC and ANN do not require such prior assumptions. This simple detail has insightful methodological consequences. Constructing a prior model is always pulling apart some fraction of the world, which can or cannot be important for the matter of the research. In the end there will be, in the extreme, a correlation, which is not fully supportive for theory construction. Due to their correlational output together with their relative nature, the interpretation of GLM-based findings must be surrounded with great cautions. On their side, multivariate methods like MELODIC or ANN do not have previous assumptions on states of the world formalised in models. Instead, such methods search for explanatory causes subjacent to the data. They are said model-free. Their findings are usually causal, in the sense that the respective missing is necessary and sufficient to deny the possibility of the data be produced in this world. These methods allow jumping over mere correlations and targeting causality, which is much more informative and supportive for theory building. These same considerations will be recovered in the section devoted to Grounded Theory.

PICA was first used for detect artefacts (head movements, magnetic field inhomogeneities, magnetic noise and phantoms, etc.) within fMRI data. However, its ability to cluster data is extensive for activation patterns, summarising in diverse independent components (ICs) voxels that exhibit similar behaviours in time. The problem here is the interpretation of the meaning of the IC set as each element can be caused by psychological processes, by physiological processes, or by physical artefacts, where only the former interest directly to Marketing theory. To isolate the ICs that support the psychological processes involved in the interesting stimulus manipulation a new approach is experimented herein: a GLM analysis is applied, where the independent variables represent the stimulus manipulation in the paradigm (the same way as in GLM-based fMRI data analysis; see previous section), and the dependent variable is the timecourse of the IC. It is then possible to make statistical inferences over the independent variables' coefficients and then conclude about which of the stimulus (or combination of stimuli) is more supportive of the activated voxel pattern represented in the IC. During the analysis, this procedure will be detailed and exemplified.

ANNs were originally developed in the 1950s and 1960s (Minsky & Papert, 1969; Rosenblatt, 1958) and their mathematical formalism can be found elsewhere (Gurney, 1997; Haykin, 2009). Figure 11 represents the architecture of a simple network with three layers: the input layer with *n* nodes (or neurons), the hidden layer with three nodes, and the output layer with two nodes.

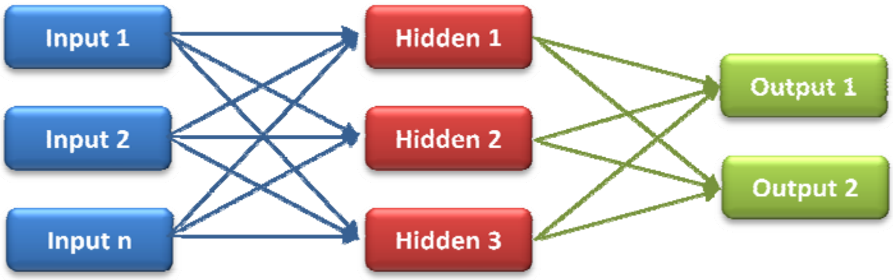


Figure 11 - An example of an artificial neural network architecture with n inputs, 3 nodes in the hidden layer, and 2 output nodes.

The relations between nodes are weighted. For example, the weight of the contribution of input node 1 on hidden node 2 is given by w_{12}. If a certain magnitude is presented to input node 1 (let call it x_1), its influence in hidden node 2 is given by the product of the magnitude times the weight, in this example $w_{12} \times x_1$ (or, more simply $w_{12}\, x_1$). The total contribution that inputs hidden node 2, u_2, will then be the sum of all the weighted partial contributions, that is $u_2 = w_{12}\, x_1 + w_{22}\, x_2 + \ldots + w_{n2}\, x_n$. Equation 1 generalises for the i^{th} node with *n* inputs. It can be applied for every node in the hidden layer or in the output layer in Figure 11.

$$u_i = w_{1i}\,x_1 + w_{2i}\,x_2 + \dots + w_{ni}\,x_n \Leftrightarrow u_i = \sum_{j=1}^{n} w_{ji}\,x_j \qquad (1)$$

Depending on the final result of the calculation performed with the aid of Equation 1, the node (neuron) will or will not fire in its turn. This operation is formalised by a step function similar to Equation 2, the activation function $\varphi(u)$, which graphical representation is depicted in Figure 12.

$$\varphi(u) = \begin{cases} 1, & u \geq \theta \\ 0, & u < \theta \end{cases} \qquad (2)$$

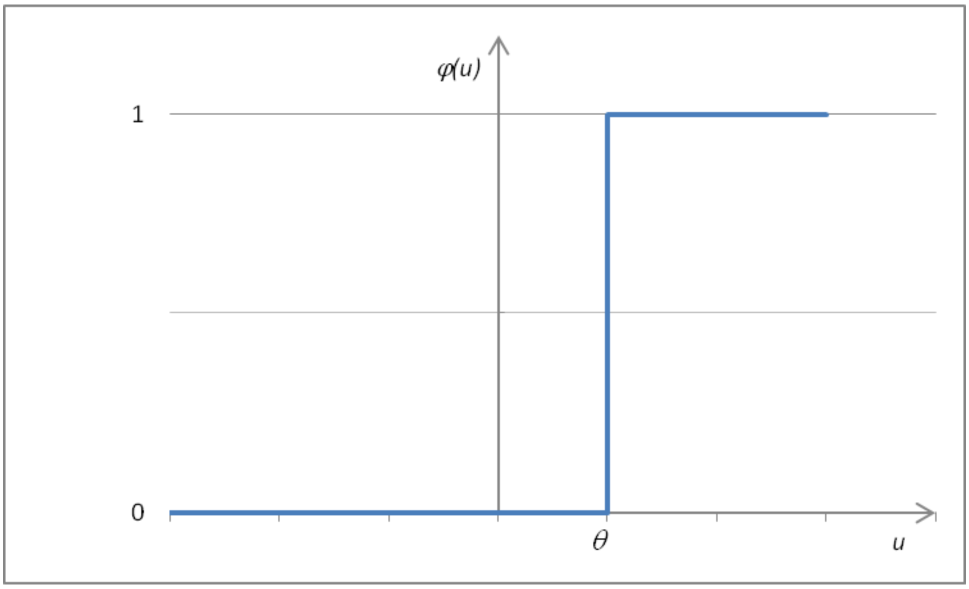


Figure 12 – Graphical representation of a step function like the one in Equation 2.

Hence, if the sum of the weighted inputs in node *i* is equal or exceeds the amount θ, the node will fire, outputting the magnitude 1. If it is inferior, the node will keep silent, outputting the magnitude 0. If node *i* inputs to other nodes (like in the case of hidden nodes in Figure 11 that feed the nodes in the output layer), it will be these magnitudes that will enter the computations of those nodes. Then, in Figure 11, the calculations are made from the left to the right, that is, after presenting *n* magnitudes in the input layer, the calculations propagate into the output side, and these networks take the designation of feedforward.

If together with the magnitudes presented in the input layer there is some expectation about the values that such magnitudes cause to output, it can be compared if the final result of the network calculations meet such expectations. If they are met, the ANN is well designed and it could foretell the outputs. If they are not met, then the weights have to be readjusted in order to improve the match between the expected and calculated outputs. This procedure of tuning ANN's weights takes the name of supervised training, and its mathematical details can be found elsewhere (Gurney, 1997; Haykin, 2009). Datasets for ANNs are usually split in two: one part is used in the supervised training stage, and the other one is used to assess the trained ANN. Likewise, it is possible to verify if the trained ANN has good predictability capabilities, which is a very important characteristic of the network.

ANNs are frequently seen together with the sigmoid function. In fact, the step function represented in Equation 2 it is not used. The discontinuities of that function put mathematical problems difficult to solve. Instead the sigmoid function (and other similar functions) formalised in Equation 3 and depicted in Figure 13, are preferred.

$$\varphi(u) = \frac{1}{1 + e^{-(u-\theta)}} \tag{3}$$

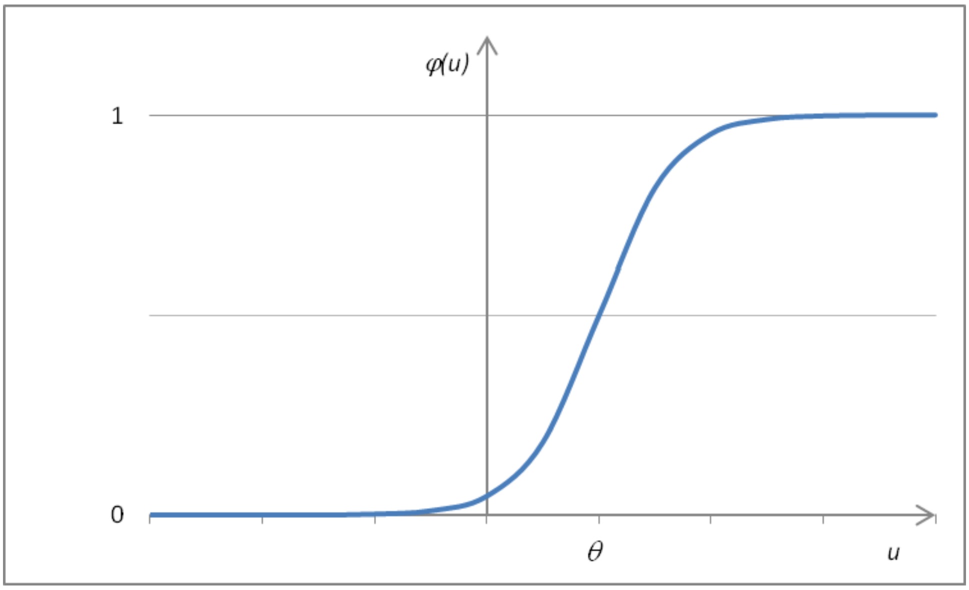


Figure 13 - Graphical representation of the sigmoid function like the one in Equation 3.

The debate about reflexive versus formative modelling should be brought to discussion. Jarvis, MacKenzie, and Podsakoff (2003) claim that the misspecification of the measurement model have been leading to the publication of biased conclusions and theories, which stresses the critical importance of this matter. This claim has been reinforced meanwhile (Diamantopoulos, Riefler, & Roth, 2008). ANNs conceal within their structures both formative and reflective modelling, which is allowed by the existence of hidden layers. Figure 14 remakes Figure 11 in order to emphasise this facet.

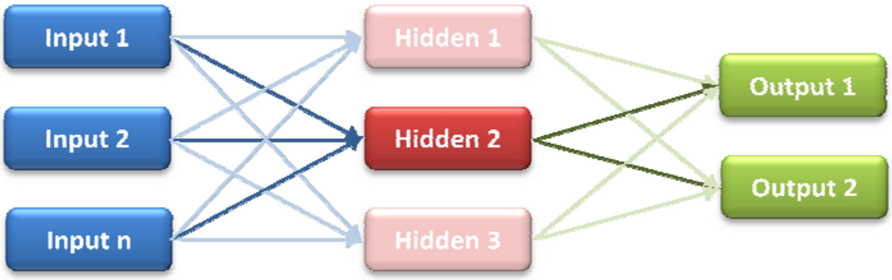


Figure 14 – The same ANN example from Figure 11, now emphasising the formative sector (in blue) and the reflective sector (in green).

There is also the strikingly similarity between Equation 1 and the equations that describe the relationships between constructs and measures both in formative and reflective modelling (Coltman, Devinney, Midgley, & Venaik, 2008; Edwards & Bagozzi, 2000). The nodes within hidden layers in ANNs may then be considered as constructs; they are not directly attainable, but their effects are observable (in the output layer), and also they can be influenced (through the input layer). This is important for the search of causality because the flow of causality is from left to right: inputs cause effects in constructs, and constructs cause effects in the outputs.

For the application of Neuroscience in Marketing, the usefulness of an ANN in much derives from its ability to replicate the S-O-R (stimulus – organism – response) framework. Having inputs (stimuli), and outputs (behavioural responses), the nodes that compose the hidden layer may represent the psychological processes that transform inputs in outputs, i.e. constructs. It is then theoretically possible to achieve a level of "mind reading" that decomposes and, simultaneously makes emerge, the strategies that subjects apply in response to stimuli. Even more, the predictability capabilities of the emerging model can be assessed in the test stage of the ANN.

Finally, ANNs are particularly suitable to resolve problems with non-linear relationships, a field where GLM and other linear-based methods fail drastically. For example, an ANN was used to investigate the linkage between market orientation (MO) and performance, a double advantage of this technique because simultaneously ANN is capable to reveal associations in problems loosely structured (Silva, Moutinho, Coelho, & Marques, 2009). The specificities of the application of ANNs to analyse fMRI data sets will be detailed further in this thesis, in dedicated sections.

Neuroscientific Approach to Brands

The literature was searched in order to concentrate the research published to date concerning the use of neuroscientific knowledge to investigate brands.

Although the researchers did not use explicit brands' logos, but full car photographs instead, nonetheless allowing the participants in the study to perceive the design and style associate with each car manufacturer, Erk, Spitzer, Wunderlich, Galley, and Walter (2002) tested for rewarding associated to sport cars, limousines, and utilitarian small cars. They found that sport cars, associated to wealth and social dominance, activated reward-related brain areas, suggesting the use of such cultural objects to spread personality traits.

Paulus and Frank (2003) used photographs of soft drinks where brands figured noticeably, cueing for preference judgements. Although they report activations in several brain structures, their study sought specifically the ventro medial prefrontal cortex. They hypothesise that this area is critical for everyday preference judgments and implicit human behaviours. In fact, this brain region activated extensively when participants made preference judgments about soft drinks when contrasted about physical perceptions of the same stimuli (liquids contained in bottles or glasses, or height of bottles).

McClure et al. (2004) used Coca-Cola and Pepsi as stimuli. They concluded that brand-cued delivery of sodas influenced the preference for one or another, but such effect was absent in anonymous deliveries, stressing the role that logos have shaping consumers decisions, indeed overriding sensory preference. This study is a cornerstone in Consumer Neuroscience as it clearly demonstrates that cultural information (in this case, brand information) can interfere, and even can override, sensory-based decisions.

In another study, participants were instructed to imagine driving cars manufactured by the brands they were seeing (Schaefer, Berens, Heinze, & Rotte, 2006). The familiar brands activated brain structures related to self-relevant processing, but the unknown symbols were unable to trigger such thoughts, concluding that logos, as cultural-based symbols, may contribute to bias behaviour into familiar realms reducing uncertainty. Delving in this research trend, in a new study, Schaefer and Rotte (2007a) stimulated participants again with car brands' logos, asked them to imagine driving a car of that manufacturer, but, in the end of the study, they asked also to assess brands according to personal attractiveness, luxury / sport character, rational electiveness, and familiarity. They found brain structures connected with emotionally salient decision-making that activated when attractive car brands were contrasted versus unattractive ones, and also found that brain structures that support rational, volitional, and deliberative decisions correlate inversely with brands' attractiveness. These findings stress the role of favourite brands as emotional rewarding stimuli, and suggest reduced strategic rational responses when persons face beloved brands. Schaefer and Rotte (2007b) went a step further and repeated the same study, now introducing car brands' logos from other markets, but that do not exist at all in the market from where participants were recruited. By this way, known and unknown real brands were contrasted in this study. Their results support previous findings, specifically that there are brain areas that disentangle self-relevant brands from those that represent value products, and that emotional processing is involved in brands appraisal.

Not using healthy participants but patients with specific damage in the brain structure ventro medial prefrontal cortex, Koenigs and Tranel (2008) repeated a trial similar to the tested by McClure and collaborators, i.e. delivering a soft drink in two conditions: anonymously and brand-cued. Whilst normal controls and other brain damaged areas patients changed their soda preference from the anonymous to the brand-cued test, ventro medial prefrontal cortex patients persisted in the original choice. They conclude that the ventro medial prefrontal cortex is a brain structure necessary to integrate taste-independent information in the decision-making process. In fact, this brain structure is known to be crucial in wisdom decisions (Damásio, 1994) and ventro medial prefrontal cortex patients just followed straightforwardly what their sensory system told them, ignoring cultural and ecological knowledge.

Yoon, Gutchess, Feinberg, and Polk (2006) investigated if trait adjectives have the same neural semantic underpinnings whether they are used to make judgements about persons, or about brands. They concluded that making judgements about persons (self and others) is subserved by different brain structures than making judgments about brands (whether they are self-relevant or not), although the exact same words (adjectives) could be used in the judgments. These results caution on many market researches that extend human attributes to brands, or even studies that relied on brand personality dimensions (Aaker, 1997; Azoulay & Kapferer, 2003), features that Yoon's study clearly defies by establishing a semantic chasm between humans and brands. However, it is worth to emphasize that this study used brand names written in black in arial font over a white background, which means, they did not use brands' logos. The authors did not consider the hypothesis that truncating a main component of the brand, its logo, would also have consequences on the brands' meaning. In fact, it can be argued that they just used brands' wording, without the entire load that brands are supposed to embody, which means that the study was biased since the beginning to produce a semantic differential.

Other researchers did experiment a different neuroscientific approach to brands by simulating brand-cued buying decisions. Deppe, Schwindt, Kugel, Plassmann, and Kenning (2005) scanned consumers while they decided which of two brands they would buy. The researchers previously elected one brand from the set as the target brand (T), and the remaining were the diverse brands (D). Each participant had to make two kinds of options: TD options, where the target brand and a diverse brand compete simultaneously for the vote, and DD options, where the competing brands were both diverse. Subsequently they divided the participants in two groups: those for whom the target brand was the preferred one, and those for whom the target brand was the second or further choice (which mean that in this group, in fact, participants were making DD options most of the time). They found neural support for two parallel decision-making mechanisms in the brain. When DD options had to me made, brain structures related to deliberative and volitional "cold" reasoning were recruited. However, when TD options had to be made, these regions deactivated, and a different pattern of brain regions achieved activation. This pattern included the ventro medial prefrontal cortex and other brain structures related to rapid and effortless decisions. The authors concluded that preferred brands recruited the emotion based decision-making mechanism, which has already been proposed (Bechara & Damásio, 2005; Bechara, Damásio, Damásio, & Lee, 1999; Bechara, Damásio, Tranel, & Damásio, 1997; Damásio, 1994, 1999, 2003b). Summarising, these authors found that when consumers had to decide about two non-preferred brands, they use a rational cognitive mechanism, but when the decision involves a preferred brand, the brand itself causes a short-cut in the deliberative process and consumers use an emotional cognitive mechanism. Strikingly, these researchers did not find a parametric correlation between brands' hierarchical preference and brain structures, which means that there is not neural support for an eventual ordered sequence of brands in the brain. In fact, their findings support the existence of considerations sets (or evoked sets) instead (Petrof & Daghfous, 1996; Roberts & Lattin, 1991; Shocker, Ben-Akiva, Boccara, & Nedungadi, 1991), even when the quantity of considered elements in the set is one (Lapersonne, Laurent, & Le Goff, 1995).

Plassmann, Kenning, Deppe, Kugel, and Schwindt (2008) went a step further on their study and introduced a cue in the paradigm to investigate the role of ambiguity in brand preference. They reported that favourite brands were not able to produce activations when contrasted with diverse ones independently of the ambiguity level, thus failing to reproduce findings from the first study. However, favourite brands activated brain structures related to emotion-based decision and self-relatedness when the ambiguity level was considered. Their findings support the signalling theory for brands, as the reduction of perceived ambiguity due to brand information contributes to drive (signal) for a brand preference (Erdem & Swait, 1998).

During the buying process (or more broadly "getting", which means acquire the possession of something at some cost), several steps can be established. At least two phases are considered: a previous motivational stage, *wanting*, and a posterior evaluative stage, *liking*, that includes learning (Berridge & Robinson, 2003; A. E. Kelley & Berridge, 2002; Knutson, Fong, Adams, Varner, & Hommer, 2001). In a wheel-of-fortune-like paradigm, together with three chocolate bar brands that participants previously accepted that would buy, Koeneke, Pedroni, Dieckmann, Bosch, and Jancke (2008) designed a study to disentangle these two phases. It is worth to emphasise that these researchers sought for neural structures that correlate with increasing preference for the chocolate brands. In the motivational stage they found activations in motor and supplementary motor areas, which they linked to behavioural actions preparations, and in the insula and orbitofrontal cortices. These later structures are known to have a role in the representation of value in the brain, and also the insula is involved in empathic processes, and in feeling the emotions (Craig, 2002; Damásio, 1994; Singer, et al., 2004). Still in the motivational stage, they found a deactivation in the dorso lateral prefrontal cortex, very similar to the deactivation reported by Deppe et al. (2005), reinforcing the conclusion that preferred brands short-cut deliberative reasoning. However, Koeneke's study misses support for the concomitant emotional response. One possible explanation for this fact is that they used brands that participants accepted would buy, which means they used brands from participants' consideration sets, all of them able to produce emotional responses, but maybe with differences too subtle among them for the fMRI resolution capacity. In the evaluative stage the authors found activation in the striatum, a complex brain structure usually reported to encode monetary rewards in many neuroeconomic studies (Montague, King-Casas, & Cohen, 2006).

Knutson, Rick, Wimmer, Prelec, and Lowenstein (2007) used a paradigm that mix the last two cited: on one hand they used a brand-cued buying decisions paradigm, but also they tried to disentangle diverse stages along the buying process. They considered three stages: product (where participants just saw the product / brand), price (where participants saw the product / brand and the price proposed), and choice (where participants saw the product / brand, the price proposed, and two options – yes or no buttons – and they had to chose one). They looked for neural correlations on preference (product + price stages), price differential (just price stage; in this study price differential is the difference between psychological price that participants accept to pay and proposed price, which means that high price differential is a good deal), and purchase (just choice stage). Three brain structures achieved correlations with these stages: the nucleus accumbens activated for preference and purchase, the ventro medial prefrontal cortex activated for high price differential and purchase, and the insula deactivated for excessive prices and no purchase. This study clearly finds that preferred products / brands are sawn as rewards, and the exhibition of such products / brands initiates behavioural strategies to achieve them. These impulses could be subsequently inhibited when costs associated with the reward are pondered, or not, which maybe reveals brain underpinnings of overspend, conspicuous consumption, and painless purchasing with credit cards.

All these experiments were conducted using fMRI. Some other studies used Magnetoencephalography (MEG) to investigate brand-cued shopping decisions, which included a virtual visit to a supermarket (Ambler, Braeutigam, Stins, Rose, & Swithenby, 2004; Braeutigam, Stins, Rose, Swithenby, & Ambler, 2001). Although it is not possible to identify brain structures due to inherent technique restrictions, it allows to clearly recognizing in time course different stages during shopping decision. Four separate processes were found. At around 90 ms after stimulus onset it was identified the participation of the visual cortex, supposedly processing the visual information, and at around 325 ms it was identified the participation of the anterior and middle temporal cortices, supposedly processing stimuli semantic decoding. Until this moment the stream process is common for every brand and situations. However, at 510 ms after stimulus onset, it was identified the participation of the left inferior frontal cortex, more in low salience stimuli (when there is no evident preference for a brand in the set) than in high salience. At 885 ms occurs the reverse: high salient situations recruited the participation of the parietal cortices more than low salience. In another analysis (Braeutigam, Rose, Swithenby, & Ambler, 2004) it was identified responses in the orbital cortices at 645-690 ms, and at 1255-1300 ms, more in low salient stimuli. Also, low salient stimuli produced phase-locked γ-band activity at 1590 ms (31 Hz) over left anterior temporal region, and at 1860 ms (22 Hz) over right dorso lateral prefrontal areas. It results evident that different brain processes subserve ambiguous versus preferred brand decisions (Braeutigam, 2005): the former rely on deliberative and time consuming reasoning, and the later are short-cut emotional based decisions. These studies also found some differences in gender decision-making.

In summary, these studies, which used techniques and knowledge from Neuroscience, essentially investigated the relationship between brands and decision-making. So far, they support a general decision-making process made-up by two parallel, but reciprocally communicating, chains (Bechara, et al., 1997) or, better, cognitive processes (in the sense, "mental processes involved in the acquisition, processing, and utilization of knowledge or information", (American Psychological Association, 2007)): rational cognition, which relies in collecting enough data and inputs that characterise the problem that must solved, and use previously learned algorithms to achieve outputs, many times using optimization, and thus is time and resources consuming and requires large amounts of data to arrive to acceptable solutions; and emotional cognition, which uses frugal data and simple heuristics, very often implicitly learned, and can be processed with limited resources, but provides rapid decisions (Gigerenzer, 2001; Todd & Gigerenzer, 2003). Preferred brands are rewards, the same way that certain foods, drinks, music, or sex are. All these stimuli cue for strategic behavioural responses that hedonically aim to achieve rewards, carelessly encumbering dorso lateral prefrontal cortex-based rational cognition. These strategies are sustained in time by the ventro medial prefrontal cortex, the brain structure that evolutionarily humans have been using to ensure adaptive behaviour (Rolls, 2000b, 2004). Within this framework some deviant economic behaviour get sense, or by insufficient inhibition of the hedonic impulse, or by insufficient rational control (A. E. Kelley & Berridge, 2002). Nevertheless, within this general mechanism that traps brand preference, some specific Marketing issues are highlighted. Brands can be powerful enough to override sensory information (Koenigs & Tranel, 2008; McClure, Li, et al., 2004), which means that brands are not just the logos, colours, jingles, slogans, etc. Brands are meaningful cultural elements, and these meanings maybe are responsible for self-relatedness that certain brands exhibit (Schaefer, et al., 2006), contribute to reduce ambiguity during judgements, and this may leads to preference (Plassmann, Kenning, et al., 2008). There is also support for consideration sets (Deppe, Schwindt, Kugel, et al., 2005), instead of a hierarchical sequence of preferences (Koeneke, et al., 2008). In spite of this, Yoon found a semantic chasm between humans and brands, which clearly puts the later in the category of objects (Yoon, et al., 2006), and the findings in Plassmann's article may signalise consumer's learning about brand meaning (Erdem, et al., 1999), although it is difficult to explain the failure to reproduce previous results in the contrast between favourite and diverse brands.

Finally, a recent study used a different imaging technique, fNIRS-DOT (Functional Near-Infrared Spectroscopy – Diffuse Optical Tomography (Boas, 2004; Villringer & Chance, 1997)) to guess brand-cued product preferences (Luu & Chau, 2009). The purpose of the study was to find a protocol that, using non-invasive techniques and in real time (fMRI scanning session sessions normally take about 30 – 40 minutes, and computer data processing usually takes 1 to 12 hours, which literally require days to complete the analysis), accurately decode preferences for products, to help individuals with disabilities to better communicate with their environment. They demonstrated that applying the near-infrared laser optodes over the ventro medial prefrontal cortex, it is possible to decode subjective preference on single trials with an average accuracy of 80%. As this technique is less expensive than fMRI, allows extensive interaction with the participants, and also it is portable, it opens new doors for market research interviews, as brains can be directly investigated surpassing the traditional verbalisation barrier.

Except in the study of Yoon et al. (2006), where brands were referenced just by their names, with the same font for all, transversal to the remaining studies, brands appear in two situations: or as cues in explicit preference judgements, or simultaneously in pairs or triads now being themselves the target of a judgement. On one hand this sounds a bit artificial as when a consumer is in front of a shelf, s/he do not draw in profile the competing products to decide, nor buy several competing products just because all are a good deal. On the other hand, as most of the fMRI tests are subtractive, this means that brands' shared characteristics become cancelled during the analysis process, which raises a pertinent previous question that none of the published studies considered yet: how do humans perceive a brand?

Three Principles from Grounded Theory

It is worth to emphasise the methodological approach of the present research. The purpose of this study it is not to find proofs from an exact discipline about brands' dimensions. Rather, this is a first study of a series that aim to experiment the use of neuroscientific techniques and knowledge to investigate brands' perception. The approach is markedly qualitative and three principles from Grounded Theory are recognisable in the research strategy (Corbin & Strauss, 2007; Strauss & Corbin, 1990).

First, there are not previous constructed models, neither from Neuroscience, nor Psychology, nor Sociology, nor, of course, from Marketing. Previous models tend to introduce biases in the studies, and if one aim of the present work is to capture a different perspective on brands, in this case a neuroscientific perspective, such biases could introduce influences from established knowledge pertaining to other disciplines. That is why this approach starts to be broad, poor bounded, and uses a simple, yet very robust, fMRI technique in its very beginning. It is now understandable the emphasis put in multivariate models for fMRI data analysis, which are progressively introduced along this research; such models are model-free, that is, they do not require prior models and then measure the fit to the observed data, which would always be an appreciation with a sharp segregated chunk of the world. Instead, methods like PICA or ANNs dig for subjacent rules within datasets and expose them, and all the world is considered until this stage. It is the interpretation of the exposed rules, a task carried out by the research team, that will integrate and weave the findings with the actual knowledge and theory, which leads to the second principle from Grounded Theory.

Second, all the findings must be data grounded. The activated brain structures will be used to infer concepts that support brands' dimensions, the same way that texts are coded to generate higher level concepts, categories, and theories. The difference is that the researcher's subjective perspective is considerably reduced as the "coding" (activated and deactivated brain structures) will be done by computer programs.

Nevertheless, comparisons with similar neuroscientific studies will be present all the time to guarantee nomological validity, and this specific work will be carried by human researchers, which will decide on the more pertinent according to their perceptions and interpretations. At this point, it is mandatory to bring to discussion the reverse inference problem. Suppose that a certain task A activates a group of voxels in, let say, the paracingulate gyrus. Then, from the literature, a task B activates an analogous group of voxels. It is not possible to conclude that A and B are equivalent or even similar because different psychological processes may rely in the same brain structure at a certain point of their flow (for a more exhaustive explanation see Poldrack (2006, 2008) or (Ariely & Berns, 2010)). When interpretations about the role of certain brain structures are made, it is important to consider not specific studies or experiment reports that focus in a very limited set of stimulus, but in meta-analysis or reviews or theories constructed around the functions of a brain structure, which provide wider and more consistent considerations of specific structures' roles. In the same line, when A and B share the same process (not particular brain activations, but brain-based psychological processes), they do not have to be considered different, because it is unlike that different processes recruit the same pattern of elements, and processes are characterised by brain structures in network and not in isolation. This strategy substantiates the option for the dual use of mass-univariate together with multivariate methods along the present work. The aim it is not a mere brain mapping for brands, but, unveil psychological processes involved in brands' perception, which are to be weaved and re-arranged to output a theory, which brings the third principle from Grounded Theory.

Third, it is implicit the aim of producing a theory about consumers' brands perception. The findings of the earlier stages of the research will be used to design future questions that will challenge previous concepts and constructed concepts' links. Early studies will seek for general brands' perceptions, but the subsequent ones will introduce the necessary refinement to produce a data-grounded theory. The dialectical tension theory progress versus theory challenge will be a ubiquitous presence in all findings' discussions. Likewise, hopefully it will bear robustness to theory construction.

Grounded Theory is then a suitable master girder that will structure all the research presented along the present thesis, and also project future work. Grounded Theory has an inverted structure when compared with conventional research. Conventional research usually starts with a model and an extensive literature review that would support the constructs and linkages that compose the model. A number of hypothesis that challenge the model are considered. Then, instruments are drawn to provide data, which statistical analyses will output correlations that in turn will (or will not) corroborate the advanced hypothesis and, consequently, the proposed model. This entire schema is inverted in Grounded Theory. Theory, the explanation of the world, is approached through data and not by previous tailoring of models. The entire world is considered as having sufficient explanatory content and it is data itself, and not the researcher, that will firstly filter the relevant issues for the research question. The role of the researcher in Grounded Theory is to weave the emerging theory with broader theories concerted among the scientific community, searching for nomological validity, but <u>after</u> some concepts and categories have emerged from data.

Recovering the example of the ANN structure in Figure 14, which depicts the dual nature of ANNs (formative and reflective), it integrates well with the enunciated Grounded Theory principles. Like in Grounded Theory, ANNs do not posit an a priori model. Like in ANNs, where the training stage is the critical part for model definition, similarly in Grounded Theory the theory emerges from data. In both cases, constructs compete for survival, and data will judge which will be supported and reject those that conflict or do not contribute to the explanation of the phenomenon. In any case, theory is never definitively taken for granted. Theory is a dynamic process whose aim is to sharp a better understanding of the world.

Peircean Semiotics on Brands Perception and Interpretation

Before entering the neuroscientific-based study of brands' perception it would be beneficial to acquire a deeper perspective about what brands really are, as surface definitions could poison or introduce bias in future considerations about the findings.

Balancing between companies' and consumers' perspectives.

A common accepted definition of brand is reproduced in the official description from the American Marketing Association is:

> A name, term, design, symbol, or any other feature that identifies one seller's good or service as distinct from those of other sellers. The legal term for brand is trademark. A brand may identify one item, a family of items, or all items of that seller. If used for the firm as a whole, the preferred term is trade name. (Bennett & American Marketing Association, 1995, "Brands", para. 1)

The word seller is used three times in the definition and there is an evident emphasis on the legal dimension of the brand, which stresses its possession: brands are assets that firms own. Importantly, words like consumer (or its synonyms) are never used along the definition; there is no role for the ultimate users of brands, i.e. for those that pay and utilise them. By displacing the epicentre of brands towards their legal owners, companies, this definition looses sense, because it forgets the other part: brands' consumers. It would be very difficult to imagine the existence of brands without their users; in that case, brands would be useless. It would be then more profitable to look for wiser and deeper definitions of brands.

Building on a two-dimensional categorisation of brands, de Chernatony (1993) proposes a shift towards consumers. One of the dimensions is functionality, which is related to the utilitarian aspects that consumers see and seek for in brands, and the other dimension is representationality, that is, the attributes of the brand that consumers can use to express personal needs, assume roles, or project personality traits, or even help them perceive and understand such messages in others. From this two-dimensional plane, eight stages arise, which brands along their evolution can go through, starting in fairly functional levels, much related to distinctiveness from competitors and its heritage from the company, and ending in the symbolic stage, where the representationality dimension assumes the most of brand's expression. In the later case, brands' role is primarily communicative, helping in coding and decoding intersubjects messages.

This framework is rearranged and re-conceptualised to nine concepts that can be divided in three groups (de Chernatony & Riley, 1997). The first group is the "input perspective" whose centre of gravity is on firms and includes the concepts of brands as a legal instrument, as a logo, as a company, and as an identity system. The second group conceptualise brands as an image in consumers' minds, as a personality, as a relationship, and as adding value, which is the "output perspective", clearly focused on consumers' side. The third group includes the single concept of brand as an evolving entity, which describes a dynamic entity that suffers metamorphoses during its life, tendentiously emancipating from manufacturers' perspectives into the direction of consumers.

There is a consensus that a shift occurred. Nowadays, the ownership of the brand is distributed and consumers are active brand co-creators (Allen, Fournier, & Miller, 2008). Consumers need brands because brands help them in self-definition (Escalas & Bettman, 2005), and are also useful for self-repair (Sivanathan & Pettit, forthcoming). Consumers auto-involve with brands and have to articulate their social discourses together and with brands. Along such discourses a brands' syntax emerges, which allows for brands' messages comprehension among social group elements and simultaneously turns possible complex narratives.

Brands' syntax, signs, and memeplexes.

Although Nöth (1988) does not recognise a syntax in the language of commodities, or at least, he only finds a rudimentary syntax that exerts its influence more in restricting and limiting eventual combinations of commodities, Kehret-Ward (1987, 1988) proposes that products are purposefully used to produce meaning in a parallel language. This language also has its inherent norms and rules that allow or deny combinations so from the harmony of the product discourse the intended idea emerges, i.e. it has its own syntax. Maybe the approach made by Nöth was too framed by common language syntax, e.g. the need of a predicate that gives information about the subject. Maybe products' syntax takes different forms other than the traditional linear sentences. In support of this view, Escalas (2004) highlights how individuals construct narratives using brands to incorporate into their self-concepts, an idea also stressed by Fournier (1998) and Elliott and Wattanasuwan (1998). In these narratives there is also space for avoidance, where specific brands are not chosen, not used (Banister & Hogg, 2004). Hence, this complex meta-language has its particular syntax where both choices and non-choices produce meaning within a semiotic frame (Mick, 1986).

Although the existence of homonyms, it is not very common that one word has more than one meaning, and it is less common that one complete sentence has more than one sense, although, once again, the existence of hidden intentions in some of them. On the contrary, a brand has a panoply of meanings that vary according to the context (Escalas & Bettman, 2005), with several actors contributing to their profusion (Allen, et al., 2008). In fact, brands are better understood as memeplexes, i.e. one brand embody a plethora of meanings, and each one may be stressed (positively or negatively), or just ignored. Brands and their symbolic representation, the logos, may then be better comprehended under the triadic semiotics of Peirce. Each Object may be a meme and the set of Objects form the memeplex that brands are. For Peirce an Object is "By an object, I mean anything that we can think, i.e. anything we can talk about. ([Reflections on Real and Unreal Objects], MS 966, not dated)" (Bergman & Paavola, 2003, "Object", para. 4), and the relationships among Signs, Objects, Meanings, and Interpretants are:

> “A sign stands for something to the idea which it produces, or modifies. Or, it is a vehicle conveying into the mind something from without. That for which it stands is called its object; that which it conveys, its meaning; and the idea to which it gives rise, its interpretant. The object of representation can be nothing but a representation of which the first representation is the interpretant. But an endless series of representations, each representing the one behind it, may be

> conceived to have an absolute object at its limit." (A Fragment, CP 1.339, not dated) (Bergman & Paavola, 2003, "Object", para. 5)

The complexity of a brand's syntax derives from its memeplexic inherent structure. When one brand is used, a multi-beam of memes irradiate, which means that a set of Objects is evoked as exemplified in Figure 15.

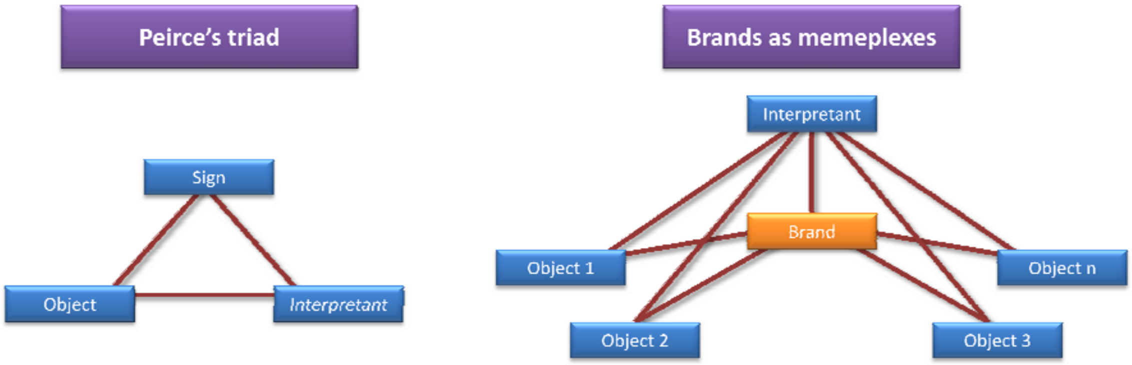


Figure 15 – Representing the memeplexic nature of brands using Peirce's triad as a framing mould.

There is then a multidimensional discourse (like in hypertext) and not the traditional linearity imposed in current sentences in languages. This aspect may be neglected by Nöth (1988), which may led to his conclusion of syntax missing (or at the most a rudimentary syntax) in products narratives. However, for Kehret-Ward (1987, 1988) there is a existing syntax when humans use brands. In her view, consumers acquire products and use products not in a discrete and hermetic manner. Instead, products serve to accomplish stages that belong to larger aims, and then it is more correct to speak about "product constellation" or "ritual artefacts" (Rook, 1985; Solomon, 1987). The way products are complimentarily admitted, sequenced, and enhanced within these sets is ruled by products' syntax, from which results a level of meaning not achieved during appraisals at single product level.

However, some authors dispute the memetic approach. Kilpinen (2008) claims that the meme concept "it is only a new version of the traditional semiotic concept of sign." (p. 215). As already pointed, memes should not be considered Signs but Objects. Meme is the fundamental meaning constructed inside a culture and that spreads within it attached to a sign. Memes are the initiators of the considerations an individual makes about a sign, moulded by his/her own idiosyncrasy, that is, brands convey memes that produce Interpretants. Two descriptions of Interpretant from Peirce should be introduced at this point.

> "(...) a sign endeavours to represent, in part at least, an Object, which is therefore in a sense the cause, or determinant, of the sign even if the sign represents its object falsely. But to say that it represents its Object implies that it affects a mind, and so affects it as, in some respect, to determine in that mind something that is mediately due to the Object. That determination of which the immediate cause, or determinant, is the Sign, and of which the mediate cause is the Object may be termed the Interpretant (...)" ('Some Amazing Mazes, Fourth Curiosity', CP 6.347, c. 1909)
>
> "I define a Sign as anything which is so determined by something else, called its Object, and so determines an effect upon a person, which effect I call its Interpretant, that the latter is thereby mediately determined by the former. My insertion of "upon a person" is a sop to Cerberus, because I despair of making

> my own broader conception understood." (A Letter to Lady Welby, SS 80-81, 1908) (Bergman & Paavola, 2003, "Interpretant", para. 2-3)

More extensively, Peirce describes the triadic relationships among Objects and Signs and the resulting impact in a mind: the Interpretant, which only exists in that mind:

> "Now let us pass to the Interpretant. I am far from having fully explained what the Object of a Sign is; but I have reached the point where further explanation must suppose some understanding of what the Interpretant is. The Sign creates something in the Mind of the Interpreter, which something, in that it has been so created by the sign, has been, in a mediate and *relative* way, also created by the Object of the Sign, although the Object is essentially other than the Sign. And this creature of the sign is called the Interpretant. It is created by the Sign; but not by the Sign *quâ* member of whichever of the Universes it belongs to; but it has been created by the Sign in its capacity of bearing the determination by the Object. It is created in a Mind (how far this mind must be real we shall see). All that part of the understanding of the Sign which the Interpreting Mind has needed collateral observation for is outside the Interpretant. I do not mean by "collateral observation" acquaintance with the system of signs. What is so gathered is *not* COLLATERAL. It is on the contrary the prerequisite for getting any idea signified by the sign. But by collateral observation, I mean previous acquaintance with what the sign denotes. Thus if the Sign be the sentence 'Hamlet was mad,' to understand what this means one must know that men are

> sometimes in that strange state; one must have seen madmen or read about them; and it will be all the better if one specifically knows (and need not be driven to *presume*) what Shakespeare's notion of insanity was. All that is collateral observation and is no part of the Interpretant. But to put together the different subjects as the sign represents them as related - that is the main of the Interpretant-forming. Take as an example of a Sign a genre painting. There is usually a lot in such a picture which can only be understood by virtue of acquaintance with customs. The style of the dresses for example, is no part of the *significance*, i.e. the deliverance, of the painting. It only tells what the *subject* of it is. *Subject* and *Object* are the same thing except for trifling distinctions. [---] But that which the writer aimed to point out to you, presuming you to have all the requisite collateral information, that is to say just the quality of the sympathetic element of the situation, generally a very familiar one - a something you probably never did so clearly realize before - *that* is the Interpretant of the Sign, - its 'significance.'" (A Letter to William James, EP 2:493-4, 1909) (Bergman & Paavola, 2003, "Interpretant", para. 1)

Hence, Signs act as conveyors, forwarding Objects into Minds, and in there producing Interpretants, for which both contribute the Objects and the actual understanding of the world that such Mind has, which in turn frames the Interpretants' construction. This is of highest importance because that Interpretant can only be produced in that Mind, because that Mind has a unique frame, or better a cradle, that will shape the formation of the Interpretant. This flow of meanings was already proposed by McCraken (1986), from the cultural system to commodities, and then to consumers. Also, the need for prior knowledge in the consumer's mind was already pointed by Keller (2003): so brand leveraging is effective, consumers had to previously know about the entity that is endorsing the meaning that is about to be transferred to the brand. Otherwise, consumers miss the message because they do not know the Object implicated in the translational process, and their blindness obstruct the creation of the Interpretant, or another divergent Interpretant is framed within this odd mould. Hence, the semantic knowledge is also critical for the semiotic process.

However, the translational process that links Objects to Brand to Interpretant (see Figure 15, right pane) is not biunivocal. By the end of the decoding processes, Interpretants metamorphose into Signs referring to the same Objects, allowing an infinite circularity (Mick, 1986). In the words of Peirce (1931b):

> A sign stands **for** something **to** the idea which it produces, or modifies. Or, it is a vehicle conveying into the mind something from without. That for which it stands is called its **object**; that which it conveys, its **meaning**; and the idea to which it gives rise, its **interpretant**. The object of representation can be nothing but a representation of which the first representation is the interpretant. But an endless series of representations, each representing the one behind it, may be conceived to have an absolute object at its limit. The meaning of a representation can be nothing but a representation. In fact, it is nothing but the representation itself conceived as stripped of irrelevant clothing. But this clothing never can be completely stripped off; it is only changed for something more diaphanous. So there is an infinite regression here. Finally, the interpretant is nothing but another representation to which the torch of truth is handed along; and as

> representation, it has its interpretant again. Lo, another infinite series. (A Fragment, CP 1.339, not dated) (Book III. Phenomenology, Chapter 2. The Categories in Detail, C. Thirdness, §2. Representation and Generality, para. 339)

With the background of the meme replication, during the interpretational process, which may be the intended or divergent, other Objects may be assigned to the Brand. Such assignment can be exemplified in the Mercedes-Benz brand, whether as the car brand for presidents and aristocracy, or whether as the car brand for building contractors, or whether as the youthfulness that emerges through the advertising discourse for Class A vehicles. When the three-pointed star enters the scene, all the Objects that are attached, and then belong to, to each of those affairs, concomitantly and indivisibly also invade minds too, promoting a multi-branched sentence, possibly with conflicting significations. Levy (1982) previously also stressed this view (it is worth to note that his taxonomy is not Peircean and then object signifies sign, and idea signifies object in his quote):

> Another way of putting this is to note that any object or action represents many ideas, and any idea is represented by many objects or actions. (…) Cigarettes and guns may be the artifacts of virile males or the superficial signs of underlying impotence, as some exaggerated tresses say sexy or frigid in the same breath. (p. 543)

But, it is also possible that the actual knowledge of the interpreting minds (or the missing of such knowledge) or the particular context that involves the moment when the signs targets minds, may produce unique Interpretants that bring to the Sign (and fastens to it) new unexpected Objects. The new Sign now has more Objects attached to it, much like in a comet tail. This is the memeplexic nature of Brands and their multi-dimensional syntax that individuals use to help in construct their self-concepts, ensuring “belonginess” but also building uniqueness (Elliott, 1994; Escalas & Bettman, 2005).

Brands and the Speculative Grammar: syntagmatatic semantics.

The assigning of meaning to symbols, the consequences of the relations among symbols, and the impacting of symbols into minds take place with rules that Peirce named Speculative Grammar (or Formal Grammar), Critical Logic, and Speculative Rhetoric (or Formal Rhetoric). Their general definition:

> “We come, therefore, to this, that logic treats of the reference of symbols in general to their objects. In this view it is one of a trivium of conceivable sciences. The first would treat of the formal conditions of symbols having meaning, that is of the reference of symbols in general to their grounds or imputed characters, and this might be called formal grammar; the second, logic, would treat of the formal conditions of the truth of symbols; and the third would treat of the formal conditions of the force of symbols, or their power of appealing to a mind, that is, of their reference in general to interpretants, and this might be called formal rhetoric.” ('On a New List of Categories', CP 1.559, 1867) (Bergman & Paavola, 2003, "Grammar: Formal", para. 1)

> “In consequence of every representamen being thus connected with three things, the ground, the object, and the interpretant, the science of semiotic has three

> branches. The first is called by Duns Scotus *grammatica speculativa*. We may term it *pure grammar*. It has for its task to ascertain what must be true of the representamen used by every scientific intelligence in order that they may embody any *meaning*. The second is logic proper. It is the science of what is quasi-necessarily true of the representamina of any scientific intelligence in order that they may hold good of any *object*, that is, may be true. Or say, logic proper is the formal science of the conditions of the truth of representations. The third, in imitation of Kant's fashion of preserving old associations of words in finding nomenclature for new conceptions, I call *pure rhetoric*. Its task is to ascertain the laws by which in every scientific intelligence one sign gives birth to another, and especially one thought brings forth another." (A Fragment, CP 2.229, c. 1897) (Bergman & Paavola, 2003, "Grammar: Speculative, Grammatica Speculativa", para. 8)

Although Peirce uses the word grammar (which implicates syntax) for the rules that structure the relation between signs and objects, and uses the word rhetoric for the structure that links signs and interpretants, Morris (cited by Kehret-Ward (1988)) proposes semantics as the study of the sign / object relations, pragmatics as the study of the relationships between signs and their users, and syntax as the study as the relations between signs. It is worth to note that interpretants and sign users are concepts that overlap but not completely. The taxonomy that Morris uses derives from spoken languages, and in translating this view to commodities, Kehret-Ward (1988) argues that:

> (...) research which decomposes products into the physical constituents that serve as cues to the products' meaning is more properly regarded as semantic analysis, since it parallels the analysis of word meaning into semantic components. In other words, if one wishes to talk about syntax below the level of sentence, one is talking about 'syntagmatatic semantics'. (p. 193)

The syntagmatatic semantics is supported by the LEX building block of syntax proposed by Grodzinsky and Friederici (2006), which puts at the word level syntactic and semantic roles simultaneously. This is clearly illustrated in Latin languages were the predicate is sufficient to define the subject and the time of the action; in just one word both semantics and syntax coexist, i.e. translating to Semiotics, one sign conveys one object (at least) and simultaneously conveys the rules of articulation with other signs / objects. It may be due to this dual role of signs that Peirce chose the expression grammar to describe the relations between signs and their implicit meanings, although it is not always clear the conceptual boundaries of sign / object / ground and the implicated relations of grammar or logic:

> "Symbols, as such, are subject to three laws one of which is the *conditio sine qua non* of its standing for anything, the second of its translating anything, and the third of its realizing anything. The first law is Logic, the second Universal Rhetoric, the third Universal Grammar." (Harvard Lectures on the Logic of Science, W 1:274, 1865) (Bergman & Paavola, 2003, "Grammar: Universal", para. 1)

> "... a *speculative rhetoric*, the science of the essential conditions under which a sign may determine an interpretant sign of itself and of whatever it signifies, or may, as a sign, bring about a physical result. (…) In the Roman schools, grammar, logic, and rhetoric were felt to be akin and to make up a rounded whole called the *trivium*. This feeling was just; for the three essential branches of semeiotics, of which the first, called *speculative grammar* by Duns Scotus, studies the ways in which an object can be a sign; the second, the leading part of logic, best termed *speculative critic*, studies the ways in which a sign can be related to the object independent of it that it represents; while the third is the speculative rhetoric just mentioned." ('Ideas, Stray or Stolen, about Scientific Writing', EP 2:326-327, 1904) (Bergman & Paavola, 2003, "Grammar: Speculative, Grammatica Speculativa", para. 2)

Brands as logical syntagmatatic entities (functions).

First-order Logic may help in understanding the syntagmatatic nature of brands. First-order Logic introduces the notion of the predicate logic. Instead of a proposition, which is intrinsically single and exhaustible in itself, the predicate, by allowing the use of variables, may assume diverse values. The predicate is then like a function. If *x* is the argument, then *Colour(x)* avows that the argument is transformed in a value, expectedly a colour from the spectrum. The predicate *Colour(x)* may assume different values (states), but only delivers one at a time (it is a function). The entity *Colour* has a syntactic nature: it is not one specific colour (it would then be a semantic entity), but the rules that lead to a specific colour in face of a determined argument (situation). There is then a syntagmatatic semantic structure here, which comprises the rules that produce a semantic meaning in the end (which may be true or false, not in itself, but only after the introduction of a quantifier). In semiotic terminology, the relations between the sign (which has a syntactic nature, defining rules) and the object (which has a semantic nature, providing concepts) are mediated by Speculative Grammar, in the logic sense that a certain rule may produce a value in face of a specific quantifier, i.e. the value it is not predetermined, but a function of a variable situation. First-order Logic, Predicate Logic, and Montague Grammar are knowledge areas that study these syntagmatatic semantics, the later approaching human natural languages and artificial programming languages, positing that their structures (syntactic and semantic) are intrinsically the same. This comes to Universal Grammar, which in turn posits that all human languages share a common syntax, a view defended by Noam Chomsky. Pinker (1995) defends even that all human languages have a biological basis, from which derives the universal grammar. Brands have then a syntactic nature concentrating rules from which semantic meanings derive, which may be expressed by, for example, Equation (4).

$$Coke(x) \tag{4}$$

It is not expectable that only one argument enters such expression. As many variables may influence the output of a brand function, it would be better represented by Equation (5).

$$Coke\ (x_1, x_2, ..., x_n) \tag{5}$$

As signs, brands do not have a certain value, but a value that depends of the situational quantifiers for each argument (and arguments may then be concepts as previous experience, social value, availability in distribution channels, likeliness of the logo, price, and so on). It is worth to note that, as functions differ, their power differs too (e.g. for smaller quantifiers, deliver greater values), and some brands also may be more prone to specific arguments than others.

In summary, there are rules that shape the flow that things happen, how meanings, signs, and interpretations arise, not all freedom is possible, and fortuity does not exist. These rules may take different names (whether as grammar, or syntax, or syntagmatatic semantics, in fact any process that establishes a meaningful ordered output). Semiotics can make substantive contributions in the study of brands' syntax, which may be hypothesised to be a complex network of considerations about different aspects that a brand embody, and where the consideration processes are significantly influenced by one's own goals, style, knowledge, and actual situation, and also by contextual elements.

Aims

Within this framework, the present study has four aims:

- evaluate the use of imaging techniques to investigate specific Marketing issues;
- brain mapping of brands' logos perception;
- characterize brands' perception with neuroscientific knowledge;
- identify brain markers of certain brands' characteristics.

Although some studies have been using imaging techniques to investigate Marketing issues they are not enough yet, they do not cover all the Marketing facets yet, and there is little replication yet, which means that much more studies are needed to ground knowledge. In line with this aim, the perception of brands' logos will be brain mapped, and the identified brain structures will be used to establish the dimensions of logos perception.

One strategy systematically present in this research is to seek for brain structures that could be used as markers for characterising brands. These markers may be used in market research to get responses (not only strictly answers but also the possible behavioural acts) to the study questions, surpassing known hurdles as verbalisation barriers, difficulties in expressing emotional states, socially desirable responses, screening for encumbered lack of cooperation, etc. (Chamberlain & Broderick, 2007; Steenkamp, et al., 2010).

This thesis is divided in three parts. The first part, which corresponds to chapter I is introductory. This chapter starts with the quote of a call from the Economic and Social Research Council (ESRC), which is very pertinent in what concerns the actual (lack of) knowledge on human behaviour, which in turn has consequences for Marketing and Consumer Behaviour disciplines. In the end it calls for multidisciplinary approaches in order to have a broader understanding about the complexity that behaviours pose. This thesis explicitly adopts such posture, targeting to better understand how humans perceive brands. Next, still within chapter I, there is a description of the main method used in this work to quest human brains, functional Magnetic Resonance Imaging (fMRI), explaining the option for this technique and introducing to some concepts used during fMRI analysis, which are of pivotal importance to fully understand the discussions of the results in the following chapters. Then there is a revision of the not very extensive published literature on neuroscientific approaches to brands, followed by a section that puts explicitly the methodological skeleton of all the research: Grounded Theory. Before entering the empirical elements, there is a section that delves into what brands are in fact, focusing on Peircean Semiotics and concluding about their inherent syntactic nature. This chapter ends with the aims of the present work.

The second part, that comprises chapters II to V, is the empirical one. Along it three studies are dissected and discussed. It is worth to note that, due to the methodological frame adopted (Grounded Theory) the relevant literature it is not previously revised in an extensive chapter at the entrance of the thesis. Instead, the relevant literature is set forth during the discussion of the results, intertwining with them to ensure nomological validity, while constructing the theory. The final chapter of this part describes an analysis that may have repercussions difficult to foresee: using a simple feedforward artificial neural network trained with fMRI data it is possible to guess the preferences of individuals better than chance at the test stage.

The third and final part includes chapters VI and VII and its main substance is summarise the theory constructed and launch the next steps of the research. A graphical model is proposed that metaphorically recalls the planet Saturn: the main planet, the core, is the individual represented by his/her Self. The disks that gravitate around the planet include symbols, meanings, memes, imitation, culture, social groups, language, and writing, and brands are a matrix that helps keep them tight, because brands touch intimately every of these concepts.

II. FIRST APPROACH: A STUDY ON BRANDS' IMPLICIT AND EXPLICIT IMPRESSIONS

Human social groups make use of signs and symbols to communicate. Some of these signs and symbols evolved into a knowledge celebrated as writing (Pinker, 1995). The first symbols were ideograms, which are graphic symbols that represent an idea. Ideograms were used in the earlier logographic writing systems, like the hieroglyphs in ancient Egypt. However, in Eastern Asia, logographic writing systems are still in use, namely the traditional Chinese system. Not surprisingly, the act of reading induces activations in several regions of the brain, and, among others, particularly in a region of the frontal lobe known as Broca's area (Bookheimer, 2002; Broca, 1861; Hickok & Poeppel, 2007; Matthews, et al., 2003). Common brain activations have been found between words and pictures (Vandenberghe, Price, Wise, Josephs, & Frackowiak, 1996), suggesting that graphics and words made with letters are intrinsically the same, and share the same biological underpinnings in the brain. Thus, it is possible that an association exists among the development of the Homo lineage, the growth of the frontal lobe, the invention of writing, and the ability to read and interpret meaningful symbols.

A particular class of these meaningful symbols, used in social context, is commercial brands. The parallel between commercial brands and the first ideograms is conspicuous; both are graphical representations that embody an idea. To understand how consumers read, interpret and use these symbols – the commercial brands – the frontal lobe should be exhaustingly explored. This was the main objective of the present work.

In the neuroscientific studies conducted with brands or branded products reviewed in the previous chapter, the characteristics of each brand, alone, never were investigated. Instead, except in Erk's (2002) study, brands were compared simultaneously in virtual shelves, or they were used as stimuli to trigger specific ulterior decisions. However and as already introduced, Semiotics identifies meanings conveyed by the symbols that represent brands: the logos (Mick, 1986). To start the present study, it was considered more cautions to begin one step back, and investigate the neural correlates of logos, without comparisons among them, and without asking for logo-cued decisions. The intention is to understand how humans perceive one brand logo with their brains.

It is an aim in this first approach to capture the same strategy that individuals use in everyday life when they face brands' logos in the social environment. When individuals make social interactions within social groups, they generally do not use rational, fully conscious and explicit strategies. On the contrary, habitually they employ implicit and automated, ready-made short cuts (Greenwald & Banaji, 1995; Pelzmann, Hudnik, & Miklautz, 2005). Because human brain processing capacity is limited, people have a propensity to use simple heuristics, theorized as Bounded Rationality (Selten, 2002; Todd & Gigerenzer, 2003). In the Bounded Rationality theory, individuals learn social rules, which obey general standards of their culture (as those perspicaciously revealed by Goffman (1959)), and each one constructs a repertoire of social behaviours, adapted to each situation (Gigerenzer, 2001). It is then expected that humans act mostly by implicit rather than by explicit strategies when they are in social groups, i.e. without full cognitive awareness (Critchley, et al., 2000). Indeed, these authors believe that common experience reveals that individuals form impressions of their peers implicitly, and implicitly use this information when they interact (Critchley, et al., 2000). In spite of this, most of the studies in Neuroscience use explicit paradigms, as all the examples reported in the introductory chapter.

In post-modern societies, each individual pursues the construction and maintenance of an identity (self-concept) within a rapid changing milieu. Change is nowadays the keyword (Smart, 1996), which stresses even more the use of the fast and frugal heuristics and adaptive behaviours: non-explicit planning (Todd & Gigerenzer, 2003). This rapidly changing milieu bears variety, which the individual uses amid countless combinations to design the self. From a potential homogenising environment, s/he raises and fosters originality and difference. This is the creative consumer, who feeds his/her self-concept through consumption (Elliott & Wattanasuwan, 1998).

However, the creative consumer does not search for functionalities or utilities. Rather s/he digs for symbolic meaning. It is widely accepted today in the marketing community that commercial brands should be loaded with symbolic content, to be used by the consumers in reinforcing their self-concept (Banister & Hogg, 2004; Grubb & Grathwohl, 1967; Ligas & Cotte, 1999). Self-concept does not emerge from singular actions, disconnected from the environment. On the contrary, it evolves in a process of social experience, nurtured by the reactions of peers, so that each individual creates his/her own self-perception that becomes apparent from the reactions of family, colleagues, friends, and all other relevant mates.

Some authors even assume subdivisions of the global self-concept in actual self-concept, ideal self-concept, social self-concept, and ideal social self-concept (Johar & Sirgy, 1991). This stratification emphasises the relevance of the social background and stresses that every individual has a social perfect state that s/he wants to reach. To achieve it, s/he will gather the necessary tools, many of which are commercial brands in Western culture.

One way to load commercial brands with symbolic content is by using stereotypes (Klucharev, Smidts, & Fernandez, 2008). Stereotypes are categorisations of experiences that are part of our understanding of the social world, or sets of ideas and fixed beliefs sustained by the members of one or more groups, about the members of other groups. Therefore, stereotypes concentrate a set of signs and emotions and, evoking that stereotype, this content may be transferred to the brand (Jagger, 1998; M. J. Sirgy, et al., 1997). Through these stereotypes, brands can transmit emotions and induce feelings to their users, enhancing their self-esteem. Self-esteem is the motivation that transforms the actual self-concept into the ideal self-concept, and the social self-concept into the ideal social self-concept, in an ever self-perfecting process.

In summary, brands may contain emotional and social relevant meaning, therefore creating a triangular connection among the individual, the social group s/he belongs to, and commercial brands (Grubb & Grathwohl, 1967).

The previously discussed models were constructed based on behavioural evidence, underrating the human organ where all these processes actually take place: the brain. In this work, it is aimed to investigate if there is a central nervous system network that sustains the theory that commercial brands have emotional and social content. Hence, it was designed an fMRI experiment to study if implicit and explicit brands' processing is in fact different.

Keeping fidelity to the Grounded Theory methodological skeleton, this first study is poor bounded and the research question is loosely posed. In two separate fMRI sessions, brands' logos were showed to subjects while their brains were scanned. In the first session subjects were not instructed (this is the implicit session), but in the second session subjects received explicit instructions to covertly assess each brand they were seeing, and they trained it before entering into the scanner (this is the explicit session). The details of the method are described in Appendix A.

Results

Behavioural results.

Subjects reported as “negative” 14% of the brands, as “indifferent” 32% of the brands, and as “positive” 53% of the brands. The “unknown” answers were negligible (1%).

Activations produced in the brain common to the implicit and explicit paradigms.

The main activations produced in the brain common to both the implicit and explicit paradigms are depicted in Figure 16. Of special interest are the activations found in the paracingulate gyrus, medial frontal pole, left frontal orbital cortex, hippocampus, and fusiform gyrus (occipital fusiform gyrus and temporal occipital fusiform cortex).

Figure 17 illustrates the hemodynamic response of the medial frontal pole and the paracingulate gyrus. The response in the frontal pole is similar in both runs (implicit and explicit), only pointing the decay in the implicit response along the stimulus block. In the paracingulate gyrus there is a distinguished decay along the stimulus block in both runs, with a very similar pattern. In the graph it results that the signal change is stronger in the explicit run than in the implicit run, although both activating.

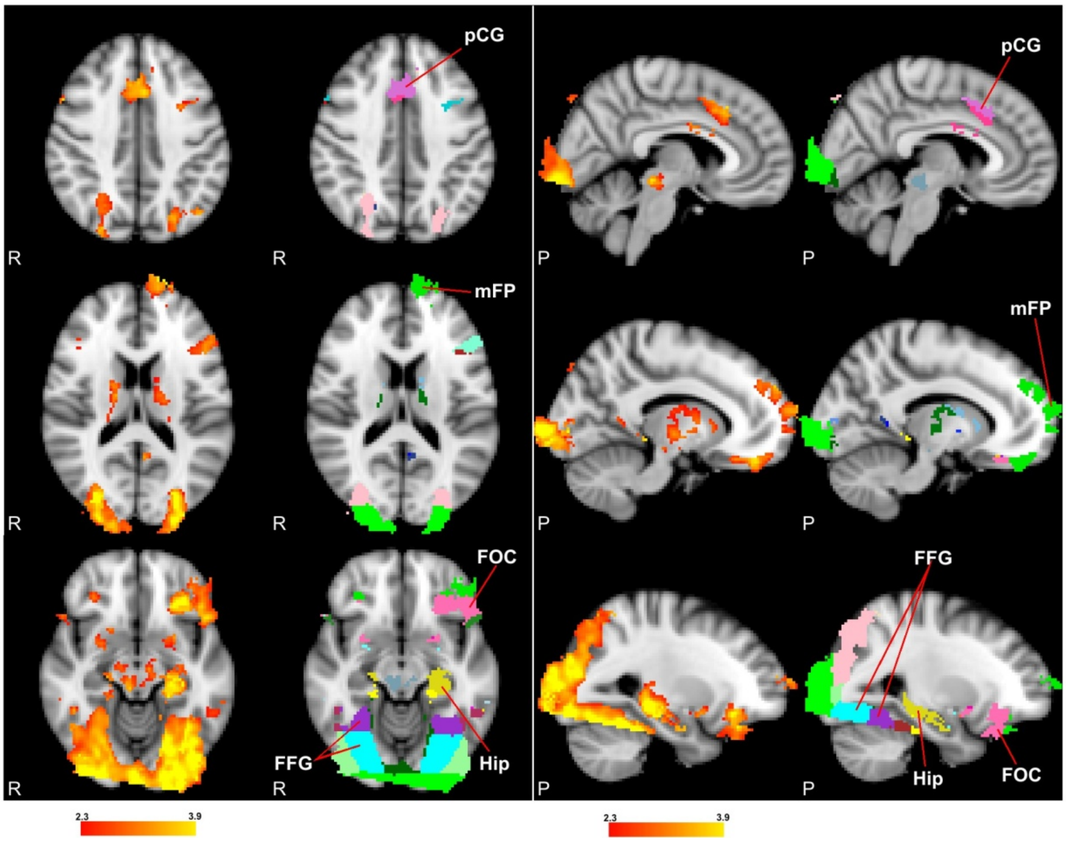


Figure 16 - Activations obtained with the conjunction analysis (statistical parametric maps produced by FEAT). In each pane the left column refers to the thresholded map (z > 2.3), and the right column refers to the thresholded activations with the brain structures highlighted with false colours (R: right; P: posterior; FFG: fusiform gyrus; FOC: frontal orbital cortex; Hip: hippocampus; mFP: medial frontal pole; pCG: paracingulate gyrus; MNI152 coordinates).

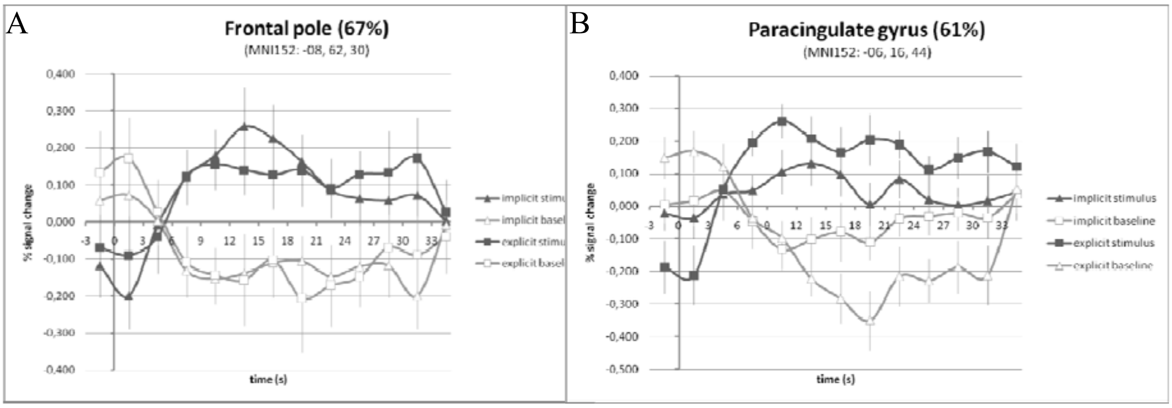


Figure 17 – Selected peristimulus hemodynamic response in two voxels: A (-08, 62, 30) that corresponds to the frontal pole (67%) in probabilistic atlases, and B (-06, 16, 44) that corresponds to the paracingulate gyrus (61%) in probabilistic atlases (MNI152 coordinates).

In the model-free analysis with MELODIC, the independent component (IC) 32 was selected due to the high correlation of its timecourse with the block-design sequence of both runs (implicit and explicit) of the experiment (*p-value* < 0.00001). This component included synchronous activity in the following areas: amygdala, fusiform gyrus, frontal medial cortex, frontal orbital cortex, frontal operculum cortex, insular cortex, medial frontal pole and paracingulate gyrus The activation of these structures had a unique period of 60 seconds (1.67 Hz/100), which was exactly the same of the stimulus onset.

The statistical parametric map with the conventional colours for activations and deactivations, together with the same map, now with the brain structures individualised with different colours, and corresponding graphs are shown in Figure 18.

Activations produced in the brain that characterise the implicit paradigm (contrast implicit > explicit).

The amygdala, the parahippocampal gyrus, and a ventral medial region comprising the ventral medial frontal pole, the frontal medial cortex, and subcallosal cortex were brain structures significantly activate when the implicit run was contrasted with the explicit run (see Figure 19).

Activations produced in the brain that characterise the explicit paradigm (contrast explicit > implicit).

The activations produced in the brain when the explicit paradigm was contrasted with the implicit are shown in Figure 20. The brain structures identified include the inferior frontal gyrus (comprising the pars opercularis and pars triangularis), insular cortex, frontal operculum, and nucleus lentiformis (comprising the pallidum and putamen).

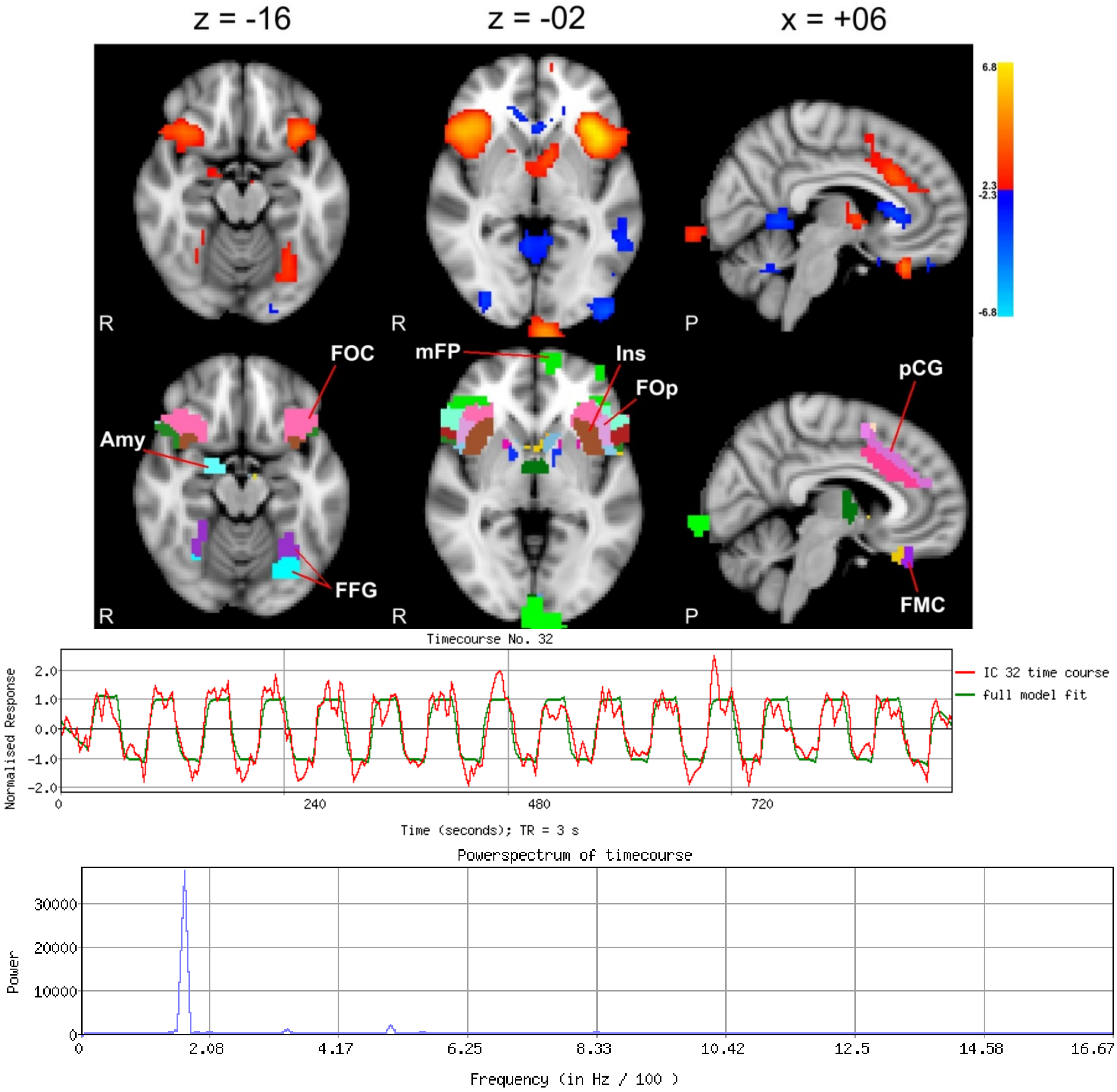


Figure 18 – Independent component (IC) 32 selected from the model-free analysis with MELODIC. This component explains 1.04% of the total variance. (a) The top row depicts thresholded activations and deactivations. The bottom row refers to only to the thresholded activations with brain structures highlighted in false colours (R: right; P: posterior; Amy: amygdala; FFG: fusiform gyrus; FMC: frontal medial cortex; FOC: frontal orbital cortex; FOp: frontal operculum cortex; Ins: insular cortex; mFP: medial frontal pole; pCG: paracingulate gyrus; MNI152 coordinates). (b) Timecourse of the IC 32 and full model fit; *F*-test on the full model fit: $F = 686.01$ (dof1 = 2; dof2 = 317) $p < 0.00001$; Contrast of parameter: $z = 22.96$; $p < 0.00001$. (c) Powerspectrum of the timecourse. The frequency of the peak is 1.67 Hz/100, which corresponds to a period of 60 seconds.

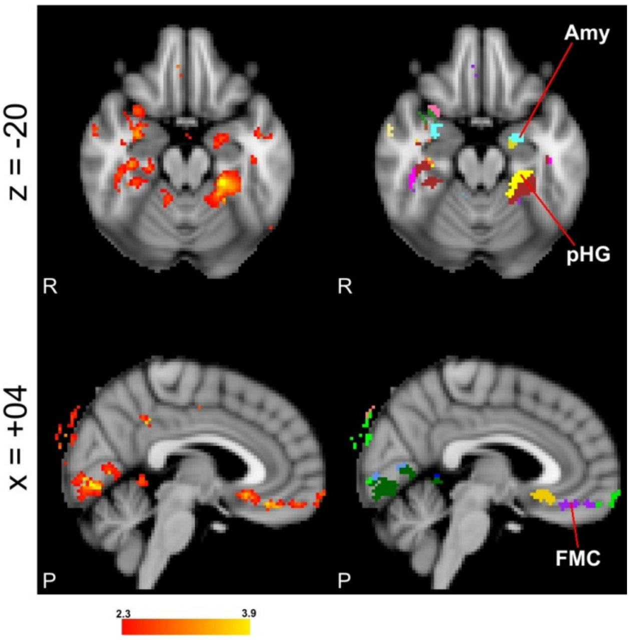


Figure 19 - Activations that characterise the implicit task when contrasted with the explicit (statistical parametric maps produced by FEAT). The left column refers to the thresholded map (z > 2.3), and the right column refers to the thresholded activations with the brain structures highlighted in false colours (R: right; P: posterior; Amy: amygdala; FMC: frontal medial cortex; pHG: parahippocampal gyrus; MNI152 coordinates).

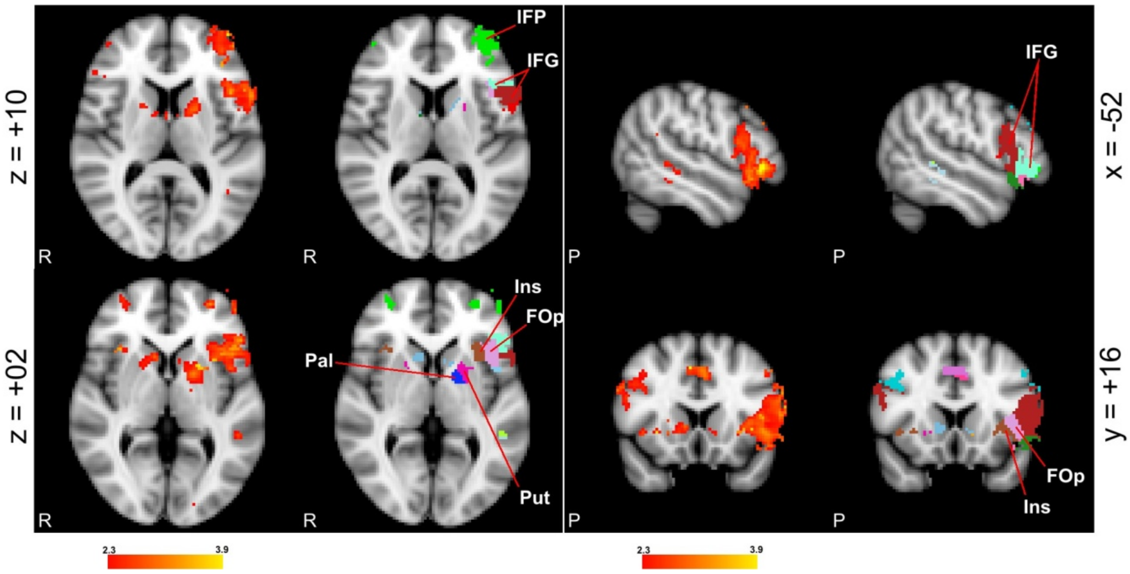


Figure 20 - Activations that characterise the explicit task when contrasted with the implicit (statistical parametric maps produced by FEAT). The left column refers to the thresholded map (z > 2.3), and the right column refers to the thresholded activations with the brain structures highlighted in false colours (R: right; P: posterior; FOp: frontal operculum cortex; IFG: inferior frontal gyrus (comprising the pars opercularis and the pars triangularis); Ins: insular cortex; lFP: lateral frontal pole; Pal: pallidum; Put: putamen; MNI152 coordinates).

Grounding Discussion

When contrasting the two tasks, implicit and explicit, the main goal was to capture specific processes hoping to better understand how individuals deal implicitly with brands' logos, and how do they assess the brands, in an explicitly and purposeful manner. There is, however, a methodological difficulty. In order to allow subjects to make free implicit assessments of brands, they could not be instructed beforehand, and also, by doing that, it would not be possible to control the execution of the task because it would be necessary to know the evaluations that subjects were being making implicitly. But the subjacent firm hypothesis is that in a daily basis, subjects more often evaluate brands implicitly than explicitly. As such, this problem was circumvented by doing a conjunction analysis of the two runs, and therefore uncovers a general mechanism of brands' assessment, common to both implicit and explicit situations.

As the slide set that contained the brands' logos that served as stimulus was the same for all subjects, there was the possibility that unknown brands / logos could introduce cognitive processes that would interfere with brands appraisals. However, as stimuli were pre-screened with a sample of different subjects, the unknown logos were negligible (1% of total stimuli). Hence, it can be admitted that subjects performed only brand assessments, at least during the explicit scanning session.

There is a common activation to the implicit and explicit tasks in the medial frontal pole (see the panels z = +16 and x = -12 in Figure 16, panel (a) in Figure 17, and the panel z = -02 in Figure 18). The location of this activation is consistent with what Amodio and Frith (2006) named as the anterior rostral medial frontal cortex, arMFC. From their meta-analysis results, this region was found to be important in the neural processing of different categories of tasks: self-knowledge, person knowledge, and mentalising. All these categories are crucial for social interactions, for example in the ability to read how others evaluate our self-image. Self-knowledge is pivotal for an individual to be able to differentiate himself/herself from others (Ruby & Decety, 2004), and subserves the capacity to self-attribute preferences and dispositions (W. M. Kelley, et al., 2002). Also, activations in this region were found to occur when trying to differentiate people from objects (Mitchell, Macrae, & Banaji, 2005), which opens the possibility that brands are not considered mere objects, but are judged to be closer to people, as distinctive components. Self-knowledge is a reference to self-concept, so that the motivations self-esteem and self-consistence can act purposefully (Banister & Hogg, 2004; M. Joseph Sirgy, 1982), mainly in the social environment (Grubb & Grathwohl, 1967; Johar & Sirgy, 1991). This self-referential processing in the social domain has been shown to have neural correlates, again in the medial frontal pole (Northoff, et al., 2006). Schaefer et al. (2006) have demonstrated that culturally self-relevant familiar cars' brands, displayed implicitly, also activate the medial frontal pole similarly to what we have found in our study. All of these findings suggest that commercial brands, together with their symbolic content, are landmarks that each individual recognises as useful for self-characterisation, and are used to construct his/her identity within the social milieu (Elliott & Wattanasuwan, 1998). Other phenomenological studies have been reporting the role that brands and commodities have in self-construal (Ahuvia, 2005; Allen, et al., 2008; Belk, 1988; Escalas & Bettman, 2005; Fournier, 1998). There is then convergence between this body of knowledge and the findings of our study obtained with fMRI. Interestingly, these processes seem to happen both consciously and also beyond conscious awareness, that is, explicitly and implicitly, supporting the initial assumption.

Another important activation common to both runs was found in the paracingulate gyrus (see panels z = +40 and x = +06 in Figure 16, panel (b) in Figure 17, and panel z = +06 in Figure 18). In line with what was discussed in the previous paragraph, functional investigations that study social interactions usually report activations in this area. Theory of Mind, mentalising, meta-representations, and second-order meta-representations have been linked to the paracingulate gyrus (Amodio & Frith, 2006; Brunet-Gouet & Decety, 2006; Frith, 2007; Gallagher & Frith, 2003; Rilling, Sanfey, Aronson, Nystrom, & Cohen, 2004; Saxe, 2006). This same brain area is thought to be involved when subjects make judgments about similar and dissimilar individuals (Mitchell, Macrae, & Banaji, 2006), and again when forming impressions of people as opposed to objects (Mitchell, Macrae, & Banaji, 2004; Mitchell, et al., 2005). The Theory of Mind is important to make predictions about others' behaviour on the basis of their mental states (Baron-Cohen, Leslie, & Frith, 1985). Stone (2006b) defends that this can be one of the underpinnings of the complexity of our social groups, attributing to humans a social cognition (Adolphs, 2001, 2003). The reflexive meta-representations, or second-order representations, where an individual predicts what other individuals think about himself/herself, are essential for communicative intentions between individuals (Ermer, Guerin, Cosmides, Tooby, & Miller, 2006; Frith, 2007), and brings up the triadic social interaction: Identity ↔ Communication ↔ Image. On the other hand, according to the theory of Symbolic Interactionism, the value of a brand is asserted within the social group (Ligas & Cotte, 1999). The Symbolic Interactionism is a complex play among social action, the self-reflexive nature of the individual, and the negotiation of each individual's self-concept in the social context. Consequently, Theory of Mind plays a crucial role, as every individual, during a social transactional process, must infer the mental state of his/her peers (namely beliefs, aims, intentions, and strategies), and brands' socially relevant meanings may have a contribution in such inferences. Considering our findings and the supportive literature, it is hypothesised that brands are meaningful utensils that each individual gathers and uses to diffuse his/her own identity and to perceive and interpret the messages emanated by his/her peers. One possible interpretation is that brands are a culturally accepted social currency, for an individual to reliably make inferences of others: brands may be social tools.

Damásio (1994) established the connection among damage of the orbitofrontal cortex, emotions, and decision-making. Other neurological cases of lesions in the same cortical area have been reported to have similar consequences, for example inability to perform advantageously in the Iowa Gambling Task (Bechara, 2004), and inappropriate social behaviour, in spite of the conservation of the awareness of social norms (Beer, John, Scabini, & Knight, 2006). The modulation of the orbitofrontal cortex extends to non-conscious brain areas, with individuals being able to anticipate rewards whilst performing economic decisions (Bechara & Damásio, 2005). It also participates in emotion modulation and behaviour conditioning, through a top-down control over structures like the insula or the amygdala (Adolphs, 2001, 2003). The orbitofrontal cortex is subdivided into three regions: one medial, which comprises the ventral medial frontal pole, the frontal medial cortex and the subcallosal cortex in the *Harvard-Oxford Cortical Structural Atlas*, and two lateral relatively to the medial, corresponding to the lateral frontal pole and the frontal orbital cortex in the considered atlas. Stimuli valence representations are usually assigned to the lateral regions (J. O'Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001; Rolls, 2004; Ursu & Carter, 2005), although this is still controversial (Elliott, Dolan, & Frith, 2000). The medial region decodes rewards and implements a reinforced learning mechanism that monitors and sustains the relevant reinforcers (Rolls, 2004; Windmann, et al., 2006). In the present study, the lateral regions participated extensively in both runs (see panels z = -12 and x = -26 in Figure 16, and panel z = -16 in Figure 18) although specific sub-regions activated more significantly in the explicit run (see z = +10 in Figure 20). A small area of activation in the medial region was registered only in the model-free analysis (see x = +06 in Figure 18), and was more extensive in the contrast implicit > explicit (see x = +04 in Figure 19). More studies are needed to further explore and challenge these findings. Maybe the orbitofrontal cortex, represented by these medial frontal areas, participates in the perception and valuation of brands.

The common activation between the implicit and explicit paradigm that it is found in the hippocampus was expected, because of its function in declarative and mnemonic memories (Critchley, et al., 2000). This structure participates in the process of recall based on recognition (Bailey & Kandel, 2004; Fortin, Wright, & Eichenbaum, 2004; Paller & Wagner, 2002; Yonelinas, 2002), and in a study performed on culturally familiar sodas, both the right and left hippocampi responded preferentially to brand-cued versus light-cued soda delivery (McClure, Li, et al., 2004).

Looking at the results of this first approach to brands perception, it is apparent that the implicit and explicit paradigms recruited a not completely overlapped network of brain regions. In other words, this data strongly suggest that the neural substrates of forming impressions about brands are different according to whether or not the participants are given instructions. The same may happen in other types of experiments. For example, games are often used in neuroeconomic research, where the participants are previously instructed about their rules (for a review see Montague et al. (2006)). In some cases, the participants are even trained before the study session, like the procedure in the second (explicit) fMRI run. Considering the output results, it has to be suggested caution in the interpretation of such studies, where conditioning the subjects' performance may modulate the resulting neural activation. Economic behaviour is not always conscious and rational. Emotions drive most of the decisions (Bechara & Damásio, 2005; Damásio, 1994), and emotions tend to induce behaviours implicitly (Critchley, et al., 2000; Pelzmann, et al., 2005).

The activation of the amygdala, just observed in the implicit run (see panel z = -20 in Figure 19) and in the model-free analysis (see panel z = -16 in Figure 18), is a key result. The amygdala is recognised to have a role in primary emotional processing (Adolphs, 2003; Adolphs, Tranel, & Damásio, 1998; Ashwin, Baron-Cohen, Wheelwright, O'Riordan, & Bullmore, 2007; Beaucousin, et al., 2007; Bechara, et al., 1999; Norris, Chen, Zhu, Small, & Cacioppo, 2004; Zald, 2003). It also has connections to the frontal medial cortex and the hippocampus (Stefanacci & Amaral, 2002). This suggests that the human emotional network can be involved in the perception of brands, although the logos that were chosen for the study were varied and not screened purposefully according to their emotional content. Adolphs (2006) proposed that the amygdala is necessary for humans systematically probe the social environment, searching for clues that let they make inferences about other's minds, and use "other people as a collective resource" (p. 25). This also comes in support of the social role that it is hypothesised that brands have. Interestingly the amygdala activated in the implicit run, but not in the explicit one. It may happen that the non-natural behaviour that subjects performed in the explicit run may had suppressed the activation of the amygdala. Further studies are required to make clear the amygdala's role in brands impressions.

Significantly more in the explicit than in the implicit paradigm, it was found activations in the frontal operculum, inferior frontal gyrus, insular cortex, pallidum, and putamen (see Figure 20), structures possibly involved in deliberative reasoning. With reference in more detail to the activation found in the inferior frontal gyrus, it is well known that it is part of Broca's area in the left brain hemisphere. Intriguingly, the paradigm's baseline was composed of words that had neither emotional content, nor suggested objects or actions, and every stimulus had only the wording correspondent to its respective brand. Therefore, in theory, non-emotional language areas should have not produced activations in the brain. It is acknowledged though that language processing is complex and far from being completely understood, and that the participation of Broca's area obtained in the present study, together with other brain regions that activated significantly more in the explicit run, may have other explanations and should therefore be further investigated.

Digest and Introducing the Second Step

Although without obtaining definite answers in this first approach to brands' logos perception using neuroscientific knowledge and methods, it is possible to infer several abductive concepts (Peirce, 1931a CP:5.188-191) that can be part of such process: emotions, self-reference, and social relevance. The interplay among these concepts is logical under a social cognition umbrella: any individual seeks to attain his/her ideal social self-concept (Johar & Sirgy, 1991); thus, tracking him/herself in the social milieu is crucial for a purposeful navigation (Blumer, 1969; Stryker, 1990);

his/her emotional system are the best adaptive behavioural trump s/he have to be succeed (Rolls, 2000b); brands supply social relevant meanings to help individuals construct their self-concepts (Belk, 1988; Kleine III, Kleine, & Kernan, 1993; M. Joseph Sirgy, 1982). This study allowed for the emergence of the social dimension in the perception of brands as one of the most relevant.

In a certain sense, these results contradict the semantic chasm that Yoon et al. (2006) found between persons and brands. Maybe the fact that the brands' logos used as stimuli were full coloured as they are sawn in everyday life and Yoon used no-coloured brands' names written in the same font for all, accounts for such differences. If it is as so, brands' logos are the effective meaning conveyors, something that has been posited for long by Semiotics (Mick, 1986).

Based on these findings, new hypothesis can be formulated and further studies should investigate the involvement of each of the concepts discussed in more detail (and respective neuroanatomic correlates). To strengthen these findings, brands' logos should be contrasted against diverse baselines. This is particularly relevant for the inferior frontal gyrus, which activated unexpectedly in the explicit run. Was this due to speech inhibition, as participants were instructed to assess the brands covertly, without speaking? Was it part of the explicit reasoning process? Also, it should be further pursued if the social relevance found is common to all brands, or if it is specific of some categories.

In the present study it was used as stimuli assorted brands' logos without any kind of categorisation or screening (except for their recognition). Future studies should introduce differences in brands and search for anatomical structures or networks that could be brain signatures for such categories, maybe surpassing the traditional limitations of verbalising when individuals are faced with questions in marketing research interviews or when they are asked to report about own emotions (Chamberlain & Broderick, 2007).

III. SECOND STEP: EMOTIONAL AND SOCIAL RELEVANT CONTENTS IN DIFFERENT CATEGORIES OF BRANDS

Although the first study opened several questions, this second approach is a small step: introduce a very simple categorization, instructing participants to rate brands' logos according they like, dislike, or are indifferent. Although this categorization is very simple, it is effective due to two main reasons. On one side, persons tend to use simple heuristics in everyday life (Gigerenzer, 2001; Todd & Gigerenzer, 2003). On the other side, some results from neuroscientific studies on brands have been giving support to the existence of consideration sets (Deppe, Schwindt, Kugel, et al., 2005), instead of a hierarchical sequence of preferences (Koeneke, et al., 2008). Thus, assessing the brands in positive, negative, or indifferent categories reflects with sufficient accuracy how persons deal with them in everyday real situations.

The diverse aspects of the paradigm and data analysis in this second step are detailed in Appendix B.

Results

During the fMRI session, participants made explicit cognitive assessments of commercial brands, as instructed. The possible ratings were *unknown*, *negative*, *indifferent*, or *positive*. Subjects reported as *negative* 14% of the brands, as *indifferent* 32% of the brands, and as *positive* 53% of the brands; because the displayed brands were previously filtered by an inquiry, the *unknown* answers were negligible (1%). The effect size for the *negative* valence was small, and five participants rated as *negative* less than 10% of the brands. Thus, for the GLM group analysis only the *indifferent* and *positive* assessments were considered, although explanatory variables (EV) were constructed for all the four possible ratings at the individual level.

Contrast positive > indifferent.

Figure 21 depicts the main structures that activated significantly during the *positive* assessment when contrasted with the *indifferent* assessment in the GLM analysis. These structures are the ventral medial frontal pole, the frontal medial cortex, and part of the ventral paracingulate gyrus; all these activations were medial and ventral.

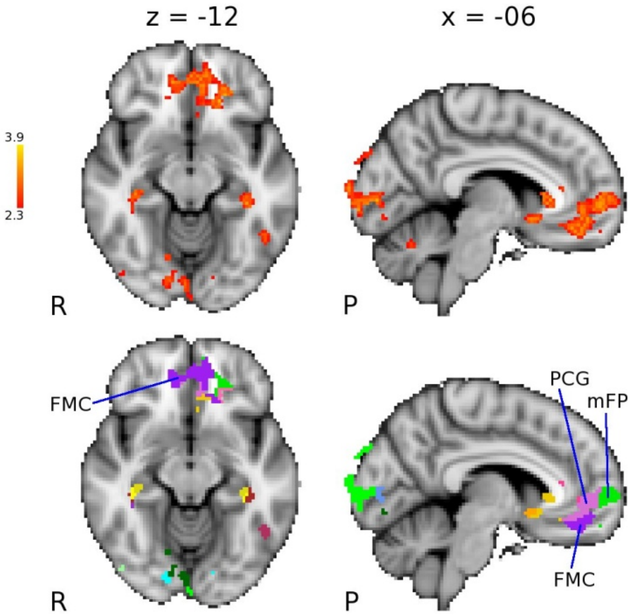


Figure 21 - Activations obtained contrasting the positive with the indifferent assessments in the axial (z = -12) and sagittal (x = -06) planes (statistical parametric maps produced by FEAT). The first row refers to the thresholded map (z > 2.3), and the second row refers to the thresholded activations with the brain structures highlighted with false colours. (R = right; P = posterior; FMC – frontal medial cortex; mFP – frontal pole; PCG – paracingulate gyrus; MNI152 coordinates).

To investigate the balance among activations and deactivations the unthresholded z maps were also considered. Again in the contrast positive > indifferent, Figure 22 represents two axial slices that reveal the activation of the ventro medial prefrontal cortex (a brain region that includes the ventro medial frontal pole, the frontal medial cortex, and the subcallosal cortex in the considered atlases), and deactivation in the dorso lateral prefrontal cortex (that includes the dorso lateral frontal pole and the middle frontal gyrus).

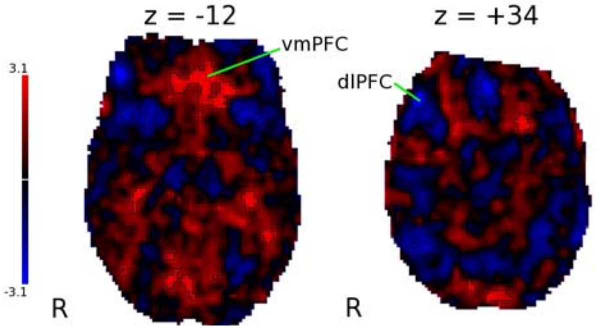


Figure 22 - Unthresholded z maps obtained with the contrast between the positive and indifferent assessments in the axial (z = -12, and +34) planes (statistical parametric maps produced by FEAT). The thresholded clusters (z > 2.3) are outlined in black. (R = right; vmPFC – ventro medial prefrontal cortex; dlPFC – dorso lateral prefrontal cortex; MNI152 coordinates).

To reveal the nature of the activation in the ventro medial prefrontal cortex, the peristimulus haemodynamic response was plotted for the *positive* and *indifferent* explanatory variables, and also for the baseline. The graph in Figure 23 depicts the results for the voxel with the coordinates (-4, 46, -14) in MNI152 space that corresponds to the frontal medial cortex (81%), paracingulate gyrus (11%), and the frontal pole (1%) in the probabilistic atlas; its statistic was $z = 3.24$. The activation in this voxel results from the combined effect of the increase in the haemodynamic response during *positive* assessments, and the decrease (with lesser magnitude) of the haemodynamic response during *indifferent* assessments and the baseline.

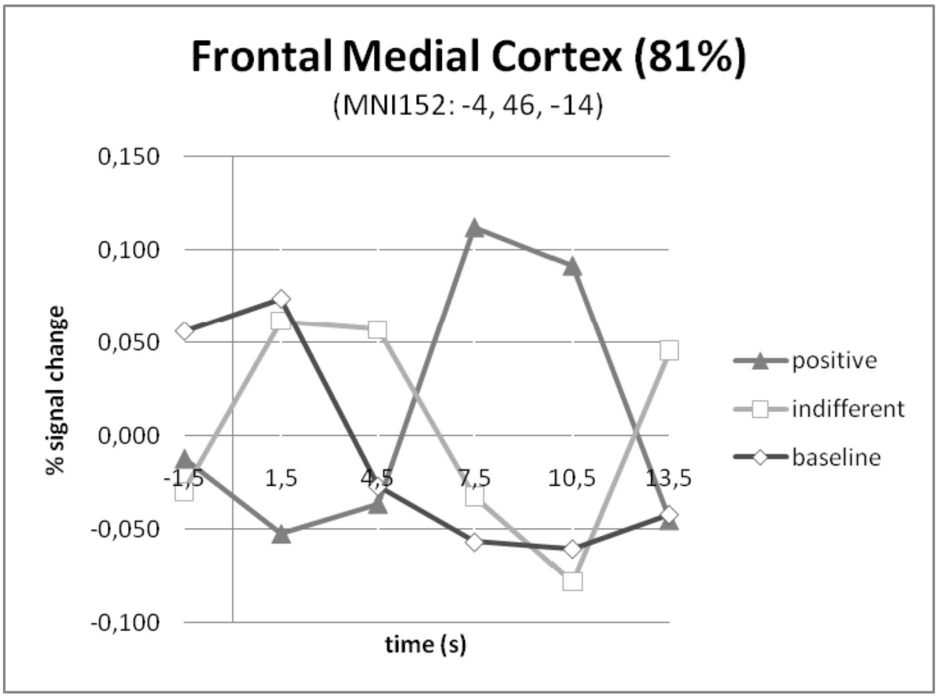


Figure 23 - Peristimulus haemodynamic response in the voxel (-4, 46, -14) (MNI152 coordinates) that corresponds to the frontal medial cortex (81%), paracingulate gyrus (11%), and the frontal pole (1%).

Conjunction between positive and indifferent valences.

The conjunction analysis demonstrates the brain structures that participated both in *positive* and *indifferent* assessments of brands. Important activated structures are emphasised in Figure 24 and include the frontal orbital cortex, frontal operculum cortex, the anterior insular cortex, the paracingulate gyrus, and the anterior cingulate gyrus. Activations in brain regions related with memory and learning, like the hippocampus and the parahippocampal gyrus were also identified. In the basal nuclei it is reported activations in the striatum (putamen, caudate nucleus, and nucleus accumbens), and in the pallidum.

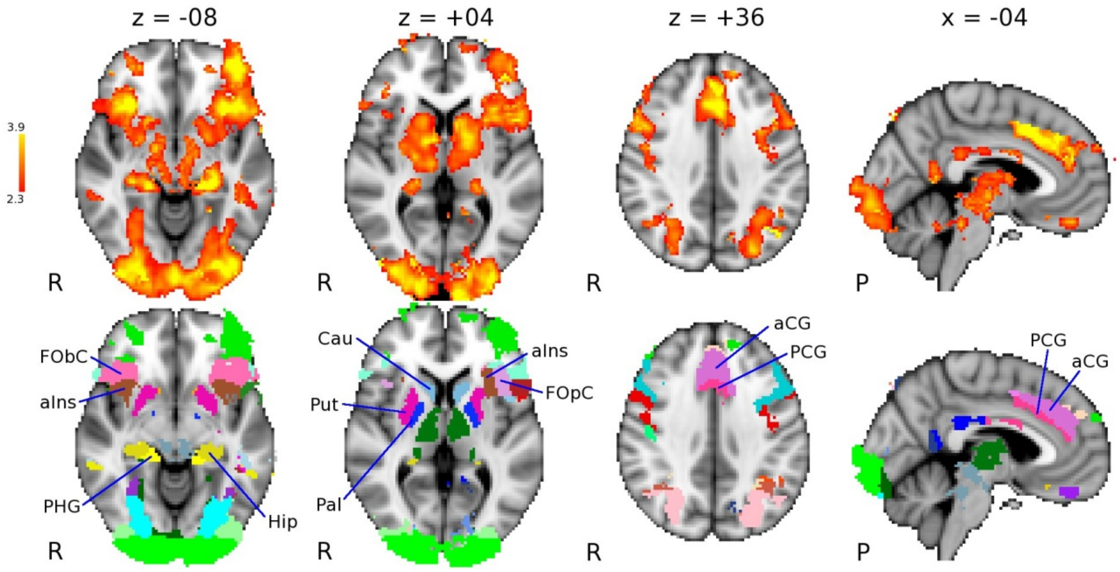


Figure 24 - FMRI maps for the conjunction analysis in the axial (z = -08, +04, and +36) and sagittal (x = -04) planes (statistical parametric maps produced by FEAT). The first row refers to the thresholded map (z > 2.3), and the second row refers to the thresholded activations with the brain structures highlighted with false colours. (R = right; P = posterior; aCG: anterior cingulate gyrus; aIns: anterior insular cortex; Cau: caudate; FObC: frontal orbital cortex; FOpC: frontal operculum cortex; Hip: Hippocampus; Pal: pallidum; PCG: paracingulate gyrus; PHG: parahippocampal gyrus; Put: putamen; MNI152 coordinates).

Model-free analysis with MELODIC.

The model-free analysis with MELODIC returned 114 independent components, which accounted for 85% of the total variance. Table 1 summarises the results of four components, selected according to the statistical tests performed for the contrasts positive > baseline, indifferent > baseline, and negative > baseline (see Appendix B for explanation of the contrasts).

The network obtained in the independent component (IC) 8 represents the neural processing of all the ratings, *positive*, *indifferent*, and *negative* ($p < 0.001$) and is consistent across all participants ($p < 0.001$). This network includes the frontal orbital cortex, frontal operculum cortex, anterior insular cortex, anterior cingulate gyrus, and paracingulate gyrus.

Table 1 - Main independent components from MELODIC.

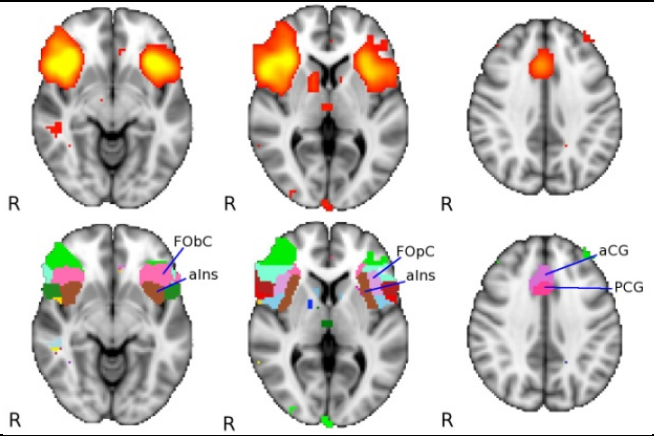
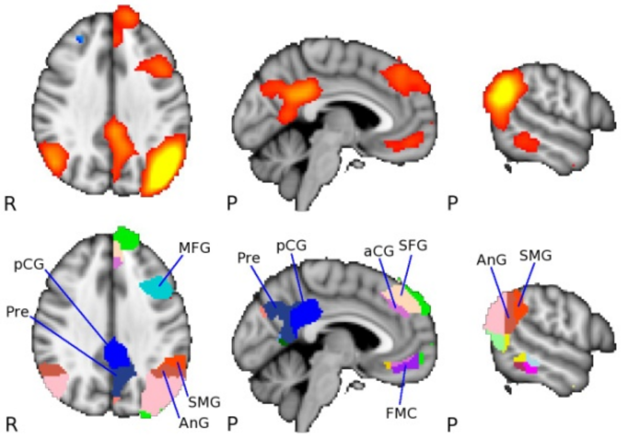
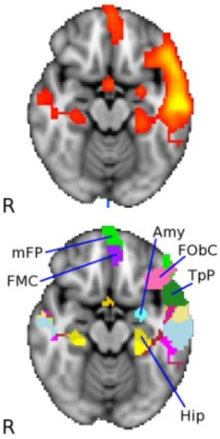
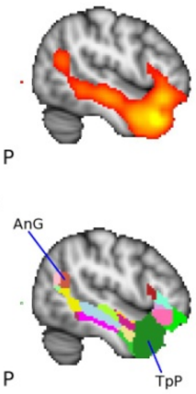
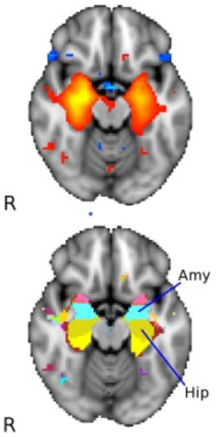
IC		8	
Coord. (MNI152)	z = -08	z = +04	z = +36
			
Test on positive > baseline		$z = 11.26$	
(*p-value*)		< 0.001	
Test on indifferent > baseline		$z = 12.32$	
(*p-value*)		< 0.001	
Test o negative > baseline		$z = 9.07$	
(*p-value*)		< 0.001	
Test on subjects		$z = 3.19$	
(*p-value*)		< 0.001	

Table 1 (cont.)

IC		15	
Coord. (MNI152)	z = +34	x = -04	x = -56
			
Test on positive > baseline		$z = 1.45$	
(*p-value*)		0.074	
Test on indifferent > baseline		$z = 3.91$	
(*p-value*)		< 0.001	

Test o negative > baseline	$z = 1.92$
(*p-value*)	0.028
Test on subjects	$z = 2.99$
(*p-value*)	0.001

Table 1 (cont.)

IC	58		84
Coord. (MNI152)	$z = -16$	$x = -48$	$z = -16$
			
Test on positive > baseline	$z = 3.64$		$z = 3.98$
(*p-value*)	< 0.001		< 0.001
Test on indifferent > baseline	$z = 1.86$		$z = -1.13$
(*p-value*)	0.032		0.871
Test o negative > baseline	$z = 1.58$		$z = -0.60$
(*p-value*)	0.057		0.724
Test on subjects	$z = 1.16$		$z = 0.72$
(*p-value*)	0.123		0.235

aCG: anterior cingulate gyrus; aIns: anterior insular cortex; Amy: amygdala; AnG: angular gyrus; FMC: frontal medial cortex; FObC: frontal orbital cortex; FOpC: frontal operculum cortex; Hip: hippocampus; MFG: middle frontal gyrus; mFP: medial frontal pole; pCG: posterior cingulate gyrus; PCG: paracingulate gyrus; Pre: precuneous cortex; SFG: superior frontal gyrus; SMG: supramarginal gyrus; TpP: temporal pole

The IC 15 was correlated more with indifferent ratings ($p < 0.001$) than with the positive ($p = 0.074$) or negative ($p = 0.028$). This suggests that the network composed by the medial frontal gyrus, superior frontal gyrus, anterior and posterior cingulate gyrus, precuneous cortex, frontal medial cortex, supramarginal gyrus, and angular gyrus is more characteristic of the indifferent brands' assessments. Also, this network activated consistently among all the participants ($p = 0.001$).

On the contrary, the networks represented in the IC 58 and 84 are more characteristic of positive assessments ($p < 0.001$ in both cases) than indifferent ($p = 0.032$ and $p = 0.871$, respectively), or negative ($p = 0.057$ and $p = 0.724$, respectively). The brain structures included in these networks are the medial frontal pole, frontal medial cortex, frontal orbital cortex, temporal pole, middle temporal gyrus, angular gyrus, hippocampus, and amygdala. However, they miss consistency across the participants ($p = 0.123$ and $p = 0.235$, respectively). An analysis of the individual performances reveals that two participants are outliers: one extremely positive (90% *positive* rates and 3% *negative* ratings), and the other is markedly less positive (28% *positive* rates and 18% *negative* ratings).

Grounded Discussion

Role of emotions in brands' appraisal.

The brain network for the processing of emotions proposed by Damásio (1994) includes the orbitofrontal cortex. Damage to this region impairs decision-making (Bechara, 2004; Koenigs & Tranel, 2007) and conduces to inappropriate social behaviour (Beer, et al., 2006) due to defective emotional representations in the brain (Rolls, 2004). The patients with lesions in the orbitofrontal cortex tend to produce exclusively utilitarian judgments (Koenigs, et al., 2007) without a social-emotional component (Koenigs & Tranel, 2008). This is believed to be the basis of their poor decision-making ability. In the present study, the entire orbitofrontal cortex (both medial and lateral subregions) participated in the assessment of brands, but probably with different roles.

It was found activations both in the right and left frontal orbital cortex, common to positive and indifferent brands (see Figure 24 for z = -08, and Table 1 for IC 8 z = -08). This pattern of activations is consistent with the value representation function of the frontal orbital cortex. This structure is associated with hedonic representation (Rolls, 2004) and subjective pleasantness (Kringelbach, O'Doherty, Rolls, & Andrews, 2003), and sustains these functions over time, being crucial for conveniently representing a reward (or punishment) outcome. The frontal orbital cortex is not responsible for the representation of sensorial stimuli, but seems to be able to make durable associations of the identified stimuli with previous acquired knowledge. Price (2008) claims that this area has a role in non-food object assessment, integrating sensorial information. It may be admitted that both *positive* and *indifferent* brands recruited the participation of the frontal orbital cortex for the same generic reason that humans must produce and maintain over time valence representations to generate sustained behavioural strategies.

The insular cortex is intimately connected to the frontal orbital cortex (Öngür & Price, 2000; Price, 2008). Empathy, the ability to share someone else's feelings or experiences by imagining what it would be like to be in their situation, has been shown to have neural correlates in the insular and in the frontal operculum cortex (Singer, et al., 2004). These two cortical structures, are believed as well to represent the sense of the physiological condition of the body: interoception (Craig, 2002). Hence, by using the interoceptive system, humans have the capability to experience the emotional states of environmental stimuli (Gallese, Keysers, & Rizzolatti, 2004), allowing each individual to feel exterior emotional states as if they were their own (Craig, 2002, 2009a). The feelings are then channelled to the frontal orbital cortex to integrate behavioural responses and associations (Craig, 2002). The participation of this network (insular cortex / frontal orbital cortex) was also reported during the *wanting* stage when playing for favourite chocolate bar brands (Koeneke, et al., 2008). This system is part as well of the general emotional network proposed by Damásio. There are contributions of all of these cortical structures (anterior insular cortex, and frontal operculum) in both assessments: positive and indifferent (see Figure 24 for z = -08 and +04, and Table 1 for IC 8 z = -08 and +04). Literally, these results suggest that humans feel brands in order to assess them.

On the other hand, the frontal medial cortex activated significantly more for the positive ratings than for the indifferent (see Figure 21 for z = -12 and x = -06, Figure 22 for z = -12, Figure 23 , and Table 1 for IC 58 z = -16). The frontal medial cortex is thought to be recruited when certain strategies should be maintained (Elliott, et al., 2000; Price, 2008; Windmann, et al., 2006), namely those that achieve rewards. The frontal medial cortex is also believed to be involved when in face of familiar stimuli or what is thought to be morally right (Ishai, 2007; Kranz & Ishai, 2006). Although both positive and indifferent brands in the present study triggered the emotional system, only the positive rated ones were able to activate the structure that pursuits reward outcomes, by maintaining timely and purposeful behavioural strategies: the frontal medial cortex (Amodio & Frith, 2006; Ochsner, et al., 2005). Interestingly, for the contrast positive > indifferent, Figure 22 reveals an activation in the ventro medial prefrontal cortex (which comprises the frontal medial cortex, the ventral medial frontal pole, and the subcallosal cortex) and a deactivation in the dorso lateral prefrontal cortex (a brain region that includes the dorso lateral frontal pole and the middle frontal gyrus). This is in line with the two way decision-making processes proposed by Bechara et al. (1997) and that was also found in brands preference (Deppe, Schwindt, Kugel, et al., 2005): one is emotion-based and relies on the ventro medial prefrontal cortex, and the other is more deliberative and recruits working memory and the dorso lateral prefrontal cortex (Bechara, Damásio, Tranel, & Anderson, 1998). In the present study, positive brands, as opposed to indifferent brands, have the ability to short cut the assessment by activating the emotion-based decision process, simultaneously encumbering deliberative reasoning. This pattern largely replicates similar findings obtained with brain lesions and brands (Koenigs & Tranel, 2008).

The amygdala is another brain structure known to be involved in emotional behaviour, particularly of the primary type like joy or fear (Adolphs, 2003; Adolphs, et al., 1998; Ashwin, et al., 2007; Beaucousin, et al., 2007; Bechara, et al., 1999; Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002; Castelli, 2005; Critchley, et al., 2000; Norris, et al., 2004; Whalen, et al., 1998; Zald, 2003) and in emotional memories (Kensinger & Schacter, 2006a; Murray, 2007). Although the GLM-based analysis did not reveal activations in the amygdala, the model-free analysis found significant activations for the positive assessments (see Table 1 for IC 58 z = -16 and for IC 84 z = -16). This taken together with the finding that the frontal medial cortex activates significantly more with the positive rated brands, involves two important brain structures of the emotional model proposed by Damásio and Bechara (Bechara, 2004; Damásio, 1994), the frontal medial cortex and the amygdala, in the processing of positive rated brands, and as revealed in Table 1 for IC 58 z = -16, both structures participate in the same network. It may be admitted that this is strong evidence of the emotional content that certain - but not all - brands have: in fact, although both positive and indifferent brands were felt in order to be assessed, only positive rated brands can be considered as primary and secondary emotional inducers.

In summary, this study suggests that the human emotional system participates in the assessment of brands, feeling them, and this same system differentiates between positive and indifferent ones, supporting previous models of economic decision-making (Deppe, Schwindt, Kugel, et al., 2005; Plassmann, O'Doherty, et al., 2008). Further, it reveals that the participation of the brain regions involved in processing emotions it is not due to the decision-making scenario, and that a single brand appraisal was enough to evoke them, i.e. one brand solely may induce emotional behavioural responses.

Brands' symbolic meanings.

Some phenomenological studies have been revealing that brands have roles beyond the mere differentiation of products. Allen, Fournier, and Miller (2008) propose an "emergent paradigm" for brands, where brands are "meaning rich tools that help people live their lives" (p. 788), and consumers, both individually and in groups, are active participants of brands' meaning co-creation. This suggests that brands' logos are much more than their graphical design: brands' logos are meaningful symbols (Elliott, 1994).

According to the model proposed by McCraken (1986) the cultural system (advertising, fashion) assigns meanings to products and brands, and individual consumers assimilate such meanings during the consumption act. However, this assimilation it is not a mere juxtaposition, but it is negotiated according to the "key existential tensions", which generates countervailing feedback to the fashion system (Thompson & Haytko, 1997). Other social groups endorsed with referential status participate in brands' meanings co-creation, which consumers use in self-construal (Elliott & Wattanasuwan, 1998; Escalas & Bettman, 2005). Belk (1988) put forward the role of the material possessions in the construction of the self-concept, and this role was supported recently (Ahuvia, 2005). In the same line, possessions are used to make social hierarchical categorisations (Dittmar, 1994; Dittmar & Pepper, 1994). The meanings conveyed by brands act as seeds that make specific communities emerge around them (Muniz Jr. & O'Guinn, 2001) or fans tribes (Moutinho, Dionísio, & Leal, 2007). Hence, brands have an active social role in promoting social groups, and the relationships that consumers maintain with them pass from a one-to-one basis to a triad: consumer – brand – consumer. These communities extend to include companies and products, with brands having a central role insuring group cohesion (McAlexander, Schouten, & Koenig, 2002), and brands were found to be critical in maintaining these long-term relationships (Veloutsou & Moutinho, 2009). At least in Latin societies, consumers emphasise the social links that brands provide rather than the products they mark (Cova & Cova, 2002), and the accomplishing or violation of the normative frame that characterise each relationship category is used by consumers on brands' appraisals (Aggarwal, 2004). The relationships that consumers initiate, maintain, and terminate with brands was investigated by Fournier (1998). Within her framework, four pillars define a relationship: first, both partners reciprocally contribute to the relationship, second, there are meanings flowing through the linkage, third, relationships span several dimensions, and forth, they evolve along the time. The first and second pillars are of particular importance for the present study, as posits consumers and brands in similar levels, both actively contributing to the relationship lively providing meanings to each other, rather than a biunivocal approach where one partner is defined by the other without returning feedback. What emerges from all this stream of research is that brands are quasi-human entities, and when consumers relate with them, they attribute human qualities to brands like emotions, thoughts, and volition (Fournier, 1998), that derive from marketing actions.

The results of the present study, report the participation of the paracingulate gyrus for both positive and indifferent assessments (see Figure 24 for z = +36 and x = -04, and Table 1 for IC 8 z = +36), and a brain region known as temporo-parietal junction, which encompasses the angular gyrus and the supramarginal gyrus, in positive assessments (see Table 1 for IC 58 x = -48) and in indifferent assessments (see Table 1 for IC 15 z = +34 and x = -56). It has been suggested that these brain structures have a relevant role in Theory of Mind and meta-representations (Amodio & Frith, 2006; Frith, 2007; Frith & Frith, 2006; Gallagher & Frith, 2003; Rilling, et al., 2004; Saxe, 2006; Saxe & Wexler, 2005) although certain points are subject of controversy (Mitchell, 2008; Stone & Gerrans, 2006). Meta-representation is the aptitude to represent representations, i.e. the ability of predicting thoughts in other individuals' brains. Imagining the intentions, strategies, beliefs, goals, and desires that take place in others' brains is crucial for an accurate and purposeful relationship management. In a financial risk decision-making task, the exhibition of messages from an expert activated the temporo-parietal junction and the dorso medial prefrontal cortex (Engelmann, Capra, Noussair, & Berns, 2009). The dorso medial prefrontal cortex also was found to activate when forming impressions of persons versus inanimate objects (Mitchell, et al., 2005) and it is reported a very similar result in the present study (see Figure 24 for x = -04, and Table 1 for IC 15 x = -04). This does not mean that humans form impressions about persons and brands in the same way, as these situations were not directly contrasted in this study. However, taking together the above mentioned literature, where the metaphor of the human social relationships is extended into brands, the study suggests that they may be considered in a human-like level and not as common objects, which will be tested in future studies. Hence, posited the antropomorphisation of brands that pushed them into a quasi-human level, which in turn allowed the establishment of human-like relationships with them, one possible explanation for the activation of Theory-of-Mind-related brain structures is that the participants appraised brands in a similar way that they appraise their conspecifics. Maybe this was accomplished by imagining in brands human attributes and using human social norms to generate an impression, supporting the use of human social norms also in brand relationships (Aggarwal, 2004).

Despite the previous discussion on the social relevance of the brands, there were brain regions that were not common in the processing of *positive* and *indifferent* evaluations: *positive* rated brands, but not the *indifferent* ones, activated the medial frontal pole (see Figure 21 for x = -06, Figure 22 for z = -12, and Table 1 for IC 58 z = -16). Amodio and Frith (2006) named this region as arMFC – anterior rostral medial frontal cortex – and assigned different categories of functions to it, and importantly, self-knowledge. Self-knowledge is fundamental in differentiating oneselves from others and objects, and subserves the capacity to self-attribute preferences and dispositions (W. M. Kelley, et al., 2002). Northoff et al. (2006) attributed to the ventral paracingulate gyrus and to the ventral medial frontal pole a role in bringing together the exteroceptive and the interoceptive stimuli within the self, and this same region was found to participate in judgments about similar persons versus dissimilar ones (Mitchell, et al., 2006). These results are coherent with such proposals because only *positive* rated brands (those that are self-related), and not the *indifferent*, activated the ventral paracingulate gyrus and the ventral medial frontal pole, in accordance with the extensive literature that supports the role of brands in self-construal (Ahuvia, 2005; Belk, 1988; Escalas & Bettman, 2005; Fournier, 1998; McCracken, 1986).

Digest, Some Limitations, and Introducing the Third Study

In this study it was possible to identify brain structures involved in brands' logos perception and find that humans use the same brain system to evaluate emotional stimuli and assess both *positive* and *indifferent* brands. In this process, brands literally are felt to represent their subjective value and its social relevant content is identified in this same process. However, only *positive* brands had the capacity to induce emotions and conspicuously, *positive* rated brands are the only ones that may be considered as self-related. Further, our findings are characteristic of each particular brand and not of the decision process.

In a certain sense contradicting the work of Yoon et al. (2006), the results of the present study are in line with the extensive literature that pushes brands to quasi-human levels, and opens the debate for the cause of such differential effect. A possible explanation is that this study used full coloured brands' logos as they are seen in everyday life and not just the brand name. The logos may convey a better experience of the brand, the same way that a photograph of a face provides more rich information about the person than his/her name.

It is worth to emphasise a major caveat that is characteristic of fMRI studies: this technique does not allow disentangling between brain structures that just participate in a process from those that are critical to accomplish the process. Relay effects may be present, were activations take place just because the structures are linked. Both the anterior insular cortex and the anterior cingulate gyrus (a neighbour structure of the paracingulate gyrus that consistently activated together along the study) have von Economo neurons. These neurons are supposed to provide fast and highly integrate representations (Craig, 2009a), and some of the activations that we here reported may be due to this effect. Similar, but different, studies are needed to address the same questions but with other techniques to resolve this issue.

Finally, the role of the striatum is elusive: the model-free analysis did not find a significant component for such role and in the GLM analysis the striatum activated consistently both in positive and indifferent assessments, even without performing manual actions to register choices. If positive rated brands are considered rewards, this study does not support the role of the striatum in coding for rewards, at least in the assessment stage.

Future steps should also investigate two methodical issues. Until now, brands were showed in trains. The association of several brands in blocks may produce brain activations that brands alone cannot reach. Participants in the studies may try to achieve some kind of interpretation of these “brands’ sentences”. To investigate this possibility, future steps should use a different method to show brands’ logos, for example by using an even-related paradigm structure, were stimulus is delivered mixed with one or more baselines in a random order. Another methodical issue that should be deeper investigated is the baseline. Other types of baselines should be used to challenge actual conclusions. Special care should exist to not choose emotional or social meaning laden baselines that would forcibly cancel expected brain activations.

At this point some brain markers emerged in these studies to identify brands’ perception, and also to identify brands’ preferences. These markers are in line with Luu and Chau (2009) study. This is very promising to develop market research protocols, affordable, easy to implement in assorted locals, and that allow surpassing known difficulties with human participants.

IV. POSITIVE, INDIFFERENT, AND FICTITIOUS BRANDS' LOGOS PERCEPTION: AN EVENT-RELATED FMRI STUDY

The studies and analysis conducted so far have been revealing consistently the participation of certain brain structures, which, by inference, have been linked to specific psychological processes. Until now, the strategy has been contrasting trains of logos versus a not so common baseline: non-emotional words. This baseline was chose because, on one hand engages participants in an activity that diverts them from self-referential thoughts that usually accompanies the passive viewing of current baselines (fixation cross, or chequered patterns, or flying dots), and on the other hand it is semantically void, which allow to investigate the meanings that brands putatively embody without cancelation effects. However, it is unquestionable that non-emotional words have a syntactic role and the influence of such is unknown until now.

It may be also argued that some of the brain structures activated, not due to the fact that subjects are viewing brands' logos, but because the logos are complex shapes with multi colours, gradients, probably including objects or their styling, or they may even include anthropomorphised shapes, which they (and not the brand itself) may explain part of the activation set, triggering the psychological processes. In such cases, the emotional responses would be triggered by the associations that each one would make from the picture and not from the underlying brand. Of course there would have some merits in triggering emotional responses from logos where the brand itself could not achieve such, but, at this stage of the research, it would be more valuable to study the neuropsychological processes that subserve brands' appraisal.

Another caveat is that brands assessments and the recording of participants' options are differed in time, i.e. there is not absolutely sure that the scanning images reproduce the exact moment where the decisions were being made. Also, it is not possible to know the extent of the influence in the results that paradigm's structure has (block design and mixed design, so far). Would the results with an event-related paradigm be the same?

The main aim in this third approach to brands' perception by Neuroscience is challenge the explanations advanced until this point. To investigate these issues, the structure of the fMRI paradigm will be event-related. In this case stimuli and baselines will be pseudo-randomly sorted and flashed to subjects while their brains are scanned. This structure causes a significant drop in the BOLD signal because it is not consistent in time and hemodynamic responses do not have enough time to develop (Huettel, et al., 2004; Jezzard, et al., 2001). However, the benefit is that activations and deactivations are much more robust because they emerge during shorten expositions.

Brands' logos still are used as stimuli. In this study they are previously screened for each participant in order to have an equal proportion of positive and indifferent brands. Also, the scale used during the screening incorporates the pleasure and the arousal that each brand triggers to the subject. It is worth to note that, although the paradigm sequence will be the same for all participants, positive and indifferent stimuli are specifically tailored to each one. With this strategy it is more certain the kind of category of the stimulus that the participant is viewing.

An artifice was added too: fictitious logos, i.e. logos that are similar to those common in the local market, that participants perceive as current brands' logos, but in fact were specifically and purposefully designed just for the present experiment. With such confounding effect, it was aimed to extract the intrinsic meaning that brands supposedly have, subtracting all the graphical paraphernalia that may involve them. Hence, this study allows giving substance to the Semiotic considerations made previously and reveal the brain correlates for brands' meanings.

A novelty was also introduced in the baseline. In this study the fixation cross will be used as baseline together with the previous non-emotional words. By this way the two baselines will be confronted in the same study together with the target stimuli (brands' logos), which will permit more robust conclusions about the suitability of baselines.

All these challenges will bring robustness to the previous findings about the involvement of the emotional and social systems in brands' appraisal and preference, in the cases where the same brain structures still activate / deactivate, or they will have to be reconsidered in the situations where there is not statistical support. The aspects of the method that sustain this study are detailed in Appendix C.

Results

Brands' logos rating with the SAM in the PAD scale.

Previously to the scanning session, each subject filled up a computer-based questionnaire where 200 brands' logos were rated. Each logo could be assessed with the SAM – self assessment manikin (Bradley & Lang, 2007; Morris, 1995), as depicted in Figure 25, in the PAD - pleasure, arousal, dominance scale (Mehrabian, 1995; Mehrabian & de Wetter, 1987; Russell & Mehrabian, 1977), although only the dimensions *pleasure* and *arousal* were used (Bradley & Lang, 2007). The participants also had the option to mark the brand's logo as *unknown*. Not considering the votes in the category *unknown*, 3,228 logos were rated into the two dimensions *pleasure* and *arousal*, and these results are summarised in Figure 26.

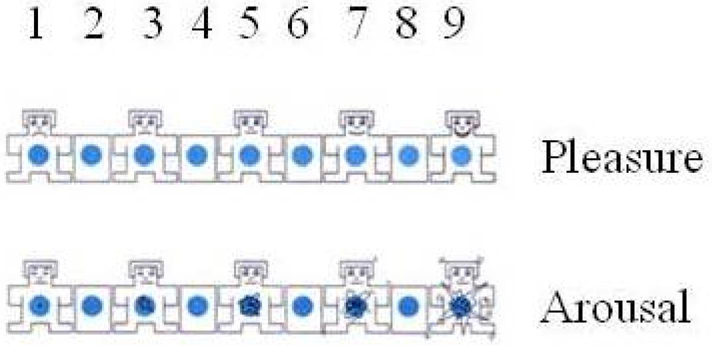


Figure 25 - The SAM - self-assessment manikin for *pleasure* and *arousal* dimensions used to assess brand's logos previously to the fMRI session.

It was observed that subjects complained about the too discriminative power of the used SAM scale and suggested removing the intermediary dots. To study this suggestion, we sought for possible bias in the ratings, favouring (or not) manikin choices at the cost of less votes on dots. Table 2 summarizes these results together with the respective statistic. At the 1% significance level, it is possible to conclude that for every condition there was a strong effect where ratings on manikins were preferred over dots (Pleasure: $z = 15.46 > z_\alpha = 2.33$; Arousal: $z = 7.03 > z_\alpha = 2.33$).

For each brand it was calculated the respective median of the rates. The medians were plotted in the Pleasure – Arousal matrix as depicted in Figure 27. From this plot it is evident the concentration of the assessments into two branches: one about Pleasure 5 and Arousal 1 to 5, and the other about Pleasure 5 to 8 and Arousal 5 to 7. Although these are categorical variables, this plot strongly suggests a correlation between them, as a similar pattern can also be perceived in Figure 26.

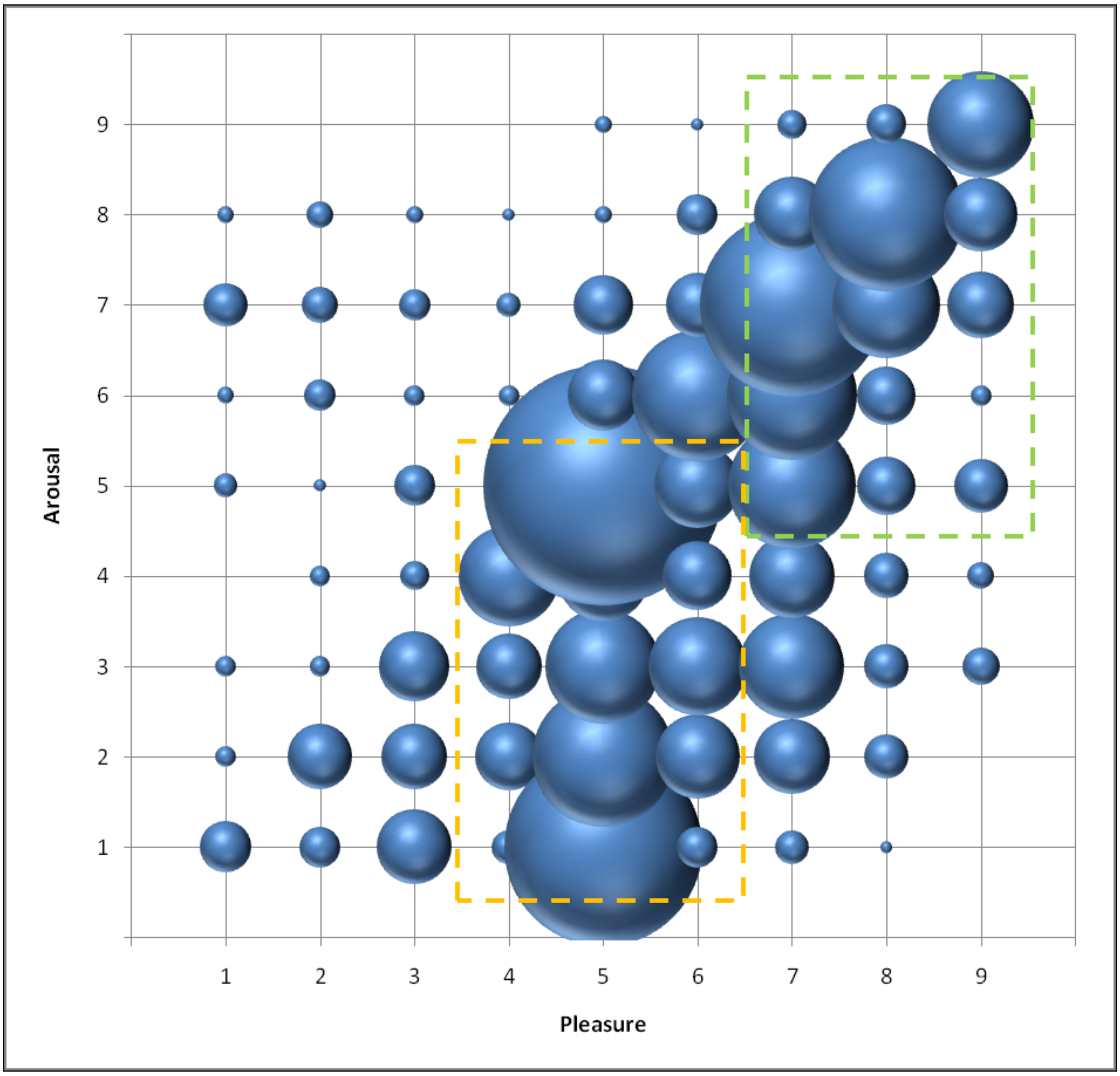


Figure 26 - Brands' logos votes obtained previously to the scanning session plotted in the Pleasure – Arousal matrix. The diameter of the circles is proportional to the quantity of votes. The green dashed rectangle bounds the criteria for positive brands selection, and the orange dashed line draw the limits for the criteria for the selected indifferent brands.

Table 2 - Votes on manikins or dots in the Pleasure and Arousal dimensions in the session previous to scanning, together with the respective z statistic (population proportion).

	Pleasure	Arousal	Total	Fraction (ideal)
Manikin	2,230	1,992	4,222	65.4% (55.6%)
(z statistic)	(15.46)	(7.03)	(11.25)	
Blue dot	998	1,236	2,234	34.6% (44.4%)
(z statistic)	(-15.46)	(-7.03)	(-11.25)	
Total	3,228	3,228	6,456	

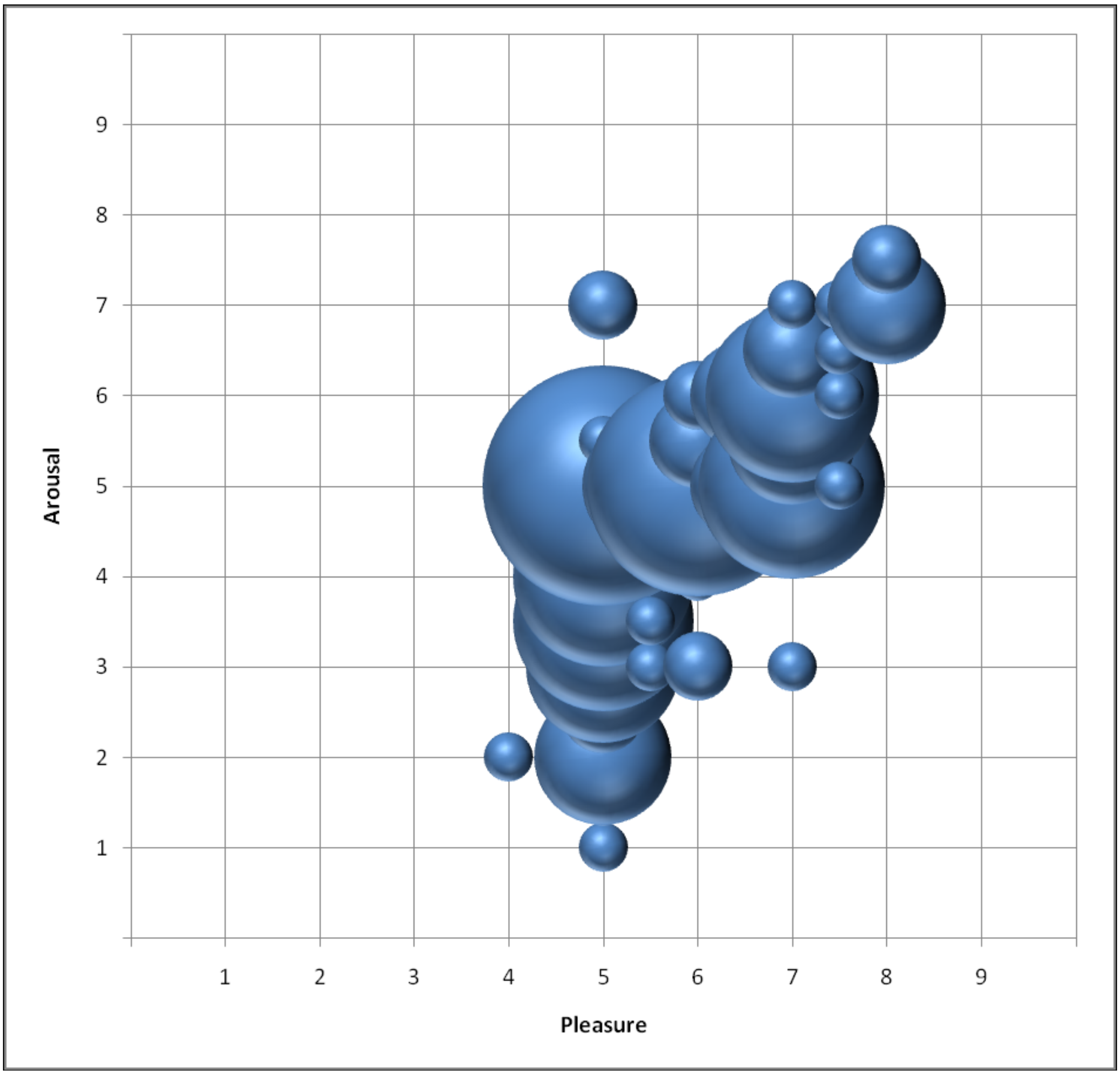


Figure 27 - Plot of the medians of brands' assessments in the Pleasure – Arousal matrix. The diameter of the circles is proportional to the quantity of votes.

The median of all votes is located at Pleasure 6 Arousal 5, and four interesting zones can be detailed with examples in the Pleasure – Arousal matrix:

- Pleasure 5, Arousal 2: C. F. Estrela da Amadora, and C. D. Trofense (second line Portuguese football teams), Juventus (Italian football team), Água de Monchique (less known bottled water), Santander, and Finibanco (banks), Axa (insurance company), and Roberto Cavalli (apparel);
- Pleasure 7, Arousal 3: Bodyshop (natural beauty products);
- Pleasure 8, Arousal 7.5: Ferrari (sport cars), Ferrero Rocher (chocolates);

- Pleasure 5, Arousal 7: F. C. Porto, and S. L. Benfica (top Portuguese football teams).

The brands that belong to the later zone deserve special attention as their pattern clearly differentiates from the remaining. Their votes are depicted in Figure 28, where are evident the extreme ratings in the Pleasure dimension. In fact, these brands are higher in Arousal than the remaining (7 versus 5), and with lesser dispersion (IQR – interquartile range for the selected brands of 3 versus an IQR of 4for the remaining, in the Arousal dimension), but there is a remarkable dispersion of the votes along the Pleasure dimension (IQR of 5.5 for the selected brands versus IQR of 2 for the remaining).

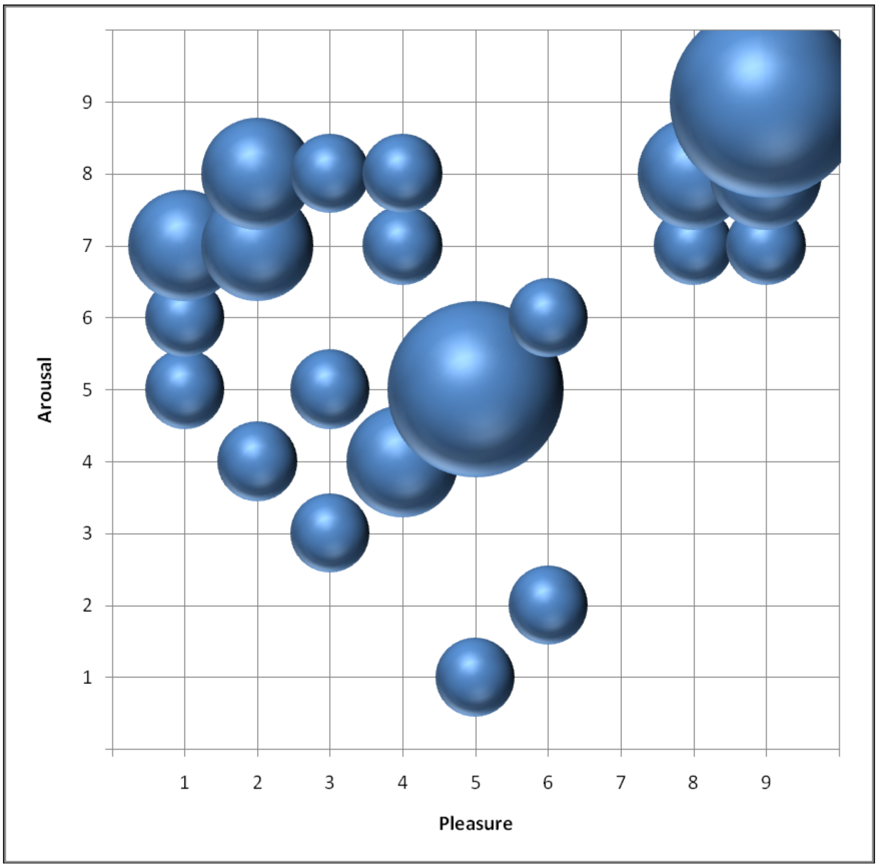


Figure 28 - Plots of the votes of the two brands (F. C. Porto and S. L. Benfica) whose medians were Pleasure 5, Arousal 7. The diameter of the circles is proportional to the quantity of votes.

The brand that is plotted at Pleasure 5, Arousal 1 (Moskvich) was recognised and assessed by only two of the 18 participants.

Consistency in the assessments between the sessions.

As already mentioned, the SAM and the PAD scale were not used during the assessments in the scanning session. To establish a basis for comparison, it was considered that positive brands were those rated with more or equal to 7 in the *pleasure* dimension and (Boolean) more or equal to 5 in the *arousal* dimension, and that indifferent brands were rated with more or equal to 4 and (Boolean) less or equal to 6 in the *pleasure* dimension and (Boolean) less or equal to 5 in the *arousal* dimension (see these boundaries in Figure 26). Inside the scanner, subjects rated the brand in a simple and expedite scale with four possibilities: *positive*, *negative*, *indifferent*, or *unknown*. Although most of the rates maintained from one session to the other, there was not always consistency. These results are summarized in Table 3.

Table 3 - Assessments during the scanning sessions separated according to the type of stimuli.

Stimuli	Recorded options					Total
	Positive	Indifferent	Negative	Unknown	No answer	
Positive	590	29	3	6	2	630
Indifferent	82	427	74	44	3	630
Fictitious	33	36	2	554	5	630
Total	705	492	79	604	10	1890

It is possible to verify that 554 fictitious brands' logos out of 630 (87.9%) were rated as *unknown*. Within the real brands domain, 590 positive brands (according to the above criterion) out of 630 (93.7%) were again rated as *positive* during the scanning session, and 427 indifferent brands out of 630 (67.8%) were again rated as *indifferent*.

Along subjects, there were inconsistencies in the assessments between the two sessions as few as 1.9%, or as large as 31.4%, with a mean value of 16.5% (7.9% standard deviation).

For the study of the overlapping of both scales, the non-answers and the *unknown* votes were not considered. Also, because the number of occurrences was small (64) the votes in the category *negative*, were not considered too. The category *indifferent* was established as the reference. Table 4 reports the coefficients of the model and the odds ratio. The residual deviance is 552.12 and the Akaike's AIC (an information criterion) was 582.12, which was the lowest when compared with other possible models (considering combined effects of pleasure and arousal, considering the negative category, considering subjects, and considering category reduction by collapsing the nine categories of each dimension in only three). The 95% confidence intervals for all categories are listed in Table 5, and in Table 6 are the predicted probabilities for the intersection of several pairs of categories in the *pleasure* and *arousal* dimensions.

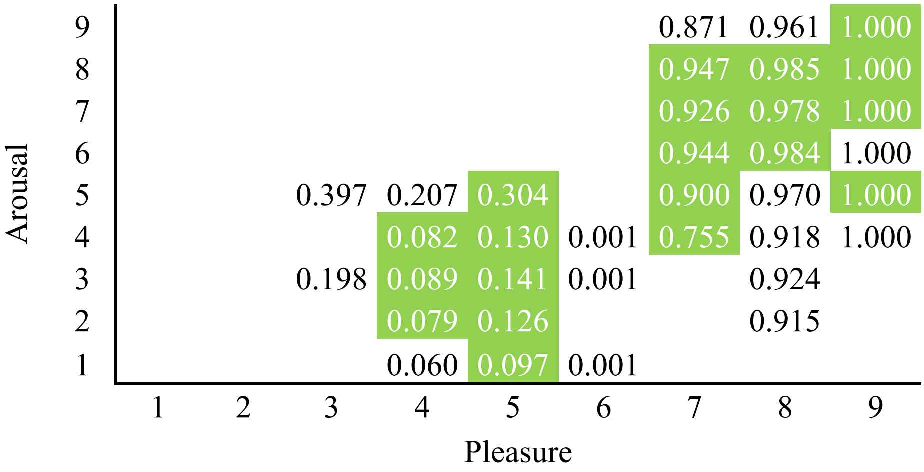
Table 4 - Coefficients of the multinomial logit model and the odds ratio for the categories in the *pleasure* and *arousal* dimensions.

Categories		Coefficients		Odds
		Values	SE	ratio
Intercept		-1.823	0.941	
Pleasure	4	-0.928	1.053	0.395
	5	-0.413	0.907	0.662
	6	-5.403	13.381	0.005
	7	2.614	1.016	13.659
	8	3.901	1.148	49.436
	9	20.252	3.75E-13	6.24E+08
Arousal	2	0.300	0.463	1.350
	3	0.427	0.556	1.533
	4	0.336	0.543	1.399
	5	1.405	0.317	4.077
	6	2.034	0.916	7.645
	7	1.731	0.640	5.648
	8	2.099	0.852	8.160
	9	1.118	1.202	3.060

Table 5 - Confidence intervals at 95% level of the multinomial logit model for the categories in the *pleasure* and *arousal* dimensions.

Categories		Conf. Intervals	
		2.5%	97.5%
Intercept		-3.666	0.021
Pleasure	4	-2.992	1.135
	5	-2.192	1.365
	6	-31.630	20.824
	7	0.623	4.606
	8	1.651	6.150
	9	20.252	20.252
Arousal	2	-0.608	1.208
	3	-0.664	1.518
	4	-0.730	1.401
	5	0.783	2.027
	6	0.239	3.829
	7	0.478	2.985
	8	0.430	3.768
	9	-1.237	3.474

Table 6 - Predicted probabilities of the multinomial logit model for the categories in the *pleasure* and *arousal* dimensions.



Arousal \ Pleasure	1	2	3	4	5	6	7	8	9
9							0.871	0.961	1.000
8							0.947	0.985	1.000
7							0.926	0.978	1.000
6							0.944	0.984	1.000
5			0.397	0.207	0.304		0.900	0.970	1.000
4				0.082	0.130	0.001	0.755	0.918	1.000
3			0.198	0.089	0.141	0.001		0.924	
2				0.079	0.126			0.915	
1				0.060	0.097	0.001			

Note. Only the categories with the green background had at least ten occurrences.

Response time.

Table 7 reports the mean reaction times recorded during the scanning sessions separated according to the type of stimuli. Among the responses consistent between sessions, positive rated brands were the fastest (1,546 ms), followed by the fictitious logos (2,334 ms) and the indifferent brands (2,370 ms). Statistical tests were conducted to investigate if these differences were significant. Between positive and fictitious logos it is reported F (553, 589) = 1.709, which corresponds to *p-value* < 0.000 001, and between positive and indifferent brands it is reported F (426, 589) = 1.701, which corresponds to *p-value* < 0.000 001. Between indifferent brands and fictitious logos it is reported F (553, 426) = 1.005, which corresponds to *p-value* = 0.969 508. The graphical analysis is consistent with the statistical tests and is depicted in Figure 29.

Table 7 - Mean reaction times in milliseconds of the assessments during the scanning sessions separated according to the type of stimuli.

Stimuli	Recorded options (milliseconds)				
	Positive	Indifferent	Negative	Unknown	No answer
Positive	1.546	2.791	3.384	3.060	-
Indifferent	2.321	2.370	2.624	2.489	-
Fictitious	2.811	3.005	3.669	2.334	-
Mean	1.695	2.442	2.679	2.353	-

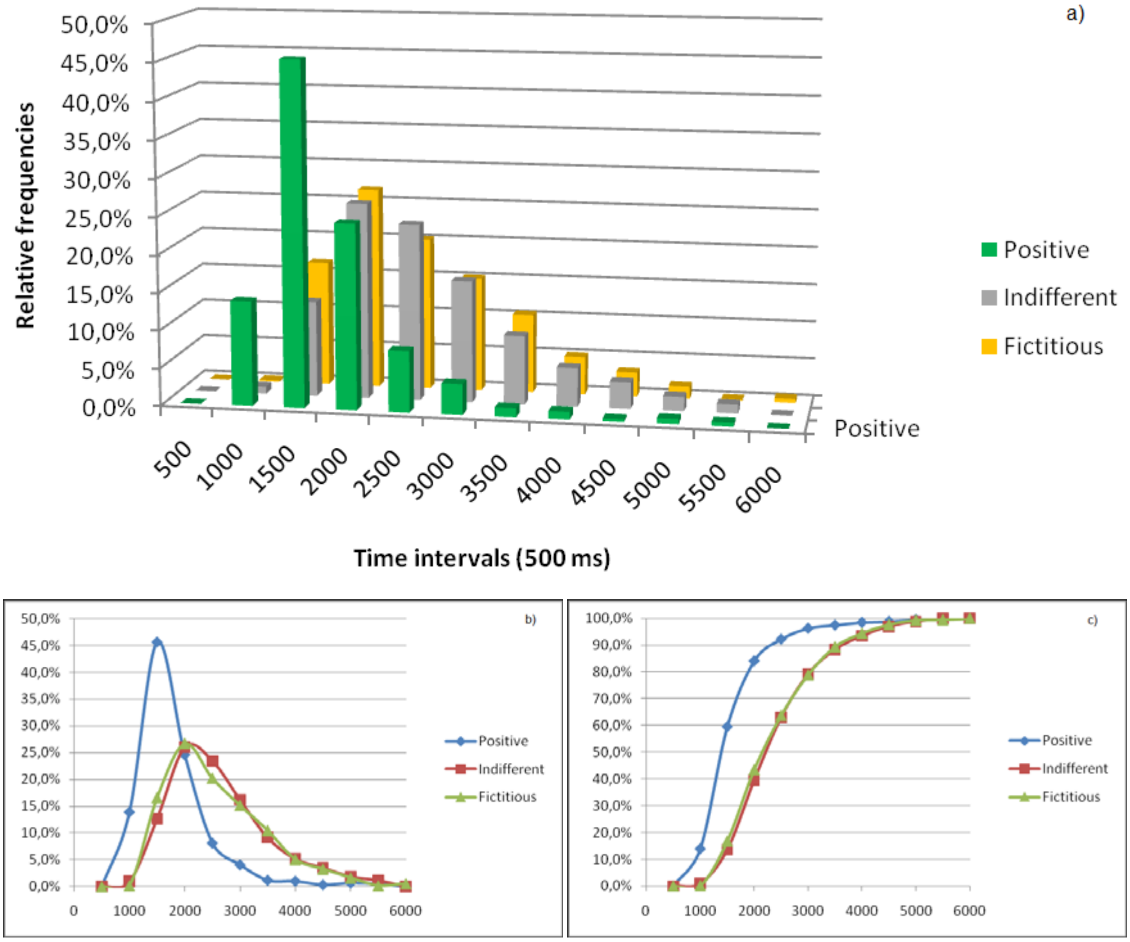


Figure 29 - Graphs with the relative frequencies of the response times obtained during the scanning session grouped in 500 ms intervals. Only the votes consistent between the two sessions were considered. **a)** and **b)** ocurrences in the intervals; **c)** cumulative ocurrences.

Contrasting logos versus baselines.

Figure 30, Figure 31, and Figure 32 represent the statistical parametric maps produced by FEAT that summarise the activations obtained in the contrasts between every sort of logos and the baselines, specifically, positive > fixation cross, positive > non-emotional words, indifferent > fixation cross, indifferent > non-emotional words, fictitious logos > fixation cross, and fictitious logos > non-emotional words. The bottom line of these figures also depict the statistical parametric maps that result from the conjunction analysis, separating in colours the different activations of the voxels (green for the voxels that cumulatively activated in the contrast with the fixation cross and the non-emotional words, red for the voxels that activated in the contrast with the fixation cross but did not activate in the contrast with the non-emotional words, and finally blue for the voxels that activated in the contrast with the non-emotional words but did not activate in the contrast with the fixation cross. Respectively, Table 8, Table 9, and Table 10 detail the quantity of voxels in each brain structure that activated when contrasting positive brands, indifferent brands, and fictitious logos with the two baselines (fixation cross, and non-emotional words). These tables also include the fraction of the brain structure that activated.

The contrasts with the used low-level baselines reveal extensive participation of the brain in brands appraisal. The contrast between positive brands and the fixation cross activated 84,307 voxels (2 × 2 × 2 mm), whereas the contrast with non-emotional words activated 73,864 voxels for the selected threshold. For indifferent brands, the contrast with the fixation cross activated 83,862 voxels, and the contrast with non-emotional words activated 75,129 voxels, and finally for the fictitious logos 66,464

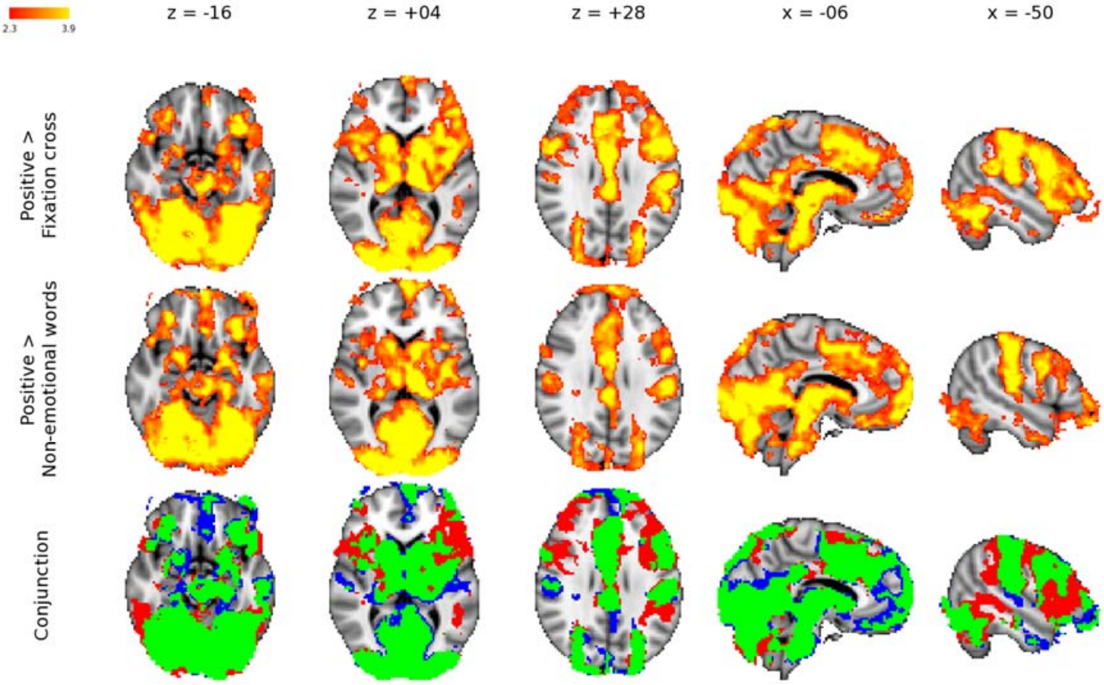


Figure 30 - FMRI maps for the contrasts between positive rated brands and the baselines, and the respective conjunction analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). The first and second rows refer to the thresholded maps (z > 2.3), respectively, the contrast between positive versus fixation cross, and the contrast between positive and non-emotional words. The third row is the conjunction analysis where common voxels are in green colour, voxels that activate only for the contrast positive versus fixation cross are in red, and voxels that activate only for the contrast positive versus non-emotional words are in blue. Radiological convention; MNI152 coordinates.

voxels activated in the contrast with the fixation cross, and 54,564 voxels activated for the contrast with non-emotional words.

The blue spots in Figure 30 and data from Table 8 report that the contrast with non-emotional words sanctions the participation of the medial ventral frontal pole, the subcallosal cortex, left anterior medial temporal gyrus, left and right planum polare, and right Heschl's gyrus in positive brands appraisal. On the other side, the red spots indicate that the contrast with the fixation cross reveals the participation of the right dorsal frontal pole, right inferior frontal gyrus (pars opercularis and pars triangularis),

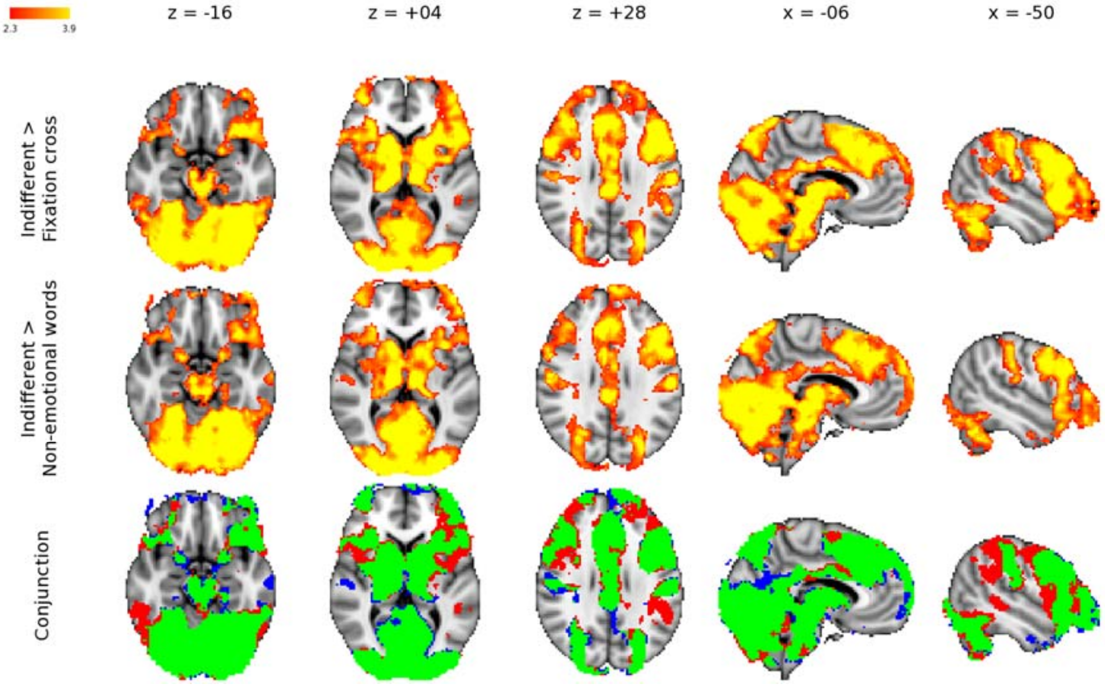


Figure 31 - FMRI maps for the contrasts between indifferent rated brands and the baselines, and the respective conjunction analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). The first and second rows refer to the thresholded maps (z > 2.3), respectively, the contrast between indifferent versus fixation cross, and the contrast between indifferent and non-emotional words. The third row is the conjunction analysis where common voxels are in green colour, voxels that activate only for the contrast indifferent versus fixation cross are in red, and voxels that activate only for the contrast indifferent versus non-emotional words are in blue. Radiological convention; MNI152 coordinates.

right medial frontal gyrus, left medial temporal gyrus (temporo-occipital part), and left and right posterior supramarginal gyrus.

Blue and red spots are not as extensive for indifferent brands as for positive brands. Even so, Figure 31 and Table 9 make evidence of the participation of subregions in the left anterior medial temporal gyrus in the contrast with non-emotional words, and the participation of subregions in the right inferior temporal gyrus (temporo-occipital part), left posterior superior temporal gyrus, left posterior supramarginal gyrus, and left parietal operculum cortex in the contrast with the fixation cross.

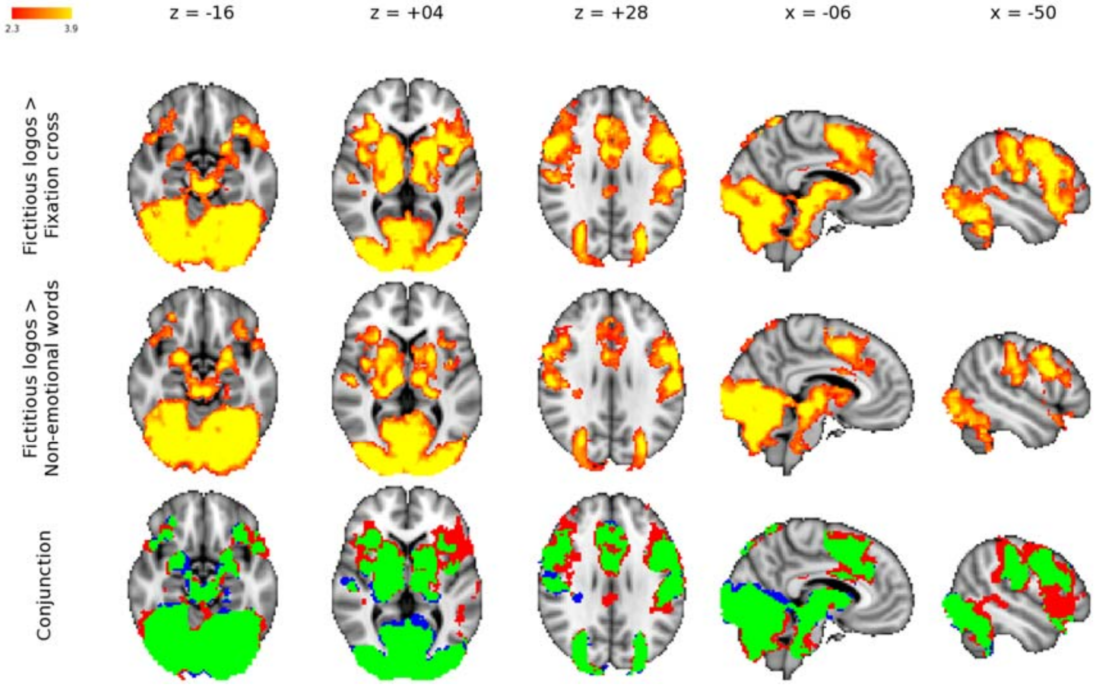


Figure 32 - FMRI maps for the contrasts between fictitious logos and the baselines, and the respective conjunction analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). The first and second rows refer to the thresholded maps (z > 2.3), respectively, the contrast between fictitious logos versus fixation cross, and the contrast between fictitious logos and non-emotional words. The third row is the conjunction analysis where common voxels are in green colour, voxels that activate only for the contrast fictitious logos versus fixation cross are in red, and voxels that activate only for the contrast fictitious logos versus non-emotional words are in blue. Radiological convention; MNI152 coordinates.

The contrast between fictitious logos and non-emotional words allowed the different activations in the right accumbens (see blue spots in Figure 32 and data in Table 10), and the contrast with the fixation cross allowed the different activations in the left dorsal frontal pole, left medial temporal gyrus (temporo-occipital part), left posterior superior temporal gyrus, and left posterior supramarginal gyrus (see red spots in Figure 32 and data in Table 10).

Table 8 - Activated voxels (2 × 2 × 2 mm) for the contrasts between positive brands and the baselines. Conjunction between the two contrasts, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	396	9.9%	14	0.4%	542	13.6%
Frontal pole ventral left	2617	657	25.1%	124	4.7%	357	13.6%
Frontal pole ventral right	3475	379	10.9%	110	3.2%	157	4.5%
Frontal pole dorsal medial	5884	1316	22.4%	174	3.0%	859	14.6%
Frontal pole dorsal left	4214	439	10.4%	1582	37.5%	183	4.3%
Frontal pole dorsal right	5729	397	6.9%	1277	22.3%	141	2.5%
Frontal medial cortex	1539	204	13.3%	7	0.5%	430	27.9%
Subcallosal cortex	2080	122	5.9%	17	0.8%	294	14.1%
Paracingulate gyrus	4095	1676	40.9%	296	7.2%	283	6.9%
Frontal orbital cortex left	2105	916	43.5%	397	18.9%	94	4.5%
Frontal orbital cortex right	1931	551	28.5%	116	6.0%	158	8.2%
Frontal operculum cortex left	562	103	18.3%	388	69.0%	4	0.7%
Frontal operculum cortex right	500	127	25.4%	240	48.0%	6	1.2%
IFG pars triangularis left	1147	242	21.1%	700	61.0%	14	1.2%
IFG pars triangularis right	1170	50	4.3%	453	38.7%	1	0.1%
IFG pars opercularis left	1205	291	24.1%	799	66.3%	9	0.7%
IFG pars opercularis right	1130	29	2.6%	629	55.7%	1	0.1%
Superior frontal gyrus	8861	1922	21.7%	996	11.2%	202	2.3%
Middle frontal gyrus left	4331	1092	25.2%	1354	31.3%	66	1.5%
Middle frontal gyrus right	4090	334	8.2%	932	22.8%	7	0.2%
Precentral gyrus left	7083	2468	34.8%	1338	18.9%	59	0.8%
Precentral gyrus right	6884	940	13.7%	1236	18.0%	111	1.6%
Juxtapositional cortex	2282	922	40.4%	574	25.2%	72	3.2%
Insular cortex left	1302	847	65.1%	197	15.1%	120	9.2%
Insular cortex right	1252	512	40.9%	115	9.2%	71	5.7%
Temporal pole left	3643	992	27.2%	472	13.0%	564	15.5%
Temporal pole right	3801	297	7.8%	200	5.3%	226	5.9%
InferiorTemporalGyrus – anterior left	592	90	15.2%	25	4.2%	97	16.4%
InferiorTemporalGyrus – anterior right	511	1	0.2%	17	3.3%	4	0.8%
InferiorTemporalGyrus – posterior left	1699	152	8.9%	82	4.8%	139	8.2%
InferiorTemporalGyrus – posterior right	1709	25	1.5%	75	4.4%	9	0.5%
ITG – temporo-occipital left	981	404	41.2%	226	23.0%	6	0.6%
ITG – temporo-occipital right	1232	219	17.8%	352	28.6%	9	0.7%
MedialTemporalGyrus – anterior left	642	49	7.6%	0	0.0%	164	25.5%
MedialTemporalGyrus – anterior right	657	11	1.7%	6	0.9%	27	4.1%
MedialTemporalGyrus – posterior left	1616	266	16.5%	97	6.0%	140	8.7%
MedialTemporalGyrus – posterior right	1653	31	1.9%	57	3.4%	4	0.2%
MTG – temporo-occipital left	1073	10	0.9%	144	13.4%	0	0.0%
MTG – temporo-occipital right	1287	0	0.0%	27	2.1%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	43	10.9%	16	4.1%	58	14.7%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	8	0.7%	88	8.0%	31	2.8%
SuperiorTemporalGyrus – posterior right	1172	1	0.1%	46	3.9%	13	1.1%
Planum polare left	383	15	3.9%	10	2.6%	61	15.9%
Planum polare right	369	0	0.0%	3	0.8%	25	6.8%
Heschls gyrus left	320	124	38.8%	0	0.0%	150	46.9%
Heschls gyrus right	263	16	6.1%	0	0.0%	35	13.3%
Planum temporale left	521	69	13.2%	45	8.6%	115	22.1%
Planum temporale right	399	71	17.8%	0	0.0%	100	25.1%
Temporal fusiform cortex – anterior left	517	252	48.7%	26	5.0%	25	4.8%
Temporal fusiform cortex – anterior right	545	170	31.2%	16	2.9%	31	5.7%

Table 8 (cont.)

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	868	68.2%	47	3.7%	88	6.9%
Temporal fusiform cortex – posterior right	1214	665	54.8%	73	6.0%	32	2.6%
Parahippocampal gyrus – anterior left	826	291	35.2%	22	2.7%	152	18.4%
Parahippocampal gyrus – anterior right	1010	190	18.8%	81	8.0%	107	10.6%
Parahippocampal gyrus – posterior left	537	300	55.9%	6	1.1%	129	24.0%
Parahippocampal gyrus – posterior right	398	258	64.8%	13	3.3%	46	11.6%
Temporal occipital fusiform cortex left	871	843	96.8%	1	0.1%	11	1.3%
Temporal occipital fusiform cortex right	1105	1049	94.9%	8	0.7%	16	1.4%
Postcentral gyrus left	4628	2318	50.1%	234	5.1%	28	0.6%
Postcentral gyrus right	4080	458	11.2%	440	10.8%	69	1.7%
Superior parietal lobule left	1737	1363	78.5%	43	2.5%	55	3.2%
Superior parietal lobule right	1712	561	32.8%	237	13.8%	32	1.9%
Supramarginal gyrus – anterior left	1248	367	29.4%	234	18.8%	21	1.7%
Supramarginal gyrus – anterior right	1064	286	26.9%	70	6.6%	66	6.2%
Supramarginal gyrus – posterior left	1414	17	1.2%	421	29.8%	0	0.0%
Supramarginal gyrus – posterior right	1529	9	0.6%	153	10.0%	0	0.0%
Angular gyrus left	1113	54	4.9%	110	9.9%	0	0.0%
Angular gyrus right	1675	23	1.4%	74	4.4%	1	0.1%
Central opercular cortex left	967	499	51.6%	142	14.7%	17	1.8%
Central opercular cortex right	850	207	24.4%	78	9.2%	72	8.5%
Parietal operculum cortex left	565	293	51.9%	178	31.5%	2	0.4%
Parietal operculum cortex right	505	120	23.8%	2	0.4%	47	9.3%
Precuneous cortex	7844	1326	16.9%	453	5.8%	785	10.0%
Lateral occipital cortex – superior left	5903	2541	43.0%	226	3.8%	152	2.6%
Lateral occipital cortex – superior right	5899	1932	32.8%	340	5.8%	88	1.5%
Lateral occipital cortex – inferior left	2814	1408	50.0%	132	4.7%	51	1.8%
Lateral occipital cortex – inferior right	3311	1495	45.2%	223	6.7%	52	1.6%
Cuneal cortex	1743	334	19.2%	32	1.8%	301	17.3%
Supracalcarine cortex	424	179	42.2%	3	0.7%	65	15.3%
Intracalcarine cortex	2211	1492	67.5%	12	0.5%	355	16.1%
Lingual gyrus	5360	4499	83.9%	1	0.0%	323	6.0%
Occipital fusiform gyrus left	1407	1282	91.1%	67	4.8%	10	0.7%
Occipital fusiform gyrus right	1459	1457	99.9%	0	0.0%	2	0.1%
Occipital pole	9658	6418	66.5%	471	4.9%	385	4.0%
Cingulate gyrus – anterior	4144	2324	56.1%	374	9.0%	213	5.1%
Cingulate gyrus – posterior	4495	1194	26.6%	188	4.2%	369	8.2%
Pallidum left	312	304	97.4%	8	2.6%	0	0.0%
Pallidum right	266	172	64.7%	65	24.4%	4	1.5%
Putamen left	923	866	93.8%	51	5.5%	6	0.7%
Putamen right	800	497	62.1%	110	13.8%	25	3.1%
Caudate left	572	342	59.8%	4	0.7%	82	14.3%
Caudate right	515	318	61.7%	20	3.9%	76	14.8%
Accumbens left	111	79	71.2%	1	0.9%	25	22.5%
Accumbens right	86	45	52.3%	0	0.0%	37	43.0%
Amygdala left	390	174	44.6%	14	3.6%	122	31.3%
Amygdala right	399	56	14.0%	15	3.8%	97	24.3%
Hippocampus left	921	469	50.9%	28	3.0%	152	16.5%
Hippocampus right	772	192	24.9%	25	3.2%	140	18.1%
Total				21625	10.8%	11182	5.6%
Grand total	199998	62682	31.3%	84307	42.2%	73864	36.9%

Note. Conjunction voxels are the green ones in Figure 30, unique to fixation cross are the red ones, and unique to the non-emotional words are the blue ones.

Table 9 - Activated voxels (2 × 2 × 2 mm) for the contrasts between indifferent brands and the baselines. Conjunction between the two contrasts, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	116	2.9%	24	0.6%	265	6.7%
Frontal pole ventral left	2617	957	36.6%	160	6.1%	197	7.5%
Frontal pole ventral right	3475	321	9.2%	231	6.6%	293	8.4%
Frontal pole dorsal medial	5884	1374	23.4%	261	4.4%	512	8.7%
Frontal pole dorsal left	4214	1183	28.1%	1266	30.0%	90	2.1%
Frontal pole dorsal right	5729	1497	26.1%	828	14.5%	151	2.6%
Frontal medial cortex	1539	0	0.0%	0	0.0%	25	1.6%
Subcallosal cortex	2080	24	1.2%	4	0.2%	111	5.3%
Paracingulate gyrus	4095	1935	47.3%	211	5.2%	77	1.9%
Frontal orbital cortex left	2105	1016	48.3%	188	8.9%	40	1.9%
Frontal orbital cortex right	1931	507	26.3%	87	4.5%	84	4.4%
Frontal operculum cortex left	562	352	62.6%	163	29.0%	5	0.9%
Frontal operculum cortex right	500	253	50.6%	146	29.2%	13	2.6%
IFG pars triangularis left	1147	675	58.8%	330	28.8%	7	0.6%
IFG pars triangularis right	1170	298	25.5%	348	29.7%	0	0.0%
IFG pars opercularis left	1205	695	57.7%	385	32.0%	6	0.5%
IFG pars opercularis right	1130	218	19.3%	524	46.4%	10	0.9%
Superior frontal gyrus	8861	3340	37.7%	595	6.7%	178	2.0%
Middle frontal gyrus left	4331	2359	54.5%	529	12.2%	63	1.5%
Middle frontal gyrus right	4090	2318	56.7%	541	13.2%	66	1.6%
Precentral gyrus left	7083	1547	21.8%	821	11.6%	45	0.6%
Precentral gyrus right	6884	2144	31.1%	1064	15.5%	72	1.0%
Juxtapositional cortex	2282	1036	45.4%	496	21.7%	35	1.5%
Insular cortex left	1302	405	31.1%	244	18.7%	7	0.5%
Insular cortex right	1252	355	28.4%	152	12.1%	52	4.2%
Temporal pole left	3643	755	20.7%	362	9.9%	225	6.2%
Temporal pole right	3801	181	4.8%	215	5.7%	86	2.3%
InferiorTemporalGyrus – anterior left	592	36	6.1%	54	9.1%	60	10.1%
InferiorTemporalGyrus – anterior right	511	0	0.0%	9	1.8%	3	0.6%
InferiorTemporalGyrus – posterior left	1699	50	2.9%	68	4.0%	38	2.2%
InferiorTemporalGyrus – posterior right	1709	7	0.4%	37	2.2%	15	0.9%
ITG – temporo-occipital left	981	451	46.0%	196	20.0%	6	0.6%
ITG – temporo-occipital right	1232	104	8.4%	323	26.2%	1	0.1%
MedialTemporalGyrus – anterior left	642	15	2.3%	6	0.9%	105	16.4%
MedialTemporalGyrus – anterior right	657	8	1.2%	10	1.5%	16	2.4%
MedialTemporalGyrus – posterior left	1616	34	2.1%	112	6.9%	184	11.4%
MedialTemporalGyrus – posterior right	1653	17	1.0%	26	1.6%	13	0.8%
MTG – temporo-occipital left	1073	8	0.7%	13	1.2%	0	0.0%
MTG – temporo-occipital right	1287	0	0.0%	13	1.0%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	18	4.6%	20	5.1%	9	2.3%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	82	7.4%	4	0.4%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	10	0.9%	3	0.3%
Planum polare left	383	0	0.0%	3	0.8%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%	2	0.6%
Heschls gyrus right	263	92	35.0%	0	0.0%	35	13.3%
Planum temporale left	521	0	0.0%	9	1.7%	10	1.9%
Planum temporale right	399	73	18.3%	9	2.3%	84	21.1%
Temporal fusiform cortex – anterior left	517	99	19.1%	56	10.8%	36	7.0%
Temporal fusiform cortex – anterior right	545	72	13.2%	3	0.6%	57	10.5%

Table 9 (cont.)

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	523	41.1%	118	9.3%	108	8.5%
Temporal fusiform cortex – posterior right	1214	519	42.8%	90	7.4%	20	1.6%
Parahippocampal gyrus – anterior left	826	77	9.3%	38	4.6%	59	7.1%
Parahippocampal gyrus – anterior right	1010	101	10.0%	84	8.3%	25	2.5%
Parahippocampal gyrus – posterior left	537	209	38.9%	7	1.3%	71	13.2%
Parahippocampal gyrus – posterior right	398	163	41.0%	9	2.3%	28	7.0%
Temporal occipital fusiform cortex left	871	836	96.0%	1	0.1%	9	1.0%
Temporal occipital fusiform cortex right	1105	938	84.9%	37	3.3%	12	1.1%
Postcentral gyrus left	4628	948	20.5%	378	8.2%	32	0.7%
Postcentral gyrus right	4080	1669	40.9%	129	3.2%	73	1.8%
Superior parietal lobule left	1737	1135	65.3%	42	2.4%	77	4.4%
Superior parietal lobule right	1712	1148	67.1%	28	1.6%	16	0.9%
Supramarginal gyrus – anterior left	1248	249	20.0%	155	12.4%	7	0.6%
Supramarginal gyrus – anterior right	1064	250	23.5%	37	3.5%	43	4.0%
Supramarginal gyrus – posterior left	1414	134	9.5%	260	18.4%	0	0.0%
Supramarginal gyrus – posterior right	1529	110	7.2%	126	8.2%	0	0.0%
Angular gyrus left	1113	126	11.3%	117	10.5%	0	0.0%
Angular gyrus right	1675	104	6.2%	71	4.2%	0	0.0%
Central opercular cortex left	967	176	18.2%	215	22.2%	11	1.1%
Central opercular cortex right	850	128	15.1%	63	7.4%	70	8.2%
Parietal operculum cortex left	565	35	6.2%	65	11.5%	7	1.2%
Parietal operculum cortex right	505	154	30.5%	9	1.8%	48	9.5%
Precuneous cortex	7844	2170	27.7%	189	2.4%	640	8.2%
Lateral occipital cortex – superior left	5903	2616	44.3%	159	2.7%	99	1.7%
Lateral occipital cortex – superior right	5899	2550	43.2%	105	1.8%	160	2.7%
Lateral occipital cortex – inferior left	2814	1298	46.1%	152	5.4%	42	1.5%
Lateral occipital cortex – inferior right	3311	1570	47.4%	233	7.0%	36	1.1%
Cuneal cortex	1743	223	12.8%	40	2.3%	164	9.4%
Supracalcarine cortex	424	167	39.4%	4	0.9%	73	17.2%
Intracalcarine cortex	2211	1532	69.3%	10	0.5%	276	12.5%
Lingual gyrus	5360	4192	78.2%	12	0.2%	360	6.7%
Occipital fusiform gyrus left	1407	1374	97.7%	15	1.1%	2	0.1%
Occipital fusiform gyrus right	1459	1458	99.9%	1	0.1%	0	0.0%
Occipital pole	9658	6589	68.2%	171	1.8%	228	2.4%
Cingulate gyrus – anterior	4144	2039	49.2%	449	10.8%	51	1.2%
Cingulate gyrus – posterior	4495	1198	26.7%	139	3.1%	229	5.1%
Pallidum left	312	274	87.8%	34	10.9%	1	0.3%
Pallidum right	266	248	93.2%	8	3.0%	2	0.8%
Putamen left	923	590	63.9%	223	24.2%	1	0.1%
Putamen right	800	719	89.9%	43	5.4%	14	1.8%
Caudate left	572	262	45.8%	15	2.6%	10	1.7%
Caudate right	515	281	54.6%	24	4.7%	25	4.9%
Accumbens left	111	52	46.8%	1	0.9%	22	19.8%
Accumbens right	86	30	34.9%	1	1.2%	23	26.7%
Amygdala left	390	16	4.1%	10	2.6%	25	6.4%
Amygdala right	399	38	9.5%	5	1.3%	29	7.3%
Hippocampus left	921	181	19.7%	39	4.2%	28	3.0%
Hippocampus right	772	108	14.0%	15	1.9%	25	3.2%
Total				15410	7.7%	6677	3.3%
Grand total	199998	68452	34.2%	83862	41.9%	75129	37.6%

Note. Conjunction voxels are the green ones in Figure 31, unique to fixation cross are the red ones, and unique to the non-emotional words are the blue ones.

Table 10 - Activated voxels (2 × 2 × 2 mm) for the contrasts between fictitious logos and the baselines. Conjunction between the two contrasts, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%	0	0.0%
Frontal pole ventral left	2617	17	0.6%	24	0.9%	9	0.3%
Frontal pole ventral right	3475	131	3.8%	67	1.9%	21	0.6%
Frontal pole dorsal medial	5884	0	0.0%	0	0.0%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	205	4.9%	0	0.0%
Frontal pole dorsal right	5729	93	1.6%	883	15.4%	1	0.0%
Frontal medial cortex	1539	0	0.0%	0	0.0%	0	0.0%
Subcallosal cortex	2080	10	0.5%	8	0.4%	4	0.2%
Paracingulate gyrus	4095	1227	30.0%	356	8.7%	55	1.3%
Frontal orbital cortex left	2105	553	26.3%	331	15.7%	26	1.2%
Frontal orbital cortex right	1931	443	22.9%	70	3.6%	45	2.3%
Frontal operculum cortex left	562	79	14.1%	390	69.4%	6	1.1%
Frontal operculum cortex right	500	139	27.8%	210	42.0%	1	0.2%
IFG pars triangularis left	1147	211	18.4%	439	38.3%	14	1.2%
IFG pars triangularis right	1170	138	11.8%	310	26.5%	1	0.1%
IFG pars opercularis left	1205	512	42.5%	548	45.5%	0	0.0%
IFG pars opercularis right	1130	245	21.7%	352	31.2%	7	0.6%
Superior frontal gyrus	8861	1492	16.8%	735	8.3%	25	0.3%
Middle frontal gyrus left	4331	635	14.7%	786	18.1%	24	0.6%
Middle frontal gyrus right	4090	600	14.7%	613	15.0%	3	0.1%
Precentral gyrus left	7083	1903	26.9%	899	12.7%	42	0.6%
Precentral gyrus right	6884	2591	37.6%	981	14.3%	52	0.8%
Juxtapositional cortex	2282	1008	44.2%	491	21.5%	22	1.0%
Insular cortex left	1302	340	26.1%	323	24.8%	25	1.9%
Insular cortex right	1252	401	32.0%	177	14.1%	101	8.1%
Temporal pole left	3643	397	10.9%	438	12.0%	53	1.5%
Temporal pole right	3801	101	2.7%	217	5.7%	62	1.6%
InferiorTemporalGyrus – anterior left	592	0	0.0%	4	0.7%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	1	0.2%	4	0.8%
InferiorTemporalGyrus – posterior left	1699	29	1.7%	35	2.1%	3	0.2%
InferiorTemporalGyrus – posterior right	1709	12	0.7%	33	1.9%	8	0.5%
ITG – temporo-occipital left	981	399	40.7%	156	15.9%	2	0.2%
ITG – temporo-occipital right	1232	288	23.4%	185	15.0%	7	0.6%
MedialTemporalGyrus – anterior left	642	3	0.5%	1	0.2%	5	0.8%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	26	1.6%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	2	0.1%	0	0.0%
MTG – temporo-occipital left	1073	9	0.8%	58	5.4%	0	0.0%
MTG – temporo-occipital right	1287	3	0.2%	18	1.4%	4	0.3%
SuperiorTemporalGyrus – anterior left	394	68	17.3%	14	3.6%	53	13.5%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	1	0.2%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	11	1.0%	102	9.2%	9	0.8%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	9	0.8%	3	0.3%
Planum polare left	383	4	1.0%	6	1.6%	2	0.5%
Planum polare right	369	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus left	320	1	0.3%	2	0.6%	1	0.3%
Heschls gyrus right	263	106	40.3%	0	0.0%	34	12.9%
Planum temporale left	521	42	8.1%	10	1.9%	32	6.1%
Planum temporale right	399	71	17.8%	8	2.0%	66	16.5%
Temporal fusiform cortex – anterior left	517	174	33.7%	23	4.4%	24	4.6%
Temporal fusiform cortex – anterior right	545	173	31.7%	9	1.7%	44	8.1%

Table 10 (cont.)

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	648	50.9%	108	8.5%	88	6.9%
Temporal fusiform cortex – posterior right	1214	665	54.8%	81	6.7%	47	3.9%
Parahippocampal gyrus – anterior left	826	75	9.1%	27	3.3%	56	6.8%
Parahippocampal gyrus – anterior right	1010	67	6.6%	54	5.3%	35	3.5%
Parahippocampal gyrus – posterior left	537	174	32.4%	11	2.0%	94	17.5%
Parahippocampal gyrus – posterior right	398	199	50.0%	29	7.3%	25	6.3%
Temporal occipital fusiform cortex left	871	841	96.6%	1	0.1%	11	1.3%
Temporal occipital fusiform cortex right	1105	1065	96.4%	15	1.4%	8	0.7%
Postcentral gyrus left	4628	1275	27.5%	372	8.0%	40	0.9%
Postcentral gyrus right	4080	1753	43.0%	170	4.2%	102	2.5%
Superior parietal lobule left	1737	1104	63.6%	167	9.6%	60	3.5%
Superior parietal lobule right	1712	1090	63.7%	69	4.0%	10	0.6%
Supramarginal gyrus – anterior left	1248	322	25.8%	153	12.3%	16	1.3%
Supramarginal gyrus – anterior right	1064	315	29.6%	30	2.8%	22	2.1%
Supramarginal gyrus – posterior left	1414	7	0.5%	133	9.4%	0	0.0%
Supramarginal gyrus – posterior right	1529	64	4.2%	81	5.3%	0	0.0%
Angular gyrus left	1113	0	0.0%	4	0.4%	0	0.0%
Angular gyrus right	1675	3	0.2%	5	0.3%	0	0.0%
Central opercular cortex left	967	274	28.3%	226	23.4%	8	0.8%
Central opercular cortex right	850	207	24.4%	80	9.4%	86	10.1%
Parietal operculum cortex left	565	92	16.3%	107	18.9%	5	0.9%
Parietal operculum cortex right	505	169	33.5%	11	2.2%	28	5.5%
Precuneous cortex	7844	315	4.0%	314	4.0%	258	3.3%
Lateral occipital cortex – superior left	5903	1779	30.1%	317	5.4%	56	0.9%
Lateral occipital cortex – superior right	5899	1967	33.3%	221	3.7%	27	0.5%
Lateral occipital cortex – inferior left	2814	1558	55.4%	118	4.2%	86	3.1%
Lateral occipital cortex – inferior right	3311	1618	48.9%	131	4.0%	52	1.6%
Cuneal cortex	1743	94	5.4%	20	1.1%	51	2.9%
Supracalcarine cortex	424	162	38.2%	1	0.2%	25	5.9%
Intracalcarine cortex	2211	1427	64.5%	18	0.8%	283	12.8%
Lingual gyrus	5360	3985	74.3%	51	1.0%	459	8.6%
Occipital fusiform gyrus left	1407	1278	90.8%	38	2.7%	2	0.1%
Occipital fusiform gyrus right	1459	1394	95.5%	33	2.3%	4	0.3%
Occipital pole	9658	6224	64.4%	183	1.9%	221	2.3%
Cingulate gyrus – anterior	4144	1236	29.8%	791	19.1%	5	0.1%
Cingulate gyrus – posterior	4495	69	1.5%	216	4.8%	94	2.1%
Pallidum left	312	276	88.5%	34	10.9%	1	0.3%
Pallidum right	266	266	100.0%	0	0.0%	0	0.0%
Putamen left	923	573	62.1%	260	28.2%	3	0.3%
Putamen right	800	747	93.4%	33	4.1%	13	1.6%
Caudate left	572	203	35.5%	43	7.5%	8	1.4%
Caudate right	515	172	33.4%	68	13.2%	7	1.4%
Accumbens left	111	12	10.8%	0	0.0%	12	10.8%
Accumbens right	86	4	4.7%	0	0.0%	9	10.5%
Amygdala left	390	130	33.3%	24	6.2%	86	22.1%
Amygdala right	399	106	26.6%	6	1.5%	90	22.6%
Hippocampus left	921	184	20.0%	49	5.3%	41	4.5%
Hippocampus right	772	130	16.8%	28	3.6%	53	6.9%
Total				15487	7.7%	3587	1.8%
Grand total	199998	50977	25.5%	66464	33.2%	54564	27.3%

Note. Conjunction voxels are the green ones in Figure 32, unique to fixation cross are the red ones, and unique to the non-emotional words are the blue ones.

A conjunction analysis among the contrasts between all sorts of logos and both baselines was also carried out. Specifically, two first level conjunctions involving the contrasts between the logos (positive, indifferent, and fictitious) versus both baselines (fixation cross, and non-emotional words) were calculated. Figure 33 depicts partial and final results, including maps where the different brain regions where individualised by the use of dissimilar colours, and Table 11 summarises the activations that are common to all the six contrasts.

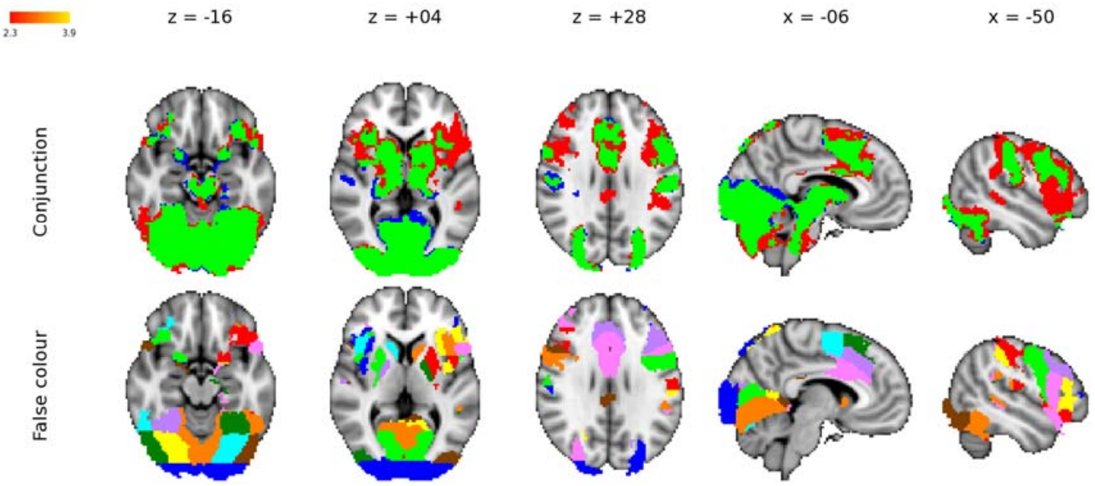


Figure 33 - FMRI maps for the conjunction analysis among the contrasts between positive brands, indifferent brands, and fictitious logos and both baselines in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). The first row contains the conjunction maps where common voxels are in green colour, voxels that activate only for the contrasts with the fixation cross are in red, and voxels that activate only for the contrasts with non-emotional words are in blue. The second row includes the maps with the conjunction analysis with the previous three types of voxels merged. In these maps the diverse brain structures are individualised with different colours. Radiological convention; MNI152 coordinates.

Table 11 - Activated voxels (2 × 2 × 2 mm) for the conjunction among the contrasts between all logos (positive, indifferent, and fictitious) and both baselines, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%	0	0.0%
Frontal pole ventral left	2617	15	0.6%	23	0.9%	6	0.2%
Frontal pole ventral right	3475	85	2.4%	53	1.5%	13	0.4%
Frontal pole dorsal medial	5884	0	0.0%	0	0.0%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	185	4.4%	0	0.0%
Frontal pole dorsal right	5729	21	0.4%	767	13.4%	2	0.0%
Frontal medial cortex	1539	0	0.0%	0	0.0%	0	0.0%
Subcallosal cortex	2080	8	0.4%	4	0.2%	4	0.2%
Paracingulate gyrus	4095	1110	27.1%	391	9.5%	44	1.1%
Frontal orbital cortex left	2105	482	22.9%	380	18.1%	25	1.2%
Frontal orbital cortex right	1931	379	19.6%	79	4.1%	47	2.4%
Frontal operculum cortex left	562	41	7.3%	407	72.4%	0	0.0%
Frontal operculum cortex right	500	84	16.8%	223	44.6%	2	0.4%
IFG pars triangularis left	1147	156	13.6%	482	42.0%	5	0.4%
IFG pars triangularis right	1170	10	0.9%	320	27.4%	1	0.1%
IFG pars opercularis left	1205	254	21.1%	768	63.7%	1	0.1%
IFG pars opercularis right	1130	14	1.2%	360	31.9%	0	0.0%
Superior frontal gyrus	8861	1204	13.6%	813	9.2%	63	0.7%
Middle frontal gyrus left	4331	475	11.0%	905	20.9%	25	0.6%
Middle frontal gyrus right	4090	254	6.2%	610	14.9%	0	0.0%
Precentral gyrus left	7083	1154	16.3%	1082	15.3%	40	0.6%
Precentral gyrus right	6884	857	12.4%	965	14.0%	106	1.5%
Juxtapositional cortex	2282	713	31.2%	584	25.6%	48	2.1%
Insular cortex left	1302	272	20.9%	337	25.9%	7	0.5%
Insular cortex right	1252	265	21.2%	179	14.3%	38	3.0%
Temporal pole left	3643	122	3.3%	422	11.6%	36	1.0%
Temporal pole right	3801	52	1.4%	149	3.9%	32	0.8%
InferiorTemporalGyrus – anterior left	592	0	0.0%	3	0.5%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	2	0.1%	29	1.7%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	2	0.1%	11	0.6%	0	0.0%
ITG – temporo-occipital left	981	306	31.2%	203	20.7%	4	0.4%
ITG – temporo-occipital right	1232	90	7.3%	208	16.9%	1	0.1%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	26	1.6%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	2	0.1%	0	0.0%
MTG – temporo-occipital left	1073	0	0.0%	5	0.5%	0	0.0%
MTG – temporo-occipital right	1287	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	7	1.8%	12	3.0%	17	4.3%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	56	5.1%	2	0.2%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	5	0.4%	0	0.0%
Planum polare left	383	0	0.0%	3	0.8%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%	2	0.6%
Heschls gyrus right	263	16	6.1%	0	0.0%	35	13.3%
Planum temporale left	521	0	0.0%	7	1.3%	10	1.9%
Planum temporale right	399	55	13.8%	8	2.0%	57	14.3%
Temporal fusiform cortex – anterior left	517	94	18.2%	46	8.9%	30	5.8%
Temporal fusiform cortex – anterior right	545	62	11.4%	3	0.6%	49	9.0%

Table 11 (cont.)

Brain structure	Total	Conjunction		+ Fixation Cross		+ Non-emot.wrd	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	486	38.2%	120	9.4%	93	7.3%
Temporal fusiform cortex – posterior right	1214	479	39.5%	101	8.3%	23	1.9%
Parahippocampal gyrus – anterior left	826	29	3.5%	21	2.5%	33	4.0%
Parahippocampal gyrus – anterior right	1010	49	4.9%	51	5.0%	14	1.4%
Parahippocampal gyrus – posterior left	537	149	27.7%	14	2.6%	85	15.8%
Parahippocampal gyrus – posterior right	398	154	38.7%	12	3.0%	24	6.0%
Temporal occipital fusiform cortex left	871	834	95.8%	1	0.1%	10	1.1%
Temporal occipital fusiform cortex right	1105	925	83.7%	46	4.2%	12	1.1%
Postcentral gyrus left	4628	855	18.5%	351	7.6%	26	0.6%
Postcentral gyrus right	4080	383	9.4%	429	10.5%	57	1.4%
Superior parietal lobule left	1737	966	55.6%	174	10.0%	70	4.0%
Superior parietal lobule right	1712	546	31.9%	226	13.2%	31	1.8%
Supramarginal gyrus – anterior left	1248	214	17.1%	157	12.6%	7	0.6%
Supramarginal gyrus – anterior right	1064	211	19.8%	50	4.7%	43	4.0%
Supramarginal gyrus – posterior left	1414	0	0.0%	136	9.6%	0	0.0%
Supramarginal gyrus – posterior right	1529	6	0.4%	120	7.8%	0	0.0%
Angular gyrus left	1113	0	0.0%	4	0.4%	0	0.0%
Angular gyrus right	1675	2	0.1%	6	0.4%	0	0.0%
Central opercular cortex left	967	161	16.6%	217	22.4%	13	1.3%
Central opercular cortex right	850	80	9.4%	61	7.2%	64	7.5%
Parietal operculum cortex left	565	31	5.5%	69	12.2%	6	1.1%
Parietal operculum cortex right	505	88	17.4%	13	2.6%	20	4.0%
Precuneous cortex	7844	207	2.6%	289	3.7%	238	3.0%
Lateral occipital cortex – superior left	5903	1697	28.7%	327	5.5%	45	0.8%
Lateral occipital cortex – superior right	5899	1644	27.9%	319	5.4%	32	0.5%
Lateral occipital cortex – inferior left	2814	1181	42.0%	172	6.1%	31	1.1%
Lateral occipital cortex – inferior right	3311	1170	35.3%	281	8.5%	18	0.5%
Cuneal cortex	1743	80	4.6%	21	1.2%	34	2.0%
Supracalcarine cortex	424	160	37.7%	2	0.5%	23	5.4%
Intracalcarine cortex	2211	1369	61.9%	13	0.6%	289	13.1%
Lingual gyrus	5360	3839	71.6%	43	0.8%	531	9.9%
Occipital fusiform gyrus left	1407	1256	89.3%	57	4.1%	3	0.2%
Occipital fusiform gyrus right	1459	1393	95.5%	34	2.3%	4	0.3%
Occipital pole	9658	5777	59.8%	464	4.8%	204	2.1%
Cingulate gyrus – anterior	4144	1154	27.8%	774	18.7%	4	0.1%
Cingulate gyrus – posterior	4495	66	1.5%	213	4.7%	95	2.1%
Pallidum left	312	251	80.4%	56	17.9%	2	0.6%
Pallidum right	266	171	64.3%	66	24.8%	3	1.1%
Putamen left	923	529	57.3%	258	28.0%	3	0.3%
Putamen right	800	480	60.0%	120	15.0%	29	3.6%
Caudate left	572	195	34.1%	38	6.6%	2	0.3%
Caudate right	515	169	32.8%	67	13.0%	8	1.6%
Accumbens left	111	10	9.0%	0	0.0%	11	9.9%
Accumbens right	86	4	4.7%	0	0.0%	9	10.5%
Amygdala left	390	13	3.3%	9	2.3%	23	5.9%
Amygdala right	399	19	4.8%	6	1.5%	38	9.5%
Hippocampus left	921	146	15.9%	34	3.7%	15	1.6%
Hippocampus right	772	91	11.8%	17	2.2%	22	2.8%
Total				17174	8.6%	3099	1.5%
Grand total	199998	38380	19.2%	55554	27.8%	41479	20.7%

Note. Conjunction voxels are the green ones in Figure 33.

As was expected, visual brain regions participate extensively in logos perception due to the high disparity between coloured multishaped logos and the white words or the white fixation cross over a black background. Consequently, it is reported the involvement of visual associative areas like the left and right posterior temporal fusiform cortex, the left and right temporal occipital fusiform cortex, and left and right superior parietal lobule,. However, other brain structures deserve being emphasized like the paracingulate and anterior cingulate gyri, left and right frontal orbital cortices, left inferior frontal gyrus (pars opercularis), left and right insular cortex, left and right parahippocampal gyri, and several nuclei in the limbic system (left and right pallidum, putamen, and caudate). To investigate further the differential role of the insular cortex, frontal orbital cortex, and paracingulate gyrus during logos perception the parameter estimates of specific foci were plotted in Figure 34 and Figure 35.

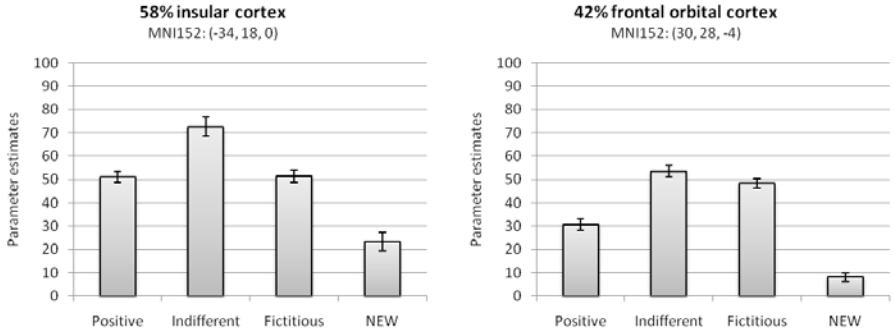


Figure 34 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in two foci: the insular cortex, and the frontal orbital cortex. MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

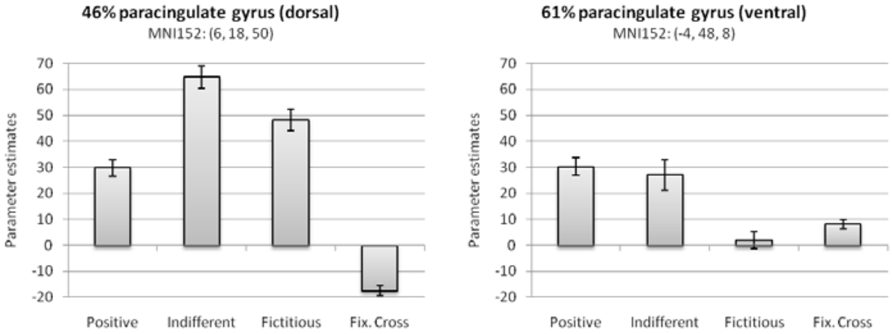


Figure 35 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the fixation cross (Fix. Cross) in three foci of the paracingulate gyrus: dorsal, medial, and ventral. MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

The conjunction activations revealed by specific baselines were studied further (see Figure 33 and Table 11). The contrast with non-emotional words (but not the contrasts with the fixation cross) revealed systematic important activations in the right Heschl’s gyrus and right nucleus accumbens, while the contrast with the fixation cross (but not the contrast with non-emotional words) revealed important activations in the right dorsal frontal pole, left and right frontal operculum cortices, left and right inferior frontal gyri (pars opercularis and pars triangularis), right middle frontal gyrus, left temporal pole, right inferior temporal gyrus (temporo-occipital part), and left parietal operculum cortex.

Contrasting recognised brands versus fictitious logos.

In Table 12 it is possible to draw attention to several brain regions that activated concurrently in the contrasts positive brands versus fictitious logos and indifferent brands versus fictitious logos (see Figure 36 for depictions). However, before going into the regions that activated, it is worth to point that the activations in the fusiform gyri - visual associative areas - disappear (comparing with the contrasts between logos and baselines), and in the visual cortex they are much reduced. Only the cuneal and the

Table 12 - Activated voxels (2 × 2 × 2 mm) for the contrasts between positive and indifferent brands vs. fictitious logos. Conjunction between the two contrasts, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Positive		+ Indifferent	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	428	10.8%	556	14.0%	114	2.9%
Frontal pole ventral left	2617	1143	43.7%	230	8.8%	413	15.8%
Frontal pole ventral right	3475	149	4.3%	73	2.1%	413	11.9%
Frontal pole dorsal medial	5884	1993	33.9%	619	10.5%	867	14.7%
Frontal pole dorsal left	4214	1083	25.7%	152	3.6%	1135	26.9%
Frontal pole dorsal right	5729	153	2.7%	53	0.9%	1380	24.1%
Frontal medial cortex	1539	155	10.1%	915	59.5%	0	0.0%
Subcallosal cortex	2080	1	0.0%	677	32.5%	3	0.1%
Paracingulate gyrus	4095	377	9.2%	790	19.3%	1267	30.9%
Frontal orbital cortex left	2105	95	4.5%	261	12.4%	654	31.1%
Frontal orbital cortex right	1931	0	0.0%	11	0.6%	162	8.4%
Frontal operculum cortex left	562	0	0.0%	0	0.0%	239	42.5%
Frontal operculum cortex right	500	0	0.0%	0	0.0%	68	13.6%
IFG pars triangularis left	1147	0	0.0%	0	0.0%	557	48.6%
IFG pars triangularis right	1170	5	0.4%	4	0.3%	66	5.6%
IFG pars opercularis left	1205	0	0.0%	0	0.0%	357	29.6%
IFG pars opercularis right	1130	25	2.2%	20	1.8%	96	8.5%
Superior frontal gyrus	8861	856	9.7%	92	1.0%	2641	29.8%
Middle frontal gyrus left	4331	985	22.7%	187	4.3%	1439	33.2%
Middle frontal gyrus right	4090	199	4.9%	10	0.2%	1592	38.9%
Precentral gyrus left	7083	0	0.0%	1398	19.7%	9	0.1%
Precentral gyrus right	6884	10	0.1%	49	0.7%	20	0.3%
Juxtapositional cortex	2282	0	0.0%	191	8.4%	24	1.1%
Insular cortex left	1302	13	1.0%	809	62.1%	209	16.1%
Insular cortex right	1252	0	0.0%	50	4.0%	4	0.3%
Temporal pole left	3643	230	6.3%	532	14.6%	221	6.1%
Temporal pole right	3801	0	0.0%	185	4.9%	22	0.6%
InferiorTemporalGyrus – anterior left	592	104	17.6%	103	17.4%	2	0.3%
InferiorTemporalGyrus – anterior right	511	0	0.0%	37	7.2%	2	0.4%
InferiorTemporalGyrus – posterior left	1699	266	15.7%	348	20.5%	7	0.4%
InferiorTemporalGyrus – posterior right	1709	146	8.5%	85	5.0%	101	5.9%
ITG – temporo-occipital left	981	10	1.0%	1	0.1%	70	7.1%
ITG – temporo-occipital right	1232	65	5.3%	53	4.3%	29	2.4%
MedialTemporalGyrus – anterior left	642	51	7.9%	173	26.9%	0	0.0%
MedialTemporalGyrus – anterior right	657	15	2.3%	77	11.7%	2	0.3%
MedialTemporalGyrus – posterior left	1616	468	29.0%	224	13.9%	54	3.3%
MedialTemporalGyrus – posterior right	1653	276	16.7%	277	16.8%	66	4.0%
MTG – temporo-occipital left	1073	22	2.1%	39	3.6%	17	1.6%
MTG – temporo-occipital right	1287	10	0.8%	49	3.8%	38	3.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	3	0.8%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	22	2.0%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	2	0.2%	0	0.0%
Planum polare left	383	0	0.0%	104	27.2%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	199	62.2%	0	0.0%
Heschls gyrus right	263	0	0.0%	0	0.0%	0	0.0%
Planum temporale left	521	0	0.0%	61	11.7%	0	0.0%
Planum temporale right	399	0	0.0%	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	14	2.7%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%	0	0.0%

Table 12 (cont.)

Brain structure	Total	Conjunction		+ Positive		+ Indifferent	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	35	2.8%	0	0.0%
Temporal fusiform cortex – posterior right	1214	0	0.0%	8	0.7%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	130	15.7%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	56	5.5%	0	0.0%
Parahippocampal gyrus – posterior left	537	11	2.0%	109	20.3%	6	1.1%
Parahippocampal gyrus – posterior right	398	0	0.0%	5	1.3%	0	0.0%
Temporal occipital fusiform cortex left	871	0	0.0%	0	0.0%	0	0.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	37	3.3%	0	0.0%
Postcentral gyrus left	4628	0	0.0%	1574	34.0%	0	0.0%
Postcentral gyrus right	4080	0	0.0%	26	0.6%	0	0.0%
Superior parietal lobule left	1737	17	1.0%	150	8.6%	209	12.0%
Superior parietal lobule right	1712	1	0.1%	0	0.0%	11	0.6%
Supramarginal gyrus – anterior left	1248	1	0.1%	111	8.9%	31	2.5%
Supramarginal gyrus – anterior right	1064	0	0.0%	113	10.6%	0	0.0%
Supramarginal gyrus – posterior left	1414	379	26.8%	129	9.1%	190	13.4%
Supramarginal gyrus – posterior right	1529	75	4.9%	138	9.0%	55	3.6%
Angular gyrus left	1113	704	63.3%	204	18.3%	11	1.0%
Angular gyrus right	1675	500	29.9%	180	10.7%	201	12.0%
Central opercular cortex left	967	0	0.0%	406	42.0%	0	0.0%
Central opercular cortex right	850	0	0.0%	0	0.0%	0	0.0%
Parietal operculum cortex left	565	0	0.0%	229	40.5%	0	0.0%
Parietal operculum cortex right	505	0	0.0%	5	1.0%	0	0.0%
Precuneous cortex	7844	2411	30.7%	691	8.8%	1145	14.6%
Lateral occipital cortex – superior left	5903	1456	24.7%	554	9.4%	744	12.6%
Lateral occipital cortex – superior right	5899	879	14.9%	92	1.6%	468	7.9%
Lateral occipital cortex – inferior left	2814	35	1.2%	30	1.1%	24	0.9%
Lateral occipital cortex – inferior right	3311	155	4.7%	7	0.2%	133	4.0%
Cuneal cortex	1743	358	20.5%	188	10.8%	152	8.7%
Supracalcarine cortex	424	25	5.9%	37	8.7%	1	0.2%
Intracalcarine cortex	2211	30	1.4%	47	2.1%	41	1.9%
Lingual gyrus	5360	172	3.2%	553	10.3%	373	7.0%
Occipital fusiform gyrus left	1407	3	0.2%	0	0.0%	57	4.1%
Occipital fusiform gyrus right	1459	26	1.8%	3	0.2%	102	7.0%
Occipital pole	9658	58	0.6%	263	2.7%	148	1.5%
Cingulate gyrus – anterior	4144	283	6.8%	1008	24.3%	573	13.8%
Cingulate gyrus – posterior	4495	1750	38.9%	818	18.2%	283	6.3%
Pallidum left	312	0	0.0%	5	1.6%	10	3.2%
Pallidum right	266	0	0.0%	0	0.0%	10	3.8%
Putamen left	923	0	0.0%	196	21.2%	41	4.4%
Putamen right	800	0	0.0%	0	0.0%	14	1.8%
Caudate left	572	25	4.4%	31	5.4%	89	15.6%
Caudate right	515	5	1.0%	1	0.2%	165	32.0%
Accumbens left	111	29	26.1%	29	26.1%	22	19.8%
Accumbens right	86	11	12.8%	14	16.3%	17	19.8%
Amygdala left	390	0	0.0%	31	7.9%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%	0	0.0%
Hippocampus left	921	20	2.2%	355	38.5%	0	0.0%
Hippocampus right	772	4	0.5%	111	14.4%	0	0.0%
Total				18444	9.2%	19686	9.8%
Grand total	199998	18756	9.4%	37200	18.6%	38442	19.2%

Note. Conjunction voxels are the green ones in Figure 36, unique to positive > fictitious are the blue ones, and unique to the indifferent > fictitious are the red ones.

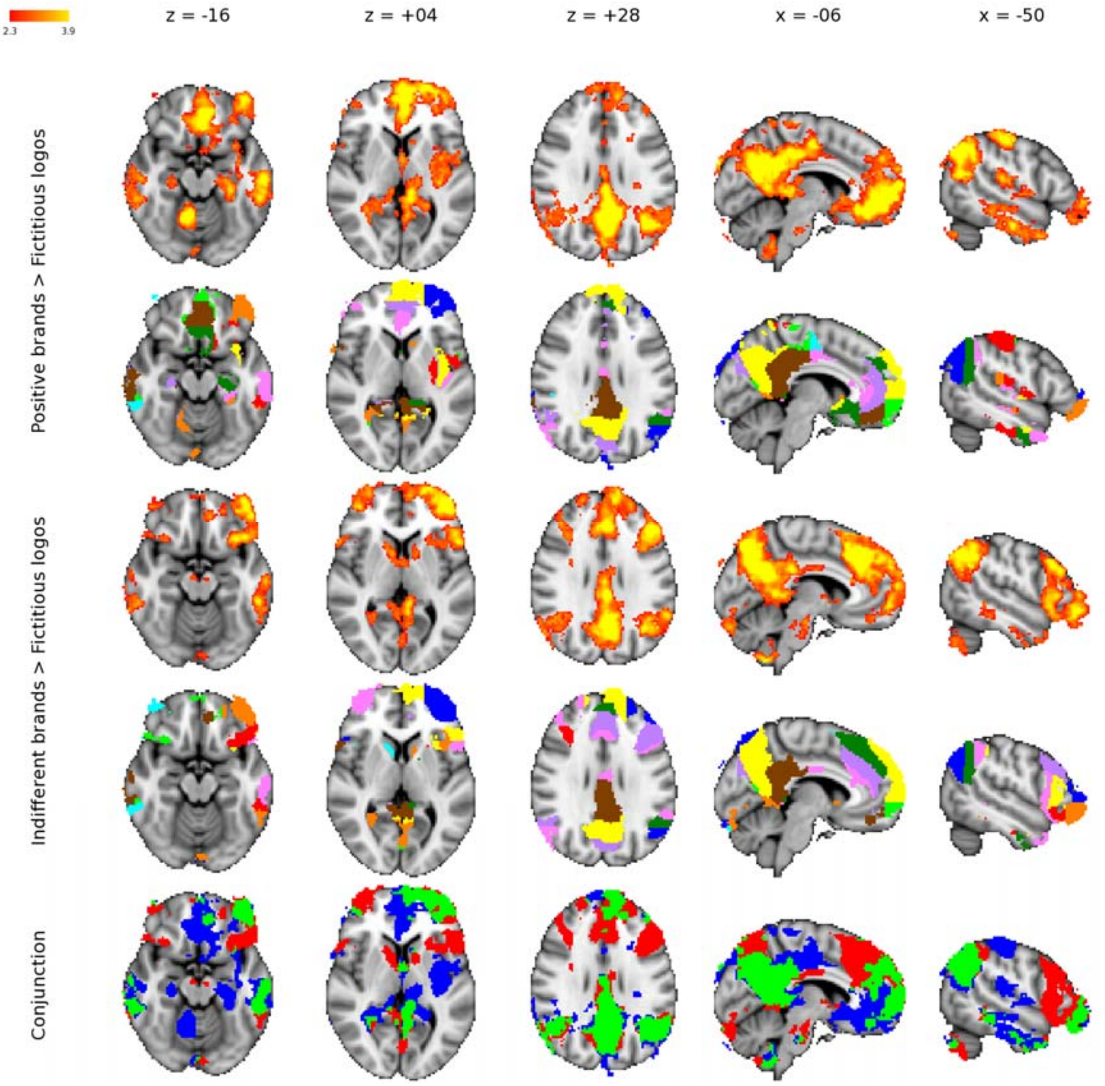


Figure 36 - FMRI maps for the contrasts between real logos (positive and indifferent) versus fictitious logos, and the respective conjunction analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). For each contrast the first row refers to the thresholded maps (z > 2.3), and in the second row the brain regions are individualised with different colours. In the conjunction analysis row common voxels are in green colour, voxels that activate only for the contrast positive versus fictitious logos are in blue, and voxels that activate only for the contrast indifferent versus fictitious logos are in red. Radiological convention; MNI152 coordinates.

superior lateral occipital cortices for both contrasts and the different subregions of the lingual gyrus for the contrasts between positive and indifferent brands versus fictitious logos had activations with noteworthy extensions. Nonetheless, the reverse contrasts (fictitious logos versus positive and indifferent brands, see Table 13 and Figure 37)

Table 13 - Activated voxels (2 × 2 × 2 mm) for the contrasts between fictitious logos vs. positive and indifferent brands. Conjunction between the two contrasts, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Positive		+ Indifferent	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%	0	0.0%
Frontal pole ventral left	2617	0	0.0%	0	0.0%	0	0.0%
Frontal pole ventral right	3475	0	0.0%	2	0.1%	13	0.4%
Frontal pole dorsal medial	5884	0	0.0%	0	0.0%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	0	0.0%	0	0.0%
Frontal pole dorsal right	5729	0	0.0%	23	0.4%	45	0.8%
Frontal medial cortex	1539	0	0.0%	0	0.0%	0	0.0%
Subcallosal cortex	2080	0	0.0%	0	0.0%	0	0.0%
Paracingulate gyrus	4095	0	0.0%	249	6.1%	0	0.0%
Frontal orbital cortex left	2105	0	0.0%	0	0.0%	0	0.0%
Frontal orbital cortex right	1931	0	0.0%	67	3.5%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	9	1.6%	0	0.0%
Frontal operculum cortex right	500	0	0.0%	1	0.2%	0	0.0%
IFG pars triangularis left	1147	0	0.0%	25	2.2%	0	0.0%
IFG pars triangularis right	1170	0	0.0%	139	11.9%	13	1.1%
IFG pars opercularis left	1205	0	0.0%	274	22.7%	0	0.0%
IFG pars opercularis right	1130	29	2.6%	279	24.7%	7	0.6%
Superior frontal gyrus	8861	0	0.0%	414	4.7%	0	0.0%
Middle frontal gyrus left	4331	0	0.0%	64	1.5%	0	0.0%
Middle frontal gyrus right	4090	0	0.0%	415	10.1%	0	0.0%
Precentral gyrus left	7083	91	1.3%	481	6.8%	228	3.2%
Precentral gyrus right	6884	201	2.9%	1922	27.9%	221	3.2%
Juxtapositional cortex	2282	0	0.0%	340	14.9%	0	0.0%
Insular cortex left	1302	0	0.0%	0	0.0%	0	0.0%
Insular cortex right	1252	0	0.0%	81	6.5%	42	3.4%
Temporal pole left	3643	0	0.0%	0	0.0%	35	1.0%
Temporal pole right	3801	0	0.0%	0	0.0%	5	0.1%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%	5	1.0%
InferiorTemporalGyrus – posterior left	1699	0	0.0%	8	0.5%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%	8	0.5%
ITG – temporo-occipital left	981	123	12.5%	69	7.0%	29	3.0%
ITG – temporo-occipital right	1232	121	9.8%	1	0.1%	103	8.4%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	0	0.0%	0	0.0%
MTG – temporo-occipital left	1073	0	0.0%	0	0.0%	114	10.6%
MTG – temporo-occipital right	1287	0	0.0%	0	0.0%	103	8.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	0	0.0%	0	0.0%
Planum polare left	383	0	0.0%	0	0.0%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus right	263	0	0.0%	97	36.9%	5	1.9%
Planum temporale left	521	0	0.0%	0	0.0%	0	0.0%
Planum temporale right	399	0	0.0%	8	2.0%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%	36	7.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%	41	7.5%

Table 13 (cont.)

Brain structure	Total	Conjunction		+ Positive		+ Indifferent	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	25	2.0%	72	5.7%	9	0.7%
Temporal fusiform cortex – posterior right	1214	1	0.1%	0	0.0%	186	15.3%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%	21	2.5%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%	15	1.5%
Parahippocampal gyrus – posterior left	537	0	0.0%	2	0.4%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%	15	3.8%
Temporal occipital fusiform cortex left	871	590	67.7%	95	10.9%	56	6.4%
Temporal occipital fusiform cortex right	1105	433	39.2%	1	0.1%	451	40.8%
Postcentral gyrus left	4628	0	0.0%	0	0.0%	236	5.1%
Postcentral gyrus right	4080	180	4.4%	1474	36.1%	32	0.8%
Superior parietal lobule left	1737	0	0.0%	62	3.6%	0	0.0%
Superior parietal lobule right	1712	122	7.1%	772	45.1%	0	0.0%
Supramarginal gyrus – anterior left	1248	0	0.0%	0	0.0%	0	0.0%
Supramarginal gyrus – anterior right	1064	5	0.5%	168	15.8%	18	1.7%
Supramarginal gyrus – posterior left	1414	0	0.0%	0	0.0%	0	0.0%
Supramarginal gyrus – posterior right	1529	2	0.1%	27	1.8%	0	0.0%
Angular gyrus left	1113	0	0.0%	0	0.0%	0	0.0%
Angular gyrus right	1675	0	0.0%	0	0.0%	0	0.0%
Central opercular cortex left	967	0	0.0%	0	0.0%	19	2.0%
Central opercular cortex right	850	0	0.0%	84	9.9%	55	6.5%
Parietal operculum cortex left	565	0	0.0%	0	0.0%	0	0.0%
Parietal operculum cortex right	505	0	0.0%	95	18.8%	0	0.0%
Precuneous cortex	7844	3	0.0%	31	0.4%	1	0.0%
Lateral occipital cortex – superior left	5903	286	4.8%	271	4.6%	108	1.8%
Lateral occipital cortex – superior right	5899	457	7.7%	487	8.3%	101	1.7%
Lateral occipital cortex – inferior left	2814	992	35.3%	117	4.2%	369	13.1%
Lateral occipital cortex – inferior right	3311	1169	35.3%	136	4.1%	237	7.2%
Cuneal cortex	1743	0	0.0%	0	0.0%	0	0.0%
Supracalcarine cortex	424	0	0.0%	0	0.0%	0	0.0%
Intracalcarine cortex	2211	0	0.0%	2	0.1%	0	0.0%
Lingual gyrus	5360	42	0.8%	269	5.0%	131	2.4%
Occipital fusiform gyrus left	1407	386	27.4%	459	32.6%	2	0.1%
Occipital fusiform gyrus right	1459	454	31.1%	86	5.9%	172	11.8%
Occipital pole	9658	1033	10.7%	1014	10.5%	289	3.0%
Cingulate gyrus – anterior	4144	0	0.0%	30	0.7%	0	0.0%
Cingulate gyrus – posterior	4495	0	0.0%	3	0.1%	0	0.0%
Pallidum left	312	0	0.0%	0	0.0%	0	0.0%
Pallidum right	266	0	0.0%	47	17.7%	0	0.0%
Putamen left	923	0	0.0%	0	0.0%	0	0.0%
Putamen right	800	0	0.0%	203	25.4%	0	0.0%
Caudate left	572	0	0.0%	0	0.0%	0	0.0%
Caudate right	515	0	0.0%	0	0.0%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%	113	29.0%
Amygdala right	399	5	1.3%	9	2.3%	116	29.1%
Hippocampus left	921	0	0.0%	0	0.0%	41	4.5%
Hippocampus right	772	0	0.0%	0	0.0%	43	5.6%
Total				10984	5.5%	3889	1.9%
Grand total	199998	6750	3.4%	17734	8.9%	10639	5.3%

Note. Conjunction voxels are the green ones in Figure 37, unique to fictitious > positive are the blue ones, and unique to the fictitious > indifferent are the red ones.

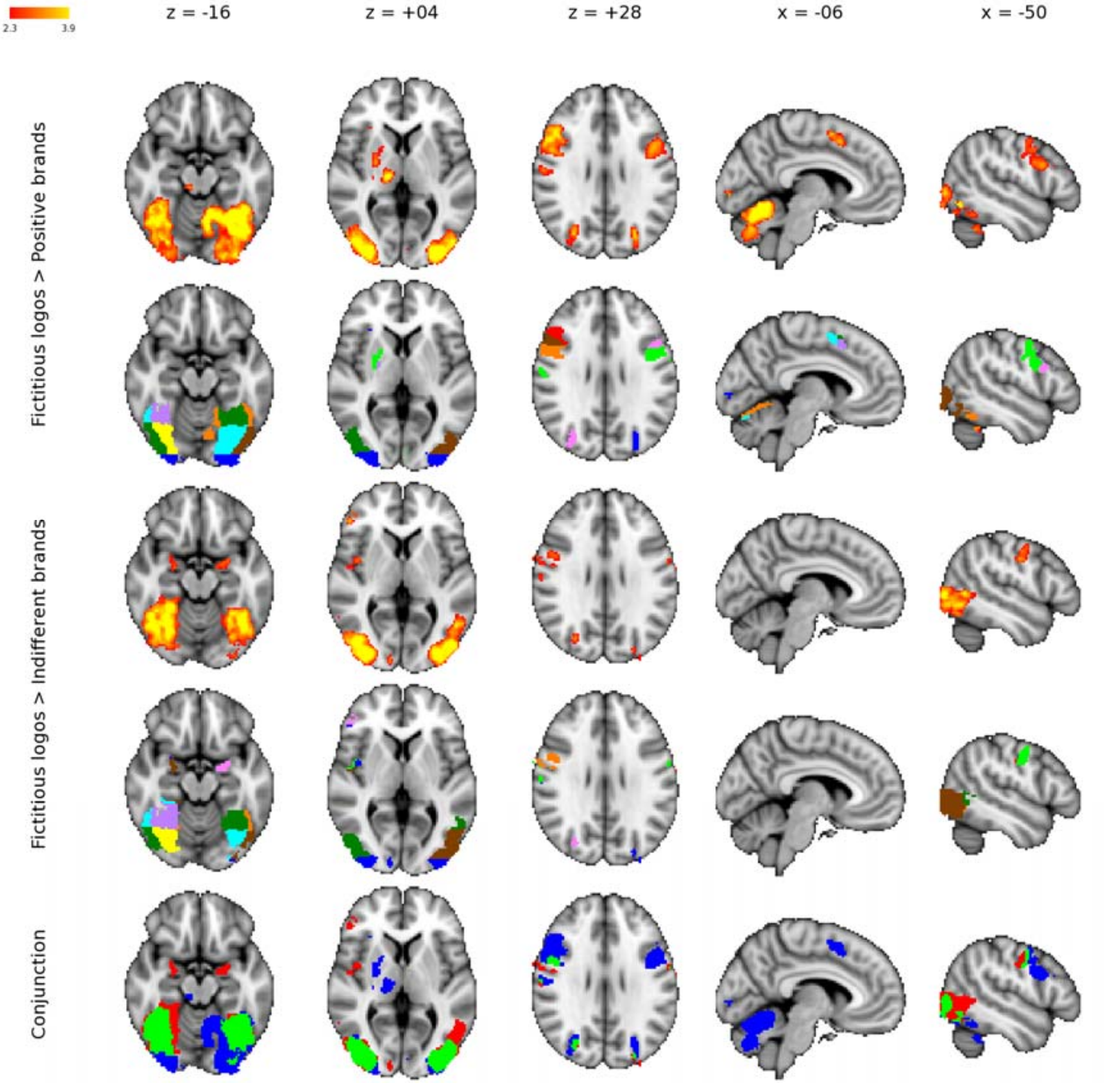


Figure 37 - FMRI maps for the contrasts between fictitious logos versus real logos (positive and indifferent), and the respective conjunction analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). For each contrast the first row refers to the thresholded maps (z > 2.3), and in the second row the brain regions are individualised with different colours. In the conjunction analysis row common voxels are in green colour, voxels that activate only for the contrast fictitious logos versus positive are in blue, and voxels that activate only for the contrast fictitious logos versus indifferent are in red. Radiological convention; MNI152 coordinates.

reveal extensive activations in visual areas like the left and right temporal occipital fusiform cortices, left and right inferior lateral occipital cortices, and left and right occipital fusiform gyri, i.e. an important part of the ventral visual stream. To investigate this elusive behaviour of the participation of visual areas in logos appraisal, the graphs in Figure 38 describe the relative contribution of the cuneal cortex and the left occipital fusiform gyrus activations for each type of stimulus. While in the cuneal cortex, positive and indifferent brands activate significantly more than both baselines and fictitious logos (although with extensive variations among subjects), the occipital fusiform gyrus participates in every logo processing.

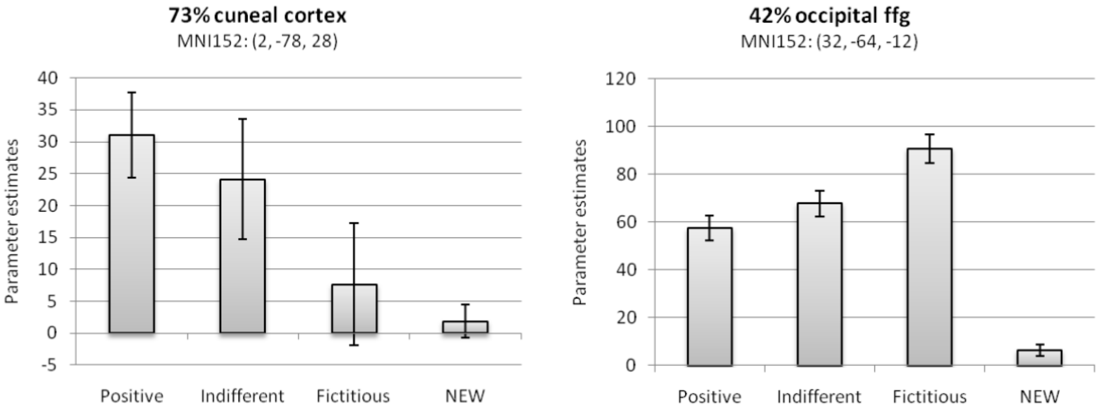


Figure 38 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in two foci in visual regions: the cuneal cortex, and the occipital fusiform gyrus. MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

The brain regions that cumulatively activated in the contrasts positive brands versus fictitious logos and indifferent brands versus fictitious logos with worth mentioning extension were the dorsal medial frontal pole, the ventral and dorsal left frontal pole, left posterior medial temporal gyrus, left posterior supramarginal gyrus, left and right angular gyrus, precuneous, and posterior cingulate gyrus (see Table 12 and Figure 36). To investigate further the differential role of each region during logos appraisal the parameter estimates of the maximal foci are compared in the graphs of Figure 39 for the frontal pole, angular gyrus, precuneous cortex, and posterior cingulate gyrus. The maximum activation in the angular gyrus is close to the posterior supramarginal gyrus. The relative participation of all these brain structures is similar, being significantly superior for the recognised real brands (positive and indifferent) than for the fictitious logos.

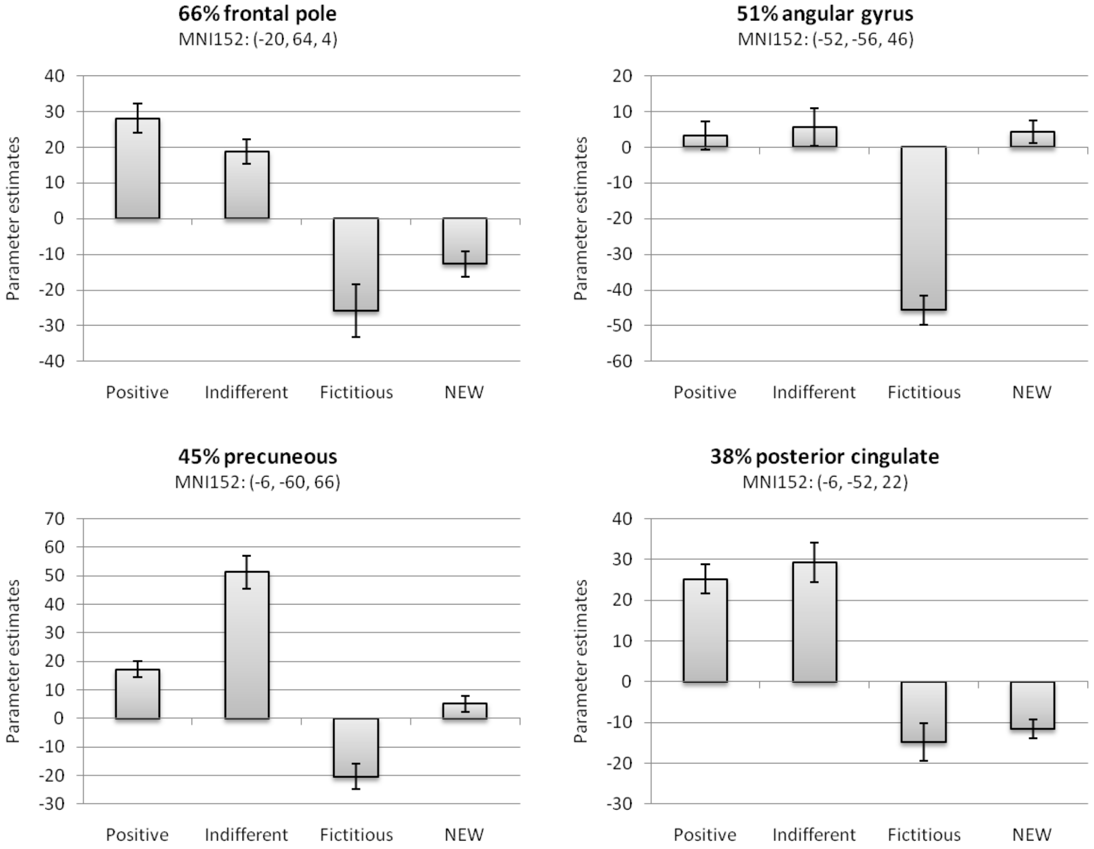


Figure 39 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in four foci: the frontal pole, the angular gyrus, the precuneous cortex, and the posterior cingulate gyrus. MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

Preferred brands versus the indifferent ones.

Table 14 and Figure 40 report the brain structures that activated for the contrast positive brands versus indifferent brands. Several clusters can be identified. These clusters are detailed in Table 15 with the coordinates of the local maxima and the probabilistic brain structure that is dominant at that voxel is also identified.

Table 14 - Activated voxels (2 × 2 × 2 mm) for the contrast between positive versus indifferent brands.

Brain structure	Total voxels	Positive > Indifferent voxels	Positive > Indifferent fraction
Frontal pole ventral medial	3981	216	5.4%
Frontal pole ventral left	2617	5	0.2%
Frontal pole ventral right	3475	125	3.6%
Frontal pole dorsal medial	5884	221	3.8%
Frontal pole dorsal left	4214	0	0.0%
Frontal pole dorsal right	5729	82	1.4%
Frontal medial cortex	1539	611	39.7%
Subcallosal cortex	2080	545	26.2%
Paracingulate gyrus	4095	638	15.6%
Frontal orbital cortex left	2105	1	0.0%
Frontal orbital cortex right	1931	19	1.0%
Frontal operculum cortex left	562	0	0.0%
Frontal operculum cortex right	500	0	0.0%
IFG pars triangularis left	1147	0	0.0%
IFG pars triangularis right	1170	5	0.4%
IFG pars opercularis left	1205	0	0.0%
IFG pars opercularis right	1130	6	0.5%
Superior frontal gyrus	8861	0	0.0%
Middle frontal gyrus left	4331	0	0.0%
Middle frontal gyrus right	4090	0	0.0%
Precentral gyrus left	7083	1447	20.4%
Precentral gyrus right	6884	24	0.3%
Juxtapositional cortex	2282	138	6.0%
Insular cortex left	1302	743	57.1%
Insular cortex right	1252	225	18.0%
Temporal pole left	3643	166	4.6%
Temporal pole right	3801	48	1.3%
InferiorTemporalGyrus – anterior left	592	0	0.0%
InferiorTemporalGyrus – anterior right	511	9	1.8%
InferiorTemporalGyrus – posterior left	1699	2	0.1%
InferiorTemporalGyrus – posterior right	1709	0	0.0%
ITG – temporo-occipital left	981	0	0.0%
ITG – temporo-occipital right	1232	11	0.9%
MedialTemporalGyrus – anterior left	642	12	1.9%
MedialTemporalGyrus – anterior right	657	35	5.3%
MedialTemporalGyrus – posterior left	1616	44	2.7%
MedialTemporalGyrus – posterior right	1653	46	2.8%
MTG – temporo-occipital left	1073	127	11.8%
MTG – temporo-occipital right	1287	370	28.7%
SuperiorTemporalGyrus – anterior left	394	7	1.8%
SuperiorTemporalGyrus – anterior right	405	55	13.6%
SuperiorTemporalGyrus – posterior left	1106	16	1.4%
SuperiorTemporalGyrus – posterior right	1172	149	12.7%
Planum polare left	383	210	54.8%
Planum polare right	369	91	24.7%
Heschls gyrus left	320	313	97.8%
Heschls gyrus right	263	1	0.4%
Planum temporale left	521	277	53.2%
Planum temporale right	399	24	6.0%
Temporal fusiform cortex – anterior left	517	36	7.0%
Temporal fusiform cortex – anterior right	545	11	2.0%

Table 14 (cont.)

Brain structure	Total	Positive > Indifferent	
	voxels	voxels	fraction
Temporal fusiform cortex – posterior left	1272	102	8.0%
Temporal fusiform cortex – posterior right	1214	157	12.9%
Parahippocampal gyrus – anterior left	826	89	10.8%
Parahippocampal gyrus – anterior right	1010	36	3.6%
Parahippocampal gyrus – posterior left	537	60	11.2%
Parahippocampal gyrus – posterior right	398	101	25.4%
Temporal occipital fusiform cortex left	871	8	0.9%
Temporal occipital fusiform cortex right	1105	382	34.6%
Postcentral gyrus left	4628	1825	39.4%
Postcentral gyrus right	4080	18	0.4%
Superior parietal lobule left	1737	289	16.6%
Superior parietal lobule right	1712	0	0.0%
Supramarginal gyrus – anterior left	1248	109	8.7%
Supramarginal gyrus – anterior right	1064	155	14.6%
Supramarginal gyrus – posterior left	1414	2	0.1%
Supramarginal gyrus – posterior right	1529	115	7.5%
Angular gyrus left	1113	30	2.7%
Angular gyrus right	1675	19	1.1%
Central opercular cortex left	967	601	62.2%
Central opercular cortex right	850	111	13.1%
Parietal operculum cortex left	565	343	60.7%
Parietal operculum cortex right	505	24	4.8%
Precuneous cortex	7844	149	1.9%
Lateral occipital cortex – superior left	5903	249	4.2%
Lateral occipital cortex – superior right	5899	0	0.0%
Lateral occipital cortex – inferior left	2814	131	4.7%
Lateral occipital cortex – inferior right	3311	78	2.4%
Cuneal cortex	1743	5	0.3%
Supracalcarine cortex	424	0	0.0%
Intracalcarine cortex	2211	16	0.7%
Lingual gyrus	5360	544	10.1%
Occipital fusiform gyrus left	1407	0	0.0%
Occipital fusiform gyrus right	1459	76	5.2%
Occipital pole	9658	399	4.1%
Cingulate gyrus – anterior	4144	532	12.8%
Cingulate gyrus – posterior	4495	278	6.2%
Pallidum left	312	12	3.8%
Pallidum right	266	0	0.0%
Putamen left	923	211	22.9%
Putamen right	800	0	0.0%
Caudate left	572	9	1.6%
Caudate right	515	0	0.0%
Accumbens left	111	0	0.0%
Accumbens right	86	2	2.3%
Amygdala left	390	271	69.5%
Amygdala right	399	161	40.4%
Hippocampus left	921	287	31.2%
Hippocampus right	772	167	21.6%
Total			
Grand total	199998	15264	7.6%

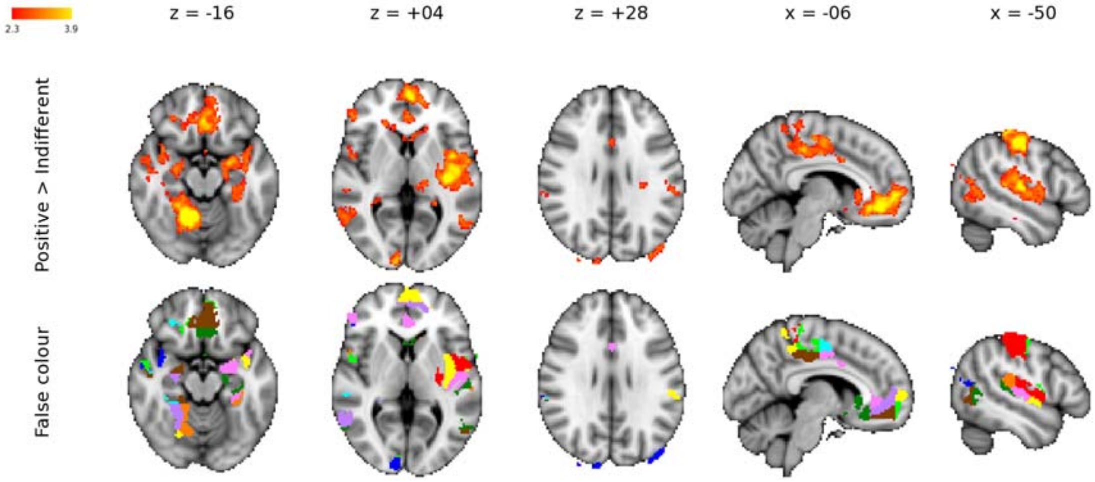


Figure 40 - FMRI maps for the contrasts between positive versus indifferent brands in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). The first row refers to the thresholded maps (z > 2.3), and in the second row the brain regions are individualised with different colours. Radiological convention; MNI152 coordinates.

In the prefrontal cortex the cluster is located in the margins of the longitudinal fissure and spans through the ventral and dorsal frontal pole, ventral paracingulate and anterior cingulate gyri, and extensively in the frontal medial and subcallosal cortices (see columns z = -16, z = +04, and x = -06 at Figure 40, and also cluster 1 in Table 15). To investigate further the role of four of the local maxima of this cluster, the respective parameter estimates were plotted in Figure 41. The frontal pole registers the maximum parameter estimate for the positive brands explanatory variable. The difference between positive and indifferent is maximal at the frontal pole and tends to diminish from the anterior parts of the cluster towards the posterior. The same is valid for the contrast between positive brands versus fictitious logos, although the amplitude of the decrease is superior. This means that although there is a significant difference between indifferent brands and fictitious logos in the frontal pole, it fades and disappears towards the subcallosal cortex. It is worth to note that the parameter estimates for indifferent brands, fictitious logos, and non-emotional words are always negative in this cluster. In

Table 15 - Clusters and local maxima voxel inside each cluster, identified with MNI152 coordinates and the dominant probabilistic brain structure.

Cluster	Local maxima			
	z	MNI152 coordinates	Main brain structure	Hemisphere
1	4.28	-2 x 58 x 4	55% frontal pole	medial
	4.28	-6 x 40 x -10	45% paracingulate gyrus	medial
	4.11	-6 x 52 x -4	50% paracingulate gyrus	medial
	3.92	2 x 36 x -14	47% frontal medial cortex	medial
	3.87	-2 x 48 x -2	75% paracingulate gyrus	medial
	3.84	-6 x 32 x -10	26% subcallosal cortex	medial
2	5.84	-30 x -24 x 50	25% precentral gyrus	left
	5.82	-44 x -22 x 58	43% postcentral gyrus	left
	5.75	-36 x -28 x 62	42% postcentral gyrus	left
	5.73	-40 x -26 x 60	42% postcentral gyrus	left
	5.73	-38 x -20 x 42	50% postcentral gyrus	left
	5.37	-36 x -30 x 66	52% postcentral gyrus	left
3	4.87	-44 x -20 x 14	59% central opercular cortex	left
	4.41	-42 x -28 x 16	45% parietal operculum cortex	left
	4.39	-36 x -20 x 6	50% insular cortex	left
	4.33	-52 x -20 x 10	37% Heschl's gyrus (H1 and H2)	left
	4.21	-42 x -2 x -2	71% insular cortex	left
	4.01	-42 x -6 x 8	36% insular cortex	left
4	3.53	44 x 2 x -6	43% insular cortex	right
	3.16	50 x 0 x 8	48% central opercular cortex	right
5	3.83	-28 x -8 x -26	70% hippocampus	left
	3.71	-22 x -4 x -18	97% amygdala	left
	3.65	-28 x -8 x -20	49% amygdala	left
	3.65	-22 x -2 x -24	79% amygdala	left
6	3.71	26 x -12 x -18	84% hippocampus	right
	3.59	20 x -6 x -22	50% hippocampus	right
	3.58	24 x -4 x -22	83% amygdala	right
	3.41	20 x -38 x -18	19% parahippocampal gyrus (posterior division)	right
7	3.61	58 x -54 x 10	54% middle temporal gyrus (temporo-occipital)	right
	3.37	58 x -58 x 2	55% middle temporal gyrus (temporo-occipital)	right
8	3.49	62 x -32 x 40	52% supramarginal gyrus (anterior division)	right
	3.30	62 x -38 x 34	59% supramarginal gyrus (posterior division)	right
	3.21	60 x -32 x 34	38% supramarginal gyrus (anterior division)	right
	3.18	62 x -28 x 20	36% parietal operculum cortex	right

order to study the accomplishment of the findings with proposed theories about emotional versus reason-based decision-making, Figure 42 depicts the comparison the activation cluster and the parameter estimates in a local maximum of the ventro medial prefrontal cortex, with the deactivation cluster and the parameter estimates of a local maximum in the middle frontal gyrus.

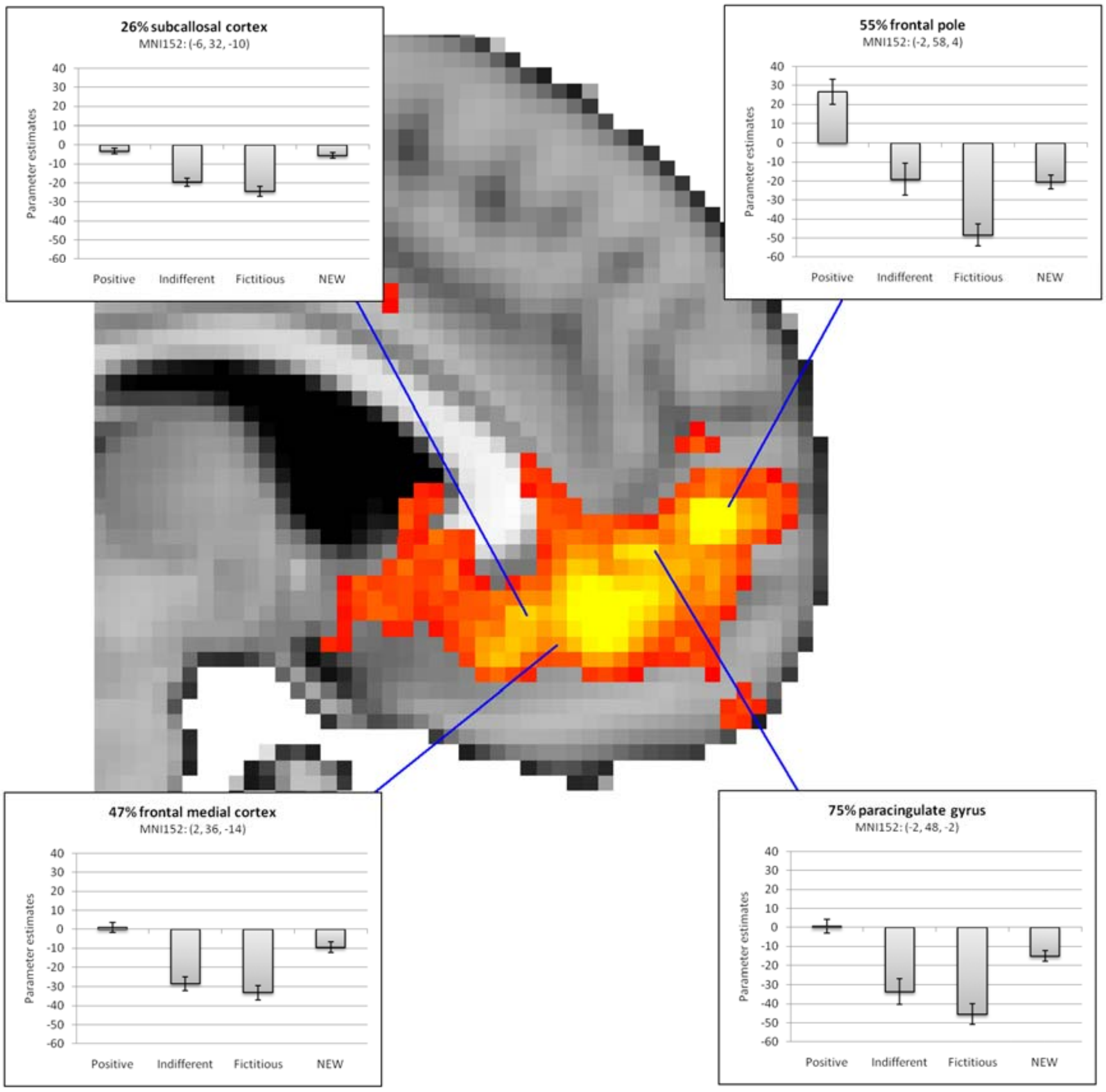


Figure 41 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in four foci in the ventro medial prefrontal cortex cluster: frontal pole, paracingulate gyrus, frontal medial cortex, and subcallosal cortex. The graphs are over a sagittal picture showing the cluster at x = -04. The location of each of the four voxels was projected into this sagittal picture along de x axis. MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

In the margins of the left central fissure there is a cluster that includes voxels from the precentral gyrus, juxtapositional cortex, postcentral gyrus, and superior parietal lobule (see cluster 2 in Table 15). More ventrally, now in the margins of the sylvian fissure of the left hemisphere, there is a complex cluster that includes several brain structures among them the posterior part of the insular cortex, planum polare, Heschl’s

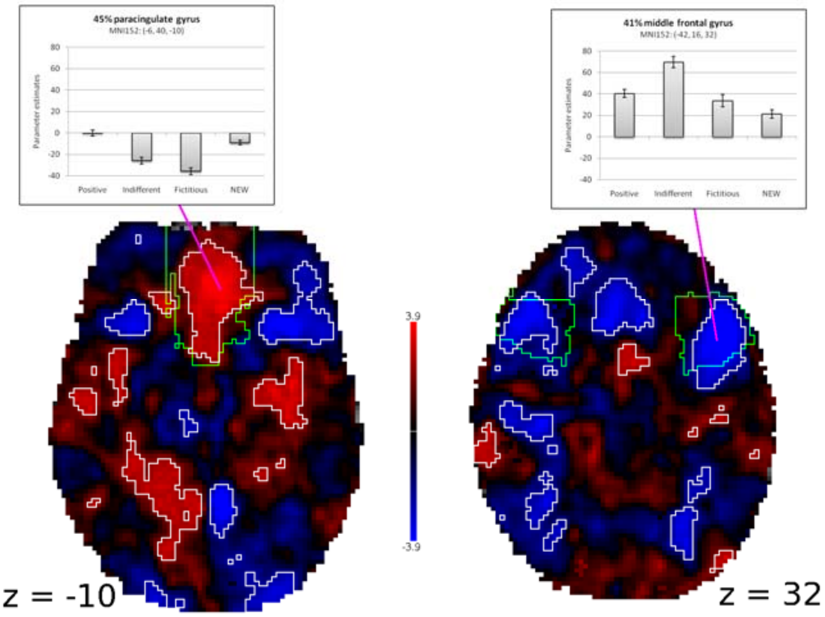


Figure 42 - FMRI z statistic maps for the contrast between positive versus indifferent brands in the axial planes z = -10, and z = +32 (statistical parametric maps produced by FEAT). The thresholded significant clusters (z > 2.3 for activations and z < -2.3 for deactivations) are outlined in white. For z = -10 the considered ventro medial prefrontal cortex (ventral medial prefrontal cortex, frontal medial cortex, ventral paracingulate gyrus, and subcallosal cortex) is outlined in green, and for z = +32 the middle frontal gyrus is outlined in green. In two example foci (one for activation and the other for deactivation), the parameter estimates graphs for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) are plotted. Error bars correspond to the confidence intervals at 95%; radiological convention; MNI152 coordinates.

gyrus, planum temporale, central opercular cortex, and parietal operculum cortex (see columns z = +04, and x = -50 in Figure 40, and also cluster 3 in Table 15). To investigate further a possible differential participation of these brain structures in the contrast, the parameter estimates of the six local maxima of this cluster were depicted in Figure 43, showing their relative position. In the opposite hemisphere there is a not so extensive cluster encompassing the insular cortex and the central opercular cortex (see cluster 4 in Table 15). The respective parameter estimates of two local maxima in this cluster are plotted in the graphs in Figure 44.

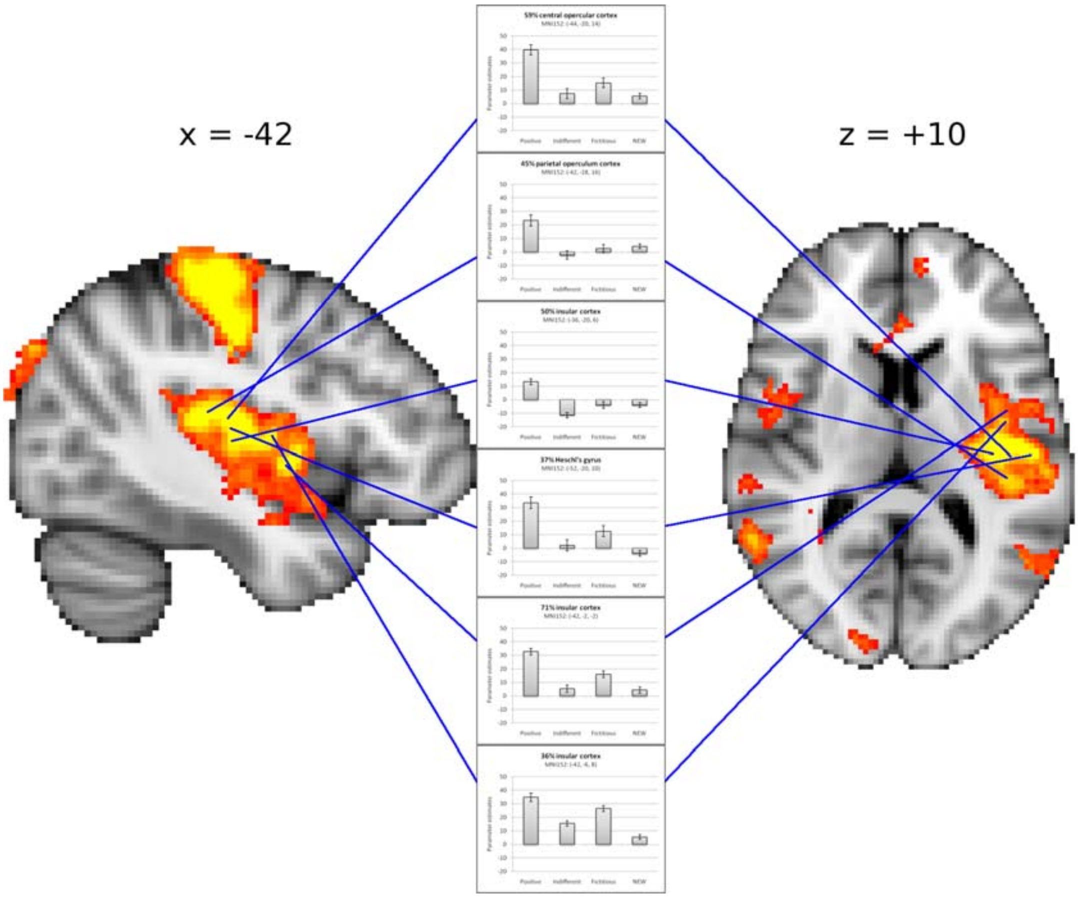


Figure 43 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in the six local maxima of the third cluster in the contrast between positive and indifferent brands. The graphs are over a sagittal picture showing the cluster at x = -42 and over an axial picture showing the cluster at z = +10. The location of each of the six voxels was projected into the sagittal picture along de x axis and into the axial picture along the z axis. Error bars correspond to the confidence intervals at 95%; radiological convention; MNI152 coordinates.

On the left and right hemispheres there are two clusters that span through the amygdala, hippocampus, and parahippocampal gyrus (see column z = -16 in Figure 40, and clusters 5 and 6 in Table 15).

In the right hemisphere there are two clusters close to each other: one of them extensively occupying the temporo-occipital part of the medial temporal gyrus (see column z = +04 in Figure 40, and cluster 7 in Table 15), and the other one passing by the superior temporal gyrus (posterior division), planum temporale, parietal operculum

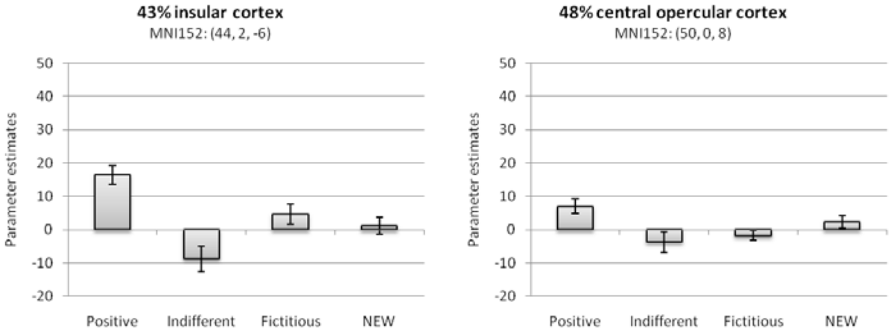


Figure 44 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in two foci of the forth cluster in the contrast between positive and indifferent brands: the insular cortex, and the central opercular cortex. MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

cortex, and the anterior and posterior divisions of the supra marginal gyri (see cluster 8 in Table 15).

It is interesting to note that the contrasts positive brands versus indifferent brands and positive brands versus fictitious logos have clusters that overlap as it is observable in Figure 36, Figure 40, Table 12, and Table 14. This is the case for the following clusters in Table 15: cluster 1 (all local maxima), cluster 2 (all local maxima), cluster 3 (all local maxima with the exception of 36% insular cortex), and cluster 8 (52% supramarginal gyrus - anterior division).

Indifferent and fictitious logos versus positive brands.

As it is evident in Figure 29, the response time for positive brands was significantly faster than the response time for indifferent brands or fictitious logos. In fact, as previously reported, between indifferent brands and fictitious logos the *F* test is *F* (553, 426) = 1.005, which corresponds to *p-value* = 0.969 508. To investigate if the delays of indifferent brands and fictitious logos rely on the same brain process, it is analysed the contrasts indifferent versus positive brands, and fictitious logos versus positive brands, as well the respective conjunction. The results are summarised in

Table 16 - Activated voxels (2 × 2 × 2 mm) for the contrasts between positive vs. indifferent and fictitious logos. Conjunction between the two contrasts, and voxels unique to each one.

Brain structure	Total	Conjunction		+ Indifferent		+ Fictitious	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%	0	0.0%
Frontal pole ventral left	2617	0	0.0%	246	9.4%	0	0.0%
Frontal pole ventral right	3475	1	0.0%	94	2.7%	1	0.0%
Frontal pole dorsal medial	5884	0	0.0%	102	1.7%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	341	8.1%	0	0.0%
Frontal pole dorsal right	5729	0	0.0%	1050	18.3%	23	0.4%
Frontal medial cortex	1539	0	0.0%	0	0.0%	0	0.0%
Subcallosal cortex	2080	0	0.0%	0	0.0%	0	0.0%
Paracingulate gyrus	4095	249	6.1%	1123	27.4%	0	0.0%
Frontal orbital cortex left	2105	0	0.0%	533	25.3%	0	0.0%
Frontal orbital cortex right	1931	65	3.4%	178	9.2%	2	0.1%
Frontal operculum cortex left	562	6	1.1%	194	34.5%	3	0.5%
Frontal operculum cortex right	500	0	0.0%	85	17.0%	1	0.2%
IFG pars triangularis left	1147	25	2.2%	625	54.5%	0	0.0%
IFG pars triangularis right	1170	93	7.9%	111	9.5%	46	3.9%
IFG pars opercularis left	1205	256	21.2%	362	30.0%	18	1.5%
IFG pars opercularis right	1130	175	15.5%	100	8.8%	133	11.8%
Superior frontal gyrus	8861	391	4.4%	2019	22.8%	23	0.3%
Middle frontal gyrus left	4331	53	1.2%	1486	34.3%	11	0.3%
Middle frontal gyrus right	4090	343	8.4%	1577	38.6%	72	1.8%
Precentral gyrus left	7083	169	2.4%	248	3.5%	403	5.7%
Precentral gyrus right	6884	1559	22.6%	104	1.5%	564	8.2%
Juxtapositional cortex	2282	260	11.4%	119	5.2%	80	3.5%
Insular cortex left	1302	0	0.0%	147	11.3%	0	0.0%
Insular cortex right	1252	42	3.4%	71	5.7%	39	3.1%
Temporal pole left	3643	0	0.0%	94	2.6%	0	0.0%
Temporal pole right	3801	0	0.0%	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	2	0.1%	0	0.0%	6	0.4%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%	0	0.0%
ITG – temporo-occipital left	981	1	0.1%	1	0.1%	191	19.5%
ITG – temporo-occipital right	1232	0	0.0%	0	0.0%	122	9.9%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	0	0.0%	0	0.0%
MTG – temporo-occipital left	1073	0	0.0%	0	0.0%	0	0.0%
MTG – temporo-occipital right	1287	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	0	0.0%	0	0.0%
Planum polare left	383	0	0.0%	0	0.0%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%	0	0.0%
Heschls gyrus right	263	66	25.1%	0	0.0%	31	11.8%
Planum temporale left	521	0	0.0%	0	0.0%	0	0.0%
Planum temporale right	399	5	1.3%	4	1.0%	3	0.8%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%	0	0.0%

Table 16 (cont.)

Brain structure	Total	Conjunction		+ Indifferent		+ Fictitious	
	voxels	voxels	fraction	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	15	1.2%	1	0.1%	82	6.4%
Temporal fusiform cortex – posterior right	1214	0	0.0%	0	0.0%	1	0.1%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	1	0.2%	0	0.0%	1	0.2%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	67	7.7%	0	0.0%	618	71.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	0	0.0%	434	39.3%
Postcentral gyrus left	4628	0	0.0%	6	0.1%	0	0.0%
Postcentral gyrus right	4080	1478	36.2%	52	1.3%	176	4.3%
Superior parietal lobule left	1737	35	2.0%	295	17.0%	27	1.6%
Superior parietal lobule right	1712	800	46.7%	164	9.6%	94	5.5%
Supramarginal gyrus – anterior left	1248	0	0.0%	63	5.0%	0	0.0%
Supramarginal gyrus – anterior right	1064	122	11.5%	10	0.9%	51	4.8%
Supramarginal gyrus – posterior left	1414	0	0.0%	115	8.1%	0	0.0%
Supramarginal gyrus – posterior right	1529	27	1.8%	57	3.7%	2	0.1%
Angular gyrus left	1113	0	0.0%	86	7.7%	0	0.0%
Angular gyrus right	1675	0	0.0%	173	10.3%	0	0.0%
Central opercular cortex left	967	0	0.0%	0	0.0%	0	0.0%
Central opercular cortex right	850	49	5.8%	0	0.0%	35	4.1%
Parietal operculum cortex left	565	0	0.0%	0	0.0%	0	0.0%
Parietal operculum cortex right	505	66	13.1%	1	0.2%	29	5.7%
Precuneous cortex	7844	2	0.0%	877	11.2%	32	0.4%
Lateral occipital cortex – superior left	5903	239	4.0%	927	15.7%	318	5.4%
Lateral occipital cortex – superior right	5899	371	6.3%	876	14.8%	573	9.7%
Lateral occipital cortex – inferior left	2814	31	1.1%	3	0.1%	1078	38.3%
Lateral occipital cortex – inferior right	3311	2	0.1%	0	0.0%	1303	39.4%
Cuneal cortex	1743	0	0.0%	2	0.1%	0	0.0%
Supracalcarine cortex	424	0	0.0%	0	0.0%	0	0.0%
Intracalcarine cortex	2211	0	0.0%	10	0.5%	2	0.1%
Lingual gyrus	5360	214	4.0%	214	4.0%	97	1.8%
Occipital fusiform gyrus left	1407	135	9.6%	90	6.4%	710	50.5%
Occipital fusiform gyrus right	1459	0	0.0%	49	3.4%	540	37.0%
Occipital pole	9658	657	6.8%	159	1.6%	1390	14.4%
Cingulate gyrus – anterior	4144	8	0.2%	318	7.7%	22	0.5%
Cingulate gyrus – posterior	4495	3	0.1%	3	0.1%	0	0.0%
Pallidum left	312	0	0.0%	7	2.2%	0	0.0%
Pallidum right	266	0	0.0%	4	1.5%	47	17.7%
Putamen left	923	0	0.0%	43	4.7%	0	0.0%
Putamen right	800	1	0.1%	0	0.0%	202	25.3%
Caudate left	572	0	0.0%	13	2.3%	0	0.0%
Caudate right	515	0	0.0%	75	14.6%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%	14	3.5%
Hippocampus left	921	0	0.0%	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	3	0.4%	0	0.0%
Total				15710	7.9%	9650	4.8%
Grand total	199998	8084	4.0%	23794	11.9%	17734	8.9%

Note. Conjunction voxels are the green ones in Figure 45, unique to indifferent > positive are the red ones, and unique to the fictitious > positive are the blue ones.

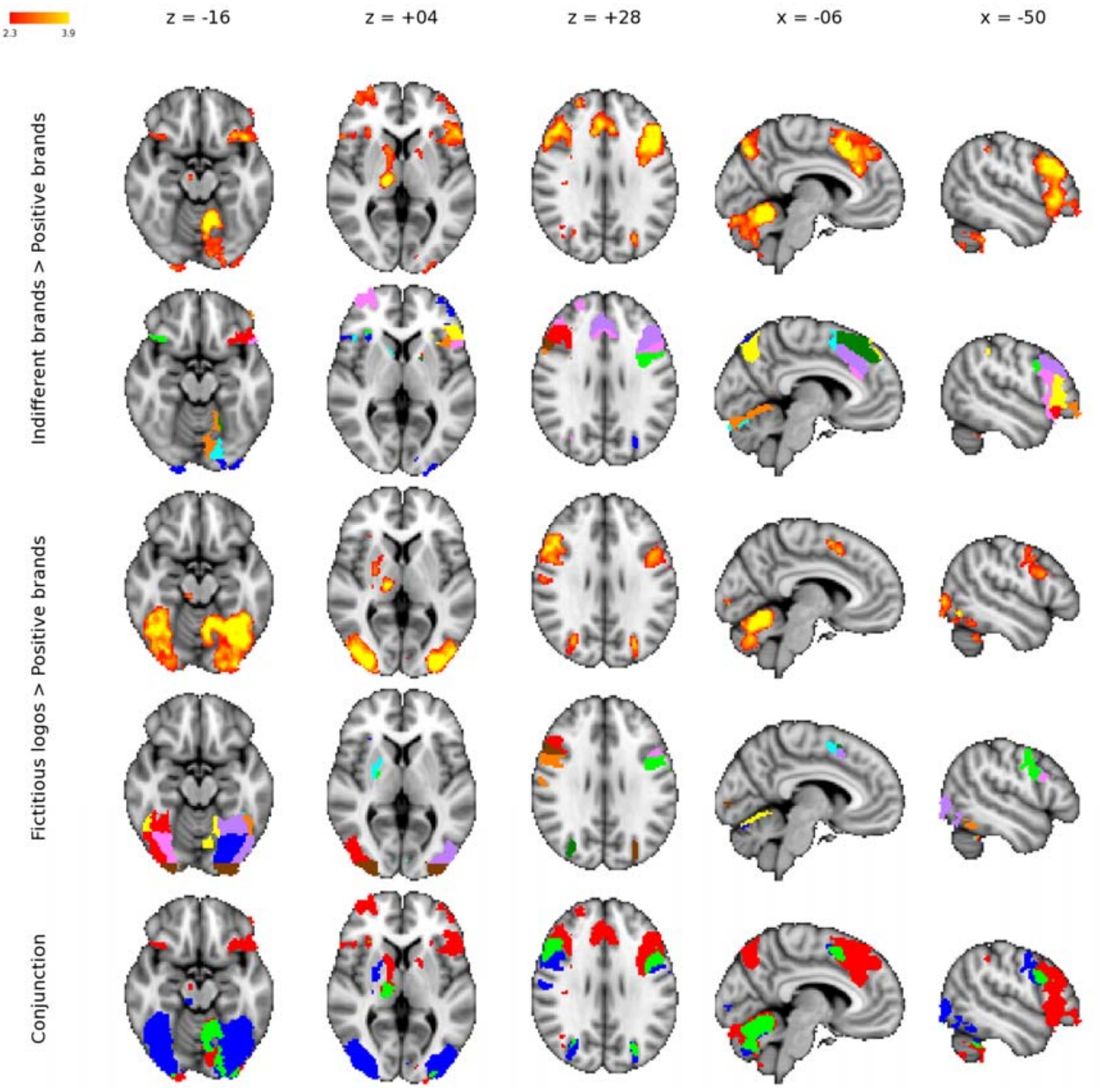


Figure 45 - FMRI maps for the contrasts between indifferent and fictitious logos versus positive brands, and the respective conjunction analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by FEAT). For each contrast the first row refers to the thresholded maps (z > 2.3), and in the second row the brain regions are individualised with different colours. In the conjunction analysis row, common voxels are in green colour, voxels that activate only for the contrast indifferent versus positive brands are in red, and voxels that activate only for the contrast fictitious logos versus positive brands are in blue. Radiological convention; MNI152 coordinates

Table 16 and depicted in Figure 45. It is worth to note the scarcity of activated voxels in the conjunction analysis other those in the motor cortex (juxtapositional cortex, and precentral and postcentral gyri), left and right pars opercularis, right Heschl’s gyrus, and right superior parietal lobule. Frontal regions are extensively more active for indifferent brands (right dorsal frontal pole, paracingulate gyrus, left frontal orbital cortex, left and right frontal operculum cortices, left inferior frontal gyrus (pars opercularis and pars triangularis), superior frontal gyrus, and left and right middle frontal gyri), while ventral temporal regions are more active for fictitious logos (left temporo-occipital part of the inferior temporal gyrus, left and right temporal occipital fusiform gyri, left and right inferior lateral occipital cortices, left and right occipital fusiform gyri, and also the right pallidum and putamen).

Multivariate independent components analysis.

The multivariate analysis with MELODIC returned 164 independent components. The focus will be only in the independent components more relevant in the process where recognised brands are differentiated from fictitious logos and in the process where preference is deployed. To support the selection of the relevant independent components on statistical criteria, it was carried on a GLM analysis for each one of the 164 independent components, using as explanatory variables the same combination type of stimuli / assessment used for the FEAT analysis. The z statistics of the respective weights (betas) of the selected independent components are reported in Table 17.

For the process where known brands (whatever their valence) are recognised, independent components 18 and 41 were found to be statistically relevant. In both cases, the differences between positive brands and fictitious logos, and between indifferent brands and fictitious logos are significant, as are the differences between positive or indifferent brands versus baselines, and the difference between fictitious logos and baselines is significantly negative. These comparisons are consistent along all the subjects with *p-values* always inferior to 0.001. Then, it may be reported that the neural

Table 17 - Selected z statistics that represent the fit between the contrasts of explanatory variables and the independent components calculated in the multivariate analysis, together with the F-test across subjects for each selected independent component.

Contrast of parameter estimates	**z statistics for ICs**								
	17	**18**	**22**	**27**	**33**	**36**	**41**	**118**	**132**
Positive > FC	22.30	6.77	-5.64	-0.82	2.33	-0.65	2.38	-6.10	-6.35
Positive > NEW	21.78	4.08	0.58	1.53	2.76	3.19	2.21	-0.38	-3.80
Indifferent > FC	1.58	15.16	-13.24	-8.74	-2.75	-3.32	9.69	-9.62	-1.39
Indifferent > NEW	-0.54	12.07	-6.92	-6.40	-2.47	0.38	9.29	-3.72	1.49
Fictitious > FC	1.92	-4.58	-16.80	-4.13	0.22	-10.95	-5.46	-6.37	-5.68
Fictitious > NEW	-0.32	-7.36	-9.54	-1.57	0.46	-6.60	-5.47	-0.05	-2.44
NEW > FC	2.24	3.22	-6.68	-2.43	-0.27	-3.91	0.35	-6.22	-3.05
Positive > Indifferent	20.30	-7.91	7.15	7.52	4.88	2.53	-6.92	3.23	-4.87
Positive > Fictitious	22.66	12.01	10.77	3.24	2.34	10.30	8.09	-0.33	-1.30
Indifferent > Fictitious	-0.20	17.92	2.33	-4.54	-2.74	6.43	13.65	-3.43	3.63
Subjects									
F-test	241.19	63.07	16.72	27.25	11.71	36.76	22.85	4.44	3.53
p-value	0.000	0.000	0.001	0.000	0.004	0.000	0.000	0.051	0.079

Note - FC: fixation cross; IC: independent component; NEW: non-emotional words.

networks described in independent components 18 and 41 significantly participate in the process of brands' recognition and differentiation from fictitious logos. The composition of these networks is listed in Table 18 and depicted in Figure 46, here in different colours to emphasize the different brain structures that compile each one.

In both independent components is possible to identify a fronto-temporo-parietal network with some differences. In independent component 18 it has to be emphasised the participation of ventral and dorsal left frontal pole, left inferior frontal gyrus (pars opercularis and pars triangularis), left middle frontal gyrus, left temporo-occipital part of the inferior temporal gyrus, left posterior medial temporal gyrus, left temporo-occipital part of the medial temporal gyrus, left superior parietal lobule, left posterior supramarginal gyrus, left angular gyrus, and left and right superior lateral occipital cortex. On the other hand, it has to be emphasised in independent component 41 the participation of left and medial dorsal frontal pole, paracingulate gyrus, left frontal orbital cortex, left frontal operculum cortex, left inferior frontal gyrus (pars opercularis

Table 18 - Composition of the networks represented in independent components 18 and 41, which correlate with the process of brands recognition (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 18		IC 41	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	157	3.9%
Frontal pole ventral left	2617	599	22.9%	271	10.4%
Frontal pole ventral right	3475	0	0.0%	1	0.0%
Frontal pole dorsal medial	5884	248	4.2%	2851	48.5%
Frontal pole dorsal left	4214	959	22.8%	798	18.9%
Frontal pole dorsal right	5729	0	0.0%	131	2.3%
Frontal medial cortex	1539	0	0.0%	9	0.6%
Subcallosal cortex	2080	0	0.0%	0	0.0%
Paracingulate gyrus	4095	129	3.2%	1431	34.9%
Frontal orbital cortex left	2105	2	0.1%	521	24.8%
Frontal orbital cortex right	1931	1	0.1%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	95	16.9%
Frontal operculum cortex right	500	0	0.0%	0	0.0%
IFG pars triangularis left	1147	222	19.4%	743	64.8%
IFG pars triangularis right	1170	5	0.4%	0	0.0%
IFG pars opercularis left	1205	231	19.2%	486	40.3%
IFG pars opercularis right	1130	0	0.0%	0	0.0%
Superior frontal gyrus	8861	831	9.4%	2634	29.7%
Middle frontal gyrus left	4331	2533	58.5%	1204	27.8%
Middle frontal gyrus right	4090	15	0.4%	0	0.0%
Precentral gyrus left	7083	173	2.4%	51	0.7%
Precentral gyrus right	6884	11	0.2%	10	0.1%
Juxtapositional cortex	2282	14	0.6%	207	9.1%
Insular cortex left	1302	0	0.0%	0	0.0%
Insular cortex right	1252	1	0.1%	0	0.0%
Temporal pole left	3643	13	0.4%	104	2.9%
Temporal pole right	3801	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	1	0.2%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	74	4.4%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	69	4.0%
ITG – temporo-occipital left	981	191	19.5%	0	0.0%
ITG – temporo-occipital right	1232	0	0.0%	79	6.4%
MedialTemporalGyrus – anterior left	642	0	0.0%	3	0.5%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	323	20.0%	148	9.2%
MedialTemporalGyrus – posterior right	1653	0	0.0%	2	0.1%
MTG – temporo-occipital left	1073	283	26.4%	0	0.0%
MTG – temporo-occipital right	1287	29	2.3%	7	0.5%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	15	3.7%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	4	0.4%	25	2.3%
SuperiorTemporalGyrus – posterior right	1172	6	0.5%	27	2.3%
Planum polare left	383	0	0.0%	0	0.0%
Planum polare right	369	2	0.5%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%
Heschls gyrus right	263	0	0.0%	10	3.8%
Planum temporale left	521	0	0.0%	0	0.0%
Planum temporale right	399	2	0.5%	42	10.5%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 18 (cont.)

Brain structure	Total	IC 18		IC 41	
	voxels	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	1	0.3%
Temporal occipital fusiform cortex left	871	0	0.0%	0	0.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	9	0.8%
Postcentral gyrus left	4628	92	2.0%	1	0.0%
Postcentral gyrus right	4080	0	0.0%	20	0.5%
Superior parietal lobule left	1737	940	54.1%	0	0.0%
Superior parietal lobule right	1712	0	0.0%	18	1.1%
Supramarginal gyrus – anterior left	1248	123	9.9%	0	0.0%
Supramarginal gyrus – anterior right	1064	0	0.0%	5	0.5%
Supramarginal gyrus – posterior left	1414	574	40.6%	354	25.0%
Supramarginal gyrus – posterior right	1529	12	0.8%	8	0.5%
Angular gyrus left	1113	689	61.9%	705	63.3%
Angular gyrus right	1675	221	13.2%	10	0.6%
Central opercular cortex left	967	0	0.0%	0	0.0%
Central opercular cortex right	850	1	0.1%	0	0.0%
Parietal operculum cortex left	565	0	0.0%	0	0.0%
Parietal operculum cortex right	505	0	0.0%	0	0.0%
Precuneous cortex	7844	415	5.3%	342	4.4%
Lateral occipital cortex – superior left	5903	3530	59.8%	1040	17.6%
Lateral occipital cortex – superior right	5899	1079	18.3%	660	11.2%
Lateral occipital cortex – inferior left	2814	1	0.0%	6	0.2%
Lateral occipital cortex – inferior right	3311	0	0.0%	3	0.1%
Cuneal cortex	1743	2	0.1%	171	9.8%
Supracalcarine cortex	424	2	0.5%	0	0.0%
Intracalcarine cortex	2211	6	0.3%	0	0.0%
Lingual gyrus	5360	45	0.8%	0	0.0%
Occipital fusiform gyrus left	1407	0	0.0%	110	7.8%
Occipital fusiform gyrus right	1459	42	2.9%	2	0.1%
Occipital pole	9658	0	0.0%	371	3.8%
Cingulate gyrus – anterior	4144	0	0.0%	640	15.4%
Cingulate gyrus – posterior	4495	544	12.1%	368	8.2%
Pallidum left	312	0	0.0%	1	0.3%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	0	0.0%	6	0.7%
Putamen right	800	0	0.0%	0	0.0%
Caudate left	572	0	0.0%	151	26.4%
Caudate right	515	5	1.0%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%
Amygdala left	390	1	0.3%	0	0.0%
Amygdala right	399	4	1.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	0	0.0%
Total	199998	15245	7.6%	17118	8.6%

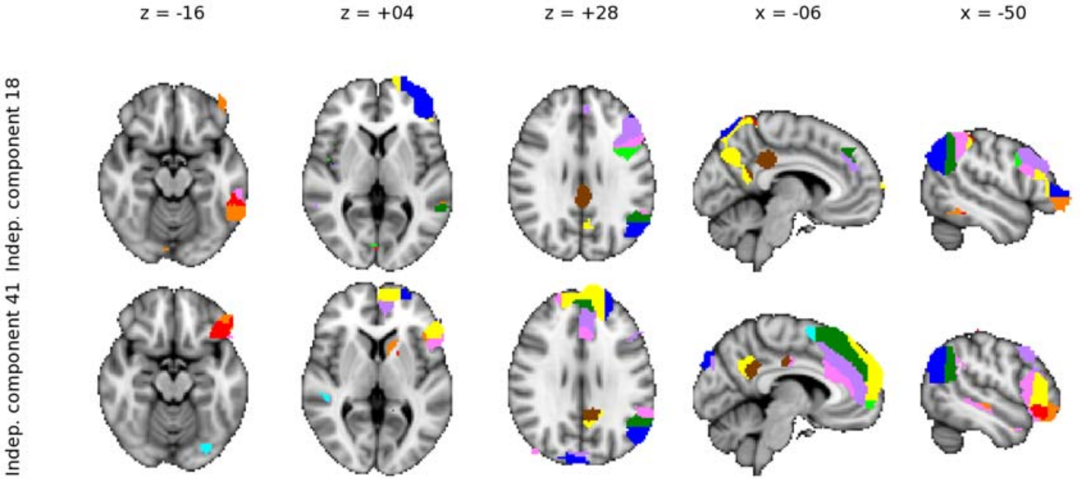


Figure 46 - Independent components 18 and 41 fMRI maps for the multivariate analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by MELODIC). The brain regions are individualised with different colours. Radiological convention; MNI152 coordinates.

and pars triangularis), superior frontal gyrus, left middle frontal gyrus, left posterior supramarginal gyrus, left angular gyrus, left superior lateral occipital cortex, anterior cingulate gyrus, and left caudate.

To confront the results of the multivariate analysis with the results from the traditional GLM analysis, the *z* statistics of the four voxels identified in Figure 39 are listed in Table 19. Interestingly all four voxels are active in the network represented in independent component 18, and all but the voxel in the precuneous are again represented in independent component 41. This finding supports the simultaneous participation of these brain structures in the conjectured psychological processes that sustain brands' recognition and differentiation from meaningless logos.

To illustrate the process where positive brands were preferred, it was selected six independent components, which will be reported in three separate sets: independent components 22 and 132, independent components 17 and 27, and independent components 33 and 36.

Table 19 – Statistic z in independent components 18 and 41 from the multivariate analysis, of selected voxels from the GLM analysis.

Brain structure	Coordinates	Independent component	
	MNI152	18	41
41% frontal pole	-18x62x4	2.70	3.62
48% angular gyrus	-50x-58x48	15.21	4.42
46% precuneous	-6x-62x64	3.46	0.00
44% posterior cingulate	-6x-54x24	3.18	5.15

Independent components 22 and 132 were chosen because they include activations or deactivations in the anterior prefrontal cortex. Unexpectedly, there were few independent components that include significant activity in the anterior prefrontal cortex, and these two, together with the previously reported independent component 41, are the only ones that can be rationale and significantly connected to the research paradigm (the others, which do not correlate with stimuli or baselines, supposedly may have a physiological explanation).

In independent component 22, while the *z* statistic of the contrasts between positive brands versus indifferent or fictitious logos is significantly positive (see Table 17), the contrast with the baselines is almost null (for non-emotional words) and significantly negative (for the fixation cross). Then, it may be parsimoniously accepted this component as relevant in manifesting preferences, acknowledging that it should detach from the baselines. However, as it will be discussed, the passive viewing of a fixation cross encompasses relevant self-referential processes which may substantiate the negative *z* statistic, but the same argument does not support the almost null result for non-emotional words. The activity of the network represented in independent component 22 is significantly constant along the subjects' set (*p-value* inferior to 0.001). The respective statistical parametric maps are represented in Figure 47 and the complete list of brain structures included in this network is in Table 20. It is emphasised the activations in ventral and dorsal medial frontal pole, frontal medial cortex,

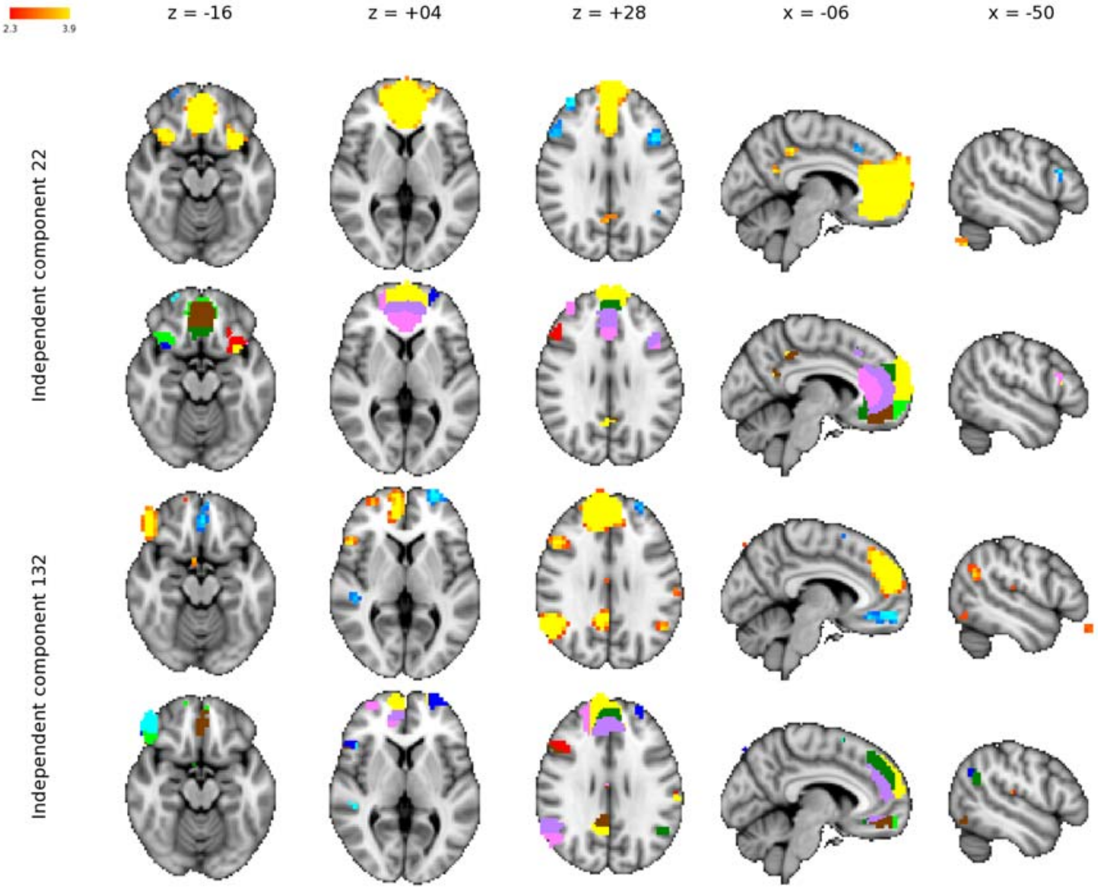


Figure 47 - Independent components 22 and 132 fMRI maps for the multivariate analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by MELODIC). For each independent component, top row depicts z statistics (activations and deactivations) and the bottom row depicts the same brain regions but individualised with different colours. Radiological convention; MNI152 coordinates.

subcallosal cortex, paracingulate gyrus, anterior cingulate gyrus, and left and right frontal orbital cortex, and on the deactivations on the right pars triangularis, left pars opercularis, and left and right middle frontal gyrus.

Table 21 includes the complete list of brain structures activated or deactivated in the network of independent component 132. The adequacy of the use of independent component 132 to interpret preferences should be cautious. This network it is not found consistently along the subjects (*p-value* = 0.079), existing one outlier. Also, the contrasts between positive brands versus indifferent and fictitious logos is negative

Table 20 - Composition of the networks represented in independent component 22 which correlate with the process of brands preference (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 22 act		IC 22 deact	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	601	15.1%	8	0.2%
Frontal pole ventral left	2617	12	0.5%	0	0.0%
Frontal pole ventral right	3475	28	0.8%	98	2.8%
Frontal pole dorsal medial	5884	2205	37.5%	0	0.0%
Frontal pole dorsal left	4214	182	4.3%	0	0.0%
Frontal pole dorsal right	5729	103	1.8%	161	2.8%
Frontal medial cortex	1539	1019	66.2%	0	0.0%
Subcallosal cortex	2080	377	18.1%	0	0.0%
Paracingulate gyrus	4095	2141	52.3%	73	1.8%
Frontal orbital cortex left	2105	390	18.5%	0	0.0%
Frontal orbital cortex right	1931	200	10.4%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	0	0.0%
Frontal operculum cortex right	500	0	0.0%	0	0.0%
IFG pars triangularis left	1147	0	0.0%	22	1.9%
IFG pars triangularis right	1170	0	0.0%	86	7.4%
IFG pars opercularis left	1205	0	0.0%	134	11.1%
IFG pars opercularis right	1130	0	0.0%	58	5.1%
Superior frontal gyrus	8861	307	3.5%	20	0.2%
Middle frontal gyrus left	4331	5	0.1%	204	4.7%
Middle frontal gyrus right	4090	0	0.0%	375	9.2%
Precentral gyrus left	7083	8	0.1%	0	0.0%
Precentral gyrus right	6884	0	0.0%	0	0.0%
Juxtapositional cortex	2282	0	0.0%	0	0.0%
Insular cortex left	1302	60	4.6%	0	0.0%
Insular cortex right	1252	45	3.6%	0	0.0%
Temporal pole left	3643	52	1.4%	0	0.0%
Temporal pole right	3801	26	0.7%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%
ITG – temporo-occipital left	981	0	0.0%	0	0.0%
ITG – temporo-occipital right	1232	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	0	0.0%
MTG – temporo-occipital left	1073	0	0.0%	0	0.0%
MTG – temporo-occipital right	1287	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	0	0.0%
Planum polare left	383	0	0.0%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%
Heschls gyrus right	263	0	0.0%	0	0.0%
Planum temporale left	521	0	0.0%	0	0.0%
Planum temporale right	399	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 20 (cont.)

Brain structure	Total	IC 22 act		IC 22 deact	
	voxels	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	0	0.0%	0	0.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	0	0.0%
Postcentral gyrus left	4628	0	0.0%	0	0.0%
Postcentral gyrus right	4080	0	0.0%	0	0.0%
Superior parietal lobule left	1737	0	0.0%	0	0.0%
Superior parietal lobule right	1712	0	0.0%	0	0.0%
Supramarginal gyrus – anterior left	1248	22	1.8%	0	0.0%
Supramarginal gyrus – anterior right	1064	24	2.3%	0	0.0%
Supramarginal gyrus – posterior left	1414	18	1.3%	0	0.0%
Supramarginal gyrus – posterior right	1529	32	2.1%	0	0.0%
Angular gyrus left	1113	0	0.0%	4	0.4%
Angular gyrus right	1675	0	0.0%	0	0.0%
Central opercular cortex left	967	0	0.0%	0	0.0%
Central opercular cortex right	850	0	0.0%	0	0.0%
Parietal operculum cortex left	565	0	0.0%	0	0.0%
Parietal operculum cortex right	505	0	0.0%	0	0.0%
Precuneous cortex	7844	98	1.2%	8	0.1%
Lateral occipital cortex – superior left	5903	0	0.0%	28	0.5%
Lateral occipital cortex – superior right	5899	0	0.0%	0	0.0%
Lateral occipital cortex – inferior left	2814	0	0.0%	0	0.0%
Lateral occipital cortex – inferior right	3311	0	0.0%	0	0.0%
Cuneal cortex	1743	0	0.0%	0	0.0%
Supracalcarine cortex	424	0	0.0%	0	0.0%
Intracalcarine cortex	2211	0	0.0%	0	0.0%
Lingual gyrus	5360	0	0.0%	0	0.0%
Occipital fusiform gyrus left	1407	0	0.0%	0	0.0%
Occipital fusiform gyrus right	1459	0	0.0%	0	0.0%
Occipital pole	9658	0	0.0%	0	0.0%
Cingulate gyrus – anterior	4144	1674	40.4%	0	0.0%
Cingulate gyrus – posterior	4495	267	5.9%	0	0.0%
Pallidum left	312	0	0.0%	0	0.0%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	0	0.0%	0	0.0%
Putamen right	800	0	0.0%	0	0.0%
Caudate left	572	0	0.0%	0	0.0%
Caudate right	515	0	0.0%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	0	0.0%
Total	199998	9896	4.9%	1279	0.6%

Note - act: activations; deact: deactivations.

Table 21 - Composition of the networks represented in independent component 132 which correlate with the process of brands preference (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 132 act		IC 132 deact	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	63	1.6%	131	3.3%
Frontal pole ventral left	2617	8	0.3%	68	2.6%
Frontal pole ventral right	3475	423	12.2%	0	0.0%
Frontal pole dorsal medial	5884	2368	40.2%	68	1.2%
Frontal pole dorsal left	4214	0	0.0%	567	13.5%
Frontal pole dorsal right	5729	1018	17.8%	0	0.0%
Frontal medial cortex	1539	17	1.1%	309	20.1%
Subcallosal cortex	2080	8	0.4%	16	0.8%
Paracingulate gyrus	4095	1683	41.1%	108	2.6%
Frontal orbital cortex left	2105	0	0.0%	0	0.0%
Frontal orbital cortex right	1931	247	12.8%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	1	0.2%
Frontal operculum cortex right	500	10	2.0%	0	0.0%
IFG pars triangularis left	1147	0	0.0%	0	0.0%
IFG pars triangularis right	1170	265	22.6%	0	0.0%
IFG pars opercularis left	1205	0	0.0%	0	0.0%
IFG pars opercularis right	1130	200	17.7%	7	0.6%
Superior frontal gyrus	8861	1841	20.8%	250	2.8%
Middle frontal gyrus left	4331	0	0.0%	13	0.3%
Middle frontal gyrus right	4090	1144	28.0%	4	0.1%
Precentral gyrus left	7083	0	0.0%	0	0.0%
Precentral gyrus right	6884	21	0.3%	1	0.0%
Juxtapositional cortex	2282	0	0.0%	21	0.9%
Insular cortex left	1302	14	1.1%	19	1.5%
Insular cortex right	1252	0	0.0%	0	0.0%
Temporal pole left	3643	0	0.0%	0	0.0%
Temporal pole right	3801	180	4.7%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	32	6.3%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%
ITG – temporo-occipital left	981	0	0.0%	0	0.0%
ITG – temporo-occipital right	1232	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	5	0.8%	0	0.0%
MedialTemporalGyrus – posterior left	1616	32	2.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	323	19.5%	2	0.1%
MTG – temporo-occipital left	1073	0	0.0%	0	0.0%
MTG – temporo-occipital right	1287	73	5.7%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	43	3.7%
Planum polare left	383	0	0.0%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%
Heschls gyrus left	320	7	2.2%	0	0.0%
Heschls gyrus right	263	0	0.0%	0	0.0%
Planum temporale left	521	8	1.5%	0	0.0%
Planum temporale right	399	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 21 (cont.)

Brain structure	Total	IC 132 act		IC 132 deact	
	voxels	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	0	0.0%	0	0.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	0	0.0%
Postcentral gyrus left	4628	56	1.2%	0	0.0%
Postcentral gyrus right	4080	0	0.0%	0	0.0%
Superior parietal lobule left	1737	0	0.0%	0	0.0%
Superior parietal lobule right	1712	0	0.0%	0	0.0%
Supramarginal gyrus – anterior left	1248	32	2.6%	0	0.0%
Supramarginal gyrus – anterior right	1064	0	0.0%	0	0.0%
Supramarginal gyrus – posterior left	1414	0	0.0%	8	0.6%
Supramarginal gyrus – posterior right	1529	9	0.6%	0	0.0%
Angular gyrus left	1113	109	9.8%	0	0.0%
Angular gyrus right	1675	732	43.7%	0	0.0%
Central opercular cortex left	967	4	0.4%	0	0.0%
Central opercular cortex right	850	0	0.0%	0	0.0%
Parietal operculum cortex left	565	8	1.4%	0	0.0%
Parietal operculum cortex right	505	0	0.0%	0	0.0%
Precuneous cortex	7844	254	3.2%	2	0.0%
Lateral occipital cortex – superior left	5903	22	0.4%	24	0.4%
Lateral occipital cortex – superior right	5899	683	11.6%	8	0.1%
Lateral occipital cortex – inferior left	2814	40	1.4%	0	0.0%
Lateral occipital cortex – inferior right	3311	92	2.8%	0	0.0%
Cuneal cortex	1743	17	1.0%	0	0.0%
Supracalcarine cortex	424	0	0.0%	0	0.0%
Intracalcarine cortex	2211	0	0.0%	0	0.0%
Lingual gyrus	5360	43	0.8%	0	0.0%
Occipital fusiform gyrus left	1407	0	0.0%	0	0.0%
Occipital fusiform gyrus right	1459	0	0.0%	0	0.0%
Occipital pole	9658	0	0.0%	0	0.0%
Cingulate gyrus – anterior	4144	249	6.0%	8	0.2%
Cingulate gyrus – posterior	4495	259	5.8%	3	0.1%
Pallidum left	312	0	0.0%	0	0.0%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	2	0.2%	0	0.0%
Putamen right	800	0	0.0%	0	0.0%
Caudate left	572	0	0.0%	0	0.0%
Caudate right	515	27	5.2%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	0	0.0%
Total	199998	12628	6.3%	1681	0.8%

Note - act: activations; deact: deactivations.

(only significant for indifferent brands), and versus the baselines are significantly negative. As such, it is more important to study the deactivations in this case, and then the left dorsal frontal pole, frontal medial cortex, and paracingulate gyrus are detached.

Table 22 lists the *z* statistics of the voxels belonging to cluster 1 in Table 15 (four of them also depicted in Figure 41). For independent component 22 all these voxels activated, but for independent component 132 only those more ventral and anterior (51% paracingulate gyrus and 57% frontal medial cortex) deactivated.

Table 22 – Statistic z in independent components 22 and 132 from the multivariate analysis, of selected voxels from the GLM analysis.

Brain structure	Coordinates MNI152	Independent component 22	Independent component 132
55% frontal pole	-2x58x4	25.43	0.00
51% paracingulate gyrus	-6x38x-8	13.01	-2.92
60% paracingulate gyrus	-6x50x-4	22.75	0.00
57% frontal medial cortex	2x34x-16	9.33	-2.91
65% paracingulate gyrus	-2x46x0	23.19	0.00
48% subcallosal cortex	-6x30x-8	7.63	0.00

The second pair of independent components statistically connected to preferences mainly involves brain regions from the motor and somatosensory cortices, as well in the margins of the sylvian fissure, and includes the independent components 17 and 27, which are depicted in Figure 48, and whose activations and deactivations are listed in Table 23 and Table 24, respectively. In both cases these networks are found consistently along the subjects set (*p-values* always inferior to 0.001).

The network represented in the independent component 17 is strongly connected to voting in positive brands. The contrasts between positive brands versus indifferent or fictitious logos are clearly positive, as well the contrasts between positive brands and both baselines. The network here represented is strongly left lateralised and includes

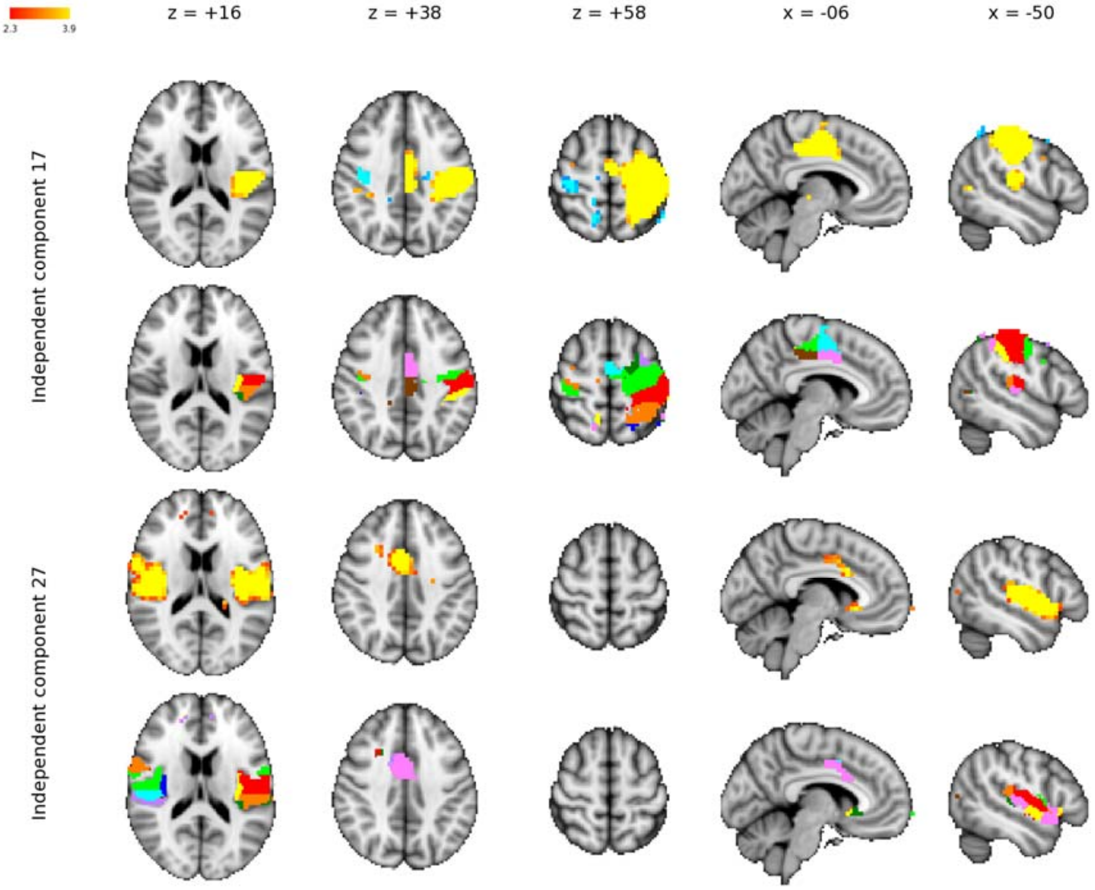


Figure 48 - Independent components 17 and 27 fMRI maps for the multivariate analysis in the axial (z = +16, +38, and +58) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by MELODIC). For each independent component, top row depicts z statistics (activations and deactivations) and the bottom row depicts the same brain regions but individualised with different colours. Radiological convention; MNI152 coordinates.

activations in the juxtapositional cortex, left precentral gyrus, left postcentral gyrus, left superior parietal lobule, left anterior supramarginal gyrus, left Heschl's gyrus, left planum temporale, left central opercular cortex, and left parietal operculum cortex. It is worth to note that this network encompasses deactivations in the left parietal operculum cortex, and also in the other hemisphere, e.g. right precentral and postcentral gyri.

The independent component 27 is also linked to the act of voting in positive brands. However, while the contrasts between positive brands versus indifferent or fictitious logos are clearly positive, the contrasts between positive brands and both

Table 23 - Composition of the networks represented in independent component 17 which correlate with the process of brands preference (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 17 act		IC 17 deact	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%
Frontal pole ventral left	2617	0	0.0%	0	0.0%
Frontal pole ventral right	3475	0	0.0%	0	0.0%
Frontal pole dorsal medial	5884	0	0.0%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	0	0.0%
Frontal pole dorsal right	5729	0	0.0%	0	0.0%
Frontal medial cortex	1539	0	0.0%	0	0.0%
Subcallosal cortex	2080	0	0.0%	0	0.0%
Paracingulate gyrus	4095	0	0.0%	0	0.0%
Frontal orbital cortex left	2105	0	0.0%	0	0.0%
Frontal orbital cortex right	1931	0	0.0%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	0	0.0%
Frontal operculum cortex right	500	0	0.0%	0	0.0%
IFG pars triangularis left	1147	0	0.0%	0	0.0%
IFG pars triangularis right	1170	0	0.0%	0	0.0%
IFG pars opercularis left	1205	5	0.4%	0	0.0%
IFG pars opercularis right	1130	0	0.0%	0	0.0%
Superior frontal gyrus	8861	311	3.5%	0	0.0%
Middle frontal gyrus left	4331	132	3.0%	24	0.6%
Middle frontal gyrus right	4090	0	0.0%	0	0.0%
Precentral gyrus left	7083	2561	36.2%	10	0.1%
Precentral gyrus right	6884	86	1.2%	316	4.6%
Juxtapositional cortex	2282	485	21.3%	0	0.0%
Insular cortex left	1302	185	14.2%	0	0.0%
Insular cortex right	1252	0	0.0%	0	0.0%
Temporal pole left	3643	0	0.0%	0	0.0%
Temporal pole right	3801	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%
ITG – temporo-occipital left	981	0	0.0%	0	0.0%
ITG – temporo-occipital right	1232	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	0	0.0%
MTG – temporo-occipital left	1073	7	0.7%	0	0.0%
MTG – temporo-occipital right	1287	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	2	0.2%
SuperiorTemporalGyrus – posterior right	1172	0	0.0%	0	0.0%
Planum polare left	383	0	0.0%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%
Heschls gyrus left	320	151	47.2%	0	0.0%
Heschls gyrus right	263	0	0.0%	0	0.0%
Planum temporale left	521	54	10.4%	21	4.0%
Planum temporale right	399	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 23 (cont.)

Brain structure	Total voxels	IC 17 act voxels	IC 17 act fraction	IC 17 deact voxels	IC 17 deact fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	8	0.7%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	0	0.0%	0	0.0%
Temporal occipital fusiform cortex right	1105	70	6.3%	0	0.0%
Postcentral gyrus left	4628	2462	53.2%	0	0.0%
Postcentral gyrus right	4080	9	0.2%	420	10.3%
Superior parietal lobule left	1737	1027	59.1%	1	0.1%
Superior parietal lobule right	1712	0	0.0%	4	0.2%
Supramarginal gyrus – anterior left	1248	284	22.8%	31	2.5%
Supramarginal gyrus – anterior right	1064	17	1.6%	0	0.0%
Supramarginal gyrus – posterior left	1414	49	3.5%	19	1.3%
Supramarginal gyrus – posterior right	1529	0	0.0%	0	0.0%
Angular gyrus left	1113	0	0.0%	11	1.0%
Angular gyrus right	1675	0	0.0%	0	0.0%
Central opercular cortex left	967	250	25.9%	0	0.0%
Central opercular cortex right	850	0	0.0%	0	0.0%
Parietal operculum cortex left	565	158	28.0%	59	10.4%
Parietal operculum cortex right	505	0	0.0%	0	0.0%
Precuneous cortex	7844	15	0.2%	62	0.8%
Lateral occipital cortex – superior left	5903	72	1.2%	8	0.1%
Lateral occipital cortex – superior right	5899	0	0.0%	20	0.3%
Lateral occipital cortex – inferior left	2814	38	1.4%	0	0.0%
Lateral occipital cortex – inferior right	3311	0	0.0%	0	0.0%
Cuneal cortex	1743	2	0.1%	0	0.0%
Supracalcarine cortex	424	0	0.0%	0	0.0%
Intracalcarine cortex	2211	0	0.0%	0	0.0%
Lingual gyrus	5360	61	1.1%	0	0.0%
Occipital fusiform gyrus left	1407	0	0.0%	0	0.0%
Occipital fusiform gyrus right	1459	3	0.2%	0	0.0%
Occipital pole	9658	0	0.0%	0	0.0%
Cingulate gyrus – anterior	4144	335	8.1%	0	0.0%
Cingulate gyrus – posterior	4495	313	7.0%	15	0.3%
Pallidum left	312	26	8.3%	0	0.0%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	68	7.4%	0	0.0%
Putamen right	800	0	0.0%	0	0.0%
Caudate left	572	0	0.0%	0	0.0%
Caudate right	515	0	0.0%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	0	0.0%
Total	199998	9244	4.6%	1023	0.5%

Note - act: activations; deact: deactivations.

Table 24 - Composition of the networks represented in independent component 27 which correlate with the process of brands preference (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 27 act		IC 27 deact	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	76	1.9%	0	0.0%
Frontal pole ventral left	2617	0	0.0%	0	0.0%
Frontal pole ventral right	3475	75	2.2%	0	0.0%
Frontal pole dorsal medial	5884	9	0.2%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	0	0.0%
Frontal pole dorsal right	5729	139	2.4%	0	0.0%
Frontal medial cortex	1539	12	0.8%	0	0.0%
Subcallosal cortex	2080	239	11.5%	0	0.0%
Paracingulate gyrus	4095	66	1.6%	0	0.0%
Frontal orbital cortex left	2105	32	1.5%	0	0.0%
Frontal orbital cortex right	1931	76	3.9%	0	0.0%
Frontal operculum cortex left	562	93	16.5%	0	0.0%
Frontal operculum cortex right	500	147	29.4%	0	0.0%
IFG pars triangularis left	1147	37	3.2%	0	0.0%
IFG pars triangularis right	1170	41	3.5%	0	0.0%
IFG pars opercularis left	1205	193	16.0%	0	0.0%
IFG pars opercularis right	1130	161	14.2%	0	0.0%
Superior frontal gyrus	8861	19	0.2%	0	0.0%
Middle frontal gyrus left	4331	0	0.0%	0	0.0%
Middle frontal gyrus right	4090	46	1.1%	0	0.0%
Precentral gyrus left	7083	273	3.9%	0	0.0%
Precentral gyrus right	6884	326	4.7%	0	0.0%
Juxtapositional cortex	2282	116	5.1%	0	0.0%
Insular cortex left	1302	1032	79.3%	0	0.0%
Insular cortex right	1252	979	78.2%	0	0.0%
Temporal pole left	3643	317	8.7%	0	0.0%
Temporal pole right	3801	428	11.3%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%
ITG – temporo-occipital left	981	0	0.0%	0	0.0%
ITG – temporo-occipital right	1232	14	1.1%	0	0.0%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	0	0.0%
MTG – temporo-occipital left	1073	0	0.0%	0	0.0%
MTG – temporo-occipital right	1287	106	8.2%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	209	53.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	208	51.4%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	104	9.4%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	52	4.4%	0	0.0%
Planum polare left	383	287	74.9%	0	0.0%
Planum polare right	369	344	93.2%	0	0.0%
Heschls gyrus left	320	315	98.4%	0	0.0%
Heschls gyrus right	263	263	100.0%	0	0.0%
Planum temporale left	521	310	59.5%	0	0.0%
Planum temporale right	399	277	69.4%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 24 (cont.)

Brain structure	Total	IC 27 act		IC 27 deact	
	voxels	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	3	0.3%	0	0.0%
Temporal occipital fusiform cortex right	1105	6	0.5%	0	0.0%
Postcentral gyrus left	4628	47	1.0%	0	0.0%
Postcentral gyrus right	4080	50	1.2%	0	0.0%
Superior parietal lobule left	1737	0	0.0%	0	0.0%
Superior parietal lobule right	1712	0	0.0%	0	0.0%
Supramarginal gyrus – anterior left	1248	42	3.4%	0	0.0%
Supramarginal gyrus – anterior right	1064	55	5.2%	0	0.0%
Supramarginal gyrus – posterior left	1414	0	0.0%	0	0.0%
Supramarginal gyrus – posterior right	1529	0	0.0%	0	0.0%
Angular gyrus left	1113	10	0.9%	0	0.0%
Angular gyrus right	1675	0	0.0%	0	0.0%
Central opercular cortex left	967	797	82.4%	0	0.0%
Central opercular cortex right	850	795	93.5%	0	0.0%
Parietal operculum cortex left	565	232	41.1%	0	0.0%
Parietal operculum cortex right	505	335	66.3%	0	0.0%
Precuneous cortex	7844	4	0.1%	0	0.0%
Lateral occipital cortex – superior left	5903	34	0.6%	0	0.0%
Lateral occipital cortex – superior right	5899	0	0.0%	0	0.0%
Lateral occipital cortex – inferior left	2814	84	3.0%	0	0.0%
Lateral occipital cortex – inferior right	3311	56	1.7%	0	0.0%
Cuneal cortex	1743	0	0.0%	0	0.0%
Supracalcarine cortex	424	3	0.7%	0	0.0%
Intracalcarine cortex	2211	61	2.8%	0	0.0%
Lingual gyrus	5360	53	1.0%	0	0.0%
Occipital fusiform gyrus left	1407	0	0.0%	0	0.0%
Occipital fusiform gyrus right	1459	0	0.0%	0	0.0%
Occipital pole	9658	8	0.1%	0	0.0%
Cingulate gyrus – anterior	4144	981	23.7%	0	0.0%
Cingulate gyrus – posterior	4495	0	0.0%	0	0.0%
Pallidum left	312	0	0.0%	0	0.0%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	222	24.1%	0	0.0%
Putamen right	800	26	3.3%	0	0.0%
Caudate left	572	20	3.5%	0	0.0%
Caudate right	515	51	9.9%	0	0.0%
Accumbens left	111	8	7.2%	0	0.0%
Accumbens right	86	25	29.1%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	0	0.0%
Total	199998	11429	5.7%	0	0.0%

Note - act: activations; deact: deactivations.

baselines are not significantly different. Contrarily to the previous network, it is equilibrated between the two hemispheres with extensive clusters in perisylvian regions. It includes activations in the left and right frontal operculum cortices, left and right insular cortices, left and right pars opercularis, left and right anterior supramarginal gyri, left and right planum polare, left and right Heschl's gyri, left and right planum temporale, left and right central operculum cortices, left and right parietal operculum cortices, anterior cingulate gyrus, left putamen, and right nucleus accumbens. It does not include deactivations.

Table 25 lists the z statistics in independent components 17, 27, and 118 for all local maxima in clusters 2, 3, and 4 of Table 15. Independent component 118 has clusters in the perisylvian regions that superimpose to similar clusters in independent components 17 and 27. However, as per the data in Table 17 it is not possible to link it to preferences because the contrasts between positive brands versus both baselines and fictitious logos do not favour significantly the former. For this reason, this network it is not considered connected to preferences and thus further details about it are not reported.

Independent component 17 is strongly left lateralised, includes the motor and somatosensory cortices, but does not encompass the posterior insula. Contrarily, the topography of independent component 27 is distributed by the two hemispheres, and includes the posterior insular cortex bilaterally.

Finally, the third pair includes independent components 33 and 36, which are depicted in Figure 49 and their complete composition is listed in Table 26 and Table 27, respectively. In both cases the represented neural networks are found consistently in all subjects that participated in this study (*p-values* always inferior to 0.004 see Table 17).

Table 25 – Statistic *z* in independent components 17, 27 and 118 from the multivariate analysis, of selected voxels from the GLM analysis.

Brain structure	Coordinates	Independent component		
	MNI152	17	27	118
31% precentral gyrus	-30x-26x52	35.43	0.00	0.00
32% postcentral gyrus	-42x-22x60	50.34	0.00	0.00
44% postcentral gyrus	-34x-30x64	43.16	0.00	0.00
49% postcentral gyrus	-38x-26x60	57.38	0.00	0.00
54% postcentral gyrus	-38x-22x40	23.01	0.00	0.00
55% central opercular cortex	-42x-22x16	14.05	4.86	3.41
43% parietal operculum cortex	-42x-26x16	10.70	4.34	4.72
50% insular cortex	-34x-22x8	4.32	5.09	6.97
34% Heschl's gyrus	-50x-22x12	7.56	5.71	8.05
75% insular cortex	-42x-2x0	0.00	11.03	0.00
36% insular cortex	-42x-6x8	0.00	11.68	0.00
22% insular cortex	46x2x-4	0.00	11.61	0.00
59% central opercular cortex	50x-2x8	0.00	8.94	0.00

All the contrasts between positive brands versus indifferent brands, fictitious logos, and non-emotional words are significantly positive, although some are close to the cutting threshold. For independent component 33 the contrast between positive brands and the fixation cross is significantly positive, although close to the threshold, but the same contrast in independent component 36 is not significant.

Independent component 33 represents a network that has a preponderance of right hemisphere structures, and includes the right pars opercularis, right insular cortex, right superior temporal gyrus, right planum polare, left and right planum temporale, right superior parietal lobule, left and right anterior and posterior supramarginal gyri, right central opercular cortex, left and right parietal operculum cortices, and anterior cingulate gyrus. Table 28 lists the *z* statistics of local maxima voxels belonging to cluster 8 in Table 15. All of them are strongly represented in this network. Table 28 also lists the *z* statistics for the same voxels but in the independent component 9, and all are negative (with the exception of the voxel 41% parietal operculum cortex which is null).

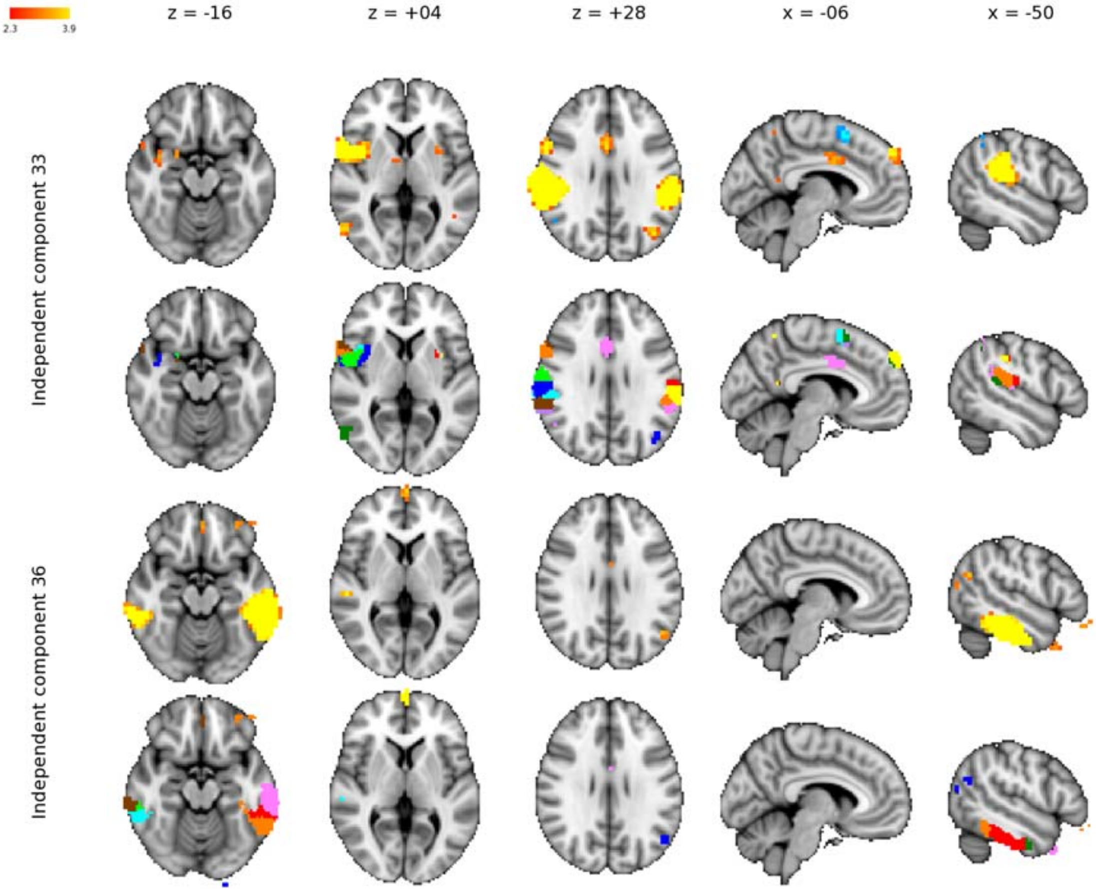


Figure 49 - Independent components 33 and 36 fMRI maps for the multivariate analysis in the axial (z = -16, +04, and +28) and sagittal (x = -06, and -50) planes (statistical parametric maps produced by MELODIC). For each independent component, top row depicts z statistics (activations and deactivations) and the bottom row depicts the same brain regions but individualised with different colours. Radiological convention; MNI152 coordinates.

The independent component 9 represents a network that clearly deactivates for positive assessments when compared with indifferent and fictitious votes (contrasts between positive versus indifferent and fictitious logos with a *z* statistic of -22.87 and -32.93, respectively). Also, positive votes do not significantly differentiate from the baselines (contrasts between positive versus fixation cross and non-emotional words with a *z* statistic of -1.54 and -0.92, respectively). In fact, independent component 9 is the reverse of independent component 17, with strong activations in the motor and somatosensory cortices of the right hemisphere. As the options for *indifferent* and

Table 26 - Composition of the networks represented in independent component 33 which correlate with the process of brands preference (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 33 act		IC 33 deact	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%
Frontal pole ventral left	2617	0	0.0%	0	0.0%
Frontal pole ventral right	3475	28	0.8%	0	0.0%
Frontal pole dorsal medial	5884	121	2.1%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	0	0.0%
Frontal pole dorsal right	5729	28	0.5%	0	0.0%
Frontal medial cortex	1539	0	0.0%	0	0.0%
Subcallosal cortex	2080	1	0.0%	0	0.0%
Paracingulate gyrus	4095	2	0.0%	17	0.4%
Frontal orbital cortex left	2105	0	0.0%	0	0.0%
Frontal orbital cortex right	1931	21	1.1%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	0	0.0%
Frontal operculum cortex right	500	24	4.8%	0	0.0%
IFG pars triangularis left	1147	0	0.0%	0	0.0%
IFG pars triangularis right	1170	0	0.0%	0	0.0%
IFG pars opercularis left	1205	0	0.0%	0	0.0%
IFG pars opercularis right	1130	328	29.0%	0	0.0%
Superior frontal gyrus	8861	170	1.9%	47	0.5%
Middle frontal gyrus left	4331	0	0.0%	0	0.0%
Middle frontal gyrus right	4090	20	0.5%	8	0.2%
Precentral gyrus left	7083	0	0.0%	32	0.5%
Precentral gyrus right	6884	700	10.2%	106	1.5%
Juxtapositional cortex	2282	55	2.4%	56	2.5%
Insular cortex left	1302	37	2.8%	0	0.0%
Insular cortex right	1252	308	24.6%	0	0.0%
Temporal pole left	3643	0	0.0%	0	0.0%
Temporal pole right	3801	212	5.6%	0	0.0%
InferiorTemporalGyrus – anterior left	592	0	0.0%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	0	0.0%	0	0.0%
ITG – temporo-occipital left	981	0	0.0%	0	0.0%
ITG – temporo-occipital right	1232	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior left	642	0	0.0%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior right	1653	0	0.0%	0	0.0%
MTG – temporo-occipital left	1073	3	0.3%	0	0.0%
MTG – temporo-occipital right	1287	36	2.8%	1	0.1%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	18	4.4%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	47	4.2%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	288	24.6%	0	0.0%
Planum polare left	383	0	0.0%	0	0.0%
Planum polare right	369	132	35.8%	0	0.0%
Heschls gyrus left	320	18	5.6%	0	0.0%
Heschls gyrus right	263	12	4.6%	0	0.0%
Planum temporale left	521	256	49.1%	0	0.0%
Planum temporale right	399	286	71.7%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 26 (cont.)

Brain structure	Total	IC 33 act		IC 33 deact	
	voxels	voxels	fraction	voxels	fraction
Temporal fusiform cortex – posterior left	1272	0	0.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior left	826	0	0.0%	0	0.0%
Parahippocampal gyrus – anterior right	1010	16	1.6%	0	0.0%
Parahippocampal gyrus – posterior left	537	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	0	0.0%	0	0.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	0	0.0%
Postcentral gyrus left	4628	264	5.7%	0	0.0%
Postcentral gyrus right	4080	659	16.2%	138	3.4%
Superior parietal lobule left	1737	62	3.6%	0	0.0%
Superior parietal lobule right	1712	306	17.9%	0	0.0%
Supramarginal gyrus – anterior left	1248	557	44.6%	0	0.0%
Supramarginal gyrus – anterior right	1064	972	91.4%	0	0.0%
Supramarginal gyrus – posterior left	1414	150	10.6%	106	7.5%
Supramarginal gyrus – posterior right	1529	1129	73.8%	0	0.0%
Angular gyrus left	1113	0	0.0%	21	1.9%
Angular gyrus right	1675	221	13.2%	76	4.5%
Central opercular cortex left	967	126	13.0%	0	0.0%
Central opercular cortex right	850	328	38.6%	0	0.0%
Parietal operculum cortex left	565	449	79.5%	0	0.0%
Parietal operculum cortex right	505	386	76.4%	0	0.0%
Precuneous cortex	7844	109	1.4%	22	0.3%
Lateral occipital cortex – superior left	5903	128	2.2%	0	0.0%
Lateral occipital cortex – superior right	5899	79	1.3%	64	1.1%
Lateral occipital cortex – inferior left	2814	0	0.0%	0	0.0%
Lateral occipital cortex – inferior right	3311	138	4.2%	4	0.1%
Cuneal cortex	1743	0	0.0%	0	0.0%
Supracalcarine cortex	424	0	0.0%	0	0.0%
Intracalcarine cortex	2211	0	0.0%	0	0.0%
Lingual gyrus	5360	2	0.0%	0	0.0%
Occipital fusiform gyrus left	1407	14	1.0%	0	0.0%
Occipital fusiform gyrus right	1459	0	0.0%	0	0.0%
Occipital pole	9658	0	0.0%	0	0.0%
Cingulate gyrus – anterior	4144	719	17.4%	0	0.0%
Cingulate gyrus – posterior	4495	240	5.3%	2	0.0%
Pallidum left	312	0	0.0%	0	0.0%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	20	2.2%	0	0.0%
Putamen right	800	0	0.0%	0	0.0%
Caudate left	572	0	0.0%	0	0.0%
Caudate right	515	0	0.0%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%
Accumbens right	86	1	1.2%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%
Amygdala right	399	16	4.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	1	0.1%	0	0.0%
Total	199998	10243	5.1%	700	0.4%

Note - act: activations; deact: deactivations.

Table 27 - Composition of the networks represented in independent component 36 which correlate with the process of brands preference (voxels 2 × 2 × 2 mm).

Brain structure	Total	IC 36 act		IC 36 deact	
	voxels	voxels	fraction	voxels	fraction
Frontal pole ventral medial	3981	0	0.0%	0	0.0%
Frontal pole ventral left	2617	157	6.0%	0	0.0%
Frontal pole ventral right	3475	0	0.0%	0	0.0%
Frontal pole dorsal medial	5884	56	1.0%	0	0.0%
Frontal pole dorsal left	4214	0	0.0%	0	0.0%
Frontal pole dorsal right	5729	0	0.0%	0	0.0%
Frontal medial cortex	1539	52	3.4%	0	0.0%
Subcallosal cortex	2080	12	0.6%	0	0.0%
Paracingulate gyrus	4095	4	0.1%	0	0.0%
Frontal orbital cortex left	2105	0	0.0%	0	0.0%
Frontal orbital cortex right	1931	19	1.0%	0	0.0%
Frontal operculum cortex left	562	0	0.0%	0	0.0%
Frontal operculum cortex right	500	0	0.0%	0	0.0%
IFG pars triangularis left	1147	0	0.0%	0	0.0%
IFG pars triangularis right	1170	0	0.0%	0	0.0%
IFG pars opercularis left	1205	0	0.0%	0	0.0%
IFG pars opercularis right	1130	0	0.0%	0	0.0%
Superior frontal gyrus	8861	0	0.0%	0	0.0%
Middle frontal gyrus left	4331	0	0.0%	0	0.0%
Middle frontal gyrus right	4090	0	0.0%	0	0.0%
Precentral gyrus left	7083	0	0.0%	0	0.0%
Precentral gyrus right	6884	0	0.0%	0	0.0%
Juxtapositional cortex	2282	0	0.0%	0	0.0%
Insular cortex left	1302	0	0.0%	0	0.0%
Insular cortex right	1252	0	0.0%	0	0.0%
Temporal pole left	3643	77	2.1%	0	0.0%
Temporal pole right	3801	29	0.8%	0	0.0%
InferiorTemporalGyrus – anterior left	592	119	20.1%	0	0.0%
InferiorTemporalGyrus – anterior right	511	0	0.0%	0	0.0%
InferiorTemporalGyrus – posterior left	1699	1352	79.6%	0	0.0%
InferiorTemporalGyrus – posterior right	1709	406	23.8%	0	0.0%
ITG – temporo-occipital left	981	440	44.9%	0	0.0%
ITG – temporo-occipital right	1232	250	20.3%	0	0.0%
MedialTemporalGyrus – anterior left	642	156	24.3%	0	0.0%
MedialTemporalGyrus – anterior right	657	0	0.0%	0	0.0%
MedialTemporalGyrus – posterior left	1616	816	50.5%	0	0.0%
MedialTemporalGyrus – posterior right	1653	253	15.3%	0	0.0%
MTG – temporo-occipital left	1073	327	30.5%	0	0.0%
MTG – temporo-occipital right	1287	44	3.4%	0	0.0%
SuperiorTemporalGyrus – anterior left	394	0	0.0%	0	0.0%
SuperiorTemporalGyrus – anterior right	405	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior left	1106	0	0.0%	0	0.0%
SuperiorTemporalGyrus – posterior right	1172	20	1.7%	0	0.0%
Planum polare left	383	0	0.0%	0	0.0%
Planum polare right	369	0	0.0%	0	0.0%
Heschls gyrus left	320	0	0.0%	0	0.0%
Heschls gyrus right	263	0	0.0%	0	0.0%
Planum temporale left	521	0	0.0%	0	0.0%
Planum temporale right	399	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior left	517	0	0.0%	0	0.0%
Temporal fusiform cortex – anterior right	545	0	0.0%	0	0.0%

Table 27 (cont.)

Brain structure	Total voxels	IC 36 act voxels	IC 36 act fraction	IC 36 deact voxels	IC 36 deact fraction
Temporal fusiform cortex – posterior left	1272	394	31.0%	0	0.0%
Temporal fusiform cortex – posterior right	1214	42	3.5%	0	0.0%
Parahippocampal gyrus – anterior left	826	3	0.4%	0	0.0%
Parahippocampal gyrus – anterior right	1010	0	0.0%	0	0.0%
Parahippocampal gyrus – posterior left	537	4	0.7%	0	0.0%
Parahippocampal gyrus – posterior right	398	0	0.0%	0	0.0%
Temporal occipital fusiform cortex left	871	29	3.3%	0	0.0%
Temporal occipital fusiform cortex right	1105	0	0.0%	0	0.0%
Postcentral gyrus left	4628	0	0.0%	0	0.0%
Postcentral gyrus right	4080	0	0.0%	0	0.0%
Superior parietal lobule left	1737	0	0.0%	0	0.0%
Superior parietal lobule right	1712	0	0.0%	0	0.0%
Supramarginal gyrus – anterior left	1248	0	0.0%	0	0.0%
Supramarginal gyrus – anterior right	1064	0	0.0%	0	0.0%
Supramarginal gyrus – posterior left	1414	0	0.0%	0	0.0%
Supramarginal gyrus – posterior right	1529	0	0.0%	0	0.0%
Angular gyrus left	1113	0	0.0%	0	0.0%
Angular gyrus right	1675	0	0.0%	0	0.0%
Central opercular cortex left	967	0	0.0%	0	0.0%
Central opercular cortex right	850	0	0.0%	0	0.0%
Parietal operculum cortex left	565	0	0.0%	0	0.0%
Parietal operculum cortex right	505	0	0.0%	0	0.0%
Precuneous cortex	7844	0	0.0%	0	0.0%
Lateral occipital cortex – superior left	5903	85	1.4%	0	0.0%
Lateral occipital cortex – superior right	5899	0	0.0%	0	0.0%
Lateral occipital cortex – inferior left	2814	53	1.9%	0	0.0%
Lateral occipital cortex – inferior right	3311	0	0.0%	0	0.0%
Cuneal cortex	1743	0	0.0%	0	0.0%
Supracalcarine cortex	424	4	0.9%	0	0.0%
Intracalcarine cortex	2211	4	0.2%	0	0.0%
Lingual gyrus	5360	0	0.0%	0	0.0%
Occipital fusiform gyrus left	1407	0	0.0%	0	0.0%
Occipital fusiform gyrus right	1459	0	0.0%	0	0.0%
Occipital pole	9658	89	0.9%	0	0.0%
Cingulate gyrus – anterior	4144	20	0.5%	0	0.0%
Cingulate gyrus – posterior	4495	0	0.0%	0	0.0%
Pallidum left	312	0	0.0%	0	0.0%
Pallidum right	266	0	0.0%	0	0.0%
Putamen left	923	0	0.0%	0	0.0%
Putamen right	800	0	0.0%	0	0.0%
Caudate left	572	1	0.2%	0	0.0%
Caudate right	515	0	0.0%	0	0.0%
Accumbens left	111	0	0.0%	0	0.0%
Accumbens right	86	0	0.0%	0	0.0%
Amygdala left	390	0	0.0%	0	0.0%
Amygdala right	399	0	0.0%	0	0.0%
Hippocampus left	921	0	0.0%	0	0.0%
Hippocampus right	772	0	0.0%	0	0.0%
Total	199998	5317	2.7%	0	0.0%

Note - act: activations; deact: deactivations.

Table 28 – Statistic *z* in independent components 9 and 33 from the multivariate analysis, of selected voxels from the GLM analysis.

Brain structure	Coordinates MNI152	Independent component 9	Independent component 33
34% anterior supramarginal gyrus	62x-34x40	-3.31	16.36
64% posterior supramarginal gyrus	62x-38x36	-3.41	15.28
30% anterior supramarginal gyrus	62x-34x36	-3.94	18.44
41% parietal operculum cortex	62x-26x20	0.00	17.72

unknown were recorded by the button box in the left hand, logically the contralateral hemisphere produces strong activations in the motor cortex. It is worth to note that the option for votes that are opposite to preferences (indifferent and fictitious) involves focal deactivations of the contralateral (right) supramarginal gyrus, and the same locus (still the right supramarginal gyrus) strongly participates, but now actively, in votes for positive brands.

Independent component 36 includes preferentially brain structures from the ventral lobules, and encompasses the left anterior inferior temporal gyrus, left and right posterior inferior temporal gyrus, left and right temporo-occipital part of the inferior temporal gyrus, left anterior medial temporal gyrus, left and right posterior medial temporal gyrus, left temporo-occipital part of the medial temporal gyrus, and left posterior temporal fusiform cortex.

Both independent components are very scarce in deactivations.

Floating time window analysis of the vmPFC.

In this analysis, the 6 seconds time window is split in two: before the decision instant (and the decision instant is the very moment when the button is pressed to record a vote; these cases are marked with the suffix b), and after the decision instant until the 6 seconds exposure limit (these cases are marked with the suffix a). The same four foci in the ventro-medial prefrontal cortex considered in Figure 41 were reanalyzed with this strategy (detailed in Appendix C) and the respective graphs are depicted in Figure 50.

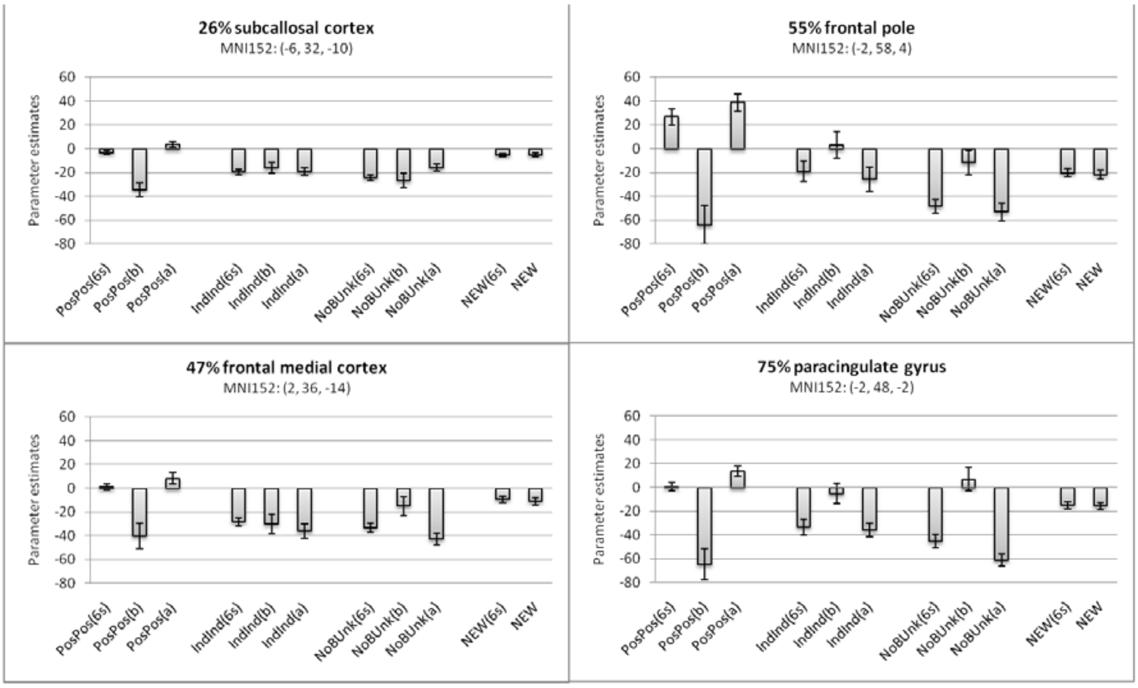


Figure 50 - Parameter estimates for the stimuli in the same four local maxima as in Figure 41. The baseline for comparison is the fixation cross. The bar graphs identified with the suffix (6s) are the conventional GLM-based analysis of fMRI data as in Figure 41. The bar graphs identified with the suffix (b) refer to the participation of the voxel before the decision instant (i.e. before button pressing). The bar graphs identified with the suffix (a) refer to the participation after the decision instant but before the stimulus offset MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

For the second baseline (NEW) there are not significant differences between the two analyses. The same happens for the more caudal voxels (subcallosal and frontal medial cortices) for indifferent and fictitious logos. However, in the more rostral foci (frontal pole and ventral paracingulate gyrus) and for indifferent and fictitious logos there are not significant differences with the fixation cross before the decision instant, but there are significant deactivations after the decision.

Conversely, the pattern for positive brands is similar along the four foci, although some differences in magnitude. Unexpectedly, when the contrast is the fixation cross, there is a clear deactivation before the decision instant and activation (not always with significance) after the decision instant.

The analysis of the *z* statistical parametric maps comes in support of this unexpected finding. In Figure 51 it is possible to verify that only the paracingulate gyrus, superior frontal cortex, and the frontal orbital cortex activate more for the processes before the decision instant than after such moment. The ventral medial prefrontal cortex is clearly blue, which is a signal that its activation is greater after the decision.

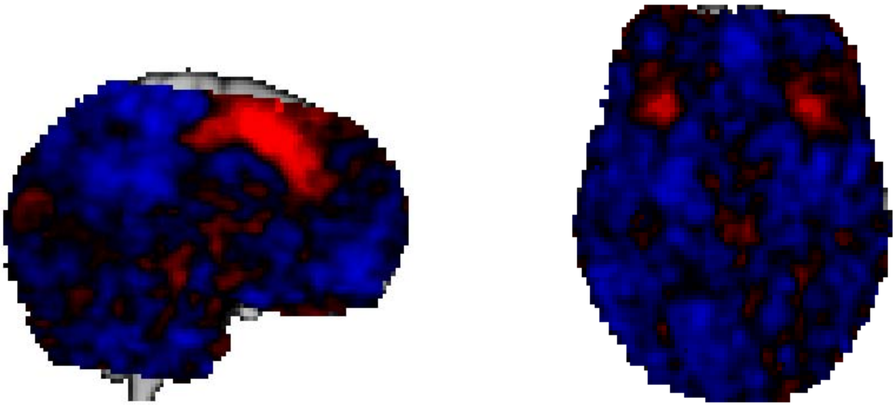


Figure 51 - FMRI *z* statistic maps for the contrast between positive before versus positive after the decision instant in the sagittal plane x = -04 (left pane) and in the axial plane z = -10 (right pane). Statistical parametric maps produced by FEAT. The colour code is the same as in Figure 42. Radiological convention; MNI152 coordinates.

As it is possible to see in Figure 50, error bars are much longer in the floating time-window analysis, which means that the variation is much larger. Nevertheless, this increased variability in the data due to the time-window splitting is not sufficient to perturb and turn null the *t* and *z* statistical tests.

The TR used in this experiment was 3000 milliseconds and 96.3% of positive brands appraisals felt inside this window; 79.2% and 78.9% were the values for indifferent and fictitious logos, respectively. This means that the decision-making psychological processes were faster than the scanner acquisition. Acknowledging that interpolation is intensively used to centre in time the acquired slices, this mathematical procedure had some influence in these results, which is not fully understood.

It was searched for justifications that could explain the unexpected deactivation before button pressing, followed for activation in the post-button pressing period, for positive rated brands, but neither for indifferent brands nor fictitious logos. One possible cause could be a manifestation of the default network (also known by resting state network). In this analysis it was used the definition of default network (DN) proposed by Andrews-Hanna, Reidler, Sepulcre, Poulin, and Buckner (2010). Figure 52, Figure 53, and Figure 54 represent the graphs with the parameter estimates, respectively for the two hubs of the DN, for the dMPFC subsystem, and for the MTL subsystem.

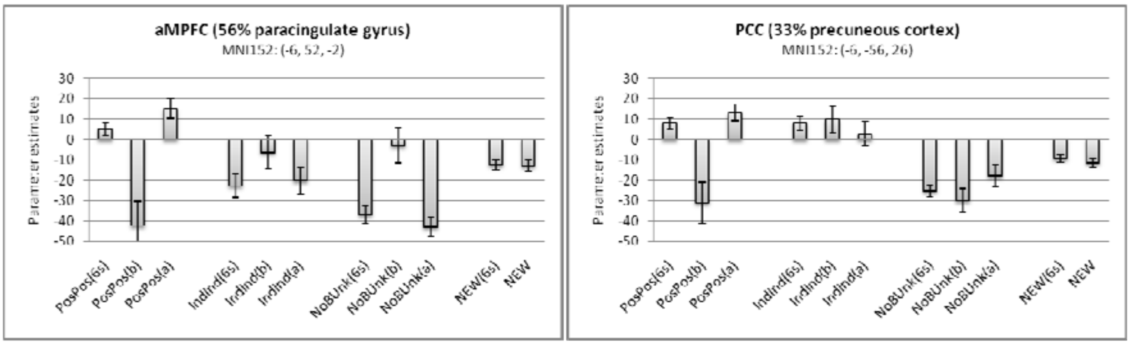


Figure 52 - Parameter estimates for the stimuli in the default network hubs (aMPFC and PCC) proposed by Andrews-Hanna et al. (2010). The baseline for comparison is the fixation cross. The bar graphs identified with the suffix (6s) are the conventional GLM-based analysis of fMRI data. The bar graphs identified with the suffix (b) refer to the participation of the voxel before the decision instant (i.e. before button pressing). The bar graphs identified with the suffix (a) refer to the participation after the decision instant but before the stimulus offset MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

For positive rated brands the previously reported unexpected results (i.e. significant deactivation in the period between stimulus onset and decision moment – button pressing – and significant activation in the period between decision moment and stimulus extinction) is similarly reproduced for both hubs. For indifferent brands and

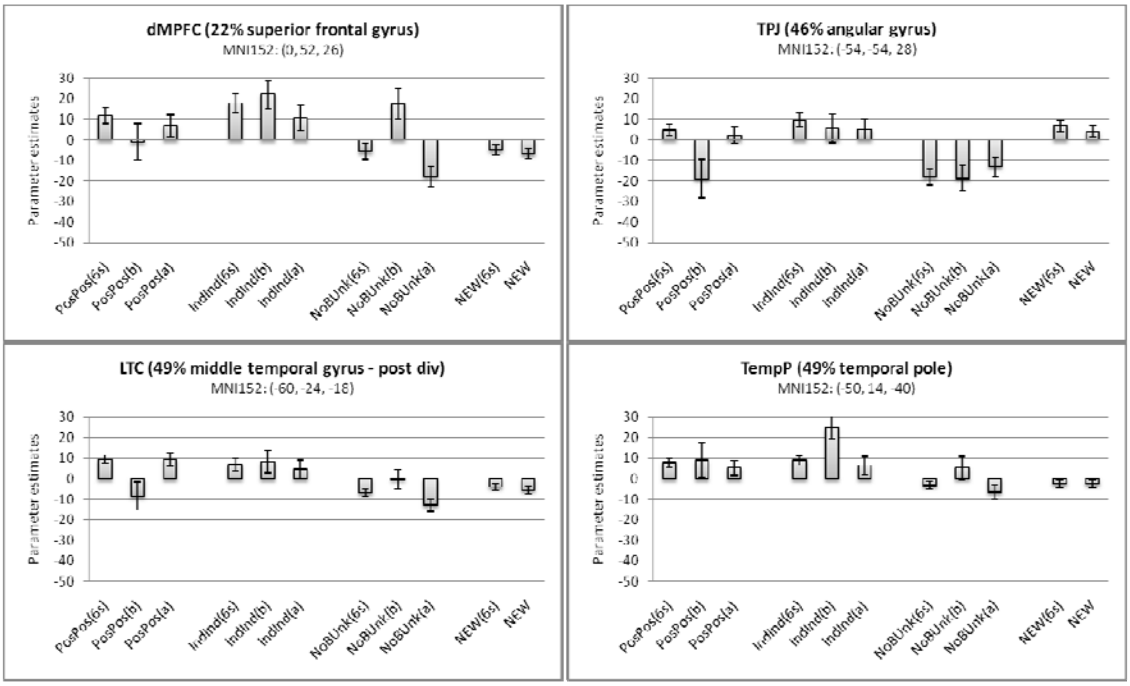


Figure 53 - Parameter estimates for the stimuli in the default network dMPFC subsystem proposed by Andrews-Hanna et al. (2010). The baseline for comparison is the fixation cross. The bar graphs identified with the suffix (6s) are the conventional GLM-based analysis of fMRI data. The bar graphs identified with the suffix (b) refer to the participation of the voxel before the decision instant (i.e. before button pressing). The bar graphs identified with the suffix (a) refer to the participation after the decision instant but before the stimulus offset MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

fictitious logos, or there is not a significant difference between before and after the decision moment, or the deactivation is after button pressing (i.e. still reproducing the same findings).

It is not possible to assert the same thing in either DN subsystems. As is verifiable both in Figure 53 and in Figure 54, the diverse elements that compose each subsystem show elusive behaviours. For positive rated brands there are voxels where there is a deactivation in the first period followed by an activation, but also happens the reverse. For indifferent brands and fictitious logos the report is similar, i.e. with elusive situations.

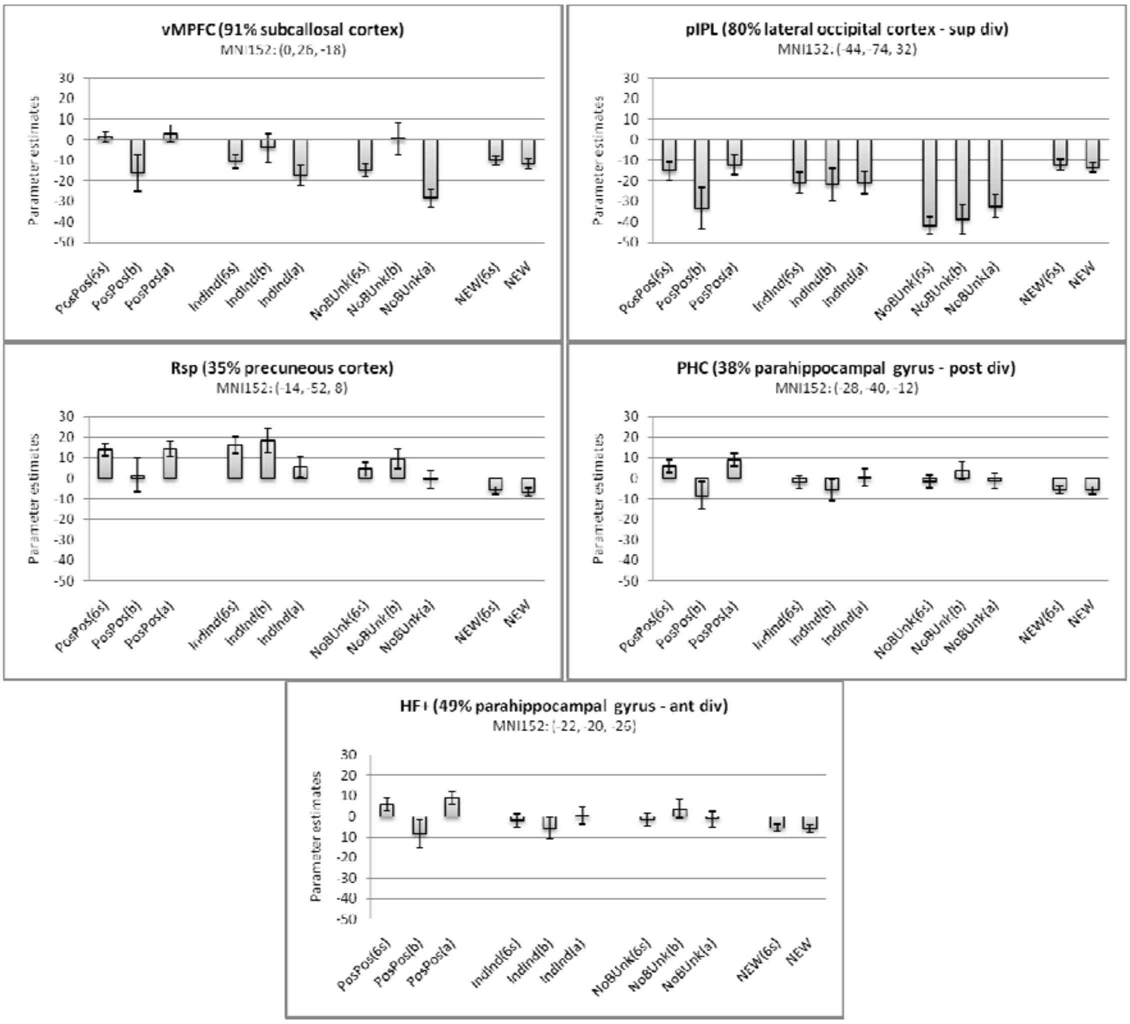


Figure 54 - Parameter estimates for the stimuli in the default network MTL subsystem proposed by Andrews-Hanna et al. (2010). The baseline for comparison is the fixation cross. The bar graphs identified with the suffix (6s) are the conventional GLM-based analysis of fMRI data. The bar graphs identified with the suffix (b) refer to the participation of the voxel before the decision instant (i.e. before button pressing). The bar graphs identified with the suffix (a) refer to the participation after the decision instant but before the stimulus offset MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

The independent components that resulted from the multivariate analysis reported in the previous section were also searched for a possible representation of the DN proposed by Andrews-Hanna et al. (2010). For a representation of the DN the criterion was a necessary activation in both hubs, together with a necessary activation in at least one subsystem. The full list is reproduced in Table 29.

Table 29 – Search in the output ICs for activations and deactivations in brain structures that compose the DN.

			dMPFC subsystem					MTL subsystem					
IC	aMPFC	PCC	dMPFC	TPJ	LTC	TempP	Active?	vMPFC	pIPL	Rsp	PHC	HF+	Active?
1	0.00	0.00	0.20	0.00	0.00	0.00		0.00	0.00	0.00	2.00	0.05	
2	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	-0.01	
3	0.00	0.00	0.00	0.00	-0.02	0.00		0.00	0.00	0.00	0.00	0.00	
4	0.00	0.00	0.00	0.00	0.27	0.00		0.00	0.00	0.00	-0.01	0.00	
5	0.00	0.00	0.00	0.00	0.29	0.00		0.00	0.00	0.00	0.00	0.00	
6	0.00	0.00	0.00	-0.07	0.00	0.00		0.00	-2.23	0.00	0.04	0.00	
7	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	-0.13	-0.26	0.00	
8	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
9	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
10	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
11	0.00	0.00	0.00	0.10	0.00	0.00		0.00	0.00	0.00	0.00	0.01	
12	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
13	0.10	0.00	0.82	0.00	0.00	0.00		0.00	0.00	0.42	0.00	0.00	
14	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	3.89	0.35	0.00	
15	0.62	-0.01	0.00	1.19	0.00	0.00		0.00	0.08	0.00	0.08	0.00	
16	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
17	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
18	0.00	0.51	0.52	3.86	0.21	0.00		0.00	8.33	0.00	0.00	0.00	
19	0.00	0.00	0.00	0.03	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
20	0.00	6.15	0.21	0.40	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
21	0.00	0.01	0.00	3.16	0.07	0.00		0.00	8.41	0.33	1.83	0.00	
22	18.98	0.49	7.33	0.00	0.00	0.00		3.67	0.00	0.00	0.00	0.00	
23	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
24	0.99	12.71	0.00	-0.07	0.14	0.00		2.66	5.26	7.68	0.86	0.42	✓
25	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
26	0.71	0.00	-0.30	5.47	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
27	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
28	0.00	0.00	0.00	0.00	-0.36	0.00		0.00	0.00	0.00	0.00	-0.23	
29	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
30	0.01	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
31	0.00	0.82	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
32	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
33	0.00	0.00	0.01	0.19	0.00	0.00		0.00	1.03	0.00	0.00	0.00	
34	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	-0.01	0.00	
35	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
36	0.00	0.00	0.00	0.01	8.45	0.61		0.00	0.00	0.00	0.00	0.00	
37	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
38	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
39	0.00	0.00	0.00	0.00	0.00	0.61		0.00	0.00	0.00	0.00	0.00	
40	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.50	0.03	
41	3.75	3.41	4.80	9.48	0.11	0.11	✓	-0.04	3.26	0.06	0.00	0.00	
42	0.00	0.00	0.00	0.00	0.02	0.00		0.00	0.00	0.00	0.00	0.01	
43	0.05	0.01	0.00	0.49	0.00	0.00		0.00	1.79	0.00	0.26	0.29	
44	0.37	0.00	-0.18	0.00	0.00	0.00		-0.17	0.00	0.07	-0.05	0.00	
45	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	

Table 29 (cont.)

			dMPFC subsystem					MTL subsystem					
IC	aMPFC	PCC	dMPFC	TPJ	LTC	TempP	Active?	vMPFC	pIPL	Rsp	PHC	HF+	Active?
46	0.00	0.00	0.00	0.00	0.00	0.18		0.00	0.00	-0.06	0.00	0.00	
47	0.00	-0.56	0.00	-1.55	0.00	0.00		0.00	2.67	0.04	0.00	0.00	
48	0.00	0.00	0.64	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
49	0.00	0.00	0.00	0.00	0.02	0.00		0.00	0.00	0.00	0.87	0.64	
50	-0.09	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.01	0.00	-0.16	
51	0.00	0.03	0.00	0.00	0.00	0.00		0.00	0.00	1.42	0.00	0.00	
52	0.09	0.00	0.28	0.00	0.00	0.00		0.02	0.74	0.18	0.00	0.00	
53	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	-0.09	0.00	0.00	
54	-0.04	-0.09	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.03	0.00	
55	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
56	0.00	1.14	-0.08	0.00	-0.11	0.00		-0.01	-0.82	0.00	0.00	-0.36	
57	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
58	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
59	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.15	0.93	0.00	
60	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
61	0.00	0.00	0.00	0.01	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
62	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
63	0.12	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
64	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
65	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
66	0.00	0.00	0.00	0.00	0.00	1.02		0.00	0.01	0.00	0.00	0.00	
67	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
68	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
69	0.00	0.69	0.00	0.14	0.39	0.00		0.00	0.03	0.80	0.00	0.00	
70	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.66	0.00	
71	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
72	0.00	0.00	0.00	0.22	0.11	0.00		0.00	0.00	0.00	0.00	2.46	
73	0.00	0.00	0.00	0.00	0.41	1.19		0.00	0.00	0.00	0.00	1.77	
74	0.00	0.00	0.00	0.00	0.00	0.00		0.07	0.00	0.00	0.00	0.00	
75	0.37	0.00	0.00	0.00	0.00	0.00		0.00	0.00	1.69	0.09	0.11	
76	0.00	-0.03	0.00	0.00	0.00	0.00		0.00	0.00	0.45	0.29	0.00	
77	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.46	
78	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	-0.64	
79	0.00	0.00	0.00	0.01	0.00	0.00		0.13	0.00	0.00	0.00	0.00	
80	0.00	0.00	0.00	-0.16	0.00	0.00		0.23	0.10	0.00	0.00	-0.11	
81	0.00	0.00	0.00	0.00	0.00	0.15		0.00	0.00	0.00	0.00	0.02	
82	0.00	0.00	0.00	0.00	0.00	0.00		0.26	0.59	0.00	0.00	0.00	
83	0.00	0.00	0.00	2.64	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
84	0.00	0.00	0.00	0.00	0.00	0.03		0.00	0.00	0.00	0.00	0.00	
85	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
86	0.00	0.00	-0.02	0.00	0.00	0.00		0.00	0.00	0.76	0.00	0.00	
87	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.15	
88	0.00	0.00	0.00	0.00	-0.21	1.90		0.00	0.00	0.01	0.00	0.20	
89	0.63	0.00	0.00	0.00	0.00	0.00		11.53	0.00	0.00	0.00	0.00	
90	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	-0.01	0.94	

Table 29 (cont.)

			dMPFC subsystem					MTL subsystem					
IC	aMPFC	PCC	dMPFC	TPJ	LTC	TempP	Active?	vMPFC	pIPL	Rsp	PHC	HF+	Active?
91	-0.42	0.00	0.00	0.00	0.00	0.00		-0.46	0.00	0.00	0.00	0.00	
92	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
93	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
94	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
95	0.00	0.00	0.58	0.00	0.00	0.00		0.00	0.00	0.00	0.00	-0.23	
96	0.00	0.00	0.00	0.00	0.00	0.00		0.04	0.00	0.01	0.00	0.00	
97	0.06	0.01	0.00	0.00	0.00	0.00		0.00	0.00	0.23	9.97	0.29	
98	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
99	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
100	0.00	0.00	0.00	4.45	0.38	3.24		0.00	0.00	0.00	0.00	0.00	
101	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
102	0.00	0.00	0.00	0.00	0.00	0.00		0.12	0.00	0.00	0.00	0.00	
103	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
104	0.27	0.00	0.00	0.00	0.00	0.00		0.61	0.00	0.00	0.08	0.36	
105	0.00	0.59	0.04	0.02	0.00	0.00		0.00	0.00	1.76	1.18	0.00	
106	0.00	0.00	0.00	0.00	0.00	0.24		0.00	0.00	0.00	0.00	0.10	
107	0.00	0.00	0.00	0.00	0.00	0.00		-0.01	0.00	0.00	0.00	0.00	
108	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
109	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	-0.03	
110	3.05	0.00	0.00	0.00	0.00	0.00		-0.01	0.00	0.00	0.00	0.00	
111	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.58	1.02	8.50	
112	-0.12	-0.02	-0.13	0.00	0.00	0.00		0.00	0.00	-0.13	0.00	0.00	
113	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
114	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
115	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
116	0.00	0.00	0.00	0.00	1.67	0.00		0.00	0.00	0.00	0.00	0.00	
117	0.00	0.00	0.00	0.00	0.00	2.02		0.00	0.00	0.00	0.00	0.00	
118	0.03	0.00	0.01	0.00	0.02	0.00		0.00	0.00	0.00	0.00	0.00	
119	0.00	0.09	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.24	0.00	
120	0.11	0.00	0.00	0.00	0.00	0.00		0.00	0.04	0.00	0.00	0.00	
121	0.00	0.00	0.00	0.00	1.48	0.00		0.00	0.00	0.00	0.00	0.00	
122	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
123	0.00	0.00	0.05	0.00	0.00	0.00		0.00	0.00	0.00	0.06	0.84	
124	0.02	0.00	0.00	0.00	0.00	0.02		0.00	0.00	0.00	0.00	0.00	
125	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
126	0.00	0.00	0.00	0.00	0.00	0.08		0.02	0.00	0.00	0.10	0.08	
127	0.00	0.00	0.01	0.03	0.35	0.30		0.00	0.00	0.00	0.54	0.00	
128	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.09	
129	0.00	0.36	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
130	0.50	0.00	0.00	0.00	0.00	0.00		0.10	0.00	0.13	0.00	-0.25	
131	0.00	0.00	0.00	0.00	0.00	0.00		-0.08	0.00	0.00	0.00	0.00	
132	-0.48	0.00	9.97	0.87	0.06	0.00		-0.18	0.00	0.00	0.00	0.00	
133	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
134	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
135	0.00	0.00	0.00	0.00	0.00	2.20		0.00	0.00	0.00	0.00	0.24	

Table 29 (cont.)

IC	aMPFC	PCC	dMPFC subsystem					MTL subsystem					
			dMPFC	TPJ	LTC	TempP	Active?	vMPFC	pIPL	Rsp	PHC	HF+	Active?
136	0.00	0.42	0.01	0.01	0.00	0.11		0.00	0.00	0.05	0.06	0.00	
137	0.00	0.00	2.57	0.00	0.00	0.00		0.04	0.00	0.00	0.00	0.00	
138	0.00	0.00	0.00	0.00	0.00	-0.60		0.00	0.00	0.00	0.00	0.00	
139	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.20	0.00	0.00	
140	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
141	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
142	0.00	0.00	0.00	0.00	-0.10	0.00		0.01	0.00	0.00	-0.14	-0.02	
143	0.00	0.00	0.00	-0.25	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
144	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
145	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.01	
146	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
147	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
148	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
149	0.04	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
150	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
151	0.00	0.00	0.00	-0.20	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
152	0.00	0.00	0.00	0.00	0.00	3.50		0.00	0.00	0.00	0.00	0.00	
153	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.01	
154	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.09	
155	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	-0.09	
156	0.00	0.00	0.00	0.36	0.20	0.00		0.00	0.00	0.00	0.00	0.00	
157	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
158	0.08	0.00	0.00	0.00	0.00	0.00		0.08	0.00	-0.18	0.00	0.51	
159	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.10	0.00	0.00	0.00	
160	0.00	0.00	0.00	-0.12	0.00	0.00		0.00	0.00	0.00	-0.04	0.01	
161	0.00	0.00	0.00	0.00	0.21	0.00		0.00	0.00	0.00	0.00	0.00	
162	0.00	0.00	0.00	0.00	2.43	6.33		0.00	0.00	0.00	0.00	0.00	
163	0.00	0.03	0.00	0.00	0.00	0.00		0.00	0.01	0.88	0.04	0.00	
164	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.24	

Note – from left to right: aMPFC – anterior medial prefrontal cortex; PCC – posterior cingulate cortex; dMPFC – dorso medial prefrontal cortex; TPJ – temporo-parietal junction; LTC – lateral temporal cortex; TempP – temporal pole; vMPFC – ventro medial prefrontal cortex; pIPL – posterior inferior parietal lobule; Rsp – retrosplenial cortex; PHC – parahippocampal cortex; HF+ - hippocampal formation.

As it results from the analysis of Table 29, only two independent components respond affirmatively to the establish criteria: IC 24 (which activates in both hubs and in all elements of the MTL subsystem), and IC 41 (which activates in both hubs and in all elements of the dMPFC subsystem). In Figure 55 the parameter estimates of a GLM fit between the 25 explanatory variables (see Appendix C for details) and the timecourses of these two independent components are plotted.

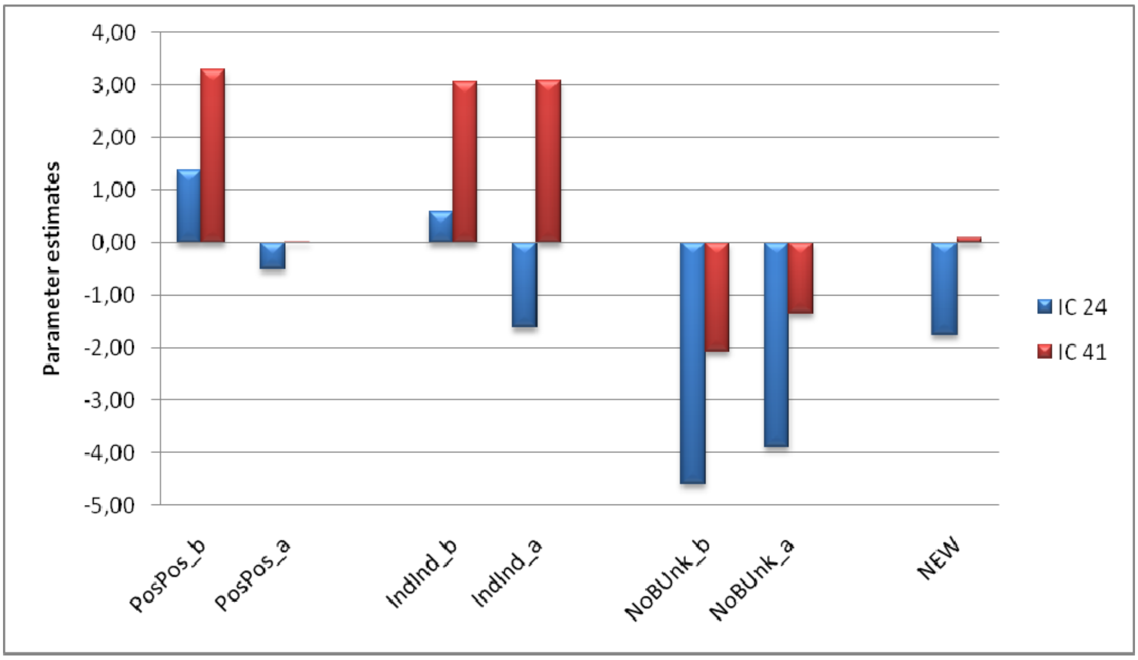


Figure 55 – Parameter estimates of the GLM fit for the 25 EVs with the timecourses for ICs 24 and 41. The comparison category is the baseline fixation cross.

In independent component 24 the pattern for positive and indifferent rated brands is similar: the network is more active than the fixation cross until the decision moment (button pressing), and decreases the activity after that moment. It suggests that this network is necessary during the decision period for both cases. In independent component 41 they diverge: the pattern for positive rated brands is similar to independent component 24 but, for indifferent rated brands the IC 41 network remains active even after the decision moment. It suggests that this network is necessary in both cases during the decision period but, after the decision, it decreases activity for positive rated brands, and maintains active for indifferent rated brands.

For fictitious logos the pattern for independent components 24 and 41 is similar. Both networks have decreased activity both before and after the decision moment. This suggests that none of these networks is necessary during fictitious logos appraisal.

Grounding Discussion

Using the SAM and the PAD scale to assess brands.

Although the evaluation of the suitability of using the SAM - self assessment manikin (Bradley & Lang, 2007; Morris, 1995) and the PAD - pleasure, arousal, dominance scale (Mehrabian, 1995; Mehrabian & de Wetter, 1987; Russell & Mehrabian, 1977) in brands' assessments did not figured as top priorities in the present study, in fact they revealed remarkable discriminative power. At least, the two groups that derived from the application of SAM and the PAD scale (see Figure 26) were sufficiently different to produce behavioural dissimilar responses as assessed by the respective response times (see Figure 29), and disparate physiological measures as revealed by the distinct evoked BOLD (blood-oxygen-level dependent) signals during fMRI acquisitions (see Figure 40). The analysis of some examples even suggests that the use of SAM with the PAD scale has more potential in discriminating brands, which may be a trend to investigate in further studies.

It may be expected for brands a V-shape plot in the Pleasure - Arousal matrix, with minimum values in the *arousal* dimension for the neighbourhoods of Pleasure 5, and increasing *arousal* with extreme values for *pleasure* in both directions, similar to the plot of pictures ratings from the IAPS (international affective picture system) database (Bradley & Lang, 2007; Lang, Bradley, & Cuthbert, 2005). Symptomatic is the resemblance of the SAM symbols for Pleasure 5 and Arousal 1. However, the observation of Figure 26 does not support such expectations, although such shape can be perceived in Figure 28, but this plot only considers the votes in the logos of the two main football teams in Portugal (which are examples of not-so-common fracturing brands). Considering not the individual votes, but the votes merged in brands' medians, which is depicted in Figure 27, at most it is possible to perceive a Y-shape plot, but clearly missing the left arm.

The position of the centre of gravity (Pleasure 6 Arousal 5) close to the middle of the matrix reveals a concentration of votes around this zone, and this may account for the bent in the right arm towards the centre. One explanation for this fact derives from the heterogeneity of the two dimensions. While the *arousal* dimension is linear, monotonously increasing from the beginning until the end (from 1 to 9), the dimension *pleasure* begins by the negative extreme (Pleasure 1) that softens until a null pleasure (Pleasure 5), and then increases in pleasantness until the end of the scale (Pleasure 9). As the pleasure dimension was the first to be used during the assessments, this neutral point centred on Pleasure 5 may had moulded similarly the assessments in the *arousal* dimension. One measure to solve this bias is to clearly use the signs "-" and "+" to indicate negative and positive pleasure, e.g. passing from 1 to 9, to -4 to +4.

Unlike the IAPS photos, where pictures with negative pleasure rating will persist in time, the market may screen brands with negative pleasure rating, impeding their subsistence in time. This may explain the absence of rates in the left side of the Pleasure - Arousal matrix in Figure 27, and the scarcity of assessments in the same left side in Figure 26, which leaded to the left amputated Y-shape. However, as demonstrated in Figure 28, votes may exist in this region, but they must be counterbalanced by votes in the other extreme, pushing the median to a null pleasure.

Nonetheless some improvements should take place. Bradley and Lang (2007) already found a correlation between the *pleasure* and *dominance* dimensions for static pictures. Because brands' logos are static pictures too, it was decided not to use the *dominance* dimension. In support of this finding, during exploratory approaches to the study, it was realised also that subjects had difficulty to conceptualise the dominance character in a brand, which meant that dominance assessments underwent subjectivity. Due to these reasons, it was not used the *dominance* dimension and left for a future experiment the study of the real impact of this dimension in brands' assessments. Another improvement for future studies is to remove the blue dots voting possibilities, as there was evidence that the existence of a SAM symbol versus a blue dot introduced bias.

The use of similar but different methods to assess brands in the two sessions could be a source of flaws. Inside the scanner it was imperative the use of a simple and expeditious scale. FMRI experiments do not allow the use of extensive keyboards, due to magnetic interference, and due to be impracticable, as participants are lay down with goggles or with a mirror to observe visual stimuli, which do not let they see the keys. However, this scale may be too much simplistic for brands discrimination, not accounting with the underlying dimensions for an emotion-based decision-making.

It was decided the use of a more elaborated scale (SAM in PAD scale) for stimuli selection purpose. The analysis of the 95% confidence intervals and the predicted probabilities of the multinomial logit model (see Table 5 and Table 6) support this procedure as reliable. Votes in the categories 7, 8, and 9 in the *pleasure* dimension combined with votes in categories 5, 6, 7, 8, and 9 in the *arousal* dimension significantly predicted more a positive assessment than an indifferent during the scanning session. The same cannot be said about votes in the categories 4, 5, and 6 of the *pleasure* dimension combined with votes in the categories 2, 3, and 4 of the *arousal* dimension, which predict more the reference category: indifferent. It may be then asserted the correspondence between the two assessments, i.e. positive votes are those with higher pleasure and arousal, whereas indifferent votes are those with undetermined pleasure (i.e. not pleasuring and not unpleasuring) and lower arousal.

Between the two sessions, 93.7% of positive brands maintained the same rating, whereas 87.9% of the fictitious logos were voted as *unknown*. For indifferent brands, 67.8% maintained the same rating, which translates a more prominent volatility within this group. These results fit well in a wealth of literature that supports the existence of consideration sets, or evoked sets (Petrof & Daghfous, 1996; Shocker, et al., 1991), were decisions about brands are made by comparing with a collection of selected brands, for which shortcuts may be already established, narrowing deviation in choices. Decisions about brands that fall out of the consideration set may be more prone to contextual circumstances (e.g. individual’s momentary mood) and it is like that they show increased variance. It may be of interest to study in the future how subjects assess the same brands along time, and if variations as those revealed in the present study are sufficient and significant to disentangle between preferred brands and the remaining.

Reaction time is enough to detach positive brands from the remaining.

The analysis of the behavioural results makes evident that positive and indifferent brands are different phenomena. The assessment of each brand in a one at a time basis is enough to produce significant differences in the reaction time. The examination of Figure 29 together with the statistical computations leads to the conclusion that the assessment of positive brands is significantly different from the assessments of indifferent brands or the non-recognition of fictitious logos, and these facts suggest that the assessment of positive brands may rely on disparate cognitive processes. These facts and suggestions come in support of consideration sets. It is like that positive brands are those that each individual is prone to accept. Thus, there is an a priori predisposition towards such brands, which may shortcut favourable evaluations about them. Hence, when subjects are faced with their logos, the answers are ready to provide. In the other side, indifferent brands and fictitious logos require more brain processing time, because it may not exist a predisposition towards the brand, or it may happen that the logo is being minutely scrutinized, which introduces a delay in the decision process.

It should also account for other possible explanations for this finding, which may be artefacts of the paradigm. For example, the buttons used to record *indifferent* and *unknown* votes were pushed with the left hand, while the buttons for *positive* or *negative* votes were pushed by the right hand. Acknowledging that all the subjects were right-handed this could had introduced a bias towards right hand answers, i.e. favouring *positive* and *negative* votes, although such scenario is unlike to persist consistently during all the scanning session and consistently for all participants. In future studies this question may be addressed, for example counterbalancing the hand that gives positive responses.

Multi-baselines in fMRI experiments on brands.

The use of low-level high-contrasting multi-baselines revealed the extensive participation of brain structures during brands and logos appraisal. This finding gives support to the complex cognitive processes that underlie the perception of brands, since their primary detection in visual brain regions until diverse associative areas in the frontal, temporal, and parietal lobes.

Matthews et al. (2003) already cautioned against the interpretations and conclusions derived from high order contrasts in fMRI studies. High order contrasts have been preferred as they seem able to narrow the research question into an atomic level, isolating the very elementary component, which should allow the conclusion that the queried brain structure participates (or not) in such specific brain process. However, fMRI only gives correlation maps, and it may happen that activation in a high order contrast does not signify that the activated brain structure participates in the first condition but not in the other one (an example with results from the present study is the activation of the frontal pole in the contrast indifferent versus fictitious logos – see columns z = +04 and x = -06 in Figure 36 – but the analysis of the parameter estimates just reveals a lesser negative parameter estimate for the indifferent brands than for the fictitious logos – see top left graph in Figure 41). The analysis of low level contrasts and the peristimulus hemodynamic responses should provide a more solid basis to conclude about the participation (or not) of the brain structure in the task.

Returning to the core of the present study, the simple analysis of the contrast between positive rated brands versus the indifferent ones may induce biased conclusions about the participation of brain structures. The extensive activation of brain structures revealed by the data in Table 8, Table 9, and Table 10 suggest that it is needed to contrast with low level baselines to better understand the complex process that brands perception is and to support the conclusion for a participation (or not) of the brain structure. Even more, analysing the data from Table 8, Table 9, and Table 10 and from Figure 30, Figure 31, and Figure 32 it is possible to conclude that complex processes, like brands' perception are, deserve a multi-baseline paradigm as even low level baselines may disguise the participation of certain brain structures in the global process. For example, the contrast between positive brands and the fixation cross does not reveal the full participation of the ventral midline structures in the prefrontal and parietal cortices, but the contrast with the non-emotional words gives a better idea of the extension (see Figure 30, Figure 35, Figure 39, and Table 8). This aspect is very important as these brain regions were suggested to support generic emotion-based decision making (Bechara, 2004; Bechara & Damásio, 2005; Damásio, 1994) and involving brands in preferences too (Koenigs & Tranel, 2008).

On the other hand, the contrast of logos (any sort of logos) with the non-emotional words does not reveal the participation of the left dorsal frontal pole, left and right frontal operculum cortex, left and right inferior frontal gyrus (pars opercularis and pars triangularis), and left parietal operculum cortex, at least with the extension that the contrast with the fixation cross exposes, (see Table 8, Table 9, Table 10, Figure 30, Figure 31, and Figure 32). Hence, these results support the cautions rose in Yoon's et al. (2006) article concerning baseline contrasts analysis, and suggests that a multi-baseline paradigm is better suited when investigating complex phenomena like brands are.

It even suggests that current used baselines, like the fixation cross, are not the most suitable when emotion-based processes are involved, that positive brands supposedly are. In such cases, the use of non-emotional words as baseline reveals better the role of the brain structures that usually are recruited in such processes, but at the cost of disguising the participation of other brain regions. This is important as the words used in the baseline are supported by symbols (letters in graphemes) and brands were represented by their symbols, i.e. logos like in a logographic writing system. It suggests then that overlaps may exist between logos and words and, although the kinds of words used in the study have not an explicit semantic content like substantives or verbs have, their syntactic role is unquestionable.

Brain regions involved in logos’ appraisal.

The conjunction analysis among the contrasts between every type of logos (positive, indifferent, and fictitious) versus both baselines (fixation cross and non-emotional words) allows concluding about the brain regions that transversally participate in logos appraisal (see Figure 33 and Table 11). The diversity of structures that survived the conjunction screening suggests that several sub-processes may occur. Also, these results extensively support and reinforce previous findings achieved in the course of the present research line, now strengthened by the extra contrast with a different baseline, and enduring the erosion provoked by the introduction of a sharp confounding effect: fictitious logos, i.e. logos that subjects were seeing for the first time in their lives and that did not permit that subjects had the opportunity to rely on previous experiences or benefit from the opinion of peers, to explicit assessments, although maintaining similar appearance, mimicking real brands and their symbols.

From the list of brain regions that activated in all contrasts between logos and baselines a group deserves special attention: the insular cortex, and the frontal orbital cortex (also known as lateral orbitofrontal cortex). This interconnected brain regions (Öngür, Ferry, & Price, 2003; Öngür & Price, 2000; Price, 2008) may form a coherent system in stimuli valuation.

On one hand, the frontal orbital cortex was found to integrate sensorial information (de Araujo, Rolls, Kringelbach, McGlone, & Phillips, 2003; Price, 2008), and represent subjective pleasantness (Kringelbach, et al., 2003), and more general stimuli valences (J. O'Doherty, et al., 2001; Rolls, 2004). It was also found that it has a role in initiating behavioural changes, especially when reversal imposes due to outcomes diverging from expected rewards or in unsteady scenarios (Elliott & Deakin, 2005; Elliott, et al., 2000; John O'Doherty, Critchley, Deichmann, & Dolan, 2003; Windmann, et al., 2006). Small et al. (2007) claim that the frontal orbital cortex must has an integrative role in taste and flavour acting as an high-order processor of pleasantness. There is evidence that in this brain structure stimuli like food or other primary reinforcers overlap (Elliott, Newman, Longe, & Deakin, 2003). It may happened that the frontal orbital cortex originally encoded chemosensory critical information about nutrients in order to insure convenient feeding, and this same system evolved in humans into a more broader purpose, now encoding valences in stimuli other than food (Small, et al., 2007).

On the other hand, the insular cortex was found to provide a subjective perception of the own body state: interoception (Craig, 2002). The interoceptive system is part of a larger organisation involved in homeostasis, i.e. the mechanisms that regulate the body condition in response to internal and external stimuli (Craig, 2002). In the somatic marker hypothesis the perception of the emotion relies on the reading of the own body state, as emotions tend to produce effects on the hormonal and autonomic systems (Bechara & Damásio, 2005; Damásio, 1994). There has been evidence that body states anticipate emotional behavioural responses even beyond conscious awareness (Bechara, et al., 1997). Hence, it was proposed that by consulting the interoceptive system, one has a sensation of the own body, named as feeling, and as the body reflects the witnessed emotions, humans - but not other living beings (Craig, 2009b) - have a system to perceive exterior stimuli, even the abstract ones, that reflects its emotional content. In support of this theory, there is compelling evidence that empathy, the ability of sharing other's experiences and emotions by imagining how it would be in such situation, critically relies on the insular cortex (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003; Singer, et al., 2004).

Then this body of literature supports that these two brain structures, the insular cortex and the frontal orbital cortex, delineate a general system for stimuli assessment that translates into a body language recognised by the brain, the emotional content observed in situations, actors, and objects, i.e. the feeling. According to these theories and the results of the present study (depicted in Figure 33 and listed in Table 11), which largely replicate previous findings, it is suggested that logos are felt in order to be perceived. The emotional content of a logo is then integrated with own goals, producing a subjective perception of it, which the individual may use in order to produce concomitant behavioural responses.

In spite of what has being claimed, in the first study of this research line, it is reported an activation of these same structures only in the explicit run, but not in the implicit run. This result suggests that the mechanism that has been described only actuates when the individual is explicitly aware of the situation, which launch doubts on the effectiveness of deploying information that do not taps directly consciousness like subliminal advertising messages, for example. Recent findings support these results and assign to the anterior insular cortex an important role in awareness (Craig, 2009a). Other studies implicate the insular cortex in the switch between the default-mode network to the central-executive network (Sridharan, Levitin, & Menon, 2008), and lesions in the insula allow leaving addicted behaviours more easily, acknowledging that cigarette craving is a conscious urge (Naqvi, Rudrauf, Damásio, & Bechara, 2007). All these findings imply the insular cortex in conscious awareness. Within this scenario, it is speculated that a brand that is emotion-void may not be capable of triggering awareness and may become transparent (in the sense that it is not noticeable, which means invisible and unremarkable).

The hippocampus and the posterior parahippocampal gyrus are brain structures repeatedly connected with declarative mnemonic memories (Critchley, et al., 2000), and recall (Bailey & Kandel, 2004; Fortin, et al., 2004; Paller & Wagner, 2002). In a study with soda brands the hippocampus was found to participate in the recognising stage (McClure, Li, et al., 2004). In the present study, these brain structures activated consistently in the contrasts between logos and the baselines repeating previous findings. One possible interpretation of this systematic activation is that a logo induces recalling, possibly for past experiences. It is not strange that even fictitious logos activate the hippocampus and the posterior parahippocampal gyrus because to recognise those symbols implicates searching for past experiences with them, both if there was in fact such contact, or if the retrieval is void due to the lack of previous experience. In any case, memories were explored and the supporting brain structures recruited for such work.

The paracingulate gyrus and the anterior cingulate gyrus are brain regions that also survived the conjunction analysis among the six conditions (see Figure 33 and Table 11). In previous studies of this research line, the paracingulate and the anterior cingulate gyri activated both in the implicit and in the explicit run when studying assorted brands' logos, and also activated both for positive and indifferent rated brands. Parts of these structures activated once again for positive and indifferent brands, and also for the fictitious logos, albeit with lesser extension. The participation of the paracingulate gyrus in brands appraisal was considered in the framework of a mentalising process, although other possibilities may be deemed as discussed therefore. The involvement of this region in Theory of Mind (Tom) tasks is recurrent and several studies and reviews have been assigning a critical role to the paracingulate gyrus in meta-representations of mental states (second order representations), i.e. when individuals represent in their own brains the representations that they imagine other individuals have in their respective own brains, expressly their intentions, beliefs, and goals (Amodio & Frith, 2006; Frith, 2007; Frith & Frith, 2006; Gallagher & Frith, 2003; Rilling, et al., 2004; Saxe, 2006).

The proposed involvement of brands in mentalising processes, a relationship that these results repeatedly suggest for a variety of situations (implicit and explicit), brand sorts (positive, indifferent, and fictitious) and low-level contrasts (fixation cross and non-emotional words), can be considered in two different planes. On one hand, brands have an important social role. They are central in promoting the formation of certain social groups and guaranteeing the respective cohesiveness and long-term duration (Cova & Cova, 2002; Moutinho, et al., 2007; Muniz Jr. & O'Guinn, 2001; Veloutsou & Moutinho, 2009). Also, like possessions, they help individuals in their self-construal (Belk, 1988; Elliott & Wattanasuwan, 1998; Escalas & Bettman, 2005). Ahuvia (2005) even stresses how “loved objects”, including brands, structure social relationships. Possessions also contribute to social hierarchical categorisations (Dittmar, 1994; Dittmar & Pepper, 1994). Hence, there is a brands linking minds, or brands supported meta-representational processes in much of social relationships, at least when brands are present in the context. In this plane, as brands synthesise and provide much information about other individuals, they also may trigger brain structures that support meta-representations.

In another plane, but not necessarily mutually excluded, the investigations of Fournier (1998) found that persons establish relationships with brands. Persons and brands, both contribute actively to the initiation, maintenance, and termination of the reciprocal relationship. The accomplishment or violation of the relationship norms, like in a human-to-human relationship, is used by individuals to make impressions about brands (Aggarwal, 2004), and the narratives that consumers draw involving brands with active roles help to tie connections tightly (Escalas, 2004). Thus, brands are brought into a quasi-human level, and this level sanctions brands with emotional, thoughtful, and volitional abilities (Fournier, 1998), which means that it is possible to imagine the intentions, beliefs, and goals of brands, i.e. brands may be themselves the target of the meta-representational processes, and in such case, thinking on brands recruits the participation of the paracingulate gyrus.

In support of this speculation, the paracingulate and the anterior cingulate gyri were found to participate in making judgments about similar and dissimilar others (Mitchell, et al., 2006), which involve meta-representational inferences about the self and others, and more strikingly when forming impressions of persons versus objects (Mitchell, et al., 2004; Mitchell, et al., 2005), i.e. as making impressions of persons and assessing brands both involve the paracingulate and the anterior cingulate gyri and differently and significantly making impressions of objects does not, then persons and brands may be in a similar trait level, but distal from objects. Caution should be taken on this speculation because it may rely on reverse inference (Poldrack, 2006, 2008). Further studies should investigate this question and directly confront persons, brands, and objects impression formation. Nonetheless, the speculation is nomologically acceptable due to the discussed literature that supports the quasi-human level that persons assign to brands and the relationships they establish mutually.

It may be argued that brands are brainless and likewise meta-representational processes are impossible because humans know that they have not agency. But it was already proposed that humans repeatedly interact with other non-biological actors (NBO) although knowing they are mindless (Owens, 2007). This counterintuitive idea is only transiently possible, and the situation necessitates four conditions to exist: first, the NBO has to be perceived as endowed with independent action, whether the human initiated or not such action; second, NBO's actions must challenge human's goals; third, these goals must be important for the human, so important that s/he will actively maintain this untenable situation; forth, the NBO is critical so the human accomplishes with his / her goals. In such cases, humans recognise a mind in NBOs and "do mind" with them. If it is retrieved again the literature that reveals how brands are important in promoting and maintaining human-to-human relationships, in self-construal, in social hierarchical categorisations, and in structuring own life, then it is justifiable that the transient assignment of mind ability to NBOs may tend to be definitive when brands are considered, making meta-representational processes systematically possible. Hence, humans may "do mind" with brands because brands allow the achievement of personal goals and help with frames of reference that contribute to wise life navigation (Holt, 2003).

However, Keysers and Gazzola (2006) justify differently the participation of the paracingulate and anterior cingulate gyri, and more generally the medial prefrontal cortex, in Theory of Mind tasks. These authors propose that the medial prefrontal cortex supports the explicit judgements required by Theory of Mind which happen downstream after the implicit simulationist stage. In their model, the first stage, which is largely implicit and automatic, produces a reflex on the own brain of the actions, emotions, and sensations that are witnessed in others behaviours, i.e. the “shared circuits” produce a simulation in the own brain that translates what is observed into a code that downstream processes can easily read. It is then when there is explicit reflection about the states of minds of others, i.e. when those codes are read, that enters the medial prefrontal cortex, expressing in the conscious plane the intentions and beliefs of other persons.

For these authors the medial prefrontal cortex is an integrative brain structure that produces conscious expressions of the own mental state. Hence, reading own state and reading the state of others relies in the same brain structure, just the later has the intermediary participation of the “shared circuits”. For this reason and within this framework, Theory of Mind tasks have been reporting the activation of the medial prefrontal cortex, not directly because the mental states of others are not being addressed, but indirectly because the medial prefrontal cortex is tackling the effects that others’ actions, emotions, and sensations are producing in our own brain.

This does not deny what was discussed in previous paragraphs. Within this perspective, brands, as quasi-human entities, would induce emotions and sensations, which are first simulated in the own body, and then are read and measured in order to outcome an explicit assessment of them. However, it is reported the activation of the paracingulate and the anterior cingulate gyri, which are medial prefrontal cortex structures, both in the explicit run and also in the implicit run in the first study. This fact challenges this theory because during the implicit run there was not the production of explicit assessments about brands, but does not corrode the proposed in the previous paragraphs where Theory of Mind tasks are admitted to arise implicitly and in such cases both it is admissible that brands' meanings are used when producing meta-representations about other individuals, or that brands, like human beings, may be the target of meta-representations.

Like the hippocampus and the posterior parahippocampal gyrus in the contrasts that involve fictitious logos versus baselines, the previous argument for the activation of memory-related brain structures is extensible to the participation of the paracingulate gyrus. It is not strange that even fictitious logos, which a priori are void in socially relevant meanings due the imposed lack of previous experience with such "brands", activate a brain structure that was proposed to support social tasks like meta-representations. Fictitious logos should not have meanings that derived from social interactions with other individuals, but the brain structure that supports such tasks may be recruited in order to search for that putative information, and then it activates.

However, it is also recognisable that those brain structures activated partially (see Table 11), and it may happen that differently sub-regions of those structures have different roles, for example as was already proposed by Sholz, Triantafyllou, Whitfield-Gabrieli, Brown, and Saxe (2009) for the temporo-occipital junction. In fact, the analysis of Figure 35 exposes such effect within the paracingulate gyrus: dorsal sub-regions are involved with every sort of logos, but ventral sub-regions exhibit a different role, active for positive and indifferent brands viewing, but close to zero for fictitious logos. These findings bring to the discussion that it is admitted that anatomical brain parcelling out and functional brain division overlaps. In fact there is not scientific support for such, even more when the anatomical partition is roughly based in macro observations of gyri, sulci, and fissures. This means that one brain anatomical structure may accounts with several functional divisions as these results suggest.

In a meta-analysis, Amodio and Frith (2006) found that the medial prefrontal cortex could be divided into three functionally different regions: the posterior rostral medial frontal cortex (prMFC) that correlated more with action monitoring and attention, the anterior rostral medial frontal cortex (arMFC) that activated more in emotional tasks or where emotional appraisals were involved together with self-knowledge, person perception, and mentalising, and the orbital medial frontal cortex (oMFC) that these authors linked to outcome monitoring involving rewards or punishments.

These findings integrate well with the present results. In the pictures corresponding to the column for x = -06 of Figure 30, Figure 31, and Figure 32 (cf. also Table 8, Table 9, and Table 10) it is possible to identify large activations that span the anterior cingulate cortex, the dorsal paracingulate gyrus, and the superior frontal gyrus, which fits into the prMFC. Amodio and Frith (2006) link this region to action monitoring and attention and in fact the evaluation of logos is a task that requires attention.

If it is true that the prMFC cortex is involved in decisions requiring attention, then the suggestion from Keysers and Gazzola (2006), where cortical midline structures hold explicit deliberations in Theory of Mind tasks, gains a new support. However, a refinement should be introduced to accommodate the present data and the theories proposed by Keysers and Gazzola (2006), and Amodio and Frith (2006): the dorsal sub-region of the paracingulate gyrus may account with the automatic mentalising processes where inferences are made about the mental states of others (Frith, 2007; Frith & Frith,

2006) – and brands may enter into these processes in two planes as already proposed – which accounts with the systematic activation of this sub-region for every kind of task, explicit or implicit, and stimuli, positive, indifferent or fictitious logos; on the other hand, the superior frontal gyrus may account with attention, which is supported by its activation in explicit tasks, and it is also coherent with the missing of activation in the implicit task. D'Argembeau (2005) found an activation in this region in a task involving reflective work, which supports this suggestion.

However and puzzlingly, the superior frontal gyrus also misses activation in the explicit task of the mixed design study for indifferent assessments, but the particular characteristic of the structure of mixed design studies, where stimulus are presented sequentially without interstimuli intervals, which in turn introduces constant flips in the process that confound attentional processes, may provide a justification.

Corroborating previous findings, the conjunction analysis of the contrasts between every sort of logos and the baselines also revealed the extensive participation of basal ganglia, specifically pallidum, putamen, and caudate. An extensive body of literature maintains that the basal ganglia, and particularly the striatum (which encompasses the caudate and the putamen), together with the dopaminergic system code for rewarding and for prediction errors when a reward is expected (Delgado, Li, Schiller, & Phelps, 2008; Elliott, et al., 2003; Knutson, et al., 2001; Montague, et al., 2006; Seymour & McClure, 2008). However, a study where the participation of the striatum was expected fails in its activation (Schiller, Freeman, Mitchell, Uleman, & Phelps, 2009). The present results do not support the role assigned to the striatum in rewards, as it would be very difficult to sustain that indifferent brands are rewards, and it would be even more unsustainable a similar claim for the fictitious logos. However, during logos appraisal the participants recorded their votes by the means of a button box, i.e. there was physical actions to register the assessments, and basal ganglia traditionally were connected with coding for automatic movements, like riding a bicycle or climbing stairs. This is in line with the proposal of Rolls (2000a, 2004) who maintains the traditional action-related role for the striatum.

Perceiving brands after logos perception.

When contrasting recognised brands (positive and indifferent) versus fictitious logos, it is hypothesised that brain structures that participate in logos recognition and effective meaning extracting are revealed, irrespective of logo’s valence. It is worth to note again that fictitious logos look like current logos of real brands, but were designed just for the present study, ensuring that participants have not any previous contact with those putative “brands”. Thus, such regions should account for previous experiences with the brand, was directly with it, or was via information obtained from the environment (e.g. social), which has produced memory records and concomitant semantic meanings.

The visual cortex and the immediately downstream visual regions in the ventral path almost do not have activations in these contrasts. In fact, such activations were not expected as those areas are essentially primary visual and form recognition processors (Ishai, Ungerleider, & Haxby, 2000; Ishai, Ungerleider, Martin, Schouten, & Haxby, 1999; Wandell, Brewer, & Dougherty, 2005), and the richness of real and fake logos was balanced. However, in the regions that activated, even scarcely (see Figure 36), there was in fact differential participations as it is evinced in Figure 38. The analysis of the reverse contrasts, i.e. fictitious logos versus positive and indifferent brands, shows significant and extensive activations in the visual ventral pathway, mainly in the fusiform gyri (see Figure 37 for column z = -16). These results are surprising and suggest then these earlier processing areas at the visual cortex may have some role in logos differentiation, which must be studied with paradigms purposefully designed to be sensible to such particularities.

The activation that it is reported in the transition between the ventral and dorsal sub-regions of the frontal pole (see the conjunction row for x = - 06 in Figure 36) was also reported in the conjunction analysis of the study where brands were assessed implicit and explicitly, and again in the conjunction analysis between the positive and indifferent covert brands' assessments after explicit instructions were given to the subjects. This systematic activation of the medial axial line of the medial frontal pole puts it forward in brands' appraisal, and this finding now becomes more robust due to the recruitment of the medial frontal pole by positive and indifferent brands' assessments and the missing of recruitment by fictitious logos (see Figure 39). This suggests that the medial frontal pole disentangle recognised from unrecognised logos, irrespective of their valence.

Returning to the meta-analysis from Amodio and Frith (2006), the medial frontal pole fits inside the arMFC. These authors proposed self-knowledge, person perception, and mentalising roles for this region, i.e. constructs that relate with the self and social navigation. In the meta-analysis conducted by Northoff et al. (2006) the ventral cortical midline structures (CMS), which largely encompasses the activation in the medial frontal pole in the present study, was found to participate in the integration of exteroceptive and interoceptive stimuli with respect to their self-referential content. Hence, these authors propose that "(...) these results lend us to suggest that the ventral CMS are involved in coding the self-relatedness of stimuli thereby representing them as self-referential" (p. 451). In the same line, Ochsner et al. (2005) report an activation in the frontal pole very similar to the conjunction depicted in column x = -06 of Figure 36, for the intersection of direct appraisals of self and reflected appraisals of the own self. In a study looking for self correlates in the brain, W. M. Kelley et al. (2002) found a significant activation in the this region, and this same finding was replicated some years later, now extending the participation for explicit and implicit tasks (Moran, Heatherton, & Kelley, 2009). D'Argembeau et al. (2005) also found activations in this area in a self-referential reflective task, which surprisingly was also active during resting. This is in line with the stream of thoughts where the self is central and that take the brain during such states. As such states may arise during the passive viewing of the fixation cross, the graph in Figure 39 sounds logical, with stimuli containing self-referential meanings activating more than the fixation cross, and the fixation cross activating more than stimuli that can be considered self-referential-void (fictitious logos and the covert reading of non-emotional words).

Considering that the medial frontal pole activates more for recognised real brands than for fictitious logos, and considering the role in self and social monitoring that all these neuropsychological studies have been assigning to this brain region, these findings suggest that the medial frontal pole may be a candidate for brands' social dimension decoding and processing the integration with the self-concept.

The precuneous cortex and the posterior cingulate gyrus form part of the posterior cluster to which Northoff et al. (2006) attribute a role in integrating stimuli in a temporal context, linking it to past self-referential experiences that comprise autobiographical memories. In fact, the review of Cavanna and Trimble (2006) also suggests participations of the precuneous in episodic memory retrieval, self-related imagery, and first-person perspective taking. Other studies have been founding the activation of these brain regions in self-referential processes when contrasted with non-self stimulus (W. M. Kelley, et al., 2002; Ochsner, et al., 2005). The activations in these two brain structures is logical in the context of the present paradigm: positive and indifferent brands have some kind of meaning that derived from past experiences with the brand (whether by direct experiences with it, or whether by social communication, herein including advertising, word of mouth and else); however, fictitious logos are meaning-void, because they were specially designed for this study and hence participants could not account on any sort of previous experiences with them. Thus, from the subtraction of both situations results the subjective experience with the brand coded in the self-related imagery.

The angular gyrus and the posterior supramarginal gyrus integrate the temporo-parietal junction (TPJ), another brain region that have been implicated in Theory of Mind tasks (Lindner, Hundhammer, Ciaramidaro, Linden, & Mussweiler, 2008; Saxe & Kanwisher, 2003; Saxe & Wexler, 2005), although this is a matter of debate (Mitchell, 2008) and concomitant response (Scholz, et al., 2009). Possible confounding effects due to attentional processes were outwitted and the TPJ was found to be critical for Theory of Mind tasks (Young, Dodell-Feder, & Saxe, forthcoming). Together with the paracingulate gyrus, these regions were proposed to support the understanding of social intentions (Ciaramidaro, et al., 2007), e.g. perceiving the social hierarchy (Chiao, et al., 2009; Zink, et al., 2008). With transcranial magnetic stimulation (TMS), the right temporo-parietal junction was found to support the sense of the own body (Tsakiris, Costantini, & Haggard, 2008), and with direct brain stimulation the same region evoked the will for conscious intentions (Desmurget, et al., 2009; Desmurget & Sirigu, 2009). It seems then that this brain region is involved in reading the intentions, beliefs and goals of others and differentiate them from own plans, i.e. it is involved in perceiving the agency of other actors that enter in the scene.

The activated network in the present study that encompasses the angular and posterior supramarginal gyri, the medial parietal cortex (precuneous), and the medial prefrontal cortex (frontal pole) is functionally interconnected (Lou, et al., 2004). Even more, these researchers proved causality towards self-relatedness using TMS. Analogous findings for the same network were reported by Jackson, Brunet, Meltzoff, and Decety (2006), emphasising the similarities and distinctiveness in representations of the self and other, which are crucial for empathy-based relationships. Still this same network was found to participate in group discrimination, favouring the in-group at the expenses of the others (Volz, Kessler, & von Cramon, 2009). It is then possible to assign to this network a crucial role in social cognition, specifically in managing self-related issues, integrating with autobiographical memories and imagery, imagining the intentions, beliefs and goals of others, and in doing such, reflectively "(...) scrutinize the propriety of our own conduct" (A. Smith, 1759, Part III, Chap. I, Of the Principle of Self-approbation and of Self-disapprobation).

All these roles integrate well with the contrasts analysed: positive and indifferent brands versus fictitious logos, i.e. meaningful brands versus meaningless logos. The results of the model-free multivariate analysis of the present study gives an extra support for this interpretation, with two independent components corroborating the conjoined and connected participation of the referred brain structures in the recognition of brands with the concomitant differentiation from meaningless logos. The meanings encompassed by known brands may then integrate the idiosyncratic set, which may then be used for self navigation and to understand other actors. At least in Western cultures brands help individuals construct, bent, maintain, and repair their self-concepts, inform about the social environment and there project their selves (Sivanathan & Pettit, forthcoming). Each brand has its own idiosyncrasy (K. W. Miller, 2007) that subjects assimilate and use to nourish their social self-concepts (O'Cass & Frost, 2002).

Conceptually, individuals do not think about brands as they think about trivial objects or animals. These findings suggest that brands are in the same plane and use the same cognitive processes supported by the same brain networks, they think about their confederates, and in this sense, it is proposed that humans have a special cognition toward brands. Phenomena like the problems faced by some companies caught using child labour in their products' manufacturing suggest the existence of a moral dimension in brands, and this moral dimension may be the cause for the differentiation from ordinary objects, as it is the moral ability that humans recognise in their peers which makes them different from objects and animals (Adolphs, 2006). Interestingly, it was found that regions in the human frontal pole are necessary to produce acceptable moral judgements and that their lesion leads to utilitarian-only decisions (Koenigs, et al., 2007). Morality is intrinsically connected to meta-representational processes (Stone, 2006a; Young & Saxe, 2008), as it provides a framework to read and interpret the behaviour of others, humans and (this grounding discussion suggests) brands too.

Neural correlates of preferred brands.

The involvement of the ventro medial prefrontal cortex.

The medial part of the orbitofrontal cortex that is located in the margins of the longitudinal fissure it is also known by ventral medial prefrontal cortex and it is reported in the present study an extensive cluster along this brain region. Since the studies of Damásio (1994) that lead to the theory which links this part of the brain to emotion-based decision-making, a wealth of other studies have been corroborating such findings.

Rolls (2000b) proposes a theory for the emotion-based decision-making that locates at the ventro medial prefrontal cortex the balance for rewards, punishments and personal goals, coding for stimulus – reinforcement associations (Rolls, 2004). This brain structure assumes a critical role in learning and also in the reversal of stereotyped behavioural responses. Subjects exhibiting damages in this region align in stiff persistent behaviours, without reversal when the environmental conditions change, e.g. not changing the preference for a soda even after knowing it is his / her preferred brand (Koenigs & Tranel, 2008).

Three out of four local maxima identified in Figure 41 (paracingulate gyrus, frontal medial cortex, and subcallosal cortex) fall into the orbital medial frontal cortex (oMFC), a subregion that in the meta-analysis of Amodio and Frith (2006) is linked to the "monitoring of task outcomes associated with punishment or reward." (p. 270). The forth local maximum (frontal pole) is in the boundary that separates the oMFC from the arPFC (anterior rostral medial frontal cortex), which these authors (and some others as previously discussed) relate to self-knowledge and mentalising tasks. It is verifiable that the pattern of the respective parameter estimate's graphs is coherent with such distribution, with the positive brands parameter estimate clearly positive in the frontal pole and close to zero in the remaining foci, and the indifferent and fictitious parameter estimates clearly negative for all situations, although there is a significant difference in the negative magnitudes in the frontal pole.

It is admissible that subjects considered positive brands as rewards. It is also admissible that positive brands are self-related, a perspective that is supported for a wealth of literature on brands and consumption products (Ahuvia, 2005; Belk, 1988; Fournier, 1998; Mittal, 2006; Schau & Gilly, 2003; M. Joseph Sirgy, 1982; Sivanathan & Pettit, forthcoming). Recently, Badre and D'Esposito (2009) proposed a hierarchical architecture for the frontal lobe, with more rostral (anterior) areas processing more abstract representations and rules, and more caudal (posterior) areas processing more defined actions, and the former exerting influence over behaviour through the later. In this case, higher level processes in the rostral regions would maintain in time long-term representations, in a certain sense precluding these long-term goals from the enchanting immediacy of environmental stimuli.

Although ventrally, a hierarchical gradient is perceptible in Figure 41, supposedly assigning to more anterior regions (frontal pole) more abstract long-term self-related strategies, which correlate more with positive brands than indifferent or fictitious. These findings put this cluster forward in processing rewards, their self-relatedness, intertwining with other minds from the social arena. As Amodio and Frith (2006) sustain, this is all about reputation, i.e. what one does so the others have a certain image about oneself, or, more simply, the concept of self-reflexive meta-representations. Bringing the words of Adam Smith that equals peers to looking-glasses:

> We suppose ourselves the spectators of our own behaviour, and endeavour to imagine what effect it would, in this light, produce upon us. This is the only looking-glass by which we can, in some measure, with the eyes of other people,

> scrutinize the propriety of our own conduct. (A. Smith, 1759, Part III, Chap. I, Of the Principle of Self-approbation and of Self-disapprobation)

This brain region may then be important for wise social navigation, reading own behaviour in the reactions of others, and maybe this study found a correlate between such processes and brands.

It has been found that patients impaired in the prefrontal cortex also perform worst than normal individuals in a gambling task (Bechara, et al., 1997), and the role of the ventral medial prefrontal cortex was evinced for achieving advantageous decisions for the individual, independently of the working memory (Bechara, et al., 1998). These findings have been repeated and incorporated into a theory that proposes that the ventro medial prefrontal cortex is necessary for the integration of the sensorial information, which conveys information of the moment, with the long-term goals of the subject (Bechara, 2004; Bechara & Damásio, 2005), although the existence of criticism (Maia & McClelland, 2005).

Such brain mechanism would allow individuals to respond accordingly in situations within an acceptable time window, which become known as emotion-based decision-making. In fact, behavioural responses must occur during a constrained time window, and this may have been the object of evolutionary screening, because lengthy decisions, even if they are accurate, may be often surpassed by the flow of the happenings. Hence, decision-making is a time constricted matter, which appeals for non-rational strategies (Gigerenzer, 2001; Todd & Gigerenzer, 2003). Humans have bounded rationality, i.e. the output for a situation is unlike to be calculated like a numeric equation, valuating each argument and optimising the solution (Selten, 2002).

The ventral medial prefrontal cortex would be then the brain structure that integrates the immediate information from the environment together with the objectives of the individual (Deppe, Schwindt, Kramer, et al., 2005), and codes a panoply of behavioural responses ready to apply that may be initiated shortly, without slow pondering.

These results integrate well with these theories of emotion-based decision-making. On one hand, the responses for positive brands were significantly faster than the responses for indifferent brands or fictitious logos. This may be interpreted as positive brands being considered rewards for which the human brain has already coded behavioural actions towards them. In fact, it was found that the ventro medial prefrontal cortex activated significantly more in all contrasts where positive brands were involved, i.e. with both baselines (fixation cross and non-emotional words), versus fictitious logos, and versus indifferent brands. If there is a brain structure that codes and deploys ready-made behavioural strategies that shortens responses, due to the swifter reaction times and due to the systematic activations with all sort of baselines and stimuli, the ventro medial prefrontal cortex is a remarkable candidate.

Bechara, Damásio, Tranel, and Damásio (1997) proposed a dual parallel stream chain for decision-making. One branch, the reasoning, ponders about facts, consider several options and optimise outputs in a time consuming process. In the other branch, the emotional, the decision is shortcut because the process largely relies on emotional experience. Both streams compete for the decision that produces the concomitant behavioural output in a way similar to the proposed by McClure, Laibson, Lowenstein, and Cohen (2004) and discussed by Ainslie and Monterosso (2004). In their study involving preferred (target) versus diverse brands, Deppe, Schwindt, Kugel, Plassmann, and Kenning (2005) found large support for this theory, involving the ventro medial prefrontal cortex among others in the decision for the target brand, together with deactivations in the middle frontal gyrus, a brain structure linked to working memory, planning, and reason-based decision-making.

As evinced in the response time graphs in Figure 29 and in the statistical parametric maps for activations in the ventro medial prefrontal cortex and deactivations in the middle frontal gyrus in Figure 42, the results of the present study support this theory, with the hypothesised emotional process in the ventro medial prefrontal cortex shortcutting the decision when preferred brands are involved, and the reason-based but lasting decision relying on the middle frontal gyrus for indifferent brands.

It is worth to note that these findings are correlational and other techniques like transcranial magnetic stimulation (TMS) are required to prove causality. However, it is also worth to note that several neuroimaging studies involving preferred brands have been reporting activations in the ventro medial cortex, similar to the one found in the present research (Knutson, et al., 2007; Luu & Chau, 2009; McClure, Li, et al., 2004; Paulus & Frank, 2003; Plassmann, Kenning, et al., 2008; Schaefer, et al., 2006; Schaefer & Rotte, 2007a).

It is interesting to compare these findings with a recent study from the Neuroeconomics field. Hare, Camerer, and Rangel (2009) studied the role of self-control in a decision-making task. They investigated self-controlled and non-self-controlled dieters performing a decision task where they rated the pleasantness of food stimuli, but where they had also to integrate the long term health dimension, while their brains were scanned. They found that the ventro medial prefrontal cortex (vmPFC) participates actively when goals are involved; in this case, whenever the goals were for taste and health in the self-controllers group, and whenever the goals were for taste (but not health) in the non-self-controllers group. However, there were situations where conflicts among stimuli arise, e.g. tasty but unhealthy food, i.e. food that is highly rewarding in the short-term perspective (tastes good), but that will compromise health in the long-term perspective, and for which self-control is needed to modulate the behaviour by integrating both short and long-term perspectives. They found that the vmPFC activates in association with subjects' goals (both short and long-term), but they also found the activation of the dorso lateral prefrontal cortex (DLPFC) in successful self-control trials, where there was the ramping down of the impetus initiated by the vmPFC in face of rewarding tasty stimuli. In this case, the DLPFC exerted self-control by redirecting the output behaviour, which now integrates the long-term goals at the expense of the suppression of the immediate tasty reward.

These findings integrate well with the theory of Bechara et al. (1997) and are supported by the results of Deppe et al. (2005) considered in the previous paragraph, which assigns the emotional-based decision-making to the vmPFC, and the reason-based decision-making to the DLPFC, both competing for the responsibility of the output behaviour. In the present study it is reported the activation of the vmPFC and the deactivation of the DLPFC in face of preferred brands' logos.

Considering the above theories, the findings of the present study may be interpreted as positive brands being rewards that are one's goals and that will be targets for immediate behavioural actions. As there are not long-term costs to be considered in the paradigm used, reasoning is dismissed, from which results a deactivation in the DLPFC. However, the DLPFC activates significantly when indifferent brands are involved, probably because they are not considered rewards, and then miss the automatic impulse towards them, but, as the paradigm requires a vote, reason has to accomplish with such task.

In an fMRI study that involved pictures and words, Kensinger and Schacter (2006b) reported three activations along the medial line of the frontal pole: two for the arousal-based emotional appraising of positive versus neutral stimuli (pictures and words), and one for the valence-based appraising of positive versus negative pictures.

In the present study, positive and indifferent brands were extremely different in the arousal dimension (the criteria established that positive brands are maximum in the arousal dimension, while indifferent brands are minimum). In the same line, valences were also different because in the pleasure dimension three valences are distinguishable: positive, negative, and indifferent. It was found a similar activation in the ventral frontal pole extending caudally (cf. Figure 40, Figure 41, and Table 14 for the contrast positive versus indifferent brands). One possible interpretation is that this cluster may reflect the combined effect of different magnitudes in valence and arousal that positive and indifferent brands exhibit. In any case the comparison of the two studies must be careful because both stimuli are similar, but not equal.

Although the traditional GLM analysis reveals a significant active participation of the vmPFC in positive assessments for positive previously rated brands, the multivariate probabilistic independent component analysis does not clearly and undoubtedly discloses such role. The most close is independent component 22. Though *positive* assessments correlate more with the network represented in this independent component than *indifferent* or *unknown* rates, it is also true that the fixation cross correlates more than *positive* assessments, and the other baseline, non-emotional words, does not significantly differentiates. In a certain sense this is also verifiable in Figure

41, with the exception of the voxel 55% frontal pole, where positive brands activate significantly more than all other cases. The rising question is: if the vmPFC is central to process emotion-based decision-making and to integrate environmental information into one’s goals and, concomitantly drive own behaviour, should not it also activate when positive brands contrast with the passive viewing of a fixation cross or the silent reading of determiners, articles, and other similar semantic-void words?

The immediate answer is yes. However, the study from Gusnard and Raichle (2001) reveals that the human brain has some structures very active during resting exactly due to the self-related thought stream. Other studies have been corroborating such finding (Andrews-Hanna, et al., 2010; D'Argembeau, et al., 2005; De Luca, Beckmann, De Stefano, Matthews, & Smith, 2006; Schilbach, Eickhoff, Rotarska-Jagiela, Fink, & Vogeley, 2008), assigning such function to anterior medial regions of the prefrontal cortex (such the depicted in Figure 47 for the independent component 22), among others. Investigating the resting-state network using MELODIC Beckmann, De Luca, Devlin, and Smith (2005) found an independent component with a pattern similar to independent component 22 of the present study, also extensively encompassing the ventro medial prefrontal cortex. More recently, Andrews-Hanna et al. (2010) identified two core hubs and two separate subsystems that subserve the resting-state network during passive viewing. One of the core hubs is located in the anterior medial prefrontal cortex, and the other in the midline between the posterior cingulate gyrus and the precuneous cortex. Both these hubs were found to be strongly correlated with self-related tasks, both in present and future scene construction simulations. This means that the ventro medial prefrontal cortex is active both during the passive viewing of the fixation cross and during the assessments of positive brands. After the subtraction of these two states, the result should then be null or close. However, as noticeable in Table 17 it is clearly negative. It is also unlike that the explanation unrolled in this paragraph may be used to sustain the lack of activation when the contrast is the non-emotional words because during the visualisation of this baseline, subjects were occupied in reading the words, which had diverted passive viewing and, presumably, did not activate the resting-state network. The above question remains then open, and will be re-addressed in further analysis.

Investigating a possible influence of the Default Network.

A possible explanation for the incongruous results of the ventro medial prefrontal cortex is the existence of a dilution effect. The assessment of positive brands took, in average, 1.546 ms, while the exhibition of the logo lasted for 6 s. This means that, assuming that the fMRI acquisition was homogeneous during the stimulus exhibition (and this assumption is sustained by the procedures implemented – see Appendix D), 25% of the signal captured the decision processes for positive assessments, while the remaining 75% just captured the passive viewing of an already rated positive brand. As the traditional GLM analysis considers all the time window, the interesting signal (25%) is diluted in time and, consequently, weakened.

The use of more discriminative EVs in the GLM analysis brought unexpected results: the vmPFC deactivates during the decision process and activates after the decision was made (see Figure 50). Even more, for more anterior subregions (55% frontal pole and 75% paracingulate gyrus) and for indifferent brands and fictitious logos, there are activations during the decision period followed by deactivations afterwards. The immediate reading is that the vmPFC does not correlate with positive brands assessment, but correlates with indifferent brands and fictitious logos assessments, which denies the interpretations of the previous section.

The results of this analysis should be interpreted with caution because it is looking for correlations below the TR level, i.e. below the time necessary for a full brain scan, and there can be conflicts with the timecourses' precision and exactitude.

One possible explanation is an elusive role of the default network (DN). The DN is known to deactivate when participants leave a passive viewing stage and engage in a task that requires focus and concentration (Andrews-Hanna, et al., 2010; Gusnard & Raichle, 2001; Schilbach, et al., 2008; Sridharan, et al., 2008). Such pattern is observable for positive brands (but neither for indifferent nor fictitious) in Figure 50. This would mean that positive brands assessments would require subjects' focus, but indifferent or fictitious assessments would not, that is, there would be a significant difference between self-referential processes and positive brands, and that would not be such difference between self-referential processes and indifferent brands and fictitious logos. This hypothesis clearly contradicts all the theory argued in the previous section.

Using the definition of DN determined by Andrews-Hanna et al. (2010), although the typical deactivation pattern is found in the two DN hubs for positive brands, it is not consistently replicated in at least one of the two subsystems (see Figure 52, Figure 53, and Figure 54). As it is not reported an integral participation of the network, it is not possible to conclude for a causation of the effect due to the DN.

Similarly, it is not admissible a participation of the network amputated, because it is necessary the simultaneous participation of one subsystem at least: the dMPFC subsystem for the representation of present self, or the MTL subsystem for the representation of the future self. This means that the deactivation of the ventro medial prefrontal cortex for positive brands remains with an explanation coherent with the published literature.

The further analysis that sought for a representation of the DN proposed by Andrews-Hanna et al. (2010), revealed two independent components: IC 24 and IC 41. Both these two networks differentiate between recognised brands (whether positive or indifferent) from fictitious logos, and both are active during the decision stage, that is until button pressing (see Figure 55). Hence, none of them has an active role in preference, because indifferent brands are also involved in the consideration of both networks.

In conclusion, although there is extensive literature that implicates the ventro medial prefrontal cortex in emotion-based decision-making and in self-referential processes, this study did not find sustainability for a participation of these processes in positive brands' assessments.

Motor and somatosensory cortices.

The present study reports extensive activations in the motor and somatosensory cortices, but only for the left hemisphere. This observation is easily justifiable because the right (contralateral) hand manipulated the answers with the button box, and the right button box had the buttons for *positive* and *negative* assessments. The same pattern of activations is verifiable in the contrast between positive brands and fictitious logos (see Table 12 and the two top rows of Figure 36). Similarly, the multivariate analysis outputs the independent component 17 (see Figure 48) that correlates with positive voting activity, which gives an extra support to the claim. The converse is also observable with extensive activations in the motor and somatosensory cortices in the contrast between fictitious logos and positive brands (see Table 13). In this case the activations are in the right hemisphere and the button box with the codes for *indifferent* and *unknown* was manipulated with the left hand (contralateral). It may then be concluded that these activations are an artefact of the procedure arranged and not a cognitive process related with the appraisal of brands.

The cluster marginal to the sylvian fissure.

More ventrally to the left motor cortex, it is reported an extensive and deep activation in the margins of the sylvian fissure, spanning several brain structures in the operculum: the posterior part of the insular cortex, planum polare, Heschl's gyrus, planum temporale, central opercular cortex, and parietal operculum cortex. The analysis of the parameter estimates of the local maxima in Figure 43 reveals a systematic higher parameter for positive brands. The pattern for the remaining stimuli is very similar in the foci 59% central opercular cortex, 37% Heschl's gyrus, 71% insular cortex, and 36% insular cortex, but something different in the 45% parietal operculum cortex and 50% insular cortex, where the parameter estimate for indifferent brands is negative and for fictitious logos is clearly flattened. However, it is not possible identifying clear distinct sub-clusters and likewise it is not tenable that this mega cluster is the result of the merging of two or more neighbouring clusters, but such hypothesis it is not denied too.

Because two maxima are in the central opercular cortex and in the parietal operculum cortex, one possible explanation would be the activation of the secondary somatosensory cortex, an artefact already pointed by Rizzolatti and Craighero (2004). In fact, *positive* votes were recorded by the button box in the right hand and, the same way such artefact caused the activation in the contralateral motor cortex, a similar reflex to the somatosensory cortex could had happened.

The pattern of the parameter estimates for the parietal operculum cortex is consistent with this perspective, as the parameter for positive brands is clearly positive when compared with the baseline (the fixation cross which did not required any manipulation of buttons, as well the non-emotional words), while all the remaining are null or proximal to null. However, it is not possible to assert the same for the central opercular cortex, where the parameter for fictitious logos (voted with the left hand) is significantly positive when contrasting with the baseline, and increases for decreasing x values. Similarly, this rationalisation cannot justify the deep activation in the posterior insular cortex. This means that this explanation would be plausible only for a small area (the parietal operculum cortex) within the cluster, which is partially in conflict with the stated in the previous paragraph, where it was not possible to collect solid arguments that would sustain that the cluster is composed by two or more merged but functionally different sub-clusters.

The multivariate analysis may come into help to clarify this result. Independent component 17 explains the left motor activation for *positive* votes more than *indifferent* or *unknown* options. It is discernible in the column x = -50 of Figure 48 that, together with the extensive activation in the left motor cortex, an activation in the secondary somatosensory cortex is registered too. These activations are hemisphere specific.

However, independent component 27 includes in its network overlapping voxels in the secondary somatosensory region, extends the network along the sylvian fissure, involves extensively the insular cortex, it is bilateral, and does not includes dorsal motor nor somatosensory regions (see Figure 48 and Table 24). More, the analysis of the activity of the local maxima reported for clusters 2, 3, and 4 from Table 15 reveals that, with the exception of the posterior insular cortex, all the remaining voxels are active in independent component 17, but in independent component 27 all the motor cortex voxels do not activate, while all the remaining, posterior insular cortex included, are active (see Table 25). Even more and in the same table, it is possible to verify that all voxels from cluster 3 but those in the posterior insular cortex (which means 55% central opercular cortex, 43% parietal operculum cortex, 50% insular cortex, and 34% Heschl's gyrus), are active too in independent component 118, which was found to participate, not only in *positive* assessments, but also for fictitious logos, as well for both baselines.

These findings suggest that there are at least three different processes that recruit overlapping brain structures, which may led to the ambiguities exposed in the previous paragraphs and that traditional GLM analysis could not disentangle. However, the multivariate analysis strongly suggests that the voxels from cluster 3 participate in a network interesting for positive brands appraisals, beyond motor-related tasks.

It is also very difficult to sustain a conventional explanation for the extensive activation of the left Heschl’s gyrus (almost 98%) in the present paradigm. This brain structure is known to be the primary and secondary auditory cortices. Its neighbour structure, planum temporale, also activated extensively (53.2%), but, similarly, only in the left hemisphere. The planum temporale largely overlaps Wernicke’s area, which is accepted to be a brain region for oral language comprehension, among other subsystems for sound decoding (Wise, et al., 2001), and has been found involved in a number of aphasias and language related disturbances (Ojemann, 1991). In fact, there are not reasons to suppose that positive brands have a special ability to elicit sounds, at least when contrasted with indifferent brands or fictitious logos. It must have then other rationale that may support the activations in these brain regions.

It has been found that the planum temporale is significantly asymmetric in great apes and humans, a particularity that is not observable in older divergent lineages in the Primates order (Gannon, Holloway, Broadfield, & Braun, 1998; Gannon, Kheck, & Hof, 2001). Gannon et al. (2001) propose then that the planum temporale serves as a proto-linguistic area. Burns (2004, 2006) claims that there was an evolutionary pressure over the planum temporale, Heschl's gyrus, and insular cortex, involving a connectivity reorganisation within these areas in the great apes and humans, and that they are involved in complex communication skills rather than oral language specifically.

Supporting that these structures have other roles other than sound and speech decoding, in a neuroimaging study it was observed that the primary auditory cortex (Heschl's gyri) is activated by the perception of visual speech (articulatory gestures) (Pekkola, et al., 2005). In the same line, using single-unit recordings in primary and secondary auditory cortices (Kayser, Petkov, & Logothetis, 2008), and using fMRI in the macaque monkey (Kayser, Petkov, Augath, & Logothetis, 2007), these researchers reported the modulation of neurons in the auditory cortex by visual stimuli, which led them to propose that such brain areas have an multimodal integrative role rather than be specific for the hearing sense. They even advance that this integrative role may be important to bear sensorial contextual information into the perception. Something similar was already proposed by Warren and Griffiths (2003) with the planum temporale processing sounds and their respective spatial localisation, which they named as a "computational hub" for spectrotemporal information (Griffiths & Warren, 2002).

Recently, it has been proposed a dual pathway for language (Hickok & Poeppel, 2007). A common initial hub includes the planum temporale for spectrotemporal analysis and the middle and posterior superior temporal sulcus. From here the stream diverges: one branch follows the dorsal pathway, which encompasses the inferior parietal and posterior prefrontal regions, and is involved in the integration of speech sounds and the respective motor articulation; the other branch projects along the ventral pathway and includes the middle and inferior temporal gyri, and is supposed to be involved in the speech to meaning representation, i.e. is where conceptual meanings are ascribed to speech sounds.

A network representation was found for this system, including networking nodes (brain structures) for process and network linkages (brain fibre tracts) for internal system communication (Saur, et al., 2008). It is interesting to note the role of the planum temporale as a hub, here defined as “sensorimotor integrator”, which immediately recalls the involvement of somatosensory cortex considered above. It is also interesting to observe that independent components 33 and 36 (which are correlated with positive votes) encompass brain structures that belong to the language ventral pathway, which is connected to lexical interface (links phonological and semantic information that is distributed throughout the cortex) and to the combinatorial network (syntactic processes).

In summary, more for positive than for indifferent brands (or even fictitious logos), there is an active network of brain structures that have been found to support language related tasks involving meaning decoding and syntactic structure, and that, for such ends, integrates multi-sensorial information with a visual emphasis.

All of these sounds logical with brands’ appraisal, as logos are visual-based ideograms that support social language communication. Nevertheless, a solid justification that explains why positive brands activate more this network than indifferent or fictitious logos is missing, because the initial assumption was that both positive and indifferent brands have a previously acquired meaning of some sort that derives from the personal experience with the brand, and only the fictitious logos could be considered meaningless. However, it is important to maintain present that the evolutionary researchers referred above sustain that the hub that is central for multimodal integration, the planum temporale, subserves general communicative skills and not exclusively oral language.

There is a final consideration about the insular cortex. The GLM analysis informs that both the left and right insular cortices activate extensively in the contrast positive versus indifferent brands (57.1% and 18.0% respectively – see Table 14). Similarly, independent component 27 reports widespread activations in the left and right insular cortices (79.3% and 78.2% respectively – see Table 24). The corresponding maps are observable in Figure 40 and Figure 48. The incidence of these activations is largely over the posterior and medial parts of the insula. As already considered, the anterior insular cortex activates for all sorts of logos (positive, indifferent, and fictitious) versus both baselines, which is interpreted through the empathetic participation of the interoceptive system to "feel" the brand, i.e. trying to read in own body the effects produced by the eventual emotional content inherent to the stimulus.

Hence, more the positive brands than the indifferent ones have the ability to trigger emotional responses, which are signalled in the body, and which signals are detected by the posterior insular cortex, and then integrated and interpreted in more medial and anterior regions of the insula (Craig, 2009a). As per the analysis of the contrasts with the baselines, only the positive brands full activate the insular cortex, and as it is discernible in Figure 43 the baselines are always proximal to null, which sounds logical within this model. Still in Figure 43, only the positive stimulus has a positive value in the more posterior graph. Moving towards the anterior regions, both indifferent and fictitious stimuli emerge, with preponderance on the fictitious. This is comprehensible, as probably fictitious logos may have induced anxiety (which is an emotion) because they were unknown and time urged to give an answer inside the scanner.

Integrative overview of positive brands appraisal.

Craig (2002, 2009a) proposed a model for the “structural instantiation of awareness” that involves the insular cortex. He claims that “(...) the neural basis for awareness is the neural representation of the physiological condition of the body, and the homeostatic neural construct for a feeling from the body is the foundation for the encoding of all feelings.” (Craig, 2009a, p. 66).

In this model, the posterior insula processes the primary interoceptive representation, i.e. represents each particular feeling that emerges from the body. Along the posterior-to-anterior axis, these representations of the feeling are re-represented and successively integrated with more pertinent information. In the case of the medial insula, these representations are integrated with “(...) activity that is associated with emotionally salient environmental stimuli of many sensory modalities (...)” (Craig, 2009a, p. 67) and subsequently with hedonic conditions, and then with the subjective motivations and social and cognitive conditions. Ultimately, close to the frontal operculum cortex, it is represented the “global emotional moment”, which affords the emotional awareness in a certain time.

This model is in complement and integrates well with the model of emotions proposed by Damásio, which also relies on the reading of the signals that external stimuli produce on the own body to extract the feeling of the thing (Damásio, 1994, 1999, 2003b). Here, the proprioceptive and interoceptive systems have a critical role because they convey information about the physical self to the brain and, as emotions are bodily responses to external stimuli, these systems provides to the processing brain valuable information about the current state of own body (Damásio, 2003a).

Through the thalamus the information is projected to the insular cortices, which have an integrative role, producing the feeling, a process that supposedly only certain primates hold (Craig, 2009b). From the insular cortices, signals are disclosed to the anterior cingulate gyrus and to the orbitofrontal cortex (Damásio, 2003a), where complex behavioural outputs are composed. For example, the frontal orbital cortex, which is neighbouring to the insular cortex, is involved in the regulation of flexible behaviour, allowing the individual to be sensible and react to changes in the environment, or when facing unexpected outcomes (Schoenbaum, Roesch, Stalnaker, & Takahashi, 2009).

The anterior cingulate gyrus is known to have a determinant role in error detection from external stimuli, which is also important for behavioural navigation (E. K. Miller & Cohen, 2001), and for difficult problem solving (Allman, Hakeem, Erwin, Nimchinsky, & Hof, 2001). Of special importance for this analysis is the ventral part of the orbitofrontal cortex. Northoff et al. (2006) propose that, mainly due to its connections, this brain region links interoceptive and exteroceptive information with respect to their self-relatedness, i.e. representing (or not) stimuli as self-referential. This brings to the scene all the considerations made about the activation of the ventro medial prefrontal cortex in positive brands appraisal, i.e. the participation of self-referential psychological processes, closing then the circle.

The involvement of the sense of the body also entails what Damásio calls the somatosensory complex, which involves the somatosensory cortex I and somatosensory cortex II (SI and SII) that incorporate signalling from the musculoskeletal and vestibular systems (Damásio, et al., 2000). Very recently, Keysers, Kaas, and Gazzola (2010) highlight the critical role of the somatosenrory cortices in social perception while subjects were witnessing sensations and actions. With an emphasis in SII, which is connected with visual and auditory cortices (both already here considered) and also with the insular cortex, adopting a relying position, it reflects the sensorial dimensions of the stimulus, which is a major part in its comprehension.

As already considered above, here it is reported an activation in the secondary somatosensory cortex, specifically the parietal operculum cortex and central opercular cortex. In the GLM analysis and unlike the insular cortex, these activations where hemispheric specific, even more in the contralateral hemisphere with reference to the hand that pressed the button for the *positive* option. This fact led to have some cautions in the interpretations as it could be an artefact of the procedure. Nonetheless, the multivariate analysis, in independent component 27, which correlates more with positive than with indifferent or fictitious logos, clearly shows a bilateral participation of the secondary somatosensory cortex, which now can be considered within an emotional feeling of positive rated brands.

Damásio claims that the sensations that the proprioceptive and interoceptive systems provide about the own structure and actual condition of the body"(...) is the source of the sense of continuous being that anchors the mental self." (Damásio, 2003c, p. 227). Such mental self assumes itself as a frame of reference to which every stimulus is compared, a perspective that also entries into the theory of self-concept as the main individual behaviour drive and how certain objects become crucial for self-construction (Banister & Hogg, 2004; Callero, 2003; Grubb & Grathwohl, 1967; Johar & Sirgy, 1991; M. Joseph Sirgy, 1982; M. Joseph Sirgy & Danes, 1982).

Hsu (1971) advanced the concept of "psychosocial homeostasis" or the internal regulation that every human performs and that is the result of the balance between the "expressible conscious layer" (everything one communicates to his / her peers about him / herself, e.g. fears, passions, intentions, perspectives, etc.) ant the "intimate society and culture" (all that share an affect-based relationship with the individual and that can be the target of own intimate communication, i.e. parents, siblings, spouse / husband, first circle friends and colleagues at workplace, but also pets, and even close artefacts and objects, everything that one is surrounded that help him / her structuring and give sense to own existence). Although he claims that western individuals miss such balance between self and peers, focusing exclusively in promoting individuality, it seems that, by the contrary, such balance exists and positive brands have a significant role in it. Positive brands help in defining the self and, simultaneously, create links towards the social environment, mastering the psychosocial homeostasis.

Putting all together it may then be suggested that such external stimuli are as well important for the organism homeostasis or, in the case of the present research, because positive brands trigger an emotional reaction, and because the elicited feelings are good, and because organisms seek for such feelings for their homeostasis, positive brands are important for life itself. Hence, it is without surprise that self-relatedness emerges as a mandatory characteristic that brands should seek to embody because "The more the respective stimulus is associated with the person's sense of belongingness, the more strongly it can be related to the self." (Northoff, et al., 2006, p. 441).

Investigating delayed decisions for indifferent and fictitious logos.

The analysis of the graphs in Figure 29 lead to conclude that indifferent and fictitious logos appraisal is significantly delayed when compared with positive brands assessments. This means that the psychological processes probably were different and for such cases, the biological bases of the processes were also different. However, this does not mean that the psychological processes that subserve indifferent and fictitious logos appraisal are the same.

In fact, analysing the row with the conjunction in Figure 45 and the results in Table 16 it is evident that the psychological processes that subserve the contrast between indifferent versus positive brands and the contrast between fictitious logos versus positive brands, do not share many brain structures, which in turn strongly suggest that the respective psychological processes are significantly distinct.

Not including the contralateral motor-related and primary somatosensory-related structures (because both the *indifferent* and *unknown* options shared the same hand to record the option during the scanning session) among those that activated in the conjunction, it is drove the attention to the left and right inferior frontal gyri - pars opercularis, right Heschl’s gyrus, and right parietal operculum cortex.

It is interesting to note the activation in the right Heschl’s gyrus, and in the right parietal operculum cortex, which suggests a reflex to the contralateral secondary somatosensory cortex of the button pressing action. Recovering what was said about the involvement of the secondary somatosensory cortex in positive brands appraisal, it is compelling now that it may has at some extent an artefact due to button pressing. However, the reflex in the secondary somatosensory cortex is now much smaller, and does not include the insular cortex, nor communication-related brain regions. It does not seem though, that any of these structures was the cause for the lag for positive assessments.

The brain structures that activated more in indifferent assessments than in the positive ones, and that were not common to fictitious logos appraisals, had an emphasis in the prefrontal cortex: right dorsal frontal pole, dorsal paracingulate gyrus, left frontal orbital cortex, left and right frontal operculum cortices, left inferior frontal gyrus (pars opercularis and pars triangularis), superior frontal gyrus, and left and right middle frontal gyri. As the prefrontal cortex is generally seen as processing deliberative reasoning (E. K. Miller & Cohen, 2001), it may be interpreted like the indecisiveness that indifferent brands may have triggered were processed herein, probably in the superior frontal gyrus, or in the middle frontal gyri.

Not surprisingly, prefrontal structures were almost absent in the contrast between fictitious logos versus positive brands. Here the prominence was in temporal and occipital structures: left temporo-occipital part of the inferior temporal gyrus, left and right temporal occipital fusiform cortices, left and right inferior lateral occipital cortices, left and right occipital fusiform gyri, occipital pole, right pallidum, and right putamen. It is plausible then that the extra time that subjects took to appraisal fictitious logos versus positive brands was principally spent in visual associative areas. This is in line with recent multivariate analysis of brain functioning that have been proposing that object recognition, and probably objects' characteristics indexation, takes place within earlier stages of the visual ventral pathway (Hanson, et al., 2004). However, it also may be argued that, if such screening occurs in earlier stages, there is no reason to sustain long delays in the answers, as the downstream psychological cognitive cascade is obviated.

Imitation During Brands' Appraisal

Syntactic roles assigned to the left inferior frontal gyrus.

The inferior frontal gyrus, with a special emphasis in the left hemisphere, activated systematically during brands' appraisals, as it is observable in the contrasts with the baselines (see Figure 30, Figure 31, Figure 32, Figure 33, and Table 8, Table 9, Table 10, and Table 11). These activations encompass both the sub-regions pars opercularis and pars triangularis. This finding replicates similar results in the mixed design experiment (second study). However, at that experiment, there were not fictitious logos involved, nor the fixation cross.

This brain structure, in the left hemisphere, is also known by Broca's area, and traditionally has been connected to speech articulation (Broca, 1861). More recently, additional roles have been assigned to this structure, namely syntactic processing in sentence comprehension (Dapretto & Bookheimer, 1999), organising the syntactic structure of utterances (Hagoort & Levelt, 2009; Sahin, Pinker, Cash, Schomer, & Halgren, 2009), and also it has been found to be one of the biological supports of the "Universal Grammar", i.e. a theory that claims that all humans have a pre-wired network of brain structures that innately allow the emergence of the language instinct (Musso, et al., 2003). In fact, Broca's area and syntactic rules have been found to be intimately connected (Grodzinsky & Friederici, 2006; Grodzinsky & Santi, 2008), and such connection is extensible to other areas where ordered sequencing is important, like music (Patel, 2003; Patel, Iversen, Wassenaar, & Hagoort, 2008).

The paradox.

Analysing the results of the present experiment, an intriguing fact emerges: although one of the baselines (non-emotional words) have indubitably syntactic characteristics (e.g. determiners, articles, i.e. words that do not have a semantic content, but link semantic-load words coherently, such the resulting sentence is meaningful), it is very clear that all sort of logos (positive, indifferent, and fictitious) activate within this region when contrasted with this baseline. What would be expectable is that words with syntactic function would activate versus logos, producing then a deactivation, and not the contrary.

To investigate the relative participation of each stimulus within the left inferior frontal gyrus, the respective parameter estimates are compared in Figure 56 for four foci. It results that every sort of logos significantly activate the left inferior frontal gyrus more than the fixation cross, and that only fictitious logos in ventral areas do not significantly activate more than non-emotional words.

Comparing these results with the second study, where similar outputs were observed, it is possible to conclude that the contrast with the fixation cross serves to define better the boundaries of the problematic, and that the effect persists when fictitious logos (meaningless, but still logos in the participants' perspective) are involved.

To investigate the causes of such intriguing result, several hypotheses can be launched. It may happen that Broca's area is recruited only during pure syntactic exercises. In fact, participants were asked to covertly read the determiners, articles, etc. and not to construct sentences were such syntactic words were involved and where their role is implemented. However, for the same reason, the non-emotional words should have not activated when contrasted with the fixation cross (because neither were a syntactic exercise), but they do, unless such activation is justified by the covert reading act itself. Nonetheless, logos were read too during their exhibition, because all logos had

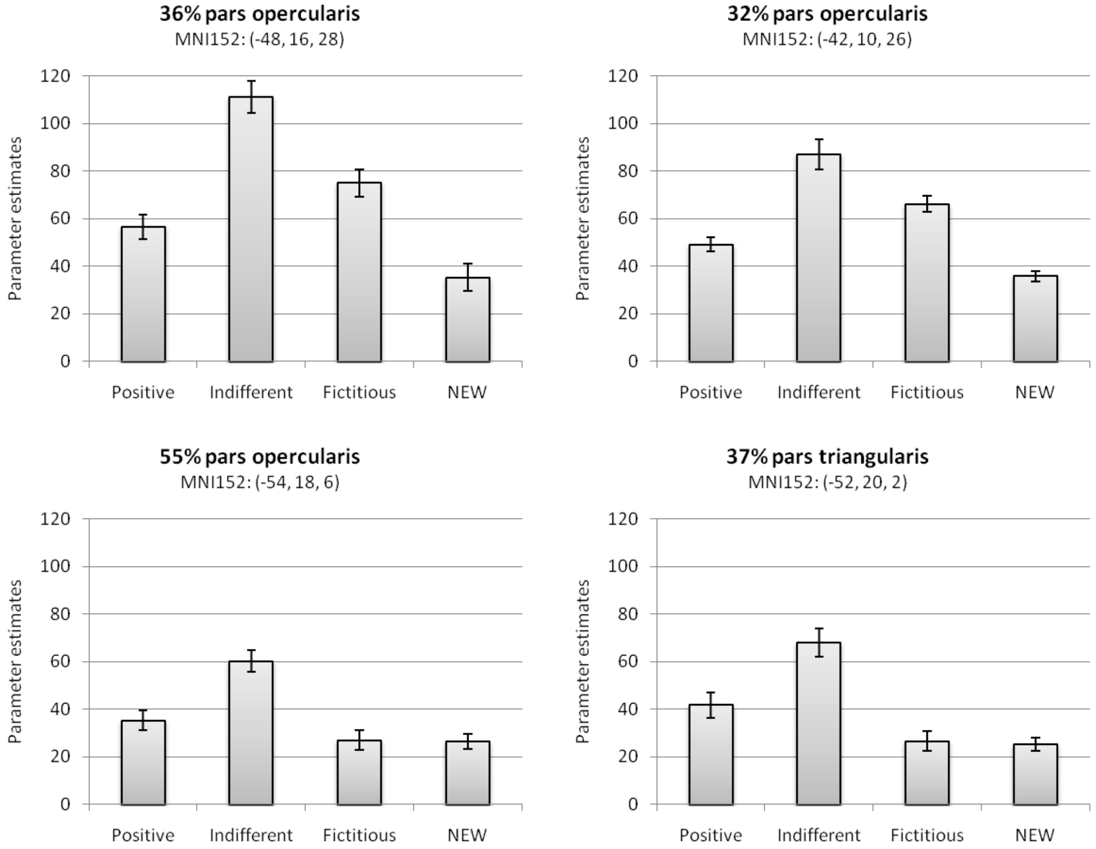


Figure 56 - Parameter estimates for positive, indifferent, and fictitious stimuli, and also for the non-emotional words (NEW) in three foci in the left inferior frontal gyrus (IFG). MNI152 coordinates. Error bars correspond to the confidence intervals at 95%.

wording (e.g. the brand name), and logos activate versus the non-emotional words. This brings again to the beginning, because it is only possible to conclude that the covert reading act is not sufficient to explain why logos activate more than non-emotional words in the left inferior frontal gyrus.

Probably conventional mechanisms difficultly would explain the involvement of Broca's area in brands' assessments. Instead, it was looked at more peripheral reasons, but that maybe will shed light over the present problem. It was looked at the putative involvement of mirror neurons.

Hypothesising the involvement of the mirror neurons system.

The mirror neurons system was originally discovered when monkeys performed and observed purposeful actions, which was suggested to be part of the process of understanding and learning by imitation (Rizzolatti & Craighero, 2004; Rizzolatti, Fogassi, & Gallese, 2001).

This paradigm was extended to support the dysfunction of emotions understanding in children diagnosed with autism (Dapretto, et al., 2006). It was also used to support a general mechanism of empathetic understanding, which relies in mirroring witnessed actions, sensations, and emotions in the own body, allowing the observer to experience them as is if s/he is the author / target of those actions, sensations, and emotions (Gallese, et al., 2004; Keysers & Gazzola, 2006). This proposed mechanism is largely automatic, act at a pre-reflective level, and produces simulations from the environment (Keysers & Gazzola, 2007).

Hence, brands, as meaningful symbols, and, as it was already discussed, quasi-human creatures, may be perceived by means of the same system, i.e. their meaning (or, metaphorically, the meaning of their actions, i.e. the observable emergences that result from brands' actions within markets) may be assimilated (learned) from the environment (supposedly, from the social environment) through the same system that supports imitation.

The research conducted on the human mirror neurons system has been pointing the involvement of the inferior frontal gyrus, the inferior parietal lobule, the posterior superior temporal sulcus, and the middle temporal gyrus (Aziz-Zadeh, Koski, Zaidel, Mazziotta, & Iacoboni, 2006; Iacoboni, 2005; Keysers & Gazzola, 2006). A conspicuous fact is that these regions are connected by the arcuate fasciculus (Cabeza, Ciaramelli, Olson, & Moscovitch, 2008). According to this parsimonious map, it was selected from the probabilistic atlas *Harvard-Oxford Cortical Structural Atlas* provided by the Harvard Centre for Morphometric Analysis (www.cma.mgh.harvard.edu), which is part of FSL View v3.0.2, part of FSL 4.1.2, the following brain structures to investigate possible activations produced by brands: pars opercularis, pars triangularis, posterior middle temporal gyrus, posterior superior temporal gyrus, anterior and posterior supramarginal gyrus, and angular gyrus.

A multivariate analysis of the participation of the mirror neurons system.

As the purpose is to look for the participation of a system, the search will rely on the multivariate model-free analysis (MELODIC), as only this one has the capability to extract sets of voxels that activate coherently, without previous assumptions of models that may introduce bias into the results.

In the universe of 164 independent components that the analysis outputs, Table 30 reports those that significantly have activated voxels within the brain structures considered that compose the mirror neurons system. Sagittal slices that reveal the involvement of the selected brain structures are depicted in Figure 57.

Two of them, independent components 18 and 41, were previously considered in the section where recognised brands (positive and indifferent, i.e. meaningful) were contrasted versus the unrecognised ones (fictitious logos, i.e. meaningless). The remaining one, independent component 100 is new. In the network represented in independent component 100, all the contrasts between logos and the fixation cross are not significantly positive (with the exception of fictitious logos, which is just over the threshold of significance), whereas all the contrasts between logos and non-emotional words are significantly negative. Also, there are not significant differences between

Table 30 - Selected z statistics that represent the fit between the contrasts of explanatory variables and the independent components calculated in the multivariate analysis, together with the F-test across subjects for independent components that have significant activated voxels within the brain structures that encompass the mirror neurons system.

Contrast of parameter estimates	z statistics for ICs		
	18	**41**	**100**
Positive > FC	6,77	2,38	2,17
Positive > NEW	4,08	2,21	-5,82
Indifferent > FC	15,16	9,69	1,01
Indifferent > NEW	12,07	9,29	-6,71
Fictitious > FC	-4,58	-5,46	2,66
Fictitious > NEW	-7,36	-5,47	-5,33
NEW > FC	3,22	0,35	8,20
Positive > Indifferent	-7,91	-6,92	1,16
Positive > Fictitious	12,01	8,09	-0,28
Indifferent > Fictitious	17,92	13,65	-1,37
Subjects			
F-test	63,07	22,85	2,35
p-value	0,000	0,000	0,145

Note - FC: fixation cross; IC: independent component; NEW: non-emotional words.

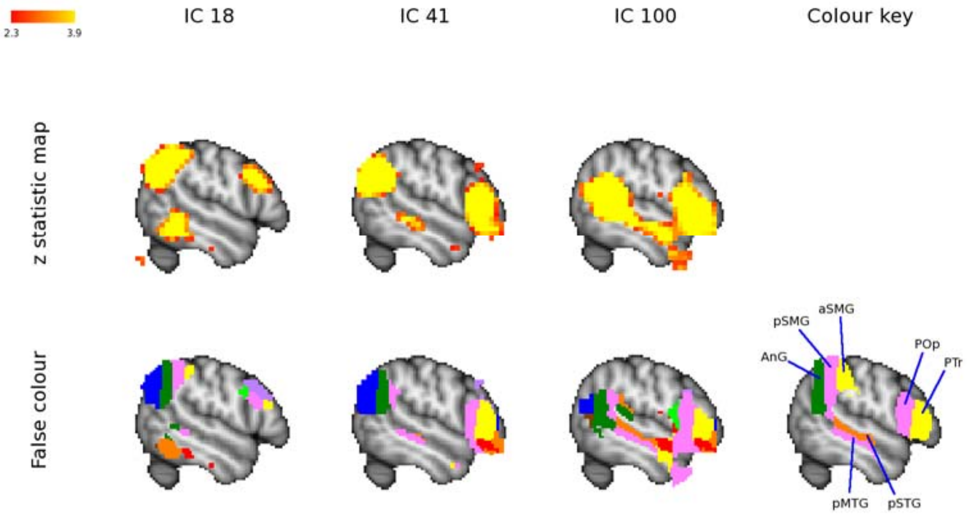


Figure 57 - Independent components 18, 41, and 100 fMRI maps for the multivariate analysis in the axial (z = -52) plane (statistical parametric maps produced by MELODIC). For each independent component, top row depicts z statistics and the bottom row depicts the same brain regions but individualised with different colours. In the right column there is a plane with the complete regions that belong to the mirror neurons system which serves as a key to interpret the planes on the left side: AnG - angular gyrus; aSMG - anterior supramarginal gyrus; pMTG - posterior middle temporal gyrus; POp - pars opercularis; pSMG - posterior supramarginal gyrus; pSTG - posterior superior temporal gyrus; PTr - pars triangularis. Radiological convention; MNI152 coordinates.

logos, and the contrast between non-emotional words and the fixation cross is significantly positive.

Hence, it may be proposed that this network is more active when non-emotional words are involved and subserves their processing. It may explain the similar parameter estimates for non-emotional words, spanning all the left inferior frontal gyrus as depicted in the graphs in Figure 56.

It also suggests that the recruiting of the inferior frontal gyrus for non-emotional words processing is different from the recruitment of the same region in the process of logos appraisal, as it was hypothesised previously. Different syntactic-based mechanisms may call the structure, according to the process at the moment. However, some caution should be took when generalising, as this network it is not consistently activated by all the participants in the study (*p-value* = 0.145).

As previously analysed, independent components 18 and 41 are very similar: the contrasts between known brands (positive and indifferent) versus both baselines significantly support these networks, but fictitious logos are significantly and negatively linked to these networks. It seems then, that these networks differentiate between meaningful brands and meaningless logos. Interestingly, this is the same network that has been proposed to subserve learning by imitation, as considered in the previous sections.

Considerations about imitation and meaningful brands.

The brands rated as *positive* or *indifferent*, but not the ones marked as *unknown*, activated significantly more a network of brain structures in the left hemisphere that encompasses the inferior frontal gyrus, posterior superior temporal gyrus, posterior middle temporal gyrus, angular gyrus, and anterior and posterior supramarginal gyrus, and thus these regions discriminate between meaningful and meaningless logos.

A similar brain pattern in the temporal and parietal lobes was reported when subjects viewed goal-directed hand movements (Pelphrey, Morris, & McCarthy, 2004), which suggests a role in perceiving intentionality in peers actions. However, it is argued that the participation of the temporal lobule's regions is due to high-order visual processing, and it is not critical in mirroring (Rizzolatti & Craighero, 2004).

On the other hand, the temporo-parietal junction (which encompasses the angular and the posterior supramarginal gyri) was found relevant in Theory of Mind tasks (Saxe & Kanwisher, 2003; Saxe & Wexler, 2005), where humans make inferences about the intentions, desires, and beliefs of other subjects. Also, the temporo-parietal junction is supposed to participate in perspective taking (Frith, 2007). Interestingly, these areas in the inferior parietal cortex, were proposed to subserve episodic memories, in recollection, were the outcome is unambiguous (Cabeza, et al., 2008). In summary, this network has been found to participate in communicative social-based processes, guessing the intentions of others, and learning from them.

Imitation is a very important matter for brands. Consumers mimic other consumers and like been mimicked, being mimicry an effective way of spreading product preference (Tanner, Ferraro, Chartrand, Bettman, & Baaren, 2008). Along this work there were already considerations about how brands are important to initiate and maintain certain social groups (Cova & Cova, 2002; McAlexander, et al., 2002; Moutinho, et al., 2007; Muniz Jr. & O'Guinn, 2001; Veloutsou & Moutinho, 2009). It has been found that there is brand congruence among individuals that share a social relation, something that could not been explained by other considered causes like conspicuousness of the product (Reingen, Foster, Brown, & Seidman, 1984).

The word-of-mouth effect is strongly imitation-based. Meanings and socio-cultural symbolism are ascribed to products by word-of-mouth communication in on-line communities (Brown, Broderick, & Lee, 2007), and it also serves as an efficient platform to new customer acquisition (Wangenheim & Bayón, 2007), which means that even conventional word-of-mouth is a convenient mean to aggregate persons around products and brands. Word-of-mouth supports social learning (Ellison & Fudenberg, 1995), and may explain the mechanism of spreading choices and preferences within the social environment (Banerjee & Fudenberg, 2004). This, in turn, may explain informational cascades and herding among social groups (Bikhchandani, Hirshleifer, & Welch, 1992; Raafat, Chater, & Frith, 2009), which occur because humans largely rely their decisions in exogenous information from the social environment (Bala & Goyal, 1998; Ellison & Fudenberg, 1993).

Thus, brands may have an important role as meanings carriers in the alternative model of social cognition proposed by Pelzmann, Hudnik, and Miklautz (2005), where peers act as a knowledge pool, and the mirror neurons system may by the door for such process in the brain.

The inference of the involvement of the neural networks that support learning by imitation in brands' appraisals and discrimination opens interesting possibilities of study. A point that deserves future research is to investigate what imitation in fact is and how it interacts with brands. The paradox is that the mirror neurons that may constitute the biological basis for imitation, were discovered in monkeys, but monkeys are poor imitators (Byrne, 2005). This author makes a distinction between two different imitative processes: learning by copying and social mirroring. The former is complex and requires powerful computation in decomposing a purposeful action into simpler components and recompose the same or similar actions, and the later is effortless and involves simple synchrony with peers to strengthen social bonds. In line with this, Iacoboni (2005) suggests the participation of the mirror neurons system core together with the dorso lateral prefrontal cortex in imitative learning, and the participation of the mirror neurons system core together with the limbic system in social mirroring. Although independent component does not include brain strictures from the limbic system, the independent component 41 has an extensive participation of the left caudate (see Table 18), which is a promising finding.

Digest, Some Limitations, and Introducing the Analysis with ANNs

It was found that the PAD scale together with the SAM have an interesting discriminative power for brands. Although some improvements may be introduced (removing the blue dots, and make the *pleasure* dimension more comprehensible with the adding of a negative sign for the displeasure side, the adding of a positive sign for the pleasure side, and the adding of a 0 (zero) to the change point) this scale has the potential to categorise brands in an emotional base. Further fMRI studies may investigate possible correlations between the dimensions (at least the pleasure and arousal dimensions) and brain structures.

This study makes evident that fMRI paradigm should include multi-baselines, especially when the target materials are complex. Brands are complex and recruit several psychological processes during their appraisals. This study used, in fact, three baselines: the conventional fixation cross (which is not able to produce discriminations when self-related processes are involved), the semantic-void non-emotional words (which is a weak baseline when syntactic processes are involved), and the fictitious logos (which graphical aspects may disguise visual-cued recognitions). The use of all three allowed achieving more robust conclusions, of course at the cost of more difficult interpretations.

However, there is an issue that introduced limitations in this study. So the response time is a useful measure, the answering buttons remained the same during all the study. This means that there are activations and deactivations that are caused by this artefact. They are considered in the motor cortex, but their extent in other rain regions is unknown. Further studies should account with this issue.

This study corroborated the existence of a general system for brands appraisal. It involves the insular cortex, frontal operculum and frontal orbital cortices, and the paracingulate gyrus. This system is not specific for brands. Instead, it is an extension from general stimuli appraisal, which reflects how humans perceive their environment: feeling it. This general system feels brands in order to perceive them and also seek for social relevant contents in a meta-representational-based process. This proposed involvement of brands in meta-representational processes may be explained in two different planes: because brands are a human creation, they may be understood as repositories of the beliefs, intentions, and goals of their creators, i.e. the target of the meta-representations are redirected to brands; or they may were promoted into a quasi-human level, and now humans attribute volitional abilities to brands like intentions, beliefs, and goals. These speculations may be the object of further experiments that challenge them.

For what it concerns the Semiotic approach to brands, the contrast between positive and indifferent brands (meaningful brands) with fictitious logos (meaningless "brands") produced very interesting results. Meaningful brands recruited more a brain network than meaningless brands, which has been linked to self-relatedness, autobiographical memories, Theory of Mind, and meta-representations, i.e. all cognitive processes that humans use to accurately navigate in the social milieu and produce purposeful behavioural conducts. Conspicuously, this brain pattern was activated when subjects not face conspecifics, but brands' logos which, together with a wealth of phenomenological studies, raise brands from mere objects to a putative human-like level moral-able. This means that the relationships that humans maintain with brands may be more than a convenient metaphor. These speculations are inferred from the findings along this series of studies and future experiments should confront directly brands, objects, and persons.

In the same line, it is reported the activation of a brain network that comprises the mirror neurons system in humans. This finding should be explored as it may pave the way for a possible mechanism of transference of brands' meanings through imitative processes within social groups, as there are already theories that, in humans, the mirror neurons system supports much more than simple purposeful actions replication.

Finally, it is revealed certain networks that support brand preference: the somatosensory cortex II and neighbouring structures, and the ventro medial prefrontal cortex. The participation of the former is interpreted as a bodily feeling of the goodness of the stimuli, which is something that humans systematically seek for their psychological homeostasis, and which is a candidate for a somatic marker for positive brands. There is a wealth of literature the assigns to the ventro medial prefrontal cortex a central role in emotion-based decision-making. At first sight the participation of the vmPFC would explain the faster responses for positive brands, acting as a shortcut coder for rewards, but the analysis of the fMRI data does not provide comfortable evidence for such, and the activations of the vmPFC are elusive.

One possibility to investigate the effective role of the vmPFC in decision-making processes would be with TMS. However, because TMS applied close to the face of subjects would be extremely uncomfortable, this technique may not be useful for the moment.

One other possibility is insisting in fMRI data analysis, but now using artificial neural networks (ANNs). Because ANNs seek for relations between inputs and outputs, they may make emerge the brain structures that mostly contribute for positive assessments. Meanwhile, the nodes in the hidden layers should code for the psychological processes that subserve the choice strategies implemented by subjects during their assessments, which may corroborate the theories constructed so far, or deny them.

V. S-O-R: TACKLING THE PSYCHE OF THE 'O' BY APPLYING ANN

Along this chapter a new multivariate analysis and interpretation of fMRI data will be drawn, which will be used to substantiate the ideas unfold until now, and that will ultimately tap the neural-based psyche in brands' perception. There is then a dual purpose: help in resolving conflicting issues (e.g. the role of the ventro medial prefrontal cortex), and benefit from the predicting capabilities of classifiers and investigate if they are applicable with success to fMRI data.

The multivariate analysis is Artificial Neural Networks (ANN), which was already introduced in the first chapter of this thesis. To date, only Hanson, Matsuka, and Haxby (2004) published a complete article where ANNs were used to analyse fMRI data. They reanalysed already published data, now with ANNs and focusing in the ventral temporal region (not whole brain analysis). They defined a procedure to look for voxels that bear information to correctly classify visual stimuli. There is also the publication of an abstract, reporting the use of ANNs for real-time fMRI analysis (Weygandt, Stark, Blecker, Walter, & Vaitl, 2007).

This analysis will be carried on raw fMRI data collected during the study reported in the previous chapter.

Data Pre-processing

An important hurdle in fMRI analysis is the existence of a lag (about 4 to 6 seconds) between stimulus onset and BOLD signal peak (Huettel, et al., 2004). To overcome this difficulty the BOLD signal is averaged out for volumes' acquisitions subsequent to stimulus onset. Two possible strategies are depicted in Figure 58.

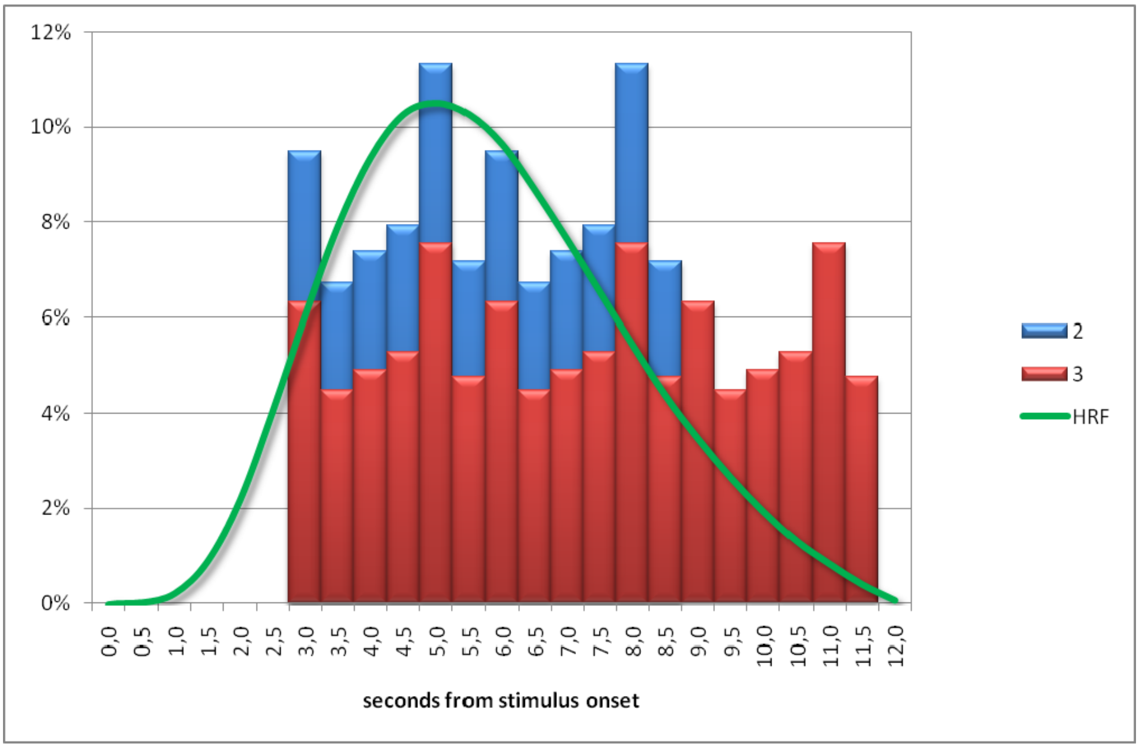


Figure 58 – Comparison of two strategies to average consecutive fMRI volumes. The green line represents the canonical hemodynamic response function (HRF). The areas represented by blue and red bars represent the amount of the contribution to the average in time periods. Each coloured area sums 100%. In strategy 2 (blue colour) the second and third volumes after stimulus onset are averaged. In strategy 3 (red colour) the second, third, and forth volumes after stimulus onset are averaged.

In the strategy number 2 in Figure 58, the second and third volumes after stimulus onset are averaged, and for strategy number 3 the volumes considered are the second, third and forth. It results that the mean time in strategy 2 is 5764 milliseconds, while it is 7264 ms for strategy 3. Because strategy 2 captures more signal centred around the BOLD peak, it was the elected.

Other strategies that included the first volume were also considered, but all of them were always much worse than this two. It is worth to note also that, because BOLD signal contain noise, it is always better to incorporate averaging in the strategy, so the levels of noise are diminished.

In the previous chapter it was detailed the conventional GLM mass-univariate voxel by voxel analysis. It was possible to identify some significant clusters that were active for different situations. Eighteen of these voxels that correspond to local maximum were selected and are described in Table 31. Afterwards, the mean of the signal of the voxels that felt inside a sphere with 5 mm radius (81 voxels with 2 × 2 × 2 mm) was calculated for all 18 cases. The 18 participants in the study provided 1452 epochs, each one encompassing the brain picture of 18 spheres for one brand assessment from three possibilities: *positive*, *indifferent*, or *fictitious* (*negative* brands were not considered because were few). It is worth to note that the data was demeaned for each subject in order to eliminate inter-subject de-centring.

Table 31 - Voxels selected for the artificial neural network inputs.

Group	Voxel		
	Probabilistic atlas	Coordinates	Description
1	58% insula	-34x18x0	Active for all sort of logos versus baseline
	42% frontal orbital cortex	30x28x-4	
	46% paracingulate (dorsal)	6x18x50	
2	73% cuneal cortex	2x-78x28	Visual areas active during discrimination
	26% occipital fusiform gyrus	-38x-68x-12	
3	66% frontal pole	-20x64x4	More active for recognised logos than for fictitious
	51% angular gyrus	-52x-56x46	
	45% precuneous cortex	-6x-60x66	
	38% posterior cingulate	-6x-52x22	
4	55% frontal pole	-2x58x4	More active for positive than for indifferent brands (prefrontal cortex)
	47% frontal medial cortex	2x36x-14	
5	59% central opercular cortex	-44x-20x14	More active for positive than for indifferent brands (left parietal cortex)
	45% parietal operculum	-42x-28x16	
	71% insula	-42x-2x-2	
6	43% insula	44x2x-6	More active for positive than for indifferent brands (right parietal cortex)
7	36% pars opercularis	-48x16x28	More active for indifferent brands than positive or fictitious
8	68% lateral occipital (sup.)	48x-64x38	Assorted voxels not active in the mass-univariate analysis for any type of brand
	88% caudate	-16x16x10	

Note - MNI152 coordinates system.

Constructing the Artificial Neural Network

Each sphere centred in the coordinates listed in Table 31 is an input node into the artificial neural network. Each possible assessment (*positive*, *indifferent*, or *fictitious*) is an output node. The hidden layer includes three nodes (more nodes did not lead to better results). The 1452 epochs were randomly sorted and 80% of them were used for training, while the remaining 20% were kept for the test stage. This network was tuned to a global learning rate of 0.01 and a global momentum of 0.5. The AMORE package (Limas, et al., 2010) implemented in R (R Development Core Team, 2010) was used to perform the necessary calculations.

Interpretation of the Artificial Neural Network

Table 32 summarises three strategies used in the test stage: the 20% of the original data set kept for the test stage, the same 20% data set but randomly ordered across the 18 inputs and 290 epochs, and random values from a uniform distribution.

Table 32 - Partial and total results of the test stage with three sets of data: the 20% of the original data set kept for the test stage (columns Hits), the same 20% data set but randomly ordered across the 18 inputs and 290 epochs (columns Randomised order), and random values from a uniform distribution (columns Random inputs).

Assessments	Tested	Hits		Randomised order		Random inputs	
Positive	121	84	69,4%	63	52,1%	59	48,8%
Indifferent	66	25	37,9%	18	27,3%	17	25,8%
Fictitious	103	68	66,0%	23	22,3%	27	26,2%
Total	290	177	61,0%	104	35,9%	103	35,5%

If, admittedly, the chance of classifying correctly is 1/3 (because there are three possible categories), the analysis of test with the 20% separated epochs reveals that the artificial neural network classifies around 2/3 for *positive* and *fictitious* brands, that is, it performs much better than chance. However, for *indifferent* brands, the performance is slightly over chance. The same data set but presented randomly leads to a general decrease in performance, which means that some voxels hold critical information for correct classification. Finally, random values lead to a poor performance, below chance for *fictitious* and *indifferent* brands, better than chance for the *positive* brands, but in this case considerably worst when compared with the original data set.

As demonstrated, although it is possible to guess the choices of the participants using a limited set of parts of the brain ("mind reading"), at least for *positive* and *fictitious* options, for the purposes of the present chapter it is interesting to analyse the nodes of the hidden layer, in order to make inferences about the psychological processes that underlie the decision process. Table 33and Table 34 report the weights and bias that structure the network.

In Table 34, the hidden node 1 is clearly positive for *positive* brands, but negative for the two remaining cases. It is then possible to conclude that the loci that mostly contributed to the hidden node 1 hold important information to correctly classify *positive* brands, which in turn suggests that such brain structures have an important role in the psychological processes that support brands' *positive* assessments. A look to Table 33 permits to include in such list the parietal operculum, central opercular cortex, angular gyrus, posterior cingulate, 66% frontal pole, and occipital fusiform gyrus.

Conversely, node 3 is clearly negative for *positive* brands, but positive for *indifferent* and *fictitious* brands. It may be admitted then that hidden node 3 represents processes common to *fictitious* and *indifferent* brands appraisal and that such processes should be absent during *positive* brands assessments (because the weight is clearly

Table 33 - Weights and bias that structure the neural network between the input and hidden layers.

Spheres		Hidden node 1	Hidden node 2	Hidden node 3
58% insula	-34x18x0	-0,039	-0,746	0,054
42% frontal orbital cortex	30x28x-4	-2,427	2,540	0,747
46% paracingulate (dorsal)	6x18x50	-5,366	-0,541	2,783
73% cuneal cortex	2x-78x28	-0,115	-2,275	-0,307
26% occipital fusiform gyrus	-38x-68x-12	1,164	3,004	3,796
66% frontal pole	-20x64x4	1,386	-1,553	-0,595
51% angular gyrus	-52x-56x46	3,334	-1,161	-2,758
45% precuneous cortex	-6x-60x66	0,496	-0,365	0,439
38% posterior cingulate	-6x-52x22	3,121	-3,278	0,080
55% frontal pole	-2x58x4	0,366	0,266	-0,322
47% frontal medial cortex	2x36x-14	0,393	0,446	0,514
59% central opercular cortex	-44x-20x14	4,053	1,839	-1,650
45% parietal operculum	-42x-28x16	4,882	1,160	-1,819
71% insula	-42x-2x-2	0,048	0,491	-0,021
43% insula	44x2x-6	-0,149	0,369	-1,216
36% pars opercularis	-48x16x28	-3,088	-1,263	2,212
68% lateral occipital (sup.)	48x-64x38	-0,405	-1,420	-0,828
88% caudate	-16x16x10	-1,175	-1,001	1,043
Bias		-0,031	0,046	0,058

Table 34 - Weights and bias that structure the neural network between the hidden and output layers.

Hidden	Positive	Indifferent	Fictitious
Node 1	1,715	-1,314	-0,870
Node 2	-0,393	-1,169	1,421
Node 3	-1,173	0,532	0,876
Bias	-0,393	-0,309	-1,796

negative and not merely close to null). The most contributing brain regions here are the occipital fusiform gyrus, dorsal paracingulate gyrus, pars opercularis, and caudate.

Node 2 is clearly positive for *fictitious* brands, close to null for *positive* brands, and clearly negative for *indifferent* brands. The brain regions that mostly support this node are the occipital fusiform gyrus, frontal orbital cortex, central opercular cortex, and parietal operculum.

The occipital fusiform gyrus has important contributions for all the three nodes, although the differences in magnitudes. This is not surprising as fusiform areas have been found to be active during visual discrimination tasks (Ishai, et al., 2000; Ishai, et al., 1999). Using also neural networks over fMRI data, Hanson, Matsuka, and Haxby (2004) found that fusiform areas hold important information to correctly classify visual stimuli. The results of the present study are in line with these findings because brands' logos are essentially visual information whose meanings have to be decoded and a primary candidate for such process are visual associative brain areas located within fusiform regions.

The posterior cingulate and the 66% frontal pole spheres overlap some of the brain regions that encompass the default network, also referred as resting-state network. This network have been consistently observed to support self-referential processes, whether the self is considered in present situations, whether the self is projected into future situation simulations (Andrews-Hanna, et al., 2010). Other authors also include a parietal region in such process: the temporal-parietal junction (TPJ). The TPJ encompasses the angular gyrus, which also has important contributions to hidden node 1. As already discussed, the TPJ have been found to support meta-representational processes where one imagines what his/her peers/interlocutors are thinking about. TPJ, posterior cingulate and anterior prefrontal cortex are functionally connected regions, and were found to be necessary to conveniently represent the self (Lou, et al., 2004). Due to the activation of this web of brain structures it is possible then to conclude that self-referential processes are well represented in hidden node 1 and that they are important to classify a brand as *positive*.

The central opercular cortex and the parietal operculum also have an important weighted contribution for hidden node 1, although with less importance to hidden node 2 and inverted in hidden node 3. Damásio (1994, 2003b) developed a theory of emotion-based decision-making where the somatosensory cortex II (which encompasses the central opercular cortex and the parietal operculum) is critical in producing the feeling. Hence, persons tend to rely their decisions mostly on the feeling that the stimulus produces and not so much on time-consuming hard computations where each element is parameterised and the result is then pondered. It may be accepted that subjects used such strategy in this study, mainly when they assessed *positive* brands, also because *positive* brands where rated quicker (1546 milliseconds) than *indifferent* (2370 milliseconds) or *fictitious* logos (2334 milliseconds).

In this paradigm, hidden node 1 concentrates brain regions that have been found to support psychological processes that involve self-relatedness and feelings in the decision, and conspicuously, node 1 is the node that supports mostly a positive output. These results suggest then that self-related and an ability to induce feelings are necessary to correctly classify brands as positive.

The analysis of the weights of two voxels belonging to the same brain structure, 66% frontal pole and 55% frontal pole, provides a clear example that anatomical and function parcelling of the brain may not overlap. While 66% frontal pole is necessary for *positive* and *fictitious* brands' classification (positively and negatively, respectively), 55% frontal pole is innocuous.

It is interesting also to retain that the spheres with the voxels 55% frontal pole and frontal medial cortex are never important for whichever category, a fact already suggested during the analysis with MELODIC. Interestingly, these two regions participate in the activation cluster in the contrast positive versus indifferent revealed in the GLM analysis (see Table 15 and Figure 41). It seems then, that, if a voxel activates in a GLM contrast (i.e. its coefficient is high enough and with low variability enough, for a certain explanatory variable more than the contrast), this is not sufficient to assign to that voxel a status of necessary for categorisation outputs purposes, i.e. that voxel does not necessarily holds critical information for the psychological process of categorisation.

Hidden node 2, which also include the feeling of the brand in a limited extent (through central opercular cortex and parietal operculum), and largely visual associative processing (through the occipital fusiform gyrus), also involves positively the frontal orbital cortex, a brain region that have been found to have a role in integrating multisensory information (Price, 2008; Rolls, 2004) and consequently in decision-making and behavioural responses (Schoenbaum, et al., 2009). Interestingly, the inputs linked with self-relatedness in node 1 (posterior cingulate, frontal pole, and angular gyrus) are now negative in node 2. All of this suggests that hidden node 2, which largely supports *fictitious* logos appraisal, is a node that concentrates visual associations, the feeling of stimuli together with multisensory integration in a tentative of recognition process, missing the shortcut to the decision conveyed by the structures that support self-relatedness, which may had delivered quicker responses for *positive* brands. In line with this, the frontal orbital cortex has an important negative contribution for the node 1.

The dorsal paracingulate gyrus, pars opercularis and caudate, together with the occipital fusiform gyrus have positive contributions for hidden node 3, a node that has some pale positive contributions for *fictitious* and *indifferent* brands classification.

Conspicuously, the angular gyrus, central opercular cortex, and parietal operculum have negative contributions to this node. It is not possible to sustain that this node is important for *indifferent* brands classification because, as considered in previous paragraphs, this network classifies *indifferent* brands at chance levels, although in the inputs figure brain structures that output activations or deactivations in the contrasts between *indifferent* versus *fictitious* or *positive* brands in the current mass-univariate GLM analysis. It is possible then to speculate that *indifferent* brands are transparent for this network, i.e. such brands are really indifferent, not noticeable, and probably impossible to classify other than unclassable.

Considerations about the Interpretation

The example presented along the previous sections is not exhaustive because it only considered some brain regions highlighted by current GLM-based analysis of fMRI data. The respective interpretation has to be considered with caution because a non-activation does not necessarily means that the considered voxel is not important in the contrast; it only means that the correlation is weak and there are many factors (physiological, physical, and statistical, at least) that may support a biased output.

A second important consideration is about what is named as reverse inference, which has to be brought to scene once again. Suppose that a certain task A activates a group of voxels in the paracingulate gyrus. Then, from the literature, a task B activates the same group of voxels. It is not possible to conclude that A and B are equivalent or even similar, because different psychological processes may rely in the same brain structure at a certain point of their flow (for a more exhaustive explanation see Poldrack (2006, 2008)).

When interpretations about the role of certain brain structures are made, like in the previous section, it is important to consider not specific studies or experiment reports that focus in a very limited set of stimulus, but in meta-analysis or reviews or theories constructed around the functions of a brain structure, which provide wider and more consistent considerations of specific structures' roles. In the same line, when A and B share the same process, they do not have to be considered different, because it is unlike that different processes recruit the same pattern of elements, and processes are characterised by brain structures in network and not in isolation.

In spite of these considerations, the use of ANN made possible the emergence of distinct pattern arrangements that can classify correctly above chance at least *positive* and *fictitious* brands and this methodology allowed to conclude that the involved brain structures are necessary and sufficient to correctly classify at least in the achieved levels. Consequently, the psychological processes that macro approaches have been identifying for each structure can be transposed for an explanation of the processes that underlie brands' assessments, i.e. between stimulus and response, this methodology allows tackling the psyche that organisms perform.

Future Developments

A question that emerges in the last section is to know what happens when the target of the analysis is extended to the whole brain and not only in convenient spheres that involve local maxima from the GLM analysis. In that case, will ANN method be able to discriminate between necessary brain structures to the process from the remaining? It has to be considered that complex processes, such as brands' appraisal are, may involve a plethora of subprocesses that concur simultaneously or in sequence (remember that each image usually takes between 2 and 3 seconds to be acquired in a scale much larger than the one in which brain processes occur). Hence, it has to be expected that multicollinearity among voxels will extensively appear. ANN has been proven resistance to multicollinearity problems, but it remains to be tested within the particularities of fMRI data.

Another issue of study is the design of convenient paradigms for multivariate analysis. Current designs like block or event-related (the example used in previous section) were improved to meet mass-univariate analysis. Are them the most suitable for multivariate analysis? At first sight the answer is no. Data for multivariate analysis need that cases are perfectly separated in order to hyperplanes conveniently separate them. Due to the specificities of hemodynamic response (e.g. the tailed response in time), event-related designs tend to present overlapped signals of neighbour stimuli, which is a severe confounding effect for ANN. Block designs tend to sum the hemodynamic responses, which may also be a source of confusion during discrimination. Then, it may be useful to improve better paradigm structures that deliver more tractable data.

VI. THE EMERGENCE OF A MODEL

There are some theories that may be important for a broad range perspective on brands, but that were not advanced because they did not provide immediate nomological support for the discussion. The aim of this chapter is to integrate the findings of the present work with those theories to generate a parsimonious model that can describe what brands are.

Symbolic Interactionism

The sociological perspective of Symbolic Interactionism provides a useful framework to comprehend the dynamic of brands within the social milieu. Blumer (Blumer, 1969) recognizes in Mead's thought three essential features that constitute the core of Symbolic Interactionism:

- humans have a self-concept, and the self-concept of each one can be the object (target) of the actions of his/her owner, i.e. humans initiate actions towards themselves by targeting their self-concept; during self-directed actions, humans indicate things to themselves; along indicating things, humans give a mean to things and, consequently, to themselves;
- action is constructed; action results from the interpretative process where stimuli are decoded, meanings are assigned and interpreted, resulting finally in an action; humans do not react to stimuli, as between input and output there is an interpretative process centred in the meanings;
- collective action results from the cumulative alignment of individual actions; if individual actions within an organisation are consistently oriented, the resulting

> collective action will emerge as clear and defined, like in a solid crystal; conversely, if individual actions cancel each other due to lack of orientation, an undefined and confusing collective action will emerge, just like in a gaseous system.

It is worth to emphasise that the signification of "symbolic" is much broader than that it has been using along this essay. For symbolic interactionists, the signification of symbolic is anything that may convey any sort of meaning, not only logos and words, but body postures, linguistic accents, room decoration, gestures, set of friends, or facial expressions as well, i.e. anything or any situation that points meanings to the observer.

It results then that situations supply objects and meanings for interpretation. The interpretation that each one makes generates actions, actions that will convey meanings to others interpret. Subsequently those interpretations will produce actions, which the original subject may witness, closing the cycle. Hence, this cycle allows each one to monitor himself/herself by observing how the others act in response to own actions, bringing again the thought of Adam Smith that equals peers to looking-glasses (A. Smith, 1759, Part III, Chap. I, Of the Principle of Self-approbation and of Self-disapprobation).

This leads to a bipartition of the self in Mead's envisage (Stryker, 1990): the "Me" that concentrates others' expectations about oneself, and the "I" which are the broadcast responses. It is the confront of these two facets that occupy much of human existence, each one playing the roles took and measuring own divergences in their peers/mirrors reflex (Goffman, 1959). It results then that social organisation is the product of people actions, where each individual needs a mirror to track himself/herself, and not an a priori axiom (Blumer, 1969).

During the own interpretation – own action – other interpretation – other action cycle, meanings flow and are interpreted and reinterpreted (Stryker, 1990). Meanings are the emergences of the concerted actions within the social group. In the case of brands, their meanings are created, or better, co-created by marketers and consumers (Allen, et al., 2008; Hirschman, 1986): the former instil meanings in brands that connect the brand to a symbolic lifestyle, and the later choose the right meanings to nourish their self-concepts and negotiate the meanings with their peers (Ligas & Cotte, 1999). The choice of a brand has hence a significant social character, and the social meaning is a chief drive that guides to choice (D. H. Lee, 1990). Meanings provide a non-linguist way to convey messages about the self, help in role transitions (Leigh & Gabel, 1992), impregnate clothes that participate in group attachment among teenagers (Piacentini & Mailer, 2004), and more generally in fashion dynamic ambiguous and complex definition (Kaiser, Nagasawa, & Hutton, 1991).

Memetics and Imitation

As meanings are not rigid entities, they suffer transformations that alter original significations, which turn meanings in mutable entities. The set of agreed meanings inside a social group, even the agreed mutant evolutions, composes the dynamic culture characteristic of the group. At this is point, it is useful to give a name to these basic cultural units that evolve and spread in the social milieu: memes.

Memes import three principles from Darwinian evolution: replication, variation, and selection. The application of these three simple rules produces the emergence of evolutionary patterns out of chaos (Blackmore, 2000). Replication is ensured by social-based imitative processes that humans systematically perform in their daily lives, variation occurs when the meanings suffer changes, even slightly, during the unmaterialised transmission vault between interlocutors, and selection is carried by interpretative processes, which consider one's diverse self-concepts.

The imitative principle, for which humans are biologically equipped (Rizzolatti, 2005; Rizzolatti, et al., 2001), is crucial for the quick spreading of memes. However, unlike genes that transmit vertically in a generational basis, thus requiring long time for the evolutionary process to accomplish in selecting the best for the species, memes have a viral-based transmission, which diffuses horizontally, maximizing contagious within the same generation (Blute, 2005). This distinctiveness will protect a meme from extinction, even if it is harmful, lethal inclusively, to its host.

Just by observation, some nonhuman species were able to develop some kind of social learning, i.e. knowledge that must be learn at some point of individual's life from his/her conspecifics, and it is not acquired by heritage, i.e. non-genetic knowledge. The french grunt fish (*Haemulon flavolineatum*) acquire the knowledge of new twilight migration routes, and maintain that knowledge in the absence of resident fish (Helfman & Schultz, 1984). In savannah sparrow birds (*Passerculus sandwichensis*) one syllable chirp is geographically widespread, but two, three, and four syllables chirps are geographically restricted, defining cultural populations by memes (Burnell, 1998). With increased complexity, cultural variation have been found in chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*), including variations in tool usage, grooming, and courtship, which significantly extends the repertoires of cultural distinctiveness among groups (Whiten, et al., 1999), however still far from reaching human cultural richness.

Blute (2005) sustains that massive social learning requires symbol-based instruction, the only one that supports the diffusion and preservation of diverse possible states, and avoids cumulative degradation within sequential transmission systems. As symbolic capacity is recognized only in humans (van Schaik, et al., 2003), this would mean that only humans can deal (be infected and transmit) with memes, which would mean that cultures are reserved to humans, and non-humans, at most, would have proto-cultures.

Reader and Laland (1999) disagree and claim that memetics can and should be applied to the animal world, maintaining that imitation it is not the only way to transmit memes. Other reliable methods also faithfully copy information between conspecifics and could support cultures in animals, like in french grunt fish or savannah sparrow birds (Burnell, 1998; Helfman & Schultz, 1984). Reader and Laland (1999) however recognize that lacks evidence for skilful imitation in animals, but any social learning process will be enough to perform such transmission, and many non-human animals are sufficiently good social learners to do it.

Blackmore (1998) distinguishes between imitation from contagion and other kinds of learning, and sustains the original idea of imitation as crucial for memes transmission, i.e. memes are something that can be passed through imitation.

Byrne (2005) also recognizes two kinds of imitation: social mirroring, and learning by copying. The former exists in humans and non-human animals, does not involves learning because actions are previously coded, signals the actions observed in other individuals and that could be equally performed by the observer, requires synchrony but not creativity, and frugal resources are need for this computations; the later capability was observed only in humans until now, involves deconstruction of the observed actions in smaller blocks and reconstruction of the same action or similar leading to creativity, and requires high processing capabilities. The mirror neurons (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996) discovered in the monkey brain (*Macaca nemestrina*) can be a neural structure that supports social mirroring.

All these apparent contradictory positions approached along this section can, in fact, integrate a coherent rationale. In the imitation spectrum, social mirroring fills the lower range, the most simple imitative process and the one that can account for the most modest form of information transmission, and thus for the most rudimentary cultures. In the other end, there is learning by copying, which involves deconstruction to simpler meanings and coding for order, i.e. semantics and syntax, and only human brain is equipped to accomplish with such processes. However, there is room for much more complex information transmission and, in turn, for much more complex cultures. This is far in line with the proposed memetic origin of human language (Vaneechoutte & Skoyles, 1998), although such theory do not explain why children effortlessly learn a language (which strongly suggests a biological basis for language and not cultural), or why humans learn how to sing only after learn how to speak. However, it paves the way for an explanation of the intriguingly fact that only humans, and no other animal, sing the same song in group: due to memes.

With this background, brands come out as memeplexes, i.e. symbol-based ordered sequences of memes that code the different meanings the same way that a meaningful sentence is formed by an ordered (syntax) sequence of words (semantics).

Brands are complex, but imitative transmission capacity among humans is enough to account with such challenge, and this framework easily accommodates valuable and proved marketing channels like word-of-mouth, or stereotyping. As already discussed in the first chapter, brands can accommodate several meanings, and these meanings may be perceived or interpreted differently from original significations (Elliott, 1994). Brands' horizontal diffusion supports social groups and cultures.

Designing a Model

Along this research it was aimed to follow two basic premises from Blumer's methodology: exploration and inspection (Blumer, 1969). There was no previous model. Instead, it was started with empirical data from neuroscientific studies and explored it. The point of view was of real consumers and how they perceive brands' logos, more specifically how their brains interpret brands and their meanings. Hence, this approach is different from many other studies that see brands as companies' assets or marketers or advertisers trying to influence their markets. It was promoted the point of view of those that use brands and pay for them.

Along inspection, concepts and links among concepts start to emerge with substantial amounts of knowledge from Neuroscience and, step by step, the frame became more defined. Inversely to conventional research, the final stage is a grounded model that summarizes all the research. This model emerged from data and will have always a provisional status until disparate new data collapses it.

The distinctive marks have been accompanying humans for centuries, helping in defining social groups and inherent hierarchies. Etymologically, the word brand comes from the Proto-Germanic with the "meaning of 'identifying mark made by a hot iron'

(1552) broadened 1827 to ‘a particular make of goods.’” (Harper, 2001). The French fleur-de-lis in coats of arms, or the Hapsburg eagle in Austria-Hungary empire, or the Imperial chrysanthemum in Japan were brands that distinguished their users with power and social status (Blackett, 2003). The branding iron was used to mark cattle, a distinctive way to signal possessions to conspecifics and affirm, again, social power. Companies beneficiated from these meaningful symbols to establish differentiations between own products and services from competence, promoting the massification of brands’ use, however forcing the evolution of brands’ concept and connections to a far socio-multi-faceted entities.

Nonhuman objects have been gaining new roles in postmodern era, helping in self-construction due to the emptying of traditional ways of socializing, which have been opening new spaces for nonhuman social resources (Callero, 2003). The insistently changes induced by postmodernity loose references, and obligate individuals to successive roles transitions. Objects help individuals during social adaptation (Silver, 1996), and brands can provide frames of references (Holt, 2003). But the gap allowed the emergence of nonbiologic objects as actors (Owens, 2007). Persons “do mind” with these raised new actors, interact with them, and measure their own reflexes in the responses of these co-constructed mirrors. These are the new symbols that stand for themselves:

> The subject matter that now confronts us supersedes symbolic interaction; rather it is the process surrounding the autonomization of signs; signs that stand for - and refer to - nothing but themselves. (Farberman, 1980, p. 18)

The new symbols actively structure subjective experience, shapes the “Me”, replacing human actors, and due to the insistent media replication, the “representation of the real becomes hyperreal” (Denzin, 1987, p. 15).

The concepts that emerged from this neuroscientific approach to brands’ perceiving by human consumers, together with those which bond to them and that emerged from the work of other researchers, allowed the construction of a nomological network (Cronbach & Meehl, 1955) in a form of a endless ring, as depicted in Figure 59.

Figure 59 - The transient model that emerged from the findings of this research, as well the investigations of several authors, in a form of an endless ring. The self-concept is at the centre, and eight linked satellites gravitate around. A brand is the idea that links all these concepts and each individual’s self-concept.

Self is central to this orbiting ring, and is the consumer's self-concept that has to deal with this network in his/her daily relationship with brands. Brands are the train that links the stations (concepts), strengthen relations among them, and are a major responsible for structuring this atomic model.

Today, brands help in self-construal and in defining social groups (Escalas & Bettman, 2005), maintaining their original role bounding social castes, but also with new assigned functions, symbolic and emotional, providing dynamic meanings, and precipitating individuals' convergence to compose brand tribes (Veloutsou & Moutinho, 2009): brands are inexorably social tools.

VII. FURTHER STEPS

Along the discussions of the various studies, some questions remained open without acceptable explanations. This chapter integrates some other theories and knowledge that together with the findings and the theories constructed along this work rise new questions, which should be the target of further work.

How do Logos Convey Brands' Experience?

The findings of Yoon et al. (2006) are challenging: there is a semantic chasm between humans and brands, which simply tosses brands to the class of objects, defying extensive literature that claims for more anthropomorphic characteristics, like personality (Aaker, 1997).

However, the findings of the present work support that brands are meaningful entities with emotional capability, which contradicts Yoon's suggestions in a certain sense. It may happen that Yoon's study is semantic biased since the beginning because they use as stimuli, not logos to represent respective brands, but just the brands' name, written with the same font and colour for every case. It may then be hypothesised that this amputation deprived participants from the full experience of the brand, and hence brands' semantic meanings (social and emotional) were not evoked, leading to the published results.

In the nearest future, it will be conducted a study, using the same neuroscientific technique, fMRI, to investigate the brain activation patterns when participants are visually stimulated with brands logos versus brands names. Of course extensive activations in the visual cortex and visual associative areas (fusiform gyrus) are expected due to the diverse colours, shapes, and fonts that logos usually exhibit. Nevertheless, when subtracting the name of the brand to the experience evoked by its logo, it is expected the emergence of a brain activation pattern quite similar to the obtained in the present work, stressing social relevant, emotional, and self-reference dimensions. To ensure a comparable basis, the same baselines, i.e. non-emotional words and fixation cross, will be maintained.

Asocial Behaviour in Autism

The main findings of this work clearly point to a social dimension in brands. Socially communicating through consumption is known for long in Marketing discipline (Belk, Bahn, & Mayer, 1982) and it links with self projection in the social environment (Richins, 1994) and self-concept construction (Mittal, 2006), as possessions reflect self identities (Belk, 1988) and particularly help to enact self's social identities (Kleine III, et al., 1993). Consumers identify and use product and brand symbolism to define themselves in the context of specific social situations (Elliott, 1994; Elliott & Wattanasuwan, 1998; Wright, Claiborne, & Sirgy, 1992). O'Cass and Frost (2002) found that young consumers are aware of the social status symbolic meaning that brands embody and manage it to project self image among their peers. High status content arouses positive feelings towards such brands. In the evolutionary path, the higher stage and most consumer-centred is the symbolic stage where consumers use such brands to express their emotions, personalities, and roles (de Chernatony, 1993). This symbolic communicative beam has two directions: persons project themselves to their peers, but also they receive and decode similar messages from them (de Chernatony, 1993). Hence, brands have meanings that help consumers to construct social reality, acknowledges social groups, align own self-concept accordingly, and is a major drive of behaviour (Solomon, 1983). In line with this grounded wealth of knowledge on the social dimension of brands, it is without surprise that Aaker (1997) proposes a measurement scale that clearly relies on human social trait attributes: sincerity, excitement, competence, sophistication, and ruggedness. Brands, humans, and human social groups are inseparable entities.

As the findings of the present work stress this proposition, further studies should challenge it. One way to accomplish it is using individuals impaired in social abilities. If those individuals fail to recognise social cues from the environment, maybe they also should miss to recognize brands' social dimension, however preserving awareness of other utilitarian dimensions. It is possible to find individuals with such impairment in the autism spectrum disorders, more specifically individuals with Asperger syndrome. The social dysfunction is the first diagnostic criterion of Asperger syndrome:

> F84.5 Asperger's syndrome
>
> A disorder of uncertain nosological validity, characterized by the same type of qualitative abnormalities of reciprocal social interaction that typify autism (…) (World Health Organization, 2007)

The social dysfunction also is primary in the American Psychiatric Association criteria:

> 299.80 Asperger's Disorder
>
> Diagnostic Features

> The essential features of Asperger's Disorder are severe and sustained impairment in social interaction (Criterion A) (…). The disturbance must cause clinically significant impairment in social (…).
> The impairment in reciprocal social interaction is gross and sustained (…) (American Psychiatric Association, 2000)

Within social dimension (Criterion A), to a diagnostic of Asperger syndrome, at least two of four items should be observed:

> (1) marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
> (2) failure to develop peer relationships appropriate to developmental level
> (3) a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest to other people)
> (4) lack of social or emotional reciprocity (American Psychiatric Association, 2000)

The dysfunction in social interaction always figures as diagnostic criterion in other classification systems (Gillberg & Gillberg, 1989; Szatmari, Bremner, & Nagy, 1989) or in reviews about this theme (Happe & Frith, 1996). The difficulties with social interaction systematically appear in the instruments designed by Baron-Cohen and co-workers (Baron-Cohen & Wheelwright, 2004; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004), and are central to the diagnostic (Baron-Cohen, Wheelwright, Robinson, & Woodbury-Smith, 2005).

However, it is worth to say that, together with these criteria, there is another one transversal to the two institutional systematisations, which establish that there is not cognitive nor linguistic disabilities (American Psychiatric Association, 2000; World Health Organization, 2007), and this distinguish individuals with Asperger syndrome from individuals with autism (World Health Organization, 2007).

Individuals with Asperger syndrome are active but odd, and individuals with autism are aloof and passive (Ghaziuddin, 2008). The social dysfunction of the individuals with Asperger syndrome would have some cause other mental retardation. Although these criteria manifest in childhood, they extend into adult age (Berney, 2004) with apparent symptoms' diminishing. The attenuation is due to acquired social mimetic behaviours that disguise eccentric conducts (Tantam, 2003).

Neuroscientific studies conducted with individuals with Asperger syndrome reveal different activation patterns when compared with normal individuals, e.g. median zones of the prefrontal cortex, paracingulate gyrus, and angular gyrus (Castelli, Frith, Happe, & Frith, 2002; Kana, Keller, Cherkassky, Minshew, & Just, 2009), and in the amygdala and orbitofrontal cortex (Ashwin, et al., 2007). Particularly, autistic children are impaired in Theory of Mind tasks, i.e. they fail to attribute mental states to others and, thus, fail to preview other's behaviour (Baron-Cohen, et al., 1985). This failure is a signal of the impermeable posture to social cues of these individuals, supposedly because their brains miss implicit and explicit awareness for social stimuli (Ashwin, et al., 2007).

On the other hand, studies with normal individuals seeking for the neural representation of social status hierarchy have been founding activations in the inferior parietal cortex, amygdala, and medial prefrontal cortex (Chiao, et al., 2009; Zink, et al., 2008). The overlapping of these maps with the results from the studies conducted so far is conspicuous, suggests the corroboration of the social dimension in brands, and posits brain structures that process social stimuli as markers for this dimension.

The future study with subjects with Asperger syndrome will confirm (or not) this hypothesis.

Evolutionary Perspectives

To help bring some sense to this puzzling neuroscientific approach to consumers' brands perception, it should be considered an evolutionary perspective too. An evolutionary frame will input an ontogenic timecourse, and may inform what is antecedent and consequent, and also the emergence of the relationships and mutual support among concepts.

Two different evolutionary approaches may be made: human proper ontogeny, from birth until adult age, considering brain development and inherent skills acquisition (Meltzoff, 1988); and long term speciation that resulted in actual humans (*Homo sapiens*). Elements for a paleosociological study are not abundant and may be excessively speculative, which turns the later approach problematic. However, it still is possible to look to humans evolutionary relatives, for example in the *Primates* order, always having in mind that humans did not evolved from chimpanzee, but both have a common ancestor. This means that both extensively share phylogeny, but there would have some aspects that are exclusive characteristic of chimpanzee, for example, and such aspects just cannot be imported to human species.

From the animal world, orang-utans may inform about social (dis)abilities and, consequently, social (not) constructions. In opposition to the remaining cohorts in the *Primates* order, the species belonging to the subfamily *Ponginae*, genus *Pongo*, *Pongo pygmaeus* and *Pongo abelii*, do not compose social groups: adult males live as solitary animals, adult females live with their offspring until emancipation, and only juveniles transiently live in multi gendered groups (Tobach, Greenberg, Radell, & McCarthy, 1989). Mating and foraging were the reported promoters for adults ephemeral encounters in the wild (MacKinnon, 1974; Mitani, Grether, Rodman, & Priatna, 1991). Although some association activity was observed in captivity animals, it was catalyzed by the offspring, and agonistic behaviour was observed among females (Tobach, et al., 1989; Tobach & Porto, 2006). MacKinnon (1974) suggests that arboreal slow moving, which limits foraging area, and rare and sparse food sources are the conditions that sustain the solitary life of adults, although these arguments do not sustain such behaviours in captivity. In fact, in the wild it is impossible to distinguish spatially discrete communities, and there is no support for social relationships among females, and maybe this can condition the lack of aggregation in social groups (van Schaik & van Hooff, 1996). In spite of this, orang-utans exhibit basic social skills as imitation and cultures (Whiten, 2000), which would provide them with social intelligence (Whiten & van Schaik, 2007).

Some authors reported the capacity to attribute meanings to symbols by enculturated bonobos (*Pan paniscus*), and that this acquisition and use were spontaneous (Savage-Rumbaugh, McDonald, Sevcik, Hopkins, & Rubert, 1986). In chimpanzees (*Pan troglodytes*) and orang-utans (*Pongo abelii*) other authors reported engagement in future planning, by overriding immediate drives favouring future outcomes (Osvath & Osvath, 2008), which would be a high-level capability. Although originally, neither chimpanzees nor orang-utans passed the false belief task, which equates them to a 4-year old humans (Call & Tomasello, 1999), other authors maintain that great apes can represent the mental states of others, “at least within the domains for which their distinctive social ecology has prepared them” (Lyons & Santos, 2006), i.e. great apes have Theory of Mind.

Heyes (1998) is very sceptic about those high-level capabilities in apes and argues that most of those findings can be explained by associative learning and in fact, apes fail to represent the mental states of others. Penn and Povinelli (2007) claim that animals, at most, represent behaviour (e.g. the presence of a dominator conspecific or a predator), and not ultimately the mental states.

In summary, the faculty of representing the mental states of others, and with that preview others’ behaviour, is an open question, but it seems that some of them can encode complex associations, including integrating past experiences, but fail to effectively represent mental states (Emery & Clayton, 2009).

Without similar controversy, there is consensus that orang-utans and other primates lack the use of symbolic elements, which seems to be an exclusive human ability (van Schaik, et al., 2003). Although the persistence in teaching primates to entail in symbolic-based communication, it was never consistently reported such ability, mainly for the consistent lack of syntax (Terrace, Petitto, Sanders, & Bever, 1979). Terrace (Terrace, 2005) puts forward that preliminary to the language instinct, speaking beings have to incorporate meta-cognitive abilities, because the meanings that language provide are intrinsically connected to reading the intentions, beliefs, and goals of others, i.e. language relies in conveniently represent the mental states of others. The underlying question is, to what extent the symbolic ability (to concentrate complex meanings in a short form to make transmission easy), and imitation (the channel to faithfully convey information) are important foundations to structure the extensive human social groups.

The asocial life of animals from the genus *Pongo* is especially striking, as it contrasts with the remaining primates. It is a fact that the evolution of the human brain (encephalisation) did not result from the multiplication of the ancestral brain by a factor. Some parts have been enlarging more than others.

Although it was expected a differential growing in the frontal lobe, it is surprising the disparity in the evolution of the parietal lobes, especially the more recent volume increasing since the archaic Neanderthal (Bruner, Manzi, & Arsuaga, 2003). It has been noticed that Brodmann area 10 in the frontal pole of the frontal lobe had extraordinary development, growing at a higher rate than the remaining growing brain, and that Brodmann area 13 increased less along the *Homo* lineage than the remaining brain (Schoenemann, 2006).

Although Brodmann area 13 does not exist in rats, it is recognized in different primate species, occupying a relay position in the frontal medial cortex (Öngür & Price, 2000). However, it is interesting that it is poor developed in the genus *Pongo* (Schoenemann, 2006). Anatomically, Brodmann area 13 does not have sensory inputs, but it is linked to the limbic system and outputs to visceral control areas, which suggests a relay role in emotional regulation (Price, 2008).

On the other hand it is remarked activations in this area when positive rated brands were contrasted with indifferent, which suggests the participation of this area in preferences. Does Brodmann area 13 has some role in integrating self-referential issues, and uses the emotional system to decide on preferences? And is this mechanism critical for a normal human socialisation? The study of orang-utans may provide useful information to answer these questions.

Furlong and Opfer (2007) used orang-utans and humans to suggest that the numerical magnitudes of rewards, and not the social skills, have a large effect on cooperation, which is a remarkably behavioural social strategy. Why this proximal relationship between social issues and number magnitude (Furlong & Opfer, 2009), centred in the parietal cortex (Chiao, et al., 2009), the same that evolved drastically since the Neanderthal (Bruner, et al., 2003)? In a study with adolescents were their ratings on songs were manipulated, this brain structure activated when they conformed to the rates of their respective reference group, exhibiting a social conforming behaviour (Berns, Capra, Moore, & Noussair, 2008). There is a puzzling relationship among social cognition, numbers, and parietal cortex that deserves to be researched, as also brands' recognition also recruits the same brain area.

Language and Writing

Although oral language has a biological basis (to an extensive and grounded support to this claim see Pinker (1995), but the strikingly fact that every child, from every race and any place, effortlessly learn his/her group language, should be enough), few human societies invented and evolved writing systems (Pinker, 1995). The first writing system was invented in Sumer about 5300 years ago (ca. 3300 BC) and was pictogram-based (Lecours, 1995). In the next 900 to 1100 years the pictograms evolved to logograms forming the cuneiform writing system.

By loosing much of its subjectivity, this evolution is crucial for the establishment of a disseminated culturally-based writing system, especially when further improvements reduced significantly the number of graphemes (22 in the Ugaritic alphabet, ca. 1400 BC), which contributed drastically to the propagation of literacy. Nonetheless, only after the French revolution in the XVIII century, the education by the writing learning is democratised. Until then, writing capability is property of higher status individuals, and a landmark that segregate the illiterate pleb.

The invention of writing systems helped then in establishing social groups' boundaries, creating cultures that share the same symbols and meanings. The educational programs that nations implement are the nowadays reflex of this enculturation process maintained with effort since its invention.

The role of graphemes, i.e. meaningful symbols, evolved from a consequence of an invention to a basic need that each individual must assimilate to avoid ostracism (e.g. illiteracy). Today, brands' logos (in the point of view of some they are the ideograms that compose our cultural alphabet) are part of the matrix (culture) that bonds individuals into organised social groups.

This scenario promoted the raising of the neural-based disability to decode meaningful symbols, which is pathological: dyslexia. A variant of dyslexia's spectrum may be of special interest for the study of brands: surface dyslexia (Marshall & Newcombe, 1973). Certain languages like the Portuguese, Spanish or Finnish are regular. Regular in the sense that pronunciation follows strict spelling-to-sound rules. When children learn to read, basically they learn the rules, which they apply to all words, and correctly they pronounce them, following a non-lexical route.

However, certain languages like English contain important quantities of irregular words. Irregular words do not follow the spelling-to-sound rules, e.g. new / sew, jetty / pretty, howl / bowl, or the strikingly ought / though / tough / thought. As the rules do not apply in such cases, children have to consider the all letters of the word simultaneously and establish a link to the correct pronunciation, following a lexical route.

Surface dyslexics maintain the ability to use the non-lexical route, but are unable to use the lexical route. This means that, when surface dyslexics are faced with irregular words or with non-words, they tend to apply the spelling-to-sound rules, force regularisations, and make pronunciation errors, or just block. Thus, there is evidence that humans have at least two routes to read symbolic messages, one based in composition rules, and the other, faster, that associates directly sounds and meanings to symbols (Coltheart, 2006).

Extending this frame for logographic writing systems like Chinese has dramatic consequences, as surface dyslexics cannot establish the link between logograms and phonemes, nor attribute semantic meanings (Shu, Meng, Chen, Luan, & Cao, 2005). Luo and colleagues (Luo, Zhao, Wang, Xu, & Weng, 2007) reported a case of acquired surface dyslexia in a Chinese speaking native, following an infarction in the left temporo-parietal region. Conspicuously the locus of the infarction is in a brain structure that extensively activated when recognized brands' logos were contrasted with meaningless symbols (logos specifically designed for the study), in the present work.

Even more, this same brain structure also activate in studies that investigate social status hierarchy (Chiao, et al., 2009), or when persons rely on the suggestion of an expert when have do decide under risk (Engelmann, et al., 2009).

What do surface dyslexics have that is useful to inform about brands' study? Probably they have many things to inform about the neural basis of symbols decoding.

As it is established that Chinese reading solely relies on the lexical route (Hu, 1989), and that the neural bases of Chinese reading are different from those that support alphabetic-based reading (Booth, et al., 2006; Liu, et al., 2006; Tan, et al., 2001; Tan, et al., 2000), the study of meaning attribution to logograms (Chinese characters) may inform about the pertinent parallel meaning attribution to ideograms (brands' logos), and also would be informative considering how westerns attribute semantic meaning commonly to words and contour drawings (Vandenberghe, et al., 1996), or mixes of letters and symbols , as it was found that "NUM83R5 ΔND $YMβ0L$ C4N B€ U$3D Δ$ L3††3R$!N 4 $3N7€NC€, ΔND †H3 R3$UL7!NG $3N7€NC€ C4N B€ UND3R$†00D" (Carreiras, Dunabeitia, & Perea, 2007).

Alphabetic-based individuals with reading impairments, but that can easily learn logographic writing systems (Rozin, Poritsky, & Sotsky, 1971), suggesting in this case a deficit in the non-lexical route and reading solely relying on the lexical route like Chinese natives, may also provide valuable information about the meaning attribution along logos perception and decoding.

Approaching Brands through Artificial Grammar Learning (AGL)

Broca's area is a brain structure that systematically have been activating in all the studies that compose the present thesis using brands' logos as stimuli. Originally, this structure was supposed to be involved in speech articulation, but it has been found to process syntax too (Dapretto & Bookheimer, 1999; Grodzinsky & Santi, 2008; Sahin, Pinker, & Halgren, 2006). Using fMRI, Broca's area was found to participate in language acquisition in a task that used the principles of universal grammar (Musso, et al., 2003), and, as already pointed, universal grammar pairs with first-order logic and syntactic structures. Recently, the integrative syntactic role of Broca's area was evinced with direct measurements of neural activity (Hagoort & Levelt, 2009; Sahin, et al., 2009). But how a brain structure involved in utterances generation may have a role in symbols perception and comprehension?

Two theories try to explain how humans learn and comprehend actions (Iacoboni, 2009): the ideomotor framework, and the associative sequence learning. In the ideomotor framework both the perception of actions and own motor plans are coded by the same brain structure. By this way, humans understand the actions they observe in others by transposing them to their own motor plans, as if they were the actors in the scene. In the associative sequence learning, actions perception and own motor plans are coded by different brain structures, but other specialized neural systems code for associations between them.

Directly or indirectly, there is then a close connection between perception / comprehension and execution, i.e. Broca's area may participate both in speech syntactic organization and in syntactic decoding of external stimuli, whether coding for syntactic rules in discourse production and decoding stimuli syntax (the syntax processing hub), whether establishing syntactic associations between stimuli and utterances (the syntactic associative hub). In either way, Broca's area is critical for processes that involve syntax.

In the neuro-studies involving brands that compose the present research, it has been showing logos to subjects once at a time. More or less extensively, Broca's area systematically have been activating for all kind of logos (positive rated, indifferent rated, and even for fictitious logos, although the later less extensively), and thus it seems that there is no need to combine brands (as proposed by Kehret-Ward (1987)) to have a product syntax. The findings suggest that a brand, just by itself, recruits syntax for its interpretation and this comes into the Peircean semiotic perspective of syntax (better identified as *syntagmatatic semantics*) that has been described in the first chapter.

The way to approach brand's inherent syntax is not obvious. A convenient strategy may be a paradigm based on artificial grammar learning, which may help study the syntactic processes involved in brand's discourse. In artificial grammar learning (AGL) studies, participants implicitly acquire the rules that determine symbols' sequencing (Forkstam, Hagoort, Fernandez, Ingvar, & Petersson, 2006). Afterwards, they are explicitly tested constructing new sequences of symbols that use the rules (grammar) previously implicitly assimilated.

Friederici at al. (2006) claim that the syntactic ability that non-human primates allegedly have is limited to sequences based in adjacent elements and rely on the frontal operculum, but the richness of human ability in syntax is the embedded hierarchical sequencing, much more complex, and which rely in an ontogenic more recent brain structure: Broca's area.

In fact, using fMRI it was found that tasks that require hierarchical syntactic processing from AGL correlate with the activation of Broca's area (Bahlmann, Schubotz, & Friederici, 2008), and using Repetitive Transcranial Magnetic Stimulation (rTMS), Broca's area was found to be necessary to accomplish AGL tasks (Uddén, et al., 2008). This approach is especially interesting because AGL tasks were found to not depend on temporal lobe participation (Skosnik, et al., 2002), which suggests that AGL paradigms investigate the syntactic dimensions without recruiting semantic involvements.

The arrangement of brands may form a non-verbal meta-language that may depend on syntactic rules similar to those of AGL, and this paradigm may be suitable to instigate the emergence of such hypothesized organization. But, the arrangement of concepts inside a brand may be also investigated with the same procedures, as they also should be organized with the same syntactic rules. In both cases, the lack of agreement of the composing elements should lead to grammatical violations, which produce odd brands' sentences. These errors pressure for a correction, which is done by brands' meaning makers.

It was already proposed that language and music, both share the uniquely human ability for syntax (Patel, 2003). One of the most rudimentary spoken languages in Earth, Pirahã, which does not have numerals, nor words for colours, and has a very limited set of pronouns, has a prosody that largely resembles music (Everett, 2005). In fact, Pirahã can be spoke, singed, hummed, or whistled. Stressing the convergent origins of language and music and the shared syntax, it was found that Broca's aphasics are impaired both in speech and in music syntactic processing (Patel, et al., 2008). Music and language may then share the syntactic platform, which is also the basis for logic and for signs like brands' logos. It may be put forward that the rhythmic section, bass players and drummers, may also have a lot to inform about syntax, logic, and brands...

APPENDIX A

DESCRIPTION OF THE METHOD FOR THE FIRST STUDY

Experimental Design

It was designed an fMRI experiment made up of two identical runs where commercial brands’ logos were the stimuli visually presented to the study subjects. In the first run, stimuli were presented without previous instructions, aiming to capture implicit behaviours, and in the second run participants received previous explicit instructions, aiming to capture overt behaviours. The scheme of the study is depicted in Figure 60.

Figure 60 - Complete sequence of the trial. Duration is approximate.

The experiment was designed in blocks, where the slide set used was the same for both runs, employing as stimuli brands’ logos, with their characteristic shapes, colours, and wording in everyday life. Before the scanning sessions, 237 commercial brands’ logos were screened by a questionnaire delivered to 147 volunteers. The purpose of this preliminary screening was to decide on the most well known brands in the population from which the study sample was to be taken, minimizing the risk of including unknown brands in the slide set. It was our assumption that unknown brands would elicit different brain processes, and thus would introduce “cognitive noise” in the data to be acquired. In each slide, a brand logo was placed over a black background. It is worth remarking that none of the participants in the screening procedure took part in the actual experiment.

As a baseline, it was used words without emotional content that could not evoke objects or actions. These words were determiners, conjunctions, prepositions, or adverbs, and they were written in white (lower case, font Arial, 150, bold) over a black background. Because this was the first study of a series, an option for an elaborated baseline (e.g. brands' logos of products and services from other markets) could disguise important activations, and prematurely eliminate possible relevant trends (Matthews, et al., 2003). The natural option would be a baseline that could achieve high contrasts with the logos, as a fixation cross, albeit knowing that looking at a fixation cross is not resting at all (D'Argembeau, et al., 2005). Other studies on passive viewing and on the default mode have reported cortical activations in structures related to self-referential reflective activity (Iacoboni, et al., 2004; Schilbach, et al., 2008). Thus, the use of a baseline that could induce self-referential reflective activity, like a fixation cross or chequered patterns, would cancel such an important characteristic. Hence, for baseline, the choice was for words that could not evoke emotions, hoping to retain an eventual emotional content associated just with the brands, and that at the same time could provide some innocuous activity swerving self-referential thoughts from participant's mind.

In each run, the slide set was composed of 16 baseline periods alternated with 16 stimuli periods, starting with a baseline period. The stimuli period had the same duration as the baseline period, 30 seconds long. Within each 30 seconds period, five slides were visually displayed, six seconds each. Thus, the slide set contained 80 stimulus slides and 80 baseline slides, and lasted for exactly 16 minutes.

In the first run, the implicit one, volunteers only had to look at the screen during the scanning procedure. Nothing was mentioned regarding what they were about to see. In the interval between the first and the second runs, the subjects completed a questionnaire with the brands' logos they saw in the first run, and that they would see during the second run. The volunteers were asked to evaluate hedonically each brand, rating them among unknown, negative, indifferent, and positive. In this way, they trained the brand assessment they were asked to do in the second run.

The order of the runs was crucial; the implicit task being first, there was the expectation to avoid any expectations and strategies from the participants, capturing covert evaluations, to then compare with the explicit assessment of the same brands. If the explicit task had been first, the next task could never have been implicit, as the participants would have guessed the intention due to the biasing effect of being previously exposed to instructions. Although it is good practice to randomise or alternate runs, in the present study this would have spoiled the intended effect.

Human Subjects

The participants were six healthy male and eight healthy female volunteers, right handed, with neither a history of neurological nor psychiatric disturbances (mean age 28.4 years, 5.4 s.d.; mean education 16.2 years, 1.5 s.d.). None of the participants was taking psychoactive medication. Informed consent was obtained in all cases. A safety form for magnetic resonance imaging (MRI) was completed by the participants. This research project compiled with the Declaration of Helsinki and was approved by the local ethics committee.

Two female participants were excluded from the analysis, one due to excessive head movement and the other due to claustrophobia.

Data Acquisition

Functional images were obtained using a T2*-weighted EPI sequence in a Siemens® Magnetom Trio 3 Tesla MRI scanner (Siemens AG, Germany) (TR = 3,000 ms, TE = 30 ms, 64 × 64 matrix, FOV = 192 mm, 36 axial slices with 3.0 mm thickness). A whole brain structural scan was also acquired for each volunteer, using a T1-weighted MPRAGE protocol (256 × 256 matrix, FOV = 192 mm, 36 axial slices with 3.0 mm thickness), for co-registration purposes. Both acquisitions were interleaved. Gradient field mapping was additionally obtained. In each run (implicit and explicit), 340 functional volumes were acquired. The first 20 volumes were discarded because of pulse stabilisation.

Image Analysis

FMRI data processing was carried out using FEAT (FMRI Expert Analysis Tool) Version 5.98, a model based GLM (General Linear Model) analysis tool, and also using Tensorial Independent Component Analysis (Beckmann & Smith, 2005) as implemented in MELODIC (Multivariate Exploratory Linear Decomposition into Independent Components) Version 3.09, a model-free analysis tool, both part of FSL - FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl (S. M. Smith, et al., 2004).

In the FEAT analysis, the following pre-statistics processing was applied: motion correction using MCFLIRT (Jenkinson, Bannister, Brady, & Smith, 2002); slice-timing correction using Fourier-space time-series phase-shifting; non-brain removal using BET (S. M. Smith, 2002); spatial smoothing using a Gaussian kernel of full width half maximum 5 mm; grand-mean intensity normalisation of the entire 4D dataset by a single multiplicative factor; highpass temporal filtering (Gaussian-weighted least-squares straight line fitting, with sigma = 30.0 s). Time-series statistical analysis was performed using FILM with local autocorrelation correction (Woolrich, Ripley, Brady, & Smith, 2001). Registration to high resolution structural and/or standard space images was done with FLIRT (Jenkinson, et al., 2002; Jenkinson & Smith, 2001).

At the first level analysis and separately for each run, stimuli and baseline were subtracted, resulting in the contrasts implicit > baseline and explicit > baseline, and also stimuli were subtracted between them, resulting in the contrasts implicit > explicit and the reverse explicit > implicit.

Higher-level analysis was performed using FLAME (FMRIB's Local Analysis of Mixed Effects) stage 1 (Beckmann, Jenkinson, & Smith, 2003; Woolrich, Behrens, Beckmann, Jenkinson, & Smith, 2004) with automatic outlier detection (Woolrich, 2008). In this level, group means were calculated from the first level contrasts.

Z (Gaussianised T/F) statistic images were thresholded using clusters determined by $z > 2.3$ and a (corrected) cluster significance threshold of p=1.00 (Worsley, 2001). Only clusters with more than 50 voxels survived the threshold.

Conjunction analysis was performed according to Nichols and colleagues' method (Nichols, Brett, Andersson, Wager, & Poline, 2005), i.e. the voxels considered active in the conjunction were those that cumulatively were statistically significant in the implicit and explicit analysis.

In the MELODIC analysis, twenty-four data sets (twelve implicit and twelve explicit) were computed, aiming to extract independent spatial components common to both runs. The following data pre-processing was applied: masking of non-brain voxels, voxel-wise de-meaning of the data, and normalisation of the voxel-wise variance. Pre-processed data were whitened and projected into a 113-dimensional subspace using probabilistic Principal Component Analysis where the number of dimensions was estimated using the Laplace approximation to the Bayesian evidence of the model order (Beckmann & Smith, 2004; Minka, 2000). The whitened observations were decomposed into sets of vectors, which describe signal variation across the temporal domain (time-courses), the session/subject domain and across the spatial domain (maps) by optimising for non-Gaussian spatial source distributions using a fixed-point iteration technique (Hyvarinen, 1999). Estimated component maps were divided by the standard deviation of the residual noise and thresholded by fitting a mixture model to the histogram of intensity values (Beckmann & Smith, 2004).

The identification of the main anatomical structures in the clusters was made with masks based on the statistical parametric maps produced by both analysis tools (GLM and model-free). The masks were designed according to the probabilistic atlases *Harvard-Oxford Cortical Structural Atlas* and *Harvard-Oxford Subcortical Structural Atlas* provided by the Harvard Centre for Morphometric Analysis (www.cma.mgh.harvard.edu), which are part of FSL View v3.0.2, part of FSL 4.1.2. Each voxel of each cluster was assigned to a single brain structure. In cases were several structures could be probabilistically attributed to one voxel, the structure that had the highest probability was chosen.

APPENDIX B

PARADIGM AND DATA ANALYSIS IN THE SECOND STEP

Paradigm

The paradigm for this step is the same of the previous one, just without the implicit run. Despite the brands' logos and non-emotional words were showed in trains, it was used the ratings that participants previously gave in the questionnaire to construct the basic shapes (see Figure 61).

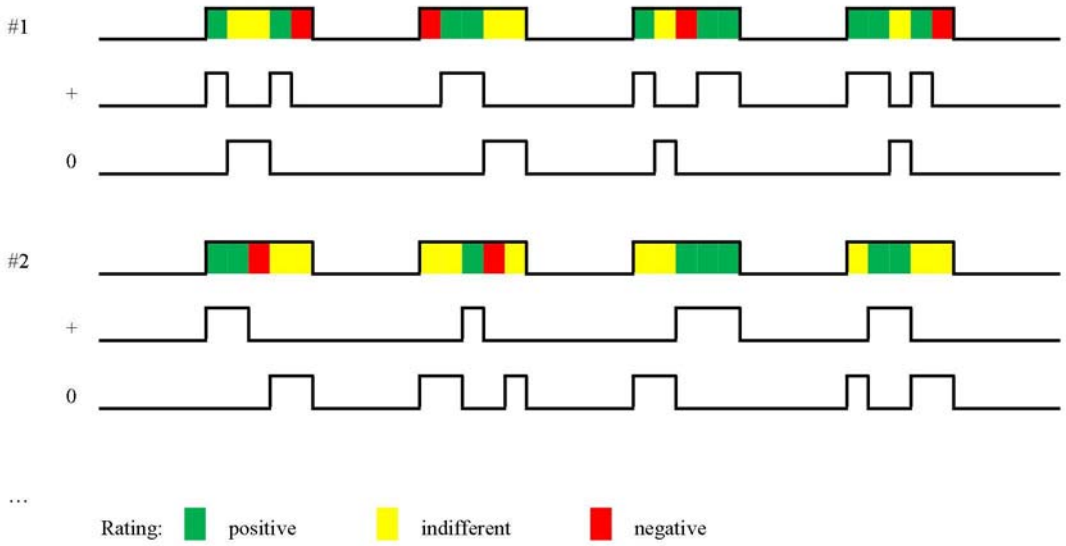


Figure 61 - Schemas of the first four cycles (baseline / stimulus) for the assessments of the first two participants. Each stimulus block had five brands either rated as *positive*, *indifferent*, or *negative*. These assessments were then used for event-related analysis.

Image Analysis

The GLM image analysis procedure was basically the same as reported in Appendix A for the first study. The only difference is that the stimuli are split in three categories, which allowed more contrasts. In the first level analysis, stimuli and baseline were subtracted for each participant, resulting in the contrasts positive > baseline and indifferent > baseline; stimuli were also subtracted between them, resulting in the contrast positive > indifferent. In the group level, the means were calculated from the first level contrasts.

As each participant's timecourse was different (because of the individual brand preferences), in the MELODIC analysis, twelve data sets were first concatenated and computed, aiming to extract independent spatial components. The following data pre-processing was applied: masking of non-brain voxels, voxel-wise de-meaning of the data, and normalisation of the voxel-wise variance. Pre-processed data were whitened and projected into a 114-dimensional subspace using probabilistic Principal Component Analysis where the number of dimensions was estimated using the Laplace approximation to the Bayesian evidence of the model order (Beckmann & Smith, 2004; Minka, 2000). The whitened observations were decomposed into sets of vectors, which describe signal variation across the temporal domain (time-courses), the session/subject domain and across the spatial domain (maps) by optimising for non-Gaussian spatial source distributions using a fixed-point iteration technique (Hyvarinen, 1999). Estimated component maps were divided by the standard deviation of the residual noise and thresholded by fitting a mixture model to the histogram of intensity values (Beckmann & Smith, 2004). The explanatory variable's basic shapes used in the FEAT analysis were concatenated for all the participants in the same order of entry of the timecourses in MELODIC, and the same contrasts used in FEAT were computed. The parameter estimates of each spatial independent component were then calculated and tested using GLM (the selection of significant spatial independent components was based on statistical criteria). For each independent component, additional GLM analysis was performed to investigate to what extent each component was used among the group.

APPENDIX C

METHOD IN THE EVENT-RELATED FMRI STUDY

Experimental Design

General structure.

To explore the research question, it was designed an fMRI event-related experiment. There was four different events, plus the interstimuli interval. Each event was composed by thirty five slides, and each one was showed during 6000 ms. The interstimuli interval ranged from 4000 until 9000 ms, in 500 ms steps. The experiment duration was 1200 s, plus 9 s added in the end to guarantee the capture all of the hemodynamic response. The sequence was optimized with Optseq2 software (Athinoula A. Martinos Center for Biomedical Imaging, USA; http://surfer.nmr.mgh.harvard.edu/optseq/).

Three of the four events were brands' logos grouped in the following categories: positive, indifferent, and fictitious brands. The fourth event was non-emotional words, written in white (font Arial, normal, 100) over a black background. Along the interstimuli interval, the participants saw a fixation cross, consisting of the "+" sign, white written (font Arial, normal, 200) over a black background.

Brands' selection.

To choose the logos for the positive and indifferent categories, the participants previously completed an electronic survey in a computer, which took place in a time window ranging from a minimum of 4 hours and a maximum of 3 days.

Along the survey, participants saw 200 brands' logos, which they had to rate in the *pleasure* and *arousal* dimensions of the PAD - pleasure, arousal, dominance scale

(Mehrabian, 1995; Mehrabian & de Wetter, 1987; Russell & Mehrabian, 1977), by using the SAM - self assessment manikin (Bradley & Lang, 2007; Morris, 1995) as depicted in Figure 25. As with static pictures (brands' logos) the third dimension, *dominance*, is highly correlated with *pleasure*, *dominance* was not include in the brands' assessments (Bradley & Lang, 2007).

To accomplish this task, there was a special keyboard connected to the computer where the logos were presented. In the keyboard there was one line with nine keys, five of them with the SAM for *pleasure* interleaved with four blue dots, and in another line, nine keys with the SAM for *arousal* interleaved with four blue dots, as depicted in Figure 25. The participants also had the option to mark the brand's logo as *unknown*.

After this task, the responses were screened and categorized according to the following criteria: positive brands were rated with more or equal to 7 in the *pleasure* dimension and (Boolean) more or equal to 5 in the *arousal* dimension; indifferent brands were rated with more or equal to 4 and (Boolean) less or equal to 6 in the *pleasure* dimension and (Boolean) less or equal to 5 in the *arousal* dimension. With this procedure, two groups of brands' logos were segregated: positive and indifferent. For each group an index was constructed. For each brand, the rate of *pleasure* was added to the double of the rate of *arousal*, and, in each group, the brands were ordered according to this index: in the positive brands group the order was decreasing and in the indifferent brands group the order was increasing.

The first thirty five brands' logos of each group were selected for the fMRI session. When draws had to be resolved, a random number was ascribed to each brand in such situation by means of Microsoft Office Excel 2007 software (Microsoft Corporation, USA), and the least values were chosen. Each brand of the two sets of thirty five brands received a random number with Microsoft Office Excel 2007 software (Microsoft Corporation, USA). Then, separately in each group, the brands were ordered increasingly. With this procedure thirty five positive and thirty five indifferent brands were chosen for each participant, and were randomised to enter the paradigm structure.

Fictitious logos.

The fictitious brands were brands' logos that were created specifically for the present study. They do not exist at all in the market. The conception of each logo was accomplished, not by a professional designer, but by a marketer. It was asked to draw logos that resemble current ones, that normal consumers could accept them as plausible in the market for the correspondent product or service. To establish the sequence for the fictitious brands' logos, it was used the same procedure as for the positive and indifferent brands groups. With Microsoft Office Excel 2007 software (Microsoft Corporation, USA), a random number was assigned to each logo and then they were ordered increasingly.

Non-emotional words as second baseline.

The non-emotional words were determiners, conjunctions, prepositions or adverbs. Importantly, it was not used any nouns or verbs that could evoke emotions, objects or actions. In this event it was hoped that the participants had a task to do, to focus his attention on it. By this way the participants were deviated from self-reflexive tasks (Beckmann & Smith, 2005; De Luca, et al., 2006; Gusnard & Raichle, 2001), which tend to happen during passive tasks and that could cancel possible self-reflexive processes elicited by brands (Yoon, et al., 2006).

Structuring the paradigm.

The structure of the paradigm was the same for all participants. Also, the sequence of the fictitious brands and of the non-emotional words events was the same for all. However, the positive and the indifferent brands sequences were tailored to each participant. In Appendix D the full sequence is detailed.

The paradigm sequences were programmed with SuperLab 4.0 software (version 4.0.6b; Cedrus Corporation, USA; http://www.superlab.com) and this same software was used to perform the projection of the slide set, by using a laptop connected to a digital projector. The images were projected to a translucent screen installed in the scanner room, and the participants saw the screen with the aid of a mirror attached to the scanner antenna. The image projected had 800 x 600 pixels. All the logos were corrected to fit inside a 650 x 400 pixels rectangle, which centre was displaced 50 pixels to the top, relative to the centre of the image. At the bottom of the image there was a legend to remember the response options to the participants. This legend was written in white (font Arial, normal, 36), and the background of the image was black. The centre of each non-emotional word was also displaced 50 pixels to the top, relative to the centre of the image, but the centre of the fixation cross in the inter stimuli interval coincided with the centre of the image.

Instructions for the scanning session.

Depending on the event type, the participants were instructed to: rate the brand if a brand logo was being projected; read covertly (to avoid head movements) the word if a word was being projected; or just look to the cross if a fixation cross was being projected.

As the reaction time was an important parameter to measure, the scale that subjects would use to rate the brands had to be simple and expedite, so the scaling had negligible interferences in the response. Due to this reason, the option was not to continue with the SAM and the PAD scale into the scanning session. It was substituted by the much simpler scale previously used, with four possibilities to rate brands: *positive*, *negative*, *indifferent*, or *unknown* (these same words appeared in the legend at the bottom of the projected image, every time a brand's logo was being projected).

To investigate the overlapping of both scales (the one used during the scanning session, and the one used during stimuli screening – PAD), it was fitted a multinomial logit model. The option for a model of this kind (and not chose other models that deal with categories, e.g. proportional odds model) was due to the serious concerns about the putative brands' order *negative* / *indifferent* / *positive*. As it was not found convincing arguments that support such order, it was preferred to consider the categories as independent (unordered).

Although the dimension *arousal* could be parsimoniously considered as an ordered category, the same does not apply at all in the *pleasure* dimension, which comprises different valences. Due to the heterogeneity found within these dimensions (which is evinced in the Results section), the option was then for considering the categories within the *arousal* and *pleasure* dimensions also unordered.

The participants made their options by using a button box (model Lumina LU400-PAIR; Cedrus Corporation, USA; http://www.cedrus.com), with two buttons for the right hand and two buttons for the left hand, selectable with the thumbs. Top right button corresponded to the answer *positive*, bottom right button corresponded to the answer *negative*, top left button corresponded to the answer *indifferent*, and bottom left button corresponded to the answer *unknown*. The options were recorded into a computer together with the response time.

Before the scanning session all the participants had the opportunity to train the responses inside the scanner, and the scanning session began only after a perfect accommodation to the response pads.

Human Subjects

The participants were eighteen, seven healthy male and eleven healthy female volunteers, right handed, with neither history of neurological nor psychiatric disturbances (mean age 28.2 years, 6.9 standard deviation, and ranging 19 – 41 years). Seven participants came from outside of the campus. Informed consent was obtained in all cases. A safety form for magnetic resonance imaging (MRI) was filled by every participant and discussed with a Neuroradiologist and a Radiographer. After each session the participants were debriefed.

This research project adhered to the Declaration of Helsinki and was approved by the Ethics Committee of São João Hospital.

Data Acquisition

Functional images with axial orientation were obtained using a T2*-weighted EPI sequence in a Siemens® Magnetom Trio high field (3 Tesla) MRI scanner (Siemens AG, Germany) (TR = 3000 ms, TE = 30 ms, 64 x 64 matrix, FOV = 192 mm, 3.0 mm axial slices). The order of acquisition of the slices was interleaved, and they covered the whole brain. The study consisted in one session where 407 volumes were acquired. The first four volumes were discarded to ensure pulses stabilization, and the last three were maintained to ensure capturing all the hemodynamic response.

A whole brain anatomical structural scan was acquired also for each volunteer, using a T1-weighted MPRAGE protocol (256 x 256 matrix, FOV = 256 mm, 3.0 mm axial slices), for co-registration purposes. Gradient field mapping was additionally acquired for image quality control.

Image Analysis

FMRI data processing was carried out using FEAT (FMRI Expert Analysis Tool) version 5.98, a model-based GLM (General Linear Model) analysis tool, and also using Probabilistic Independent Component Analysis (Beckmann & Smith, 2004) as implemented in MELODIC (Multivariate Exploratory Linear Decomposition into Independent Components) version 3.09, a model-free analysis tool, both part of FSL - FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl (S. M. Smith, et al., 2004; Woolrich, et al., 2009).

General Linear Model analysis - common procedures.

In the FEAT analysis, the following pre-statistics processing was applied; motion correction using MCFLIRT (Jenkinson, et al., 2002); slice-timing correction using Fourier-space time-series phase-shifting; non-brain removal using BET (S. M. Smith, 2002); spatial smoothing using a Gaussian kernel of FWHM 5mm; grand-mean intensity normalization of the entire 4D dataset by a single multiplicative factor; highpass temporal filtering (Gaussian-weighted least-squares straight line fitting, with sigma=30.0s). Time-series statistical analysis was performed using FILM with local autocorrelation correction (Woolrich, et al., 2001). Registration to high-resolution structural and/or standard space images was done using FLIRT (Jenkinson, et al., 2002; Jenkinson & Smith, 2001).

Although the pre-statistics and the group level analysis shared the same procedures, there were two different individual level analyses, each one relying in a distinct model. Stimuli slides (logos and non-emotional words) were visible for 6 seconds long. The first model is a traditional approach where the hemodynamic response was investigated within the complete time window wherein stimulus was present (6 seconds). This model composes the bulk of the present study and supports most of the findings. However, the investigation was extended by splitting the 6 seconds time window in two: the period before button pressing, and the period after button pressing until the end. In this approach, the explanatory variables for stimuli with logos (not for non-emotional words) were then doubled. Like this it was hoped to refine the brain processes that support decision-making, segregating the periods when subjects were passive viewing the stimulus after the decision was already made, which could introduce a dilution effect and contamination with post-decision processes. This analysis is in a separate section.

General Linear Model analysis - conventional fixed time window analysis.

Previously to the scanning session, participants assessed a set of two hundred brands' logos, from which the *positive* and *indifferent* stimuli were extracted. Then, during the scanning, participants rated again the brands. There was not maintenance of the same ratings between the two sessions and, inside the scanner, some fictitious logos received ratings other than *unknown* (see Table 3). Thus, in the first model and to consider all the possible combination of assessments, 13 explanatory variables (EVs) were included: the three types of stimulus (positive, indifferent, and fictitious logos) times the four possible votes (positive, indifferent, negative, and unknown), plus the non-emotional words.

Most of the assessments were consistent between the two sessions, but some of the possible combinations received little or even none votes. Although all the possibilities were modelled with explanatory variables aiming to explain most of the variance, it was considered in the analysis only those that were consistent between sessions, i.e. positive logos that were rated as positive during scanning (PosPos), indifferent logos that were rated as indifferent in the scanner (IndInd), and fictitious brands that were marked as unknown inside the scanner (NoBUnk). Hence, in the individual level analysis, stimuli and baseline were subtracted for each participant, resulting in the following ten contrasts: positive > fixation cross, positive > non-emotional words, positive > unrecognised logos, indifferent > fixation cross, indifferent > non-emotional words, indifferent > unrecognised logos, unrecognised logos > fixation cross, unrecognised logos > non-emotional words, positive > indifferent, and non-emotional words > fixation cross.

General Linear Model analysis - floating time window analysis.

In the second model 25 explanatory variables were considered: the three types of stimulus (positive, indifferent, and fictitious logos), times the four possible votes (positive, indifferent, negative, and unknown), times the two epochs (before and after button pressing), plus the non-emotional words.

Although all the possibilities were modelled with explanatory variables, again the votes that were analysed were just those consistent between the two sessions. Hence, in the individual level of the second model, stimuli and baseline were subtracted for each participant, resulting in the following 19 contrasts (abp: after button pressing; bbp:

before button pressing): positive bbp > fixation cross, positive bbp > non-emotional words, indifferent bbp > fixation cross, indifferent bbp > non-emotional words, unrecognised logos bbp > fixation cross, unrecognised logos bbp > non-emotional words, positive abp > fixation cross, positive abp > non-emotional words, indifferent abp > fixation cross, indifferent abp > non-emotional words, unrecognised logos abp > fixation cross, unrecognised logos abp > non-emotional words, positive bbp > indifferent bbp, positive bbp > unrecognised logos bbp, indifferent bbp > unrecognised logos bbp, positive bbp > positive abp, indifferent bbp > indifferent abp, unrecognised logos bbp > unrecognised logos abp, and non-emotional words > fixation cross.

General Linear Model analysis - group analysis.

For both models, group analysis was done with FLAME (FMRIB's Local Analysis of Mixed Effects) stage 1 and stage 2 with automatic outlier detection (Beckmann, et al., 2003; Woolrich, 2008; Woolrich, et al., 2004). In this level, group means were calculated from the individual level contrasts.

Z (Gaussianised T/F) statistic images were thresholded using clusters determined by $z > 2.3$ and a (corrected) cluster significance threshold of $p = 1.00$ (Worsley, 2001). Only clusters with more than 50 voxels survived the threshold.

Probabilistic Independent Component Analysis.

As each participant’s timecourse was different (although the paradigm structure was the same for all participants – see Appendix D – there was brands that did not maintain the same rating between the two sessions which lead to different output responses), in the MELODIC analysis, the eighteen data sets were concatenated and computed, aiming to extract independent spatial components. The following data pre-processing was applied: masking of non-brain voxels, voxel-wise de-meaning of the data, and normalisation of the voxel-wise variance. Pre-processed data were whitened and projected into a 164-dimensional subspace using probabilistic Principal Component Analysis where the number of dimensions was estimated using the Laplace approximation to the Bayesian evidence of the model order (Beckmann & Smith, 2004; Minka, 2000). The whitened observations were decomposed into sets of vectors, which describe signal variation across the temporal domain (time-courses), the session/subject domain and across the spatial domain (maps) by optimising for non-Gaussian spatial source distributions using a fixed-point iteration technique (Hyvarinen, 1999). Estimated component maps were divided by the standard deviation of the residual noise and thresholded by fitting a mixture model to the histogram of intensity values (Beckmann & Smith, 2004).

The explanatory variable's basic shapes used in the FEAT analysis were concatenated for all the participants in the same order that timecourses entered MELODIC, and the same contrasts used in FEAT were computed. The parameter estimates of each spatial independent component were then calculated and tested using GLM. As this, the selection of significant spatial independent component was based on statistical criteria. For each independent component, additional GLM analysis was carried on with subjects to investigate to what extent the component was used among the group.

Identification of the anatomical brain structures.

The identification of the main anatomical structures in the clusters was made with masks based on the statistical parametric maps produced by both analysis tools (GLM and model-free). The masks were designed according to the probabilistic atlases *Harvard-Oxford Cortical Structural Atlas* and *Harvard-Oxford Subcortical Structural*

Atlas provided by the Harvard Centre for Morphometric Analysis (www.cma.mgh.harvard.edu), which are part of FSL View v3.0.2, part of FSL 4.1.2. Each voxel of each cluster was assigned to a single brain structure. In cases were several structures could be probabilistically attributed to a voxel, the structure that had the highest probability was chosen.

APPENDIX D

PARADIGM SEQUENCING AND OPTIMISATION IN THE EVENT-RELATED FMRI STUDY

Table 35 lists the sequence of the slides used in the present study. This sequence was obtained with the software Optseq2, which randomises the slides' order and optimises it for fMRI acquisition. The inter-stimulus interval (ISI) is variable and its duration is a value from 4.0 until 9.0 s in 0.5 s steps. Hence, the stimuli onsets were spread by every 1/6 of TR (i.e. every 0.5 s) as depicted in Figure 62. The interpolation that FSL performs is then based in several points along the scanning acquisition, i.e. supported by more dense time points, minimising the long gaps that fixed ISIs would introduce. With this strategy, the hemodynamic response was better captured, avoiding overestimating stimulus that would be synchronised with the TR beginning, at the cost of underestimating those stimulus which onsets would not be in phase with the TR. In any case, and also aiming to minimise inter-slice magnetic perturbation, the 36 slices acquired during each TR were interleaved: first were acquired even slices and then the odd ones.

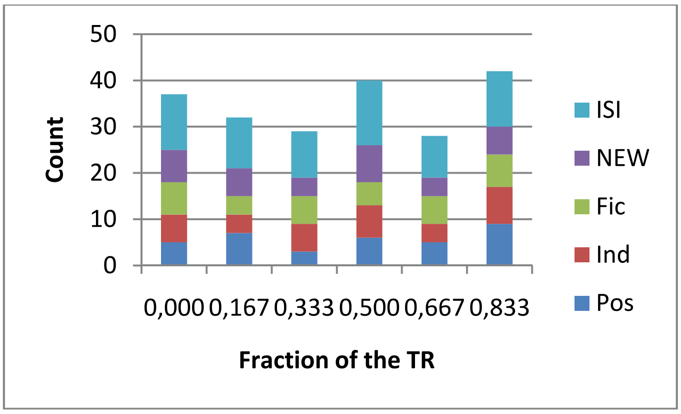


Figure 62 - Distribution of the stimuli onsets by fractions of the TR.

Table 35 - Sequence of the paradigm optimized with Optseq2 (TR: repetition time, i.e. the difference in time between two acquisitions; in this study TR = 3 s; NEW: non-emotional words; ISI: inter-stimulus interval which was a slide with a fixation cross).

Onset		**Duration**	**Label**		**Sequence number**		**Name of the stimulus**	
[s]	**[TR]**	**[s]**			**Positive**	**Indifferent**	**NEW**	**Fictitious**
0.0	0.000	6.0	Ind	2		1		
6.0	2.000	6.0	NEW	3			onde	
12.0	4.000	4.0	ISI	0				
16.0	5.333	6.0	NEW	3			num	
22.0	7.333	6.0	Fict	4				thairice
28.0	9.333	5.0	ISI	0				
33.0	11.000	6.0	Pos	1	1			
39.0	13.000	6.5	ISI	0				
45.5	15.167	6.0	Pos	1	2			
51.5	17.167	4.5	ISI	0				
56.0	18.667	6.0	Pos	1	3			
62.0	20.667	6.0	Fict	4				robsonreco
68.0	22.667	4.5	ISI	0				
72.5	24.167	6.0	Fict	4				powerdrink
78.5	26.167	6.0	Pos	1	4			
84.5	28.167	6.0	NEW	3			esta	
90.5	30.167	4.5	ISI	0				
95.0	31.667	6.0	Pos	1	5			
101.0	33.667	6.0	Fict	4				woodslanc
107.0	35.667	6.0	Fict	4				capitainsnack
113.0	37.667	6.0	NEW	3			uma	
119.0	39.667	6.0	Fict	4				bell
125.0	41.667	6.5	ISI	0				
131.5	43.833	6.0	Pos	1	6			
137.5	45.833	6.0	Ind	2		2		
143.5	47.833	5.5	ISI	0				
149.0	49.667	6.0	Pos	1	7			
155.0	51.667	6.0	NEW	3			de	
161.0	53.667	6.5	ISI	0				
167.5	55.833	6.0	Ind	2		3		
173.5	57.833	6.0	Pos	1	8			
179.5	59.833	5.0	ISI	0				
184.5	61.500	6.0	Pos	1	9			
190.5	63.500	6.0	ISI	0				
196.5	65.500	6.0	Fict	4				emerald
202.5	67.500	7.5	ISI	0				
210.0	70.000	6.0	Fict	4				2faces
216.0	72.000	6.0	Fict	4				corundil
222.0	74.000	6.0	Fict	4				sritea

Table 35 (cont.)

Onset		**Duration**	**Label**		**Sequence number**		**Name of the stimulus**	
[s]	**[TR]**	**[s]**			**Positive**	**Indifferent**	**NEW**	**Fictitious**
228.0	76.000	6.0	NEW	3			essas	
234.0	78.000	6.0	Fict	4				refresq
240.0	80.000	6.0	ISI	0				
246.0	82.000	6.0	NEW	3			contudo	
252.0	84.000	6.0	Pos	1	10			
258.0	86.000	5.0	ISI	0				
263.0	87.667	6.0	Pos	1	11			
269.0	89.667	4.0	ISI	0				
273.0	91.000	6.0	Ind	2		4		
279.0	93.000	6.0	Fict	4				jenna
285.0	95.000	4.0	ISI	0				
289.0	96.333	6.0	Ind	2		5		
295.0	98.333	6.0	Ind	2		6		
301.0	100.333	6.0	Ind	2		7		
307.0	102.333	6.0	ISI	0				
313.0	104.333	6.0	Pos	1	12			
319.0	106.333	5.0	ISI	0				
324.0	108.000	6.0	NEW	3			outra	
330.0	110.000	6.0	Ind	2		8		
336.0	112.000	5.5	ISI	0				
341.5	113.833	6.0	NEW	3			quanto	
347.5	115.833	5.5	ISI	0				
353.0	117.667	6.0	Ind	2		9		
359.0	119.667	6.0	Fict	4				choconuts
365.0	121.667	4.0	ISI	0				
369.0	123.000	6.0	Pos	1	13			
375.0	125.000	7.0	ISI	0				
382.0	127.333	6.0	Pos	1	14			
388.0	129.333	9.0	ISI	0				
397.0	132.333	6.0	Ind	2		10		
403.0	134.333	6.0	Fict	4				polarbear
409.0	136.333	6.0	Ind	2		11		
415.0	138.333	6.0	Fict	4				cyon
421.0	140.333	5.5	ISI	0				
426.5	142.167	6.0	NEW	3			nuns	
432.5	144.167	6.0	Pos	1	15			
438.5	146.167	5.5	ISI	0				
444.0	148.000	6.0	Pos	1	16			
450.0	150.000	8.5	ISI	0				

Table 35 (cont.)

Onset		Duration	Label		Sequence number		Name of the stimulus	
[s]	[TR]	[s]			Positive	Indifferent	NEW	Fictitious
458.5	152.833	6.0	NEW	3			nestas	
464.5	154.833	6.0	Fict	4				sunorange
470.5	156.833	4.0	ISI	0				
474.5	158.167	6.0	Ind	2		12		
480.5	160.167	6.0	Ind	2		13		
486.5	162.167	4.0	ISI	0				
490.5	163.500	6.0	NEW	3			algo	
496.5	165.500	4.0	ISI	0				
500.5	166.833	6.0	Ind	2		14		
506.5	168.833	5.0	ISI	0				
511.5	170.500	6.0	NEW	3			cada	
517.5	172.500	4.0	ISI	0				
521.5	173.833	6.0	Fict	4				casalherm
527.5	175.833	6.0	NEW	3			em	
533.5	177.833	6.0	Pos	1	17			
539.5	179.833	4.0	ISI	0				
543.5	181.167	6.0	Fict	4				gulliver
549.5	183.167	4.0	ISI	0				
553.5	184.500	6.0	Pos	1	18			
559.5	186.500	4.5	ISI	0				
564.0	188.000	6.0	Ind	2		15		
570.0	190.000	6.0	Ind	2		16		
576.0	192.000	6.0	Pos	1	19			
582.0	194.000	8.5	ISI	0				
590.5	196.833	6.0	Ind	2		17		
596.5	198.833	6.0	Fict	4				ranald
602.5	200.833	5.0	ISI	0				
607.5	202.500	6.0	Fict	4				tmm
613.5	204.500	6.0	NEW	3			o	
619.5	206.500	6.0	Fict	4				fluteball
625.5	208.500	6.0	Pos	1	20			
631.5	210.500	6.0	ISI	0				
637.5	212.500	6.0	NEW	3			se	
643.5	214.500	6.0	Ind	2		18		
649.5	216.500	6.0	NEW	3			tudo	
655.5	218.500	5.5	ISI	0				
661.0	220.333	6.0	NEW	3			dos	
667.0	222.333	6.0	ISI	0				
673.0	224.333	6.0	Pos	1	21			

Table 35 (cont.)

Onset		Duration	Label		Sequence number		Name of the stimulus	
[s]	[TR]	[s]			Positive	Indifferent	NEW	Fictitious
679.0	226.333	6.0	Fict	4				tgym
685.0	228.333	4.5	ISI	0				
689.5	229.833	6.0	Fict	4				crunchclev
695.5	231.833	6.0	Fict	4				18jeans
701.5	233.833	6.0	Ind	2		19		
707.5	235.833	6.0	Pos	1	22			
713.5	237.833	6.0	Pos	1	23			
719.5	239.833	5.0	ISI	0				
724.5	241.500	6.0	Pos	1	24			
730.5	243.500	4.5	ISI	0				
735.0	245.000	6.0	NEW	3			nesses	
741.0	247.000	6.0	Fict	4				love
747.0	249.000	6.0	Ind	2		20		
753.0	251.000	6.0	NEW	3			todos	
759.0	253.000	6.0	Fict	4				yoko
765.0	255.000	4.5	ISI	0				
769.5	256.500	6.0	Pos	1	25			
775.5	258.500	5.0	ISI	0				
780.5	260.167	6.0	Pos	1	26			
786.5	262.167	6.0	Ind	2		21		
792.5	264.167	5.5	ISI	0				
798.0	266.000	6.0	NEW	3			porém	
804.0	268.000	7.5	ISI	0				
811.5	270.500	6.0	NEW	3			qual	
817.5	272.500	6.0	Pos	1	27			
823.5	274.500	6.0	Ind	2		22		
829.5	276.500	6.0	NEW	3			porquanto	
835.5	278.500	4.0	ISI	0				
839.5	279.833	6.0	NEW	3			cujas	
845.5	281.833	6.0	Pos	1	28			
851.5	283.833	6.0	Fict	4				flyshoe
857.5	285.833	6.0	Ind	2		23		
863.5	287.833	6.0	Pos	1	29			
869.5	289.833	5.0	ISI	0				
874.5	291.500	6.0	Ind	2		24		
880.5	293.500	6.0	NEW	3			aquele	
886.5	295.500	6.0	Fict	4				limaloca
892.5	297.500	6.0	Ind	2		25		
898.5	299.500	5.0	ISI	0				

Table 35 (cont.)

Onset		Duration	Label		Sequence number		Name of the stimulus	
[s]	[TR]	[s]			Positive	Indifferent	NEW	Fictitious
903.5	301.167	6.0	NEW	3			neste	
909.5	303.167	6.0	Fict	4				grandmother
915.5	305.167	4.0	ISI	0				
919.5	306.500	6.0	Fict	4				coconut
925.5	308.500	6.0	Ind	2		26		
931.5	310.500	5.5	ISI	0				
937.0	312.333	6.0	NEW	3			um	
943.0	314.333	4.5	ISI	0				
947.5	315.833	6.0	NEW	3			todas	
953.5	317.833	5.5	ISI	0				
959.0	319.667	6.0	Pos	1	30			
965.0	321.667	6.0	Ind	2		27		
971.0	323.667	6.5	ISI	0				
977.5	325.833	6.0	Pos	1	31			
983.5	327.833	6.0	Ind	2		28		
989.5	329.833	4.5	ISI	0				
994.0	331.333	6.0	NEW	3			mas	
1000.0	333.333	6.0	Fict	4				twiggy
1006.0	335.333	6.5	ISI	0				
1012.5	337.500	6.0	Ind	2		29		
1018.5	339.500	5.0	ISI	0				
1023.5	341.167	6.0	NEW	3			por	
1029.5	343.167	6.0	Pos	1	32			
1035.5	345.167	6.0	ISI	0				
1041.5	347.167	6.0	Pos	1	33			
1047.5	349.167	8.0	ISI	0				
1055.5	351.833	6.0	Ind	2		30		
1061.5	353.833	6.0	Fict	4				günt ritta
1067.5	355.833	6.0	NEW	3			do	
1073.5	357.833	6.0	Pos	1	34			
1079.5	359.833	8.5	ISI	0				
1088.0	362.667	6.0	NEW	3			cujos	
1094.0	364.667	6.0	Ind	2		31		
1100.0	366.667	5.5	ISI	0				
1105.5	368.500	6.0	Ind	2		32		
1111.5	370.500	5.5	ISI	0				
1117.0	372.333	6.0	Ind	2		33		
1123.0	374.333	6.0	Fict	4				kik
1129.0	376.333	4.0	ISI	0				

Table 35 (cont.)

Onset		Duration	Label		Sequence number		Name of the stimulus	
[s]	[TR]	[s]			Positive	Indifferent	NEW	Fictitious
1133.0	377.667	6.0	NEW	3			das	
1139.0	379.667	6.0	Ind	2		34		
1145.0	381.667	4.5	ISI	0				
1149.5	383.167	6.0	Ind	2		35		
1155.5	385.167	6.0	Pos	1	35			
1161.5	387.167	6.0	ISI	0				
1167.5	389.167	6.0	NEW	3			deste	
1173.5	391.167	6.0	NEW	3			aqueles	
1179.5	393.167	6.0	Fict	4				4you
1185.5	395.167	4.5	ISI	0				
1190.0	396.667	6.0	Fict	4				biteabit
1196.0	398.667	4.0	ISI	0				
1200.0	400.000	9.0	ISI	0				
1209.0	403.000		Stop					

BIBLIOGRAPHY

Aaker, J. L. (1997). Dimensions of brand personality. *Journal of Marketing Research, 34*(3), 347-356.

Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology, 11*(2), 231-239. doi: 10.1016/S0959-4388(00)00202-6

Adolphs, R. (2003). Cognitive neuroscience of human social behaviour. *Nature Reviews Neuroscience, 4*(3), 165-178. doi: 10.1038/nrn1056

Adolphs, R. (2006). How do we know the minds of others? Domain-specificity, simulation, and enactive social cognition. *Brain Research, 1079*(1), 25-35. doi: 10.1016/j.brainres.2005.12.127

Adolphs, R., Tranel, D., & Damásio, A. R. (1998). The human amygdala in social judgment. *Nature, 393*(6684), 470-474. doi: 10.1038/30982

Aggarwal, P. (2004). The effects of brand relationship norms on consumer attitudes and behavior. *Journal of Consumer Research, 31*(1), 87-101. doi: 10.1086/383426

Ahuvia, A. C. (2005). Beyond the extended self: loved objects and consumers' identity narratives. *Journal of Consumer Research, 32*(1), 171-184. doi: 10.1086/429607

Ainslie, G., & Monterosso, J. (2004). A marketplace in the brain? *Science, 306*(5695), 421-423. doi: 10.1126/science.1104884

Allen, C. T., Fournier, S., & Miller, F. (2008). Brands and Their Meaning Makers. In C. P. Haugtvedt, P. M. Herr & F. R. Kardes (Eds.), *Handbook of Consumer Psychology* (pp. 781-822). New York: Taylor & Francis.

Allman, J. M., Hakeem, A., Erwin, J. M., Nimchinsky, E., & Hof, P. (2001). The anterior cingulate cortex. The evolution of an interface between emotion and cognition. *Annals of the New York Academy of Sciences, 935*, 107-117. doi: 10.1111/j.1749-6632.2001.tb03476.x

Ambler, T. (2008). What will neuroscience do for advertisers? Is brain-scanning the answer to marketers' prayers? *Admap, 490*, 24-26.

Ambler, T., Braeutigam, S., Stins, J., Rose, S., & Swithenby, S. (2004). Salience and choice: Neural correlates of shopping decisions. *Psychology and Marketing, 21*(4), 247-261. doi: 10.1002/mar.20004

American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders: Text Revision DSM-IV-TR* (4th. ed.). Washington, DC: American Psychiatric Association.

American Psychological Association. (2007). *Thesaurus of Psychological Index Terms* (11th. ed.). Washington, D.C.: American Psychological Association.

Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nature Reviews Neuroscience, 7*(4), 268-277. doi: 10.1038/nrn1884

Andrews-Hanna, J. R., Reidler, J. S., Sepulcre, J., Poulin, R., & Buckner, R. L. (2010). Functional-anatomic fractionation of the brain's default network. *Neuron, 65*(4), 550-562. doi: 10.1016/j.neuron.2010.02.005

Ariely, D., & Berns, G. (2010). Neuromarketing: the hope and hype of neuroimaging in business. *Nature Reviews Neuroscience, 11*(4), 284-292. doi: 10.1038/nrn2795

Ashwin, C., Baron-Cohen, S., Wheelwright, S., O'Riordan, M., & Bullmore, E. T. (2007). Differential activation of the amygdala and the 'social brain' during fearful face-processing in Asperger Syndrome. *Neuropsychologia, 45*(1), 2-14. doi: 10.1016/j.neuropsychologia.2006.04.014

Aziz-Zadeh, L., Koski, L., Zaidel, E., Mazziotta, J., & Iacoboni, M. (2006). Lateralization of the human mirror neuron system. *The Journal of Neuroscience, 26*(11), 2964-2970. doi: 10.1523/JNEUROSCI.2921-05.2006

Azoulay, A., & Kapferer, J.-N. (2003). Do brand personality scales really measure brand personality? *Journal of Brand Management, 11*(2), 143-155. doi: 10.1057/palgrave.bm.2540162

Badre, D., & D'Esposito, M. (2009). Is the rostro-caudal axis of the frontal lobe hierarchical? *Nature Reviews Neuroscience, 10*(9), 659-669. doi: 10.1038/nrn2667

Bahlmann, J., Schubotz, R. I., & Friederici, A. D. (2008). Hierarchical artificial grammar processing engages Broca's area. *Neuroimage, 42*(2), 525-534. doi: 10.1016/j.neuroimage.2008.04.249

Bailey, C. H., & Kandel, E. R. (2004). Synaptic Growth and the Persistance of Long-Term Memory: A Molecular Perspective. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences III* (pp. 647-663). Cambridge: MIT Press.

Bala, V., & Goyal, S. (1998). Learning from neighbours. *The Review of Economic Studies, 65*(3), 595-621. doi: 10.1111/1467-937X.00059

Banerjee, A., & Fudenberg, D. (2004). Word-of-mouth learning. *Games and Economic Behavior, 46*(1), 1-22. doi: 10.1016/s0899-8256(03)00048-4

Banister, E. N., & Hogg, M. K. (2004). Negative symbolic consumption and consumers' drive for self-esteem: The case of the fashion industry *European Journal of Marketing, 38*(7), 850–868. doi: 10.1108/03090560410539285

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37-46. doi: 10.1016/0010-0277(85)90022-8

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: an investigation of adults with Asperger syndrome or high functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders, 34*(2), 163-175. doi: 10.1023/B:JADD.0000022607.19833.00

Baron-Cohen, S., Wheelwright, S., Robinson, J., & Woodbury-Smith, M. (2005). The Adult Asperger Assessment (AAA): a diagnostic method. *Journal of Autism and Developmental Disorders, 35*(6), 807-819. doi: 10.1007/s10803-005-0026-5

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31*(1), 5-17. doi: 10.1023/A:1005653411471

Beaucousin, V., Lacheret, A., Turbelin, M. R., Morel, M., Mazoyer, B., & Tzourio-Mazoyer, N. (2007). FMRI study of emotional speech comprehension. *Cerebral Cortex, 17*(2), 339-352. doi: 10.1093/cercor/bhj151

Bechara, A. (2004). The role of emotion in decision-making: evidence from neurological patients with orbitofrontal damage. *Brain and Cognition, 55*(1), 30-40. doi: 10.1016/j.bandc.2003.04.001

Bechara, A., & Damásio, A. R. (2005). The somatic marker hypothesis: a neural theory of economic decision. *Games and Economic Behavior, 52*(2), 336-372. doi: 10.1016/j.geb.2004.06.010

Bechara, A., Damásio, H., Damásio, A. R., & Lee, G. P. (1999). Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. *The Journal of Neuroscience, 19*(13), 5473-5481.

Bechara, A., Damásio, H., Tranel, D., & Anderson, S. W. (1998). Dissociation of working memory from decision making within the human prefrontal cortex. *The Journal of Neuroscience, 18*(1), 428-437.

Bechara, A., Damásio, H., Tranel, D., & Damásio, A. R. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*(5304), 1293-1295. doi: 10.1126/science.275.5304.1293

Beckmann, C. F., De Luca, M., Devlin, J. T., & Smith, S. M. (2005). Investigations into resting-state connectivity using independent component analysis. *Philosophical Transactions of the Royal Society B, 360*(1457), 1001-1013. doi: 10.1098/rstb.2005.1634

Beckmann, C. F., Jenkinson, M., & Smith, S. M. (2003). General multilevel linear modeling for group analysis in FMRI. *Neuroimage, 20*(2), 1052-1063. doi: 10.1016/S1053-8119(03)00435-X

Beckmann, C. F., & Smith, S. M. (2004). Probabilistic independent component analysis for functional magnetic resonance imaging. *IEEE Transactions on Medical Imaging, 23*(2), 137-152. doi: 10.1109/TMI.2003.822821

Beckmann, C. F., & Smith, S. M. (2005). Tensorial extensions of independent component analysis for multisubject FMRI analysis. *Neuroimage, 25*(1), 294-311. doi: 10.1016/j.neuroimage.2004.10.043

Beer, J. S., John, O. P., Scabini, D., & Knight, R. T. (2006). Orbitofrontal cortex and social behavior: integrating self-monitoring and emotion-cognition interactions. *Journal of Cognitive Neuroscience, 18*(6), 871-879. doi: 10.1162/jocn.2006.18.6.871

Belk, R. W. (1988). Possessions and the extended self. *Journal of Consumer Research, 15*(2), 139-168. doi: 10.1086/209154

Belk, R. W., Bahn, K. D., & Mayer, R. N. (1982). Developmental recognition of consumption symbolism. *Journal of Consumer Research, 9*(1), 4-17. doi: 10.1086/208892

Bennett, P. D., & American Marketing Association. (1995). Dictionary of Marketing Terms P. D. Bennett (Ed.) Retrieved from http://www.marketingpower.com/_layouts/dictionary.aspx

Bergman, M., & Paavola, S. (2003). The Commens Dictionary of Peirce's Terms - Peirce's Terminology in His Own Words Retrieved from http://www.helsinki.fi/science/commens/dictionary.html

Berney, T. (2004). Asperger syndrome from childhood into adulthood. *Advances in Psychiatric Treatment, 10*(5), 341-351. doi: 10.1192/apt.10.5.341

Berns, G., Capra, C. M., Moore, S., & Noussair, C. (2008). *Neural mechanisms of social influence in consumer decisions*. Paper presented at the Theory and Experimental Economics Seminars - 10/31/2008, Texas A&M University - Dep. of Economics, Texas A&M University - Dep. of Economics. http://econweb.tamu.edu/workshops/Theory%20and%20Experimental%20Economics/2008_10_31_Monica_Capra.pdf

Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neuroscience, 26*(9), 507-513. doi: 10.1016/S0166-2236(03)00233-9

Bikhchandani, S., Hirshleifer, D., & Welch, I. (1992). A theory of fads, fashion, custom, and cultural change as informational cascades. *Journal of Political Economy, 100*(5), 992-1026. doi: 10.1086/261849

Blackett, T. (2003). What is a brand? In R. Clifton & J. Simmons (Eds.), *Brands and Branding (The Economist)*. Princeton NJ: Bloomberg Press.

Blackmore, S. (1998). Imitation and the definition of a meme. *Journal of Memetics - Evolutionary Models of Information Transmission, 2*(2), 159-170.

Blackmore, S. (2000). The power of memes. *Scientific American, 283*(4), 64-73.

Blow, N. (2009). Functional Neuroscience: How to get ahead in imaging. *Nature, 458*(7240), 925-928. doi: 10.1038/458925a

Blumer, H. (1969). *Symbolic Interactionism: Perspective and Method*. Los Angeles: University of California Press.

Blute, M. (2005). Memetics and evolutionary social science. *Journal of Memetics - Evolutionary Models of Information Transmission, 9*(1).

Boas, G. (2004). Noninvasive imaging of the brain. *Optics and Photonics News, 15*(1), 52-55. doi: 10.1364/OPN.15.1.000052

Bookheimer, S. Y. (2002). Functional MRI of language: new approaches to understanding the cortical organization of semantic processing. *Annual Review in Neuroscience, 25*, 151-188. doi: 10.1146/annurev.neuro.25.112701.142946

Booth, J. R., Lu, D., Burman, D. D., Chou, T.-l., Jin, Z., Peng, D.-l., et al. (2006). Specialization of phonological and semantic processing in Chinese word reading. *Brain Research, 1071*(1), 197-207. doi: 10.1016/j.brainres.2005.11.097

Bradley, M. M., & Lang, P. J. (2007). The International Affective Picture System (IAPS) in the Study of Emotion and Attention. In J. A. Coan & J. J. B. Allen (Eds.), *Handbook of Emotion Elicitation and Assessment* (pp. 29-46). New York: Oxford University Press.

Braeutigam, S. (2005). Neuroeconomics - From neural systems to economic behaviour. *Brain Research Bulletin, 67*(5), 355-360. doi: 10.1016/j.brainresbull.2005.06.009

Braeutigam, S., Rose, S., Swithenby, S., & Ambler, T. (2004). The distributed neuronal systems supporting choice-making in real-life situations: differences between men and women when choosing groceries detected using magnetoencephalography. *European Journal of Neuroscience, 20*(1), 293-302. doi: 10.1111/j.1460-9568.2004.03467.x

Braeutigam, S., Stins, J., Rose, S., Swithenby, S., & Ambler, T. (2001). Magnetoencephalographic signals identify stages in real-life decision processes. *Neural Plasticity, 8*(4), 241-254. doi: 10.1155/NP.2001.241

Brett, M. (1999, 2002-02-14). The MNI brain and the Talairach atlas Retrieved May 07th, 2010, from http://imaging.mrc-cbu.cam.ac.uk/imaging/MniTalairach

Broca, P. (1861). Remarques sur le siége de la faculté du langage articulé, suivies d'une observation d'aphémie (perte de la parole). *Bulletin de la Société Anatomique, 6*, 330-357.

Brown, J., Broderick, A. J., & Lee, N. (2007). Word of mouth communication within online communities: conceptualizing the online social network. *Journal of Interactive Marketing, 21*(3), 2-20. doi: 10.1002/dir.20082

Bruner, E., Manzi, G., & Arsuaga, J. L. (2003). Encephalization and allometric trajectories in the genus Homo: evidence from the Neandertal and modern lineages. *Proceedings of the National Academy of Sciences of the U S A, 100*(26), 15335-15340. doi: 10.1073/pnas.2536671100

Brunet-Gouet, E., & Decety, J. (2006). Social brain dysfunctions in schizophrenia: a review of neuroimaging studies. *Psychiatry Research: Neuroimaging, 148*(2-3), 75-92. doi: 10.1016/j.pscychresns.2006.05.001

Burnell, K. (1998). Cultural variation in savannah sparrow, Passerculus sandwichensis, songs: an analysis using the meme concept. *Animal Behaviour, 56*(4), 995-1003. doi: 10.1006/anbe.1998.0864

Burns, J. K. (2004). An evolutionary theory of schizophrenia: cortical connectivity, metarepresentation, and the social brain. *Behavioral and Brain Sciences, 27*(6), 831-855; discussion 855-885. doi: 10.1017/S0140525X04000196

Burns, J. K. (2006). Psychosis: a costly by-product of social brain evolution in Homo sapiens. *Progress in Neuropsychopharmacology & Biological Psychiatry, 30*(5), 797-814. doi: 10.1016/j.pnpbp.2006.01.006

Byrne, R. W. (2005). Social cognition: imitation, imitation, imitation. *Current Biology, 15*(13), R498-R500. doi: 10.1016/j.cub.2005.06.031

Cabeza, R., Ciaramelli, E., Olson, I. R., & Moscovitch, M. (2008). The parietal cortex and episodic memory: an attentional account. *Nature Reviews Neuroscience, 9*(8), 613-625. doi: 10.1038/nrn2459

Call, J., & Tomasello, M. (1999). A nonverbal false belief task: the performance of children and great apes. *Child Development, 70*(2), 381-395. doi: 10.1111/1467-8624.00028

Callero, P. L. (2003). The sociology of the self. *Annual Review of Sociology, 29*(1), 115-133. doi: 10.1146/annurev.soc.29.010202.100057

Canli, T., Sivers, H., Whitfield, S. L., Gotlib, I. H., & Gabrieli, J. D. (2002). Amygdala response to happy faces as a function of extraversion. *Science, 296*(5576), 2191. doi: 10.1126/science.1068749

Carr, L., Iacoboni, M., Dubeau, M.-C., Mazziotta, J. C., & Lenzi, G. L. (2003). Neural mechanisms of empathy in humans: a relay from neural systems for imitation to limbic areas. *Proceedings of the National Academy of Sciences of the USA, 100*(9), 5497-5502. doi: 10.1073/pnas.0935845100

Carreiras, M., Dunabeitia, J. A., & Perea, M. (2007). Reading WORDS, NUMB3R5 and $YMB0L$. *Trends in Cognitive Sciences, 11*(11), 454-455; author reply 456-457. doi: 10.1016/j.tics.2007.08.007

Castelli, F. (2005). Understanding emotions from standardized facial expressions in autism and normal development. *Autism, 9*(4), 428-449. doi: 10.1177/1362361305056082

Castelli, F., Frith, C., Happe, F., & Frith, U. (2002). Autism, Asperger syndrome and brain mechanisms for the attribution of mental states to animated shapes. *Brain, 125*(Pt 8), 1839-1849.

Cavanna, A. E., & Trimble, M. R. (2006). The precuneus: a review of its functional anatomy and behavioural correlates. *Brain, 129*(Pt 3), 564-583. doi: 10.1093/brain/awl004

Chamberlain, L., & Broderick, A. (2007). The application of physiological observation methods to emotion research. *Qualitative Market Research: An International Journal, 10*(2), 199-216. doi: 10.1108/13522750710740853

Chiao, J. Y., Harada, T., Oby, E. R., Li, Z., Parrish, T., & Bridge, D. J. (2009). Neural representations of social status hierarchy in human inferior parietal cortex. *Neuropsychologia, 47*(2), 354-363. doi: 10.1016/j.neuropsychologia.2008.09.023

Christensen, G. L., & Olson, J. C. (2002). Mapping consumers' mental models with ZMET. *Psychology and Marketing, 19*(6), 477-501. doi: 10.1002/mar.10021

Ciaramidaro, A., Adenzato, M., Enrici, I., Erk, S., Pia, L., Bara, B. G., et al. (2007). The intentional network: how the brain reads varieties of intentions. *Neuropsychologia, 45*(13), 3105-3113. doi: 10.1016/j.neuropsychologia.2007.05.011

Clithero, J. A., Carter, R. M., & Huettel, S. A. (2009). Local pattern classification differentiates processes of economic valuation. *Neuroimage, 45*(4), 1329-1338. doi: 10.1016/j.neuroimage.2008.12.074

Collins, D. L. (1994). *3D Model-based Segmentation of Individual Brain Structures from Magnetic Resonance Imaging Data.* Thesis for the degree of Doctor of Philosophy, McGill University, Montreal. Retrieved from http://www.bic.mni.mcgill.ca/users/louis/papers/phd_thesis/

Coltheart, M. (2006). Acquired dyslexias and the computational modelling of reading. *Cognitive Neuropsychology, 23*(1), 96-109. doi: 10.1080/02643290500202649

Coltman, T., Devinney, T. M., Midgley, D. F., & Venaik, S. (2008). Formative versus reflective measurement models: two applications of formative measurement. *Journal of Business Research, 61*(12), 1250-1262. doi: 10.1016/j.jbusres.2008.01.013

Corbin, J., & Strauss, A. (2007). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* (3rd. ed.). Thousand Oaks: SAGE Publications Ltd.

Coulter, R. A., Zaltman, G., & Coulter, K. S. (2001). Interpreting consumer perceptions of advertising: An application of the Zaltman metaphor elicitation technique. *Journal of Advertising, 30*(4), 1-21.

Cova, B., & Cova, V. (2002). Tribal marketing: the tribilisation of society and its impact on the conduct of marketing. *European Journal of Marketing, 36*(5/6), 595-620. doi: 10.1108/03090560210423023

Craig, A. D. (2002). How do you feel? Interoception: the sense of the physiological condition of the body. *Nature Reviews Neuroscience, 3*(8), 655-666. doi: 10.1038/nrn894

Craig, A. D. (2009a). How do you feel--now? The anterior insula and human awareness. *Nature Reviews Neuroscience, 10*(1), 59-70. doi: 10.1038/nrn2555

Craig, A. D. (2009b). A rat is not a monkey is not a human: comment on Mogil (Nature Rev. Neurosci. 10, 283-294 (2009)). *Nature Reviews Neuroscience, 10*(6), 466. doi: 10.1038/nrn2606-c1

Critchley, H., Daly, E., Phillips, M., Brammer, M., Bullmore, E., Williams, S., et al. (2000). Explicit and implicit neural mechanisms for processing of social information from facial expressions: a functional magnetic resonance imaging study. *Human Brain Mapping, 9*(2), 93-105. doi: 10.1002/(SICI)1097-0193(200002)9:2<93::AID-HBM4>3.0.CO;2-Z

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological Bulletin, 52*(4), 281-302.

D'Argembeau, A., Collette, F., Van der Linden, M., Laureys, S., Del Fiore, G., Degueldre, C., et al. (2005). Self-referential reflective activity and its relationship with rest: a PET study. *Neuroimage, 25*(2), 616-624. doi: 10.1016/j.neuroimage.2004.11.048

Damásio, A. R. (1994). *Descarte's Error - Emotion, Reason and the Human Brain*. New York: Penguin Putnam.

Damásio, A. R. (1999). *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*. Orlando: Harcourt Publishers.

Damásio, A. R. (2003a). Feelings of emotion and the self. *Annals of the New York Academy of Sciences, 1001*, 253-261. doi: 10.1196/annals.1279.014

Damásio, A. R. (2003b). *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain*. Orlando: Harcourt Books.

Damásio, A. R. (2003c). Mental self: the person within. *Nature, 423*(6937), 227. doi: 10.1038/423227a

Damásio, A. R., Grabowski, T. J., Bechara, A., Damásio, H., Ponto, L. L. B., Parvizi, J., et al. (2000). Subcortical and cortical brain activity during the feeling of self-generated emotions. *Nature Neuroscience, 3*(10), 1049-1056. doi: 10.1038/79871

Dapretto, M., & Bookheimer, S. Y. (1999). Form and content: dissociating syntax and semantics in sentence comprehension. *Neuron, 24*(2), 427-432. doi: 10.1016/S0896-6273(00)80855-7

Dapretto, M., Davies, M. S., Pfeifer, J. H., Scott, A. A., Sigman, M., Bookheimer, S. Y., et al. (2006). Understanding emotions in others: mirror neuron dysfunction in children with autism spectrum disorders. *Nature Neuroscience, 9*(1), 28-30. doi: 10.1038/nn1611

de Araujo, I. E., Rolls, E. T., Kringelbach, M. L., McGlone, F., & Phillips, N. (2003). Taste-olfactory convergence, and the representation of the pleasantness of flavour, in the human brain. *European Journal of Neuroscience, 18*(7), 2059-2068. doi: 10.1046/j.1460-9568.2003.02915.x

de Chernatony, L. (1993). Categorizing brands: evolutionary processes underpinned by two key dimensions. *Journal of Marketing Management, 9*(2), 173-188. doi: 10.1080/0267257X.1993.9964228

de Chernatony, L., & Riley, F. D. O. (1997). The chasm between managers' and consumers' views of brands: the experts' perspectives. *Journal of Strategic Marketing, 5*(2), 89-104. doi: 10.1080/096525497346811

De Luca, M., Beckmann, C. F., De Stefano, N., Matthews, P. M., & Smith, S. M. (2006). FMRI resting state networks define distinct modes of long-distance interactions in the human brain. *Neuroimage, 29*(4), 1359-1367. doi: 10.1016/j.neuroimage.2005.08.035

Delgado, M. R., Li, J., Schiller, D., & Phelps, E. A. (2008). The role of the striatum in aversive learning and aversive prediction errors. *Philosophical Transactions of the Royal Society B, 363*(1511), 3787-3800. doi: 10.1098/rstb.2008.0161

Denzin, N. K. (1987). On Semiotics and Symbolic Interactionism. *Symbolic Interaction, 10*(1), 1-19. doi: 10.1525/si.1987.10.1.1

Deppe, M., Schwindt, W., Kramer, J., Kugel, H., Plassmann, H., Kenning, P., et al. (2005). Evidence for a neural correlate of a framing effect: bias-specific activity in the ventromedial prefrontal cortex during credibility judgments. *Brain Research Bulletin, 67*(5), 413-421. doi: 10.1016/j.brainresbull.2005.06.017

Deppe, M., Schwindt, W., Kugel, H., Plassmann, H., & Kenning, P. (2005). Nonlinear responses within the medial prefrontal cortex reveal when specific implicit information influences economic decision making. *Journal of Neuroimaging, 15*(2), 171-182. doi: 10.1177/1051228405275074

Desmurget, M., Reilly, K. T., Richard, N., Szathmari, A., Mottolese, C., & Sirigu, A. (2009). Movement intention after parietal cortex stimulation in humans. *Science, 324*(5928), 811-813. doi: 10.1126/science.1169896

Desmurget, M., & Sirigu, A. (2009). A parietal-premotor network for movement intention and motor awareness. *Trends in Cognitive Sciences, 13*(10), 411-419. doi: 10.1016/j.tics.2009.08.001

Diamantopoulos, A., Riefler, P., & Roth, K. P. (2008). Advancing formative measurement models. *Journal of Business Research, 61*(12), 1203-1218. doi: 10.1016/j.jbusres.2008.01.009

Dittmar, H. (1994). Material possessions as stereotypes: material images of different socio-economic groups. *Journal of Economic Psychology, 15*(4), 561-585. doi: 10.1016/0167-4870(94)90011-6

Dittmar, H., & Pepper, L. (1994). To have is to be: materialism and person perception in working-class and middle-class British adolescents. *Journal of Economic Psychology, 15*(2), 233-251. doi: 10.1016/0167-4870(94)90002-7

Edwards, J. R., & Bagozzi, R. P. (2000). On the nature and direction of relationships between constructs and measures. *Psychological Methods, 5*(2), 155-174. doi: 10.1037/1082-989X.5.2.155

Elliott, R. (1994). Exploring the symbolic meaning of brands. *British Journal of Management, 5*(s1), S13-S19. doi: 10.1111/j.1467-8551.1994.tb00126.x

Elliott, R., & Deakin, B. (2005). Role of the orbitofrontal cortex in reinforcement processing and inhibitory control: evidence from functional magnetic resonance imaging studies in healthy human subjects. *International Review of Neurobiology, 65*, 89-116. doi: 10.1016/S0074-7742(04)65004-5

Elliott, R., Dolan, R. J., & Frith, C. D. (2000). Dissociable functions in the medial and lateral orbitofrontal cortex: evidence from human neuroimaging studies. *Cerebral Cortex, 10*(3), 308-317.

Elliott, R., Newman, J. L., Longe, O. A., & Deakin, J. F. W. (2003). Differential response patterns in the striatum and orbitofrontal cortex to financial reward in humans: a parametric functional magnetic resonance imaging study. *The Journal of Neuroscience, 23*(1), 303-307.

Elliott, R., & Wattanasuwan, K. (1998). Brands as symbolic resources for the construction of identity. *International Journal of Advertising, 17*(2), 131-144.

Ellison, G., & Fudenberg, D. (1993). Rules of thumb for social learning. *Journal of Political Economy, 101*(4), 612-643. doi: 10.1086/261890

Ellison, G., & Fudenberg, D. (1995). Word-of-mouth communication and social learning. *The Quarterly Journal of Economics, 110*(1), 93-125. doi: 10.2307/2118512

Emery, N. J., & Clayton, N. S. (2009). Comparative social cognition. *Annual Review of Psychology, 60*, 87-113. doi: 10.1146/annurev.psych.60.110707.163526

Engelmann, J. B., Capra, C. M., Noussair, C., & Berns, G. (2009). Expert financial advice neurobiologically "offloads" financial decision-making under risk. *PLoS ONE, 4*(3), e4957. doi: 10.1371/journal.pone.0004957

Erdem, T., & Swait, J. (1998). Brand equity as a signaling phenomenon. *Journal of Consumer Psychology, 7*(2), 131-157. doi: 10.1207/s15327663jcp0702_02

Erdem, T., Swait, J., Broniarczyk, S., Chakravarti, D., Kapferer, J.-N., Keane, M., et al. (1999). Brand equity, consumer learning and choice. *Marketing Letters, 10*(3), 301-318. doi: 10.1023/A:1008135224357

Erk, S., Spitzer, M., Wunderlich, A. P., Galley, L., & Walter, H. (2002). Cultural objects modulate reward circuitry. *Neuroreport, 13*(18), 2499-2503. doi: 10.1097/01.wnr.0000048542.12213.60

Ermer, E., Guerin, S. A., Cosmides, L., Tooby, J., & Miller, M. B. (2006). Theory of mind broad and narrow: reasoning about social exchange engages ToM areas, precautionary reasoning does not. *Social Neuroscience, 1*(3-4), 196-219. doi: 10.1080/17470910600989771

Escalas, J. E. (2004). Narrative processing: building consumer connections to brands. *Journal of Consumer Psychology, 14*(1-2), 168-180. doi: 10.1207/s15327663jcp1401&2_19

Escalas, J. E., & Bettman, J. R. (2005). Self-construal, reference groups, and brand meaning. *Journal of Consumer Research, 32*(3), 378-389. doi: 10.1086/497549

Etzel, J. A., Gazzola, V., & Keysers, C. (2009). An introduction to anatomical ROI-based fMRI classification analysis. *Brain Research, 1282*, 114-125. doi: 10.1016/j.brainres.2009.05.090

Everett, D. L. (2005). Cultural constraints on grammar and cognition in Pirahã. Another look at the design features of human language. *Current Anthropology, 46*(4), 621-646. doi: 10.1086/431525

Farberman, H. A. (1980). Fantasy in everyday life: some aspects of the intersection between Social Psychology and Political-Economy. *Symbolic Interaction, 3*(1), 9-22. doi: 10.1525/si.1980.3.1.9

Forkstam, C., Hagoort, P., Fernandez, G., Ingvar, M., & Petersson, K. M. (2006). Neural correlates of artificial syntactic structure classification. *Neuroimage, 32*(2), 956-967. doi: 10.1016/j.neuroimage.2006.03.057

Fortin, N. J., Wright, S. P., & Eichenbaum, H. (2004). Recollection-like memory retrieval in rats is dependent on the hippocampus. *Nature, 431*(7005), 188-191. doi: 10.1038/nature02853

Fournier, S. (1998). Consumers and their brands: developing relationship theory in consumer research. *Journal of Consumer Research, 24*(4), 343-353. doi: 10.1086/209515

Friederici, A. D., Bahlmann, J., Heim, S., Schubotz, R. I., & Anwander, A. (2006). The brain differentiates human and non-human grammars: functional localization and structural connectivity. *Proceedings of the National Academy of Sciences of the U S A, 103*(7), 2458-2463. doi: 10.1073/pnas.0509389103

Frith, C. D. (2007). The social brain? *Philosophical Transactions of the Royal Society B, 362*(1480), 671-678. doi: 10.1098/rstb.2006.2003

Frith, C. D., & Frith, U. (2006). The neural basis of mentalizing. *Neuron, 50*(4), 531-534. doi: 10.1016/j.neuron.2006.05.001

Furlong, E. E., & Opfer, J. E. (2007). Numbers, not value, motivate cooperation in humans and orangutans. *Nature Precedings*. Retrieved from http://hdl.handle.net/10101/npre.2007.1392.1

Furlong, E. E., & Opfer, J. E. (2009). Cognitive constraints on how economic rewards affect cooperation. *Psychological Science, 20*(1), 11-16. doi: 10.1111/j.1467-9280.2008.02244.x

Gallagher, H. L., & Frith, C. D. (2003). Functional imaging of 'theory of mind'. *Trends in Cognitive Sciences, 7*(2), 77-83. doi: 10.1016/S1364-6613(02)00025-6

Gallese, V., Fadiga, L., Fogassi, L., & Rizzolatti, G. (1996). Action recognition in the premotor cortex. *Brain, 119 (Pt 2)*, 593-609.

Gallese, V., Keysers, C., & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in Cognitive Sciences, 8*(9), 396-403. doi: 10.1016/j.tics.2004.07.002

Gannon, P. J., Holloway, R. L., Broadfield, D. C., & Braun, A. R. (1998). Asymmetry of chimpanzee planum temporale: humanlike pattern of Wernicke's brain language area homolog. *Science, 279*(5348), 220-222. doi: 10.1126/science.279.5348.220

Gannon, P. J., Kheck, N. M., & Hof, P. R. (2001). Language Areas of the Hominoid Brain: A Dynamic Communicative Shift on the Upper East Side Planum. In D. Falk & K. R. Gibson (Eds.), *Evolutionary Anatomy of the Primate Cerebral Cortex* (pp. 216-240). Cambridge: Cambridge University Press.

Ghaziuddin, M. (2008). Defining the behavioral phenotype of Asperger syndrome. *Journal of Autism and Developmental Disorders, 38*(1), 138-142. doi: 10.1007/s10803-007-0371-7

Gigerenzer, G. (2001). Decision Making: Nonrational Theories. In N. J. Smelser & P. B. Baltes (Eds.), *International Encyclopedia of the Social and Behavioral Sciences* (Vol. 5, pp. 3304-3309). Oxford: Elsevier Science.

Gillberg, I. C., & Gillberg, C. (1989). Asperger syndrome--Some epidemiological considerations: A research note. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 30*(4), 631-638. doi: 10.1111/1469-7610.ep11831866

Glimcher, P. W. (2003). *Decisions, Uncertainty, and the Brain: The Science of Neuroeconomics*. Cambridge: The MIT Press.

Glimcher, P. W., Camerer, C. F., Fehr, E., & Poldrack, R. A. (2009). *Neuroeconomics: Decision Making and the Brain*. Burlington: Academic Press - Elsevier Inc.

Goffman, E. (1959). *The Presentation of Self in Everyday Life*. New York: Anchor Book.

Goldstein, R., Almenberg, J., Dreber, A., Emerson, J. W., Herschkowitsch, A., & Katz, J. (2008). Do more expensive wines taste better? Evidence from a large sample of blind tastings. *Journal of Wine Economics, 3*(1), 1-9.

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: attitudes, self-esteem, and stereotypes. *Psychological Review, 102*(1), 4-27.

Griffiths, T. D., & Warren, J. D. (2002). The planum temporale as a computational hub. *Trends in Neuroscience, 25*(7), 348-353. doi: 10.1016/S0166-2236(02)02191-4

Grodzinsky, Y., & Friederici, A. D. (2006). Neuroimaging of syntax and syntactic processing. *Current Opinion in Neurobiology, 16*(2), 240-246. doi: 10.1016/j.conb.2006.03.007

Grodzinsky, Y., & Santi, A. (2008). The battle for Broca's region. *Trends in Cognitive Sciences, 12*(12), 474-480. doi: 10.1016/j.tics.2008.09.001

Grubb, E. L., & Grathwohl, H. L. (1967). Consumer self-concept, symbolism and market behavior: A theoretical approach. *Journal of Marketing, 31*(4), 22-27. doi: 10.2307/1249461

Gurney, K. (1997). *An Introduction to Neural Networks*. Boca Raton: CRC Press.

Gusnard, D. A., & Raichle, M. E. (2001). Searching for a baseline: functional imaging and the resting human brain. *Nature Review Neuroscience, 2*(10), 685-694. doi: 10.1038/35094500

Hagoort, P., & Levelt, W. J. (2009). The speaking brain. *Science, 326*(5951), 372-373. doi: 10.1126/science.1181675

Hanson, S. J., Matsuka, T., & Haxby, J. V. (2004). Combinatorial codes in ventral temporal lobe for object recognition: Haxby (2001) revisited: is there a "face" area? *Neuroimage, 23*(1), 156-166. doi: 10.1016/j.neuroimage.2004.05.020

Happe, F., & Frith, U. (1996). The neuropsychology of autism. *Brain, 119 (Pt 4)*, 1377-1400.

Hare, T. A., Camerer, C. F., & Rangel, A. (2009). Self-control in decision-making involves modulation of the vmPFC valuation system. *Science, 324*(5927), 646-648. doi: 10.1126/science.1168450

Harper, D. (2001). "Brand" at Online Etymology Dictionary. Retrieved 2009-05-09 http://www.etymonline.com/index.php?term=brand

Haykin, S. (2009). *Neural Networks and Learning Machines* (3rd ed.). New Jersey: Prentice Hall.

Haynes, J.-D., & Rees, G. (2006). Decoding mental states from brain activity in humans. *Nature Reviews Neuroscience, 7*(7), 523-534. doi: 10.1038/nrn1931

Helfman, G. S., & Schultz, E. T. (1984). Social transmission of behavioural traditions in a coral reef fish. *Animal Behaviour, 32*(2), 379-384. doi: 10.1016/S0003-3472(84)80272-9

Heyes, C. M. (1998). Theory of mind in nonhuman primates. *Behavioral and Brain Sciences, 21*(1), 101-114; discussion 115-148.

Hickok, G., & Poeppel, D. (2007). The cortical organization of speech processing. *Nature Reviews Neuroscience, 8*(5), 393-402. doi: 10.1038/nrn2113

Hirschman, E. C. (1986). The Creation of Product Symbolism. In R. J. Lutz (Ed.), *Advances in Consumer Research* (Vol. 13, pp. 327-331). Provo, UT: Association for Consumer Reserach.

Holt, D. B. (2003). What becomes an icon most? *Harvard Business Review, 81*(3), 43-49.

Hsu, F. L. K. (1971). Psychosocial homeostasis and Jen: conceptual tools for advancing psychological anthropology. *American Anthropologist, 73*(1), 23-44. doi: 10.1525/aa.1971.73.1.02a00030

Hu, C. (1989). Investigation of the 3 dimensional relation of grapheme, phonetics and semantics in the reading process of patients with dyslexia. *Acta Psychology Sinica, 21*, 41-46.

Hubert, M., & Kenning, P. (2008). A current overview of consumer neuroscience. *Journal of Consumer Behaviour, 7*(4-5), 272-292. doi: 10.1002/cb.251

Huettel, S. A., Song, A. W., & McCarthy, G. (2004). *Functional Magnetic Resonance Imaging*. Sunderland: Sinauer Associates.

Hyvarinen, A. (1999). Fast and robust fixed-point algorithms for independent component analysis. *IEEE Transactions on Neural Networks, 10*(3), 626-634. doi: 10.1109/72.761722

Iacoboni, M. (2005). Neural mechanisms of imitation. *Current Opinion in Neurobiology, 15*(6), 632-637. doi: 10.1016/j.conb.2005.10.010

Iacoboni, M. (2009). Imitation, empathy, and mirror neurons. *Annual Review of Psychology, 60*, 653-670. doi: 10.1146/annurev.psych.60.110707.163604

Iacoboni, M., Lieberman, M. D., Knowlton, B. J., Molnar-Szakacs, I., Moritz, M., Throop, C. J., et al. (2004). Watching social interactions produces dorsomedial prefrontal and medial parietal BOLD fMRI signal increases compared to a resting baseline. *Neuroimage, 21*(3), 1167-1173. doi: 10.1016/j.neuroimage.2003.11.013

Ishai, A. (2007). Sex, beauty and the orbitofrontal cortex. *International Journal of Psychophysiology, 63*(2), 181-185. doi: 10.1016/j.ijpsycho.2006.03.010

Ishai, A., Ungerleider, L. G., & Haxby, J. V. (2000). Distributed neural systems for the generation of visual images. *Neuron, 28*(3), 979-990. doi: 10.1016/S0896-6273(00)00168-9

Ishai, A., Ungerleider, L. G., Martin, A., Schouten, J. L., & Haxby, J. V. (1999). Distributed representation of objects in the human ventral visual pathway. *Proceedings of the National Academy of Sciences of the USA, 96*(16), 9379-9384.

Jackson, P. L., Brunet, E., Meltzoff, A. N., & Decety, J. (2006). Empathy examined through the neural mechanisms involved in imagining how I feel versus how you feel pain. *Neuropsychologia, 44*(5), 752-761. doi: 10.1016/j.neuropsychologia.2005.07.015

Jagger, E. (1998). Marketing the self, buying and other: dating in a post modern, consumer society. *Sociology, 32 (4)*, 795-814. doi: 10.1177/0038038598032004009

Jarvis, C. B., MacKenzie, S. B., & Podsakoff, P. M. (2003). A critical review of construct indicators and measurement model misspecification in Marketing and Consumer Research. *Journal of Consumer Research, 30*(2), 199-218. doi: 10.1086/376806

Jenkinson, M., Bannister, P. R., Brady, J. M., & Smith, S. M. (2002). Improved optimization for the robust and accurate linear registration and motion correction of brain images. *Neuroimage, 17*(2), 825-841. doi: 10.1016/S1053-8119(02)91132-8

Jenkinson, M., & Smith, S. M. (2001). A global optimisation method for robust affine registration of brain images. *Medical Image Analysis, 5*(2), 143-156. doi: 10.1016/S1361-8415(01)00036-6

Jezzard, P., Matthews, P. M., & Smith, S. M. (2001). *Functional MRI: An Introduction to Methods*. Oxford: Oxford University Press.

Johar, J. S., & Sirgy, J. M. (1991). Value-expressive versus utilitarian advertising appeals: when and why to use which appeal. *Journal of Advertising, 20 (3)*, 23-33.

Kaiser, S. B., Nagasawa, R. H., & Hutton, S. S. (1991). Fashion, postmodernity and personal appearance: a symbolic interactionist formulation. *Symbolic Interaction, 14*(2), 165-185. doi: 10.1525/si.1991.14.2.165

Kana, R. K., Keller, T. A., Cherkassky, V. L., Minshew, N. J., & Just, M. A. (2009). Atypical frontal-posterior synchronization of Theory of Mind regions in autism during mental state attribution. *Social Neuroscience, 4*(2), 135-152. doi: 10.1080/17470910802198510

Kayser, C., Petkov, C. I., Augath, M., & Logothetis, N. K. (2007). Functional imaging reveals visual modulation of specific fields in auditory cortex. *The Journal of Neuroscience, 27*(8), 1824-1835. doi: 10.1523/JNEUROSCI.4737-06.2007

Kayser, C., Petkov, C. I., & Logothetis, N. K. (2008). Visual modulation of neurons in auditory cortex. *Cerebral Cortex, 18*(7), 1560-1574. doi: 10.1093/cercor/bhm187

Kehret-Ward, T. (1987). Combining Products in Use: How the Syntax of Product Use Affects Marketing Decisions. In J. Umiker-Sebeok (Ed.), *Marketing and Semiotics: New Directions in the Study of Signs for Sale* (pp. 219-238). Berlin: Walter de Gruyter.

Kehret-Ward, T. (1988). Using a semiotic approach to study the consumption of functionally related products. *International Journal of Research in Marketing, 4*(3), 187-200. doi: 10.1016/S0167-8116(88)80004-1

Keller, K. L. (1993). Conceptualizing, measuring, and managing customer-based brand equity. *The Journal of Marketing, 57*(1), 1-22.

Keller, K. L. (2003). Brand synthesis: the multidimensionality of brand knowledge. *Journal of Consumer Research, 29*(4), 595-600. doi: 10.1086/346254

Kelley, A. E., & Berridge, K. C. (2002). The neuroscience of natural rewards: relevance to addictive drugs. *The Journal of Neuroscience, 22*(9), 3306-3311.

Kelley, W. M., Macrae, C. N., Wyland, C. L., Caglar, S., Inati, S., & Heatherton, T. F. (2002). Finding the self? An event-related fMRI study. *Journal of Cognitive Neuroscience, 14*(5), 785-794. doi: 10.1162/08989290260138672

Kenning, P., Plassmann, H., & Ahlert, D. (2007). Applications of functional magnetic resonance imaging for market research. *Qualitative Market Research: An International Journal, 10*(2), 135-152. doi: 10.1108/13522750710740817

Kensinger, E. A., & Schacter, D. L. (2006a). Amygdala activity is associated with the successful encoding of item, but not source, information for positive and negative stimuli. *The Journal of Neuroscience, 26*(9), 2564-2570. doi: 10.1523/JNEUROSCI.5241-05.2006

Kensinger, E. A., & Schacter, D. L. (2006b). Processing emotional pictures and words: effects of valence and arousal. *Cognitive, Affective, & Behavioral Neuroscience, 6*(2), 110-126. doi: 10.3758/CABN.6.2.110

Keysers, C., & Gazzola, V. (2006). Towards a unifying neural theory of social cognition. *Progress in Brain Research, 156*, 379-401. doi: 10.1016/S0079-6123(06)56021-2

Keysers, C., & Gazzola, V. (2007). Integrating simulation and theory of mind: from self to social cognition. *Trends in Cognitive Sciences, 11*(5), 194-196. doi: 10.1016/j.tics.2007.02.002

Keysers, C., Kaas, J. H., & Gazzola, V. (2010). Somatosensation in social perception. *Nature Reviews Neuroscience, 11*(6), 417-428. doi: 10.1038/nrn2833

Kilpinen, E. (2008). Memes versus signs: on the use of meaning concepts about nature and culture. *Semiotica, 2008*(171), 215-237. doi: 10.1515/semi.2008.075

Kleine III, R., Kleine, S., & Kernan, J. (1993). Mundane consumption and the self: A social-identity perspective. *Journal of Consumer Psychology*, 209-235. doi: 10.1016/S1057-7408(08)80015-0

Klucharev, V., Smidts, A., & Fernandez, G. (2008). Brain mechanisms of persuasion: how 'expert power' modulates memory and attitudes. *Social Cognitive and Affective Neuroscience, 3*(4), 353-366. doi: 10.1093/scan/nsn022

Knutson, B., Fong, G. W., Adams, C. M., Varner, J. L., & Hommer, D. (2001). Dissociation of reward anticipation and outcome with event-related fMRI. *Neuroreport, 12*(17), 3683-3687.

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

Koeneke, S., Pedroni, A. F., Dieckmann, A., Bosch, V., & Jancke, L. (2008). Individual preferences modulate incentive values: Evidence from functional MRI. *Behavioral and Brain Functions, 4*, 55. doi: 10.1186/1744-9081-4-55

Koenigs, M., & Tranel, D. (2007). Irrational economic decision-making after ventromedial prefrontal damage: evidence from the Ultimatum Game. *The Journal of Neuroscience, 27*(4), 951-956. doi: 10.1523/JNEUROSCI.4606-06.2007

Koenigs, M., & Tranel, D. (2008). Prefrontal cortex damage abolishes brand-cued changes in cola preference. *Social Cognitive and Affective Neuroscience, 3*(1), 1-6. doi: 10.1093/scan/nsm032

Koenigs, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M., et al. (2007). Damage to the prefrontal cortex increases utilitarian moral judgements. *Nature, 446*(7138), 908-911. doi: 10.1038/nature05631

Kranz, F., & Ishai, A. (2006). Face perception is modulated by sexual preference. *Current Biology, 16*(1), 63-68. doi: 10.1016/j.cub.2005.10.070

Kringelbach, M. L., O'Doherty, J., Rolls, E. T., & Andrews, C. (2003). Activation of the human orbitofrontal cortex to a liquid food stimulus is correlated with its subjective pleasantness. *Cerebral Cortex, 13*(10), 1064-1071.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2005). International affective picture system (IAPS): affective ratings of pictures and instruction manual. Technical report A-6. Gainesville, FL: University of Florida.

Lapersonne, E., Laurent, G., & Le Goff, J.-J. (1995). Consideration sets of size one: An empirical investigation of automobile purchases. *International Journal of Research in Marketing, 12*(1), 55-66. doi: 10.1016/0167-8116(95)00005-M

Lassar, W., Mittal, B., & Sharma, A. (1995). Measuring customer-based brand equity. *Journal of Consumer Marketing, 12*(4), 11-19. doi: 10.1108/07363769510095270

Lawrence, E. J., Shaw, P., Baker, D., Baron-Cohen, S., & David, A. S. (2004). Measuring empathy: reliability and validity of the Empathy Quotient. *Psychological Medicine, 34*(5), 911-919.

Lecours, A. R. (1995). The Origins and Evolution of Writing. In J.-P. Changeux & J. Chavaillon (Eds.), *Origins of the Human Brain* (pp. 213-236). Oxford: Oxford University Press.

Lee, D. H. (1990). Symbolic Interactionism: some implications for consumer self-concept and product symbolism research. In M. E. Goldberg, G. Gorn & R. W. Pollay (Eds.), *Advances in Consumer Research* (Vol. 17, pp. 386-393). Provo, UT: Association for Consumer Research.

Lee, N., Broderick, A. J., & Chamberlain, L. (2007). What is "neuromarketing"? A discussion and agenda for future research. *International Journal of Psychophysiology, 63*(2), 199-204. doi: 10.1016/j.ijpsycho.2006.03.007

Leigh, J. H., & Gabel, T. G. (1992). Symbolic interactionism: its effects on consumer behavior and implications for marketing strategy. *Journal of Consumer Marketing, 9*(1), 27-38. doi: 10.1108/EUM0000000002594

Leone, R. P., Rao, V. R., Keller, K. L., Luo, A. M., McAlister, L., & Srivastava, R. (2006). Linking brand equity to customer equity. *Journal of Service Research, 9*(2), 125-138. doi: 10.1177/1094670506293563

Levy, S. J. (1982). Symbols, Selves, and Others. In A. Mitchell (Ed.), *Advances in Consumer Research* (Vol. 9, pp. 542-543). Ann Abor: Association for Consumer Research.

Ligas, M., & Cotte, J. (1999). The Process of Negotiating Brand Meaning: A Symbolic Interactionist Perspective. In E. J. Arnould & L. M. Scott (Eds.), *Advances in Consumer Research* (Vol. 26, pp. 609-614). Provo, UT: Association for Consumer Research.

Limas, M. C., Meré, J. B. O., Marcos, A. G., Ascacibar, F. J. M. d. P., Espinoza, A. V. P., & Elías, F. A. (2010). AMORE: A MORE flexible neural network package (Version 0.2-12). León. Retrieved from http://rwiki.sciviews.org/doku.php?id=packages:cran:amore

Lindner, M., Hundhammer, T., Ciaramidaro, A., Linden, D. E., & Mussweiler, T. (2008). The neural substrates of person comparison--an fMRI study. *Neuroimage, 40*(2), 963-971. doi: 10.1016/j.neuroimage.2007.12.022

Liu, C.-l., Hue, C.-w., Chen, C.-c., Chuang, K.-h., Liang, K.-c., Wang, Y.-h., et al. (2006). Dissociated roles of the middle frontal gyri in the processing of Chinese characters. *Neuroreport, 17*(13), 1397-1401. doi: 10.1097/01.wnr.0000233090.00463.35

Logothetis, N. K. (2008). What we can do and what we cannot do with fMRI. *Nature, 453*(7197), 869-878. doi: 10.1038/nature06976

Lou, H. C., Luber, B., Crupain, M., Keenan, J. P., Nowak, M., Kjaer, T. W., et al. (2004). Parietal cortex and representation of the mental Self. *Proceedings of the National Academy of Sciences of the U S A, 101*(17), 6827-6832. doi: 10.1073/pnas.0400049101

Luo, B.-y., Zhao, X.-y., Wang, Y.-w., Xu, M.-w., & Weng, X.-c. (2007). Is surface dyslexia in Chinese the same as in alphabetic one? *Chinese Medical Journal (Engl), 120*(4), 348-349.

Luu, S., & Chau, T. (2009). Decoding subjective preference from single-trial near-infrared spectroscopy signals. *Journal of Neural Engineering, 6*(1), 016003. doi: 10.1088/1741-2560/6/1/016003

Lyons, D. E., & Santos, L. R. (2006). Ecology, domain specificity, and the origins of Theory of Mind: is competition the catalyst? *Philosophy Compass, 1*(5), 481-492. doi: 10.1111/j.1747-9991.2006.00032.x

MacKinnon, J. (1974). The behaviour and ecology of wild orang-utans (Pongo pygmaeus). *Animal Behaviour, 22*(1), 3-74. doi: 10.1016/S0003-3472(74)80054-0

Maia, T. V., & McClelland, J. L. (2005). The somatic marker hypothesis: still many questions but no answers. *Trends in Cognitive Sciences, 9*(4), 162-164. doi: 10.1016/j.tics.2005.02.006

Makkai, T., & McAllister, I. (1992). Measuring social indicators in opinion surveys: A method to improve accuracy on sensitive questions. *Social Indicators Research, 27*(2), 169-186. doi: 10.1007/BF00300560

Marshall, J. C., & Newcombe, F. (1973). Patterns of paralexia: a psycholinguistic approach. *Journal of Psycholinguistic Research, 2*(3), 175-199. doi: 10.1007/BF01067101

Matthews, P. M., Adcock, J., Chen, Y., Fu, S., Devlin, J. T., Rushworth, M. F., et al. (2003). Towards understanding language organisation in the brain using fMRI. *Human Brain Mapping, 18*(3), 239-247. doi: 10.1002/hbm.10099

McAlexander, J. H., Schouten, J. W., & Koenig, H. F. (2002). Building brand community. *The Journal of Marketing, 66*(1), 38-54.

McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science, 306*(5695), 503-507. doi: 10.1126/science.1100907

McClure, S. M., Li, J., Tomlin, D., Cypert, K. S., Montague, L. M., & Montague, P. R. (2004). Neural correlates of behavioral preference for culturally familiar drinks. *Neuron, 44*(2), 379-387. doi: 10.1016/j.neuron.2004.09.019

McCracken, G. (1986). Culture and consumption: a theoretical account of the structure and movement of the cultural meaning of consumer goods. *Journal of Consumer Research, 13*(1), 71-84. doi: 10.1086/209048

Mehrabian, A. (1995). Framework for a comprehensive description and measurement of emotional states. *Genetic, Social & General Psychology Monographs, 121*(3), 339-361.

Mehrabian, A., & de Wetter, R. (1987). Experimental test of an emotion-based approach to fitting brand names to products. *Journal of Applied Psychology, 72*(1), 125-130. doi: 10.1037/0021-9010.72.1.125

Meltzoff, A. N. (1988). Imitation, objects, tools, and the rudiments of language in human ontogeny. *Human Evolution, 3*(1-2), 45-64. doi: 10.1007/BF02436590

Mick, D. G. (1986). Consumer research and Semiotics: Exploring the morphology of signs, symbols, and significance. *Journal of Consumer Research, 13*(2), 196-213. doi: 10.1086/209060

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Reviews in Neuroscience, 24*, 167-202. doi: 10.1146/annurev.neuro.24.1.167

Miller, K. W. (2007). Investigating the idiosyncratic nature of brand value. *Australasian Marketing Journal, 15*(2), 81-96.

Minka, T. (2000). Automatic choice of dimensionality for PCA. Technical Report 514, MIT Media Lab Vision and Modeling Group. Cambridge: MIT.

Minsky, M., & Papert, S. (1969). *Perceptrons: An Introduction to Computational Geometry* (Vol. 10). Cambridge: MIT Press.

Mitani, J. C., Grether, G. F., Rodman, P. S., & Priatna, D. (1991). Associations among wild orang-utans: sociality, passive aggregations or chance. *Animal Behaviour, 42*(1), 33-46. doi: 10.1016/S0003-3472(05)80603-7

Mitchell, J. P. (2008). Activity in right temporo-parietal junction is not selective for theory-of-mind. *Cerebral Cortex, 18*(2), 262-271. doi: 10.1093/cercor/bhm051

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2004). Encoding-specific effects of social cognition on the neural correlates of subsequent memory. *The Journal of Neuroscience, 24*(21), 4912-4917. doi: 10.1523/JNEUROSCI.0481-04.2004

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2005). Forming impressions of people versus inanimate objects: social-cognitive processing in the medial prefrontal cortex. *Neuroimage, 26*(1), 251-257. doi: 10.1016/j.neuroimage.2005.01.031

Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron, 50*(4), 655-663. doi: 10.1016/j.neuron.2006.03.040

Mittal, B. (2006). I, me, and mine - how products become consumers' extended selves. *Journal of Consumer Behaviour, 5*(6), 550-562. doi: 10.1002/cb.202

Montague, P. R., King-Casas, B., & Cohen, J. D. (2006). Imaging valuation models in human choice. *Annual Reviews in Neuroscience, 29*, 417-448. doi: 10.1146/annurev.neuro.29.051605.112903

Moran, J. M., Heatherton, T. F., & Kelley, W. M. (2009). Modulation of cortical midline structures by implicit and explicit self-relevance evaluation. *Social Neuroscience, 4*(3), 197-211. doi: 10.1080/17470910802250519

Morris, J. D. (1995). Observations: SAM: The self-assessment manikin - an efficient cross-cultural measurement of emotional response. *Journal of Advertising Research, 35*(6), 63–68.

Moutinho, L., Dionísio, P., & Leal, C. (2007). Surf tribal behaviour: a sports marketing application. *Marketing Intelligence & Planning, 25*(7), 668-690. doi: 10.1108/02634500710834160

Muniz Jr., A. M., & O'Guinn, T. C. (2001). Brand community. *Journal of Consumer Research, 27*(4), 412-432. doi: 10.1086/319618

Murphy, K., & Garavan, H. (2005). Deriving the optimal number of events for an event-related fMRI study based on the spatial extent of activation. *Neuroimage, 27*(4), 771-777. doi: 10.1016/j.neuroimage.2005.05.007

Murray, E. A. (2007). The amygdala, reward and emotion. *Trends in Cognitive Sciences, 11*(11), 489-497. doi: 10.1016/j.tics.2007.08.013

Musso, M., Moro, A., Glauche, V., Rijntjes, M., Reichenbach, J., Büchel, C., et al. (2003). Broca's area and the language instinct. *Nature Neuroscience, 6*(7), 774-781. doi: 10.1038/nn1077

Naqvi, N. H., Rudrauf, D., Damásio, H., & Bechara, A. (2007). Damage to the insula disrupts addiction to cigarette smoking. *Science, 315*(5811), 531-534. doi: 10.1126/science.1135926

Nichols, T. E., Brett, M., Andersson, J., Wager, T., & Poline, J.-B. (2005). Valid conjunction inference with the minimum statistic. *Neuroimage, 25*(3), 653-660. doi: 10.1016/j.neuroimage.2004.12.005

Norman, K. A., Polyn, S. M., Detre, G. J., & Haxby, J. V. (2006). Beyond mind-reading: multi-voxel pattern analysis of fMRI data. *Trends in Cognitive Sciences, 10*(9), 424-430. doi: 10.1016/j.tics.2006.07.005

Norris, C. J., Chen, E. E., Zhu, D. C., Small, S. L., & Cacioppo, J. T. (2004). The interaction of social and emotional processes in the brain. *Journal of Cognitive Neuroscience, 16*(10), 1818-1829. doi: 10.1162/0898929042947847

Northoff, G., Heinzel, A., de Greck, M., Bermpohl, F., Dobrowolny, H., & Panksepp, J. (2006). Self-referential processing in our brain--a meta-analysis of imaging studies on the self. *Neuroimage, 31*(1), 440-457. doi: 10.1016/j.neuroimage.2005.12.002

Nöth, W. (1988). The language of commodities: groundwork for a semiotics of consumer goods. *International Journal of Research in Marketing, 4*(3), 173-186. doi: 10.1016/S0167-8116(88)80003-X

O'Cass, A., & Frost, H. (2002). Status brands: examining the effects of non-product-related brand associations on status and conspicuous consumption. *Journal of Product & Brand Management, 11*(2), 67-88. doi: 10.1108/10610420210423455

O'Doherty, J., Critchley, H., Deichmann, R., & Dolan, R. J. (2003). Dissociating valence of outcome from behavioral control in human orbital and ventral prefrontal cortices. *The Journal of Neuroscience, 23*(21), 7931-7939.

O'Doherty, J., Kringelbach, M. L., Rolls, E. T., Hornak, J., & Andrews, C. (2001). Abstract reward and punishment representations in the human orbitofrontal cortex. *Nature Neuroscience, 4*(1), 95-102. doi: 10.1038/82959

Ochsner, K. N., Beer, J. S., Robertson, E. R., Cooper, J. C., Gabrieli, J. D., Kihsltrom, J. F., et al. (2005). The neural correlates of direct and reflected self-knowledge. *Neuroimage, 28*(4), 797-814. doi: 10.1016/j.neuroimage.2005.06.069

Ojemann, G. A. (1991). Cortical organization of language. *The Journal of Neuroscience, 11*(8), 2281-2287.

Öngür, D., Ferry, A. T., & Price, J. L. (2003). Architectonic subdivision of the human orbital and medial prefrontal cortex. *Journal of Comparative Neurology, 460*(3), 425-449. doi: 10.1002/cne.10609

Öngür, D., & Price, J. L. (2000). The organization of networks within the orbital and medial prefrontal cortex of rats, monkeys and humans. *Cerebral Cortex, 10*(3), 206-219.

Osvath, M., & Osvath, H. (2008). Chimpanzee (Pan troglodytes) and orangutan (Pongo abelii) forethought: self-control and pre-experience in the face of future tool use. *Animal Cognition, 11*(4), 661-674. doi: 10.1007/s10071-008-0157-0

Owens, E. (2007). Nonbiologic objects as actors. *Symbolic Interaction, 30*(4), 567-584. doi: 10.1525/si.2007.30.4.567

Paller, K. A., & Wagner, A. D. (2002). Observing the transformation of experience into memory. *Trends in Cognitive Sciences, 6*(2), 93-102. doi: 10.1016/S1364-6613(00)01845-3

Patel, A. D. (2003). Language, music, syntax and the brain. *Nature Neuroscience, 6*(7), 674-681. doi: 10.1038/nn1082

Patel, A. D., Iversen, J. R., Wassenaar, M., & Hagoort, P. (2008). Musical syntactic processing in agrammatic Broca's aphasia. *Aphasiology, 22*(7), 776 - 789. doi: 10.1080/02687030701803804

Paulus, M. P., & Frank, L. R. (2003). Ventromedial prefrontal cortex activation is critical for preference judgments. *Neuroreport, 14*(10), 1311-1315. doi: 10.1097/01.wnr.0000078543.07662.02

Peirce, C. S. (1931a). Collected Papers of Charles Sanders Peirce - Pragmatism and Pragmaticism Vol. V. Retrieved from http://www.textlog.de/peirce_pragmatism.html

Peirce, C. S. (1931b). Collected Papers of Charles Sanders Peirce - Principles of Phylosophy Vol. I. Retrieved from http://www.textlog.de/peirce_principles.html

Pekkola, J., Ojanen, V., Autti, T., Jääskelainen, I. P., Möttönen, R., Tarkiainen, A., et al. (2005). Primary auditory cortex activation by visual speech: an fMRI study at 3 T. *Neuroreport, 16*(2), 125-128.

Pelphrey, K. A., Morris, J. P., & McCarthy, G. (2004). Grasping the intentions of others: the perceived intentionality of an action influences activity in the superior temporal sulcus during social perception. *Journal of Cognitive Neuroscience, 16*(10), 1706-1716. doi: 10.1162/0898929042947900

Pelzmann, L., Hudnik, U., & Miklautz, M. (2005). Reasoning or reacting to others? How consumers use the rationality of other consumers. *Brain Research Bulletin, 67*(5), 438-442. doi: 10.1016/j.brainresbull.2005.06.007

Penn, D. (2008). Beyond neuroscience-whatever happened to neuromarketing? *Admap, 490*, 27-29.

Penn, D. C., & Povinelli, D. J. (2007). On the lack of evidence that non-human animals possess anything remotely resembling a 'theory of mind'. *Philosophical Transactions of the Royal Society B, 362*(1480), 731-744. doi: 10.1098/rstb.2006.2023

Pereira, F., Mitchell, T. M., & Botvinick, M. (2009). Machine learning classifiers and fMRI: a tutorial overview. *Neuroimage, 45*(1 Suppl), S199-S209. doi: 10.1016/j.neuroimage.2008.11.007

Perrachione, T. K., & Perrachione, J. R. (2008). Brains and brands: Developing mutually informative research in Neuroscience and Marketing. *Journal of Consumer Behaviour, 7*(4-5), 303-318. doi: 10.1002/cb.253

Petrof, J. V., & Daghfous, N. (1996). Evoked set: Myth or reality? *Business Horizons, 39*(3), 72-77. doi: 10.1016/S0007-6813(96)90012-9

Piacentini, M., & Mailer, G. (2004). Symbolic consumption in teenagers' clothing choices. *Journal of Consumer Behaviour, 3*(3), 251-262. doi: 10.1002/cb.138

Pinker, S. (1995). Facts About Human Language Relevant to Its Evolution. In J.-P. Changeux & J. Chavaillon (Eds.), *Origins of the Human Brain* (pp. 262-285). Oxford: Oxford University Press.

Plassmann, H., Ambler, T., Braeutigam, S., & Kenning, P. (2007). What can advertisers learn from neuroscience? *International Journal of Advertising, 26*(2), 151-175.

Plassmann, H., Kenning, P., Deppe, M., Kugel, H., & Schwindt, W. (2008). How choice ambiguity modulates activity in brain areas representing brand preference: evidence from consumer neuroscience. *Journal of Consumer Behaviour, 7*(4-5), 360-367. doi: 10.1002/cb.257

Plassmann, H., O'Doherty, J., Shiv, B., & Rangel, A. (2008). Marketing actions can modulate neural representations of experienced pleasantness. *Proceedings of the National Academy of Sciences of the USA, 105*(3), 1050-1054. doi: 10.1073/pnas.0706929105

Poldrack, R. A. (2006). Can cognitive processes be inferred from neuroimaging data? *Trends in Cognitive Sciences, 10*(2), 59-63. doi: 10.1016/j.tics.2005.12.004

Poldrack, R. A. (2008). The role of fMRI in cognitive neuroscience: where do we stand? *Current Opinion in Neurobiology, 18*(2), 223-227. doi: 10.1016/j.conb.2008.07.006

Politser, P. (2008). *Neuroeconomics: A Guide to the New Science of Making Choices*. New York: Oxford University Press.

Price, J. L. (2008). Multisensory convergence in the orbital and ventrolateral prefrontal cortex. *Chemosensory Perception, 1*(2), 103-109. doi: 10.1007/s12078-008-9013-5

R Development Core Team. (2010). R: A Language and Environment for Statistical Computing. Vienna: R Foundation for Statistical Computing. Retrieved from http://www.R-project.org

Raafat, R. M., Chater, N., & Frith, C. D. (2009). Herding in humans. *Trends in Cognitive Sciences, 13*(10), 420-428. doi: 10.1016/j.tics.2009.08.002

Rao, A. R., & Monroe, K. B. (1989). The effect of price, brand name, and store name on buyers' perceptions of product quality: An integrative review. *Journal of Marketing Research, 26*(3), 351-357.

Reader, S. M., & Laland, K. N. (1999). Do animals have memes? *Journal of Memetics - Evolutionary Models of Information Transmission, 3*(2), 100-108.

Reingen, P. H., Foster, B. L., Brown, J. J., & Seidman, S. B. (1984). Brand congruence in interpersonal relations: a social network analysis. *Journal of Consumer Research, 11*(3), 771-783. doi: 10.1086/209013

Richins, M. L. (1994). Special possessions and the expression of material values. *Journal of Consumer Research, 21*(3), 522-533. doi: 10.1086/209415

Rilling, J. K., Sanfey, A. G., Aronson, J. A., Nystrom, L. E., & Cohen, J. D. (2004). The neural correlates of theory of mind within interpersonal interactions. *Neuroimage, 22*(4), 1694-1703. doi: 10.1016/j.neuroimage.2004.04.015

Rizzolatti, G. (2005). The mirror neuron system and its function in humans. *Anatomy and Embryology, 210*(5-6), 419-421. doi: 10.1007/s00429-005-0039-z

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Reviews in Neuroscience, 27*, 169-192. doi: 10.1146/annurev.neuro.27.070203.144230

Rizzolatti, G., Fadiga, L., Gallese, V., & Fogassi, L. (1996). Premotor cortex and the recognition of motor actions. *Cognitive Brain Research, 3*(2), 131-141. doi: 10.1016/0926-6410(95)00038-0

Rizzolatti, G., Fogassi, L., & Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews Neuroscience, 2*(9), 661-670. doi: 10.1038/35090060

Roberts, J., & Lattin, J. (1991). Development and testing of a model of consideration set composition. *Journal of Marketing Research, 28*(4), 429-440.

Rolls, E. T. (2000a). Memory systems in the brain. *Annual Review of Psychology, 51*, 599-630. doi: 10.1146/annurev.psych.51.1.599

Rolls, E. T. (2000b). Precis of "The Brain and Emotion". *Behavioural and Brain Sciences, 23*(2), 177-191; discussion 192-233.

Rolls, E. T. (2004). The functions of the orbitofrontal cortex. *Brain and Cognition, 55*(1), 11-29. doi: 10.1016/S0278-2626(03)00277-X

Rook, D. W. (1985). The ritual dimension of consumer behavior. *Journal of Consumer Research, 12*(3), 251-264. doi: 10.1086/208514

Rosenblatt, F. (1958). The perceptron: A probabilistic model for information storage and organization in the brain. *Psychological Review, 65*(6), 386-408. doi: 10.1037/h0042519

Rozin, P., Poritsky, S., & Sotsky, R. (1971). American children with reading problems can easily learn to read English represented by Chinese characters. *Science, 171*(977), 1264-1267. doi: 10.1126/science.171.3977.1264

Ruby, P., & Decety, J. (2004). How would you feel versus how do you think she would feel? A neuroimaging study of perspective-taking with social emotions. *Journal of Cognitive Neuroscience, 16*(6), 988-999. doi: 10.1162/0898929041502661

Russell, J. A., & Mehrabian, A. (1977). Evidence for a three-factor theory of emotions. *Journal of Research in Personality, 11*(3), 273-294. doi: 10.1016/0092-6566(77)90037-X

Sahin, N. T., Pinker, S., Cash, S. S., Schomer, D., & Halgren, E. (2009). Sequential processing of lexical, grammatical, and phonological information within Broca's area. *Science, 326*(5951), 445-449. doi: 10.1126/science.1174481

Sahin, N. T., Pinker, S., & Halgren, E. (2006). Abstract grammatical processing of nouns and verbs in Broca's area: evidence from fMRI. *Cortex, 42*(4), 540-562. doi: 10.1016/S0010-9452(08)70394-0

Saur, D., Kreher, B. W., Schnell, S., Kümmerer, D., Kellmeyer, P., Vry, M.-S., et al. (2008). Ventral and dorsal pathways for language. *Proceedings of the National Academy of Sciences of the U S A, 105*(46), 18035-18040. doi: 10.1073/pnas.0805234105

Savage-Rumbaugh, S., McDonald, K., Sevcik, R. A., Hopkins, W. D., & Rubert, E. (1986). Spontaneous symbol acquisition and communicative use by pygmy chimpanzees (Pan paniscus). *Journal of Experimental Psychology: General, 115*(3), 211-235.

Saxe, R. (2006). Four Brain Regions for One Theory of Mind? In J. T. Cacioppo, P. S. Visser & C. L. Pickett (Eds.), *Social Neuroscience: People Thinking About Thinking People* (pp. 83-101). Cambridge: MIT Press.

Saxe, R., & Kanwisher, N. (2003). People thinking about thinking people. The role of the temporo-parietal junction in "theory of mind". *Neuroimage, 19*(4), 1835-1842. doi: 10.1016/S1053-8119(03)00230-1

Saxe, R., & Wexler, A. (2005). Making sense of another mind: the role of the right temporo-parietal junction. *Neuropsychologia, 43*(10), 1391-1399. doi: 10.1016/j.neuropsychologia.2005.02.013

Schaefer, M., Berens, H., Heinze, H. J., & Rotte, M. (2006). Neural correlates of culturally familiar brands of car manufacturers. *Neuroimage, 31*(2), 861-865. doi: 10.1016/j.neuroimage.2005.12.047

Schaefer, M., & Rotte, M. (2007a). Favorite brands as cultural objects modulate reward circuit. *Neuroreport, 18*(2), 141-145. doi: 10.1097/WNR.0b013e328010ac84

Schaefer, M., & Rotte, M. (2007b). Thinking on luxury or pragmatic brand products: Brain responses to different categories of culturally based brands. *Brain Research, 1165*, 98-104. doi: 10.1016/j.brainres.2007.06.038

Schau, H. J., & Gilly, Mary C. (2003). We are what we post? Self-presentation in personal web space. *Journal of Consumer Research, 30*(3), 385-404. doi: 10.1086/378616

Schilbach, L., Eickhoff, S. B., Rotarska-Jagiela, A., Fink, G. R., & Vogeley, K. (2008). Minds at rest? Social cognition as the default mode of cognizing and its putative relationship to the "default system" of the brain. *Consciousness and Cognition, 17*(2), 457-467. doi: 10.1016/j.concog.2008.03.013

Schiller, D., Freeman, J. B., Mitchell, J. P., Uleman, J. S., & Phelps, E. A. (2009). A neural mechanism of first impressions. *Nature Neuroscience, 12*(4), 508-514. doi: 10.1038/nn.2278

Schoenbaum, G., Roesch, M. R., Stalnaker, T. A., & Takahashi, Y. K. (2009). A new perspective on the role of the orbitofrontal cortex in adaptive behaviour. *Nature Reviews Neuroscience, 10*(12), 885-892. doi: 10.1038/nrn2753

Schoenemann, P. T. (2006). Evolution of the size and functional areas of the human brain. *Annual Review of Anthropology, 35*(1), 379-406. doi: 10.1146/annurev.anthro.35.081705.123210

Scholz, J., Triantafyllou, C., Whitfield-Gabrieli, S., Brown, E. N., & Saxe, R. (2009). Distinct regions of right temporo-parietal junction are selective for theory of mind and exogenous attention. *PLoS ONE, 4*(3), e4869. doi: 10.1371/journal.pone.0004869

Seixas, D., & Ayres Basto, M. (2008). Ethics in fMRI studies. *Clinical Neuroradiology, 18*(2), 79-87. doi: 10.1007/s00062-008-8009-5

Selten, R. (2002). What is Bounded Rationality? In G. Gigerenzer & R. Selten (Eds.), *Bounded Rationality: The Adaptative Toolbox* (pp. 13-36). Cambridge: MIT Press.

Senior, C., Smyth, H., Cooke, R., Shaw, R. L., & Peel, E. (2007). Mapping the mind for the modern market researcher. *Qualitative Market Research: An International Journal, 10*(2), 153-167. doi: 10.1108/13522750710740826

Seymour, B., & McClure, S. M. (2008). Anchors, scales and the relative coding of value in the brain. *Current Opinion in Neurobiology, 18*(2), 173-178. doi: 10.1016/j.conb.2008.07.010

Shocker, A., Ben-Akiva, M., Boccara, B., & Nedungadi, P. (1991). Consideration set influences on consumer decision-making and choice: Issues, models, and suggestions. *Marketing Letters, 2*(3), 181-197. doi: 10.1007/BF00554125

Shu, H., Meng, X., Chen, X., Luan, H., & Cao, F. (2005). The subtypes of developmental dyslexia in Chinese: evidence from three cases. *Dyslexia, 11*(4), 311-329.

Silva, M., Moutinho, L., Coelho, A., & Marques, A. (2009). Market orientation and performance: modelling a neural network. *European Journal of Marketing, 43*(3/4), 421-437. doi: 10.1108/03090560910935505

Silver, I. (1996). Role transitions, objects, and identity. *Symbolic Interaction, 19*(1), 1-20. doi: 10.1525/si.1996.19.1.1

Singer, T., Seymour, B., O'Doherty, J., Kaube, H., Dolan, R. J., & Frith, C. D. (2004). Empathy for pain involves the affective but not sensory components of pain. *Science, 303*(5661), 1157-1162. doi: 10.1126/science.1093535

Sirgy, M. J. (1982). Self-concept in consumer behavior: a critical review. *Journal of Consumer Research, 9*(3), 287-300. doi: 10.1086/208924

Sirgy, M. J., & Danes, J. E. (1982). Self-image / Product-image Congruence Models: Testing Selected Models. In A. Mitchell & A. Abor (Eds.), *Advances in Consumer Research* (Vol. 9, pp. 556-561). Provo, UT: Association for Consumer Research.

Sirgy, M. J., Grewal, D., Mangleburg, T. F., Park, J. O., Chon, K. S., Claiborne, C. B., et al. (1997). Assessing the predictive validity of two methods of measuring self-image congruence. *Journal of the Academy of Marketing Science, 25*(3), 229. doi: 10.1177/0092070397253004

Sivanathan, N., & Pettit, N. C. (forthcoming). Protecting the self through consumption: status goods as affirmational commodities. *Journal of Experimental Social Psychology, In Press, Accepted Manuscript*. doi: 10.1016/j.jesp.2010.01.006

Skosnik, P. D., Mirza, F., Gitelman, D. R., Parrish, T. B., Mesulam, M. M., & Reber, P. J. (2002). Neural correlates of artificial grammar learning. *Neuroimage, 17*(3), 1306-1314. doi: 10.1006/nimg.2002.1291

Small, D. M., Bender, G., Veldhuizen, M. G., Rudenga, K., Nachtigal, D., & Felsted, J. (2007). The role of the human orbitofrontal cortex in taste and flavor processing.

Annals of the New York Academy of Sciences, 1121, 136-151. doi: 10.1196/annals.1401.002

Smart, B. (1996). Postmodern Social Theory. In B. S. Turner (Ed.), *The Blackwell Companion to Social Theory* (pp. 396-428). Oxford: Blackwell Publishers.

Smith, A. (1759). The Theory of the Moral Sentiments. Retrieved from http://www.adamsmith.org/smith/tms/tms-index.htm

Smith, S. M. (2002). Fast robust automated brain extraction. *Human Brain Mapping, 17*(3), 143-155. doi: 10.1002/hbm.10062

Smith, S. M., Jenkinson, M., Woolrich, M. W., Beckmann, C. F., Behrens, T. E., Johansen-Berg, H., et al. (2004). Advances in functional and structural MR image analysis and implementation as FSL. *Neuroimage, 23 Suppl 1*, S208-S219. doi: 10.1016/j.neuroimage.2004.07.051

Solomon, M. R. (1983). The role of products as social stimuli: A symbolic interactionism perspective. *Journal of Consumer Research, 10*(3), 319-329. doi: 10.1086/208971

Solomon, M. R. (1987). The Forest or the Trees? A Gestalt approach to Symbolic Consumption. In J. Umiker-Sebeok (Ed.), *Marketing and Semiotics: New Directions in the Study of Signs for Sale* (pp. 190-217). Berlin: Walter de Gruyter.

Sotero, R. C., & Trujillo-Barreto, N. J. (2007). Modelling the role of excitatory and inhibitory neuronal activity in the generation of the BOLD signal. *Neuroimage, 35*(1), 149-165. doi: 10.1016/j.neuroimage.2006.10.027

Sridharan, D., Levitin, D. J., & Menon, V. (2008). A critical role for the right fronto-insular cortex in switching between central-executive and default-mode networks. *Proceedings of the National Academy of Sciences of the U S A, 105*(34), 12569-12574. doi: 10.1073/pnas.0800005105

Steenkamp, J.-B. E. M., de Jong, M. G., & Baumgartner, H. (2010). Socially desirable response tendencies in survey research. *Journal of Marketing Research, 47*(2), 199-214. doi: 10.1509/jmkr.47.2.199

Stefanacci, L., & Amaral, D. G. (2002). Some observations on cortical inputs to the macaque monkey amygdala: an anterograde tracing study. *Journal of Comparative Neurology, 451*(4), 301-323. doi: 10.1002/cne.10339

Stone, V. E. (2006a). The moral dimensions of human social intelligence -- Domain-specific and domain-general mechanisms. *Philosophical Explorations: An International Journal for the Philosophy of Mind and Action, 9*(1), 55 - 68. doi: 10.1080/13869790500492516

Stone, V. E. (2006b). Theory of mind and the evolution of social intelligence. In J. T. Cacioppo, P. S. Visser & C. L. Pickett (Eds.), *Social Neuroscience: People Thinking About Thinking People* (pp. 103-129). Cambridge: MIT Press.

Stone, V. E., & Gerrans, P. (2006). What's domain-specific about theory of mind? *Social Neuroscience, 1*(3), 309-319. doi: 10.1080/17470910601029221

Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. Thousand Oaks: Sage Publications.

Stryker, S. (1990). Symbolic Interactionism: Themes and Variations. In M. Rosenberg & R. Turner (Eds.), *Social Psychology: Sociological Perspectives* (pp. 3-29). New Brunswick: Transaction Publishers.

Szatmari, P., Bremner, R., & Nagy, J. (1989). Asperger's syndrome: a review of clinical features. *Canadian Journal of Psychiatry, 34*(6), 554-560.

Tan, L. H., Liu, H.-L., Perfetti, C. A., Spinks, J. A., Fox, P. T., & Gao, J.-H. (2001). The neural system underlying Chinese logograph reading. *Neuroimage, 13*(5), 836-846. doi: 10.1006/nimg.2001.0749

Tan, L. H., Spinks, J. A., Gao, J.-H., Liu, H.-L., Perfetti, C. A., Xiong, J., et al. (2000). Brain activation in the processing of Chinese characters and words: a functional MRI study. *Human Brain Mapping, 10*(1), 16-27. doi: 10.1002/(SICI)1097-0193(200005)10:1<16::AID-HBM30>3.0.CO;2-M

Tanner, R. J., Ferraro, R., Chartrand, Tanya L., Bettman, J. R., & Baaren, R. v. (2008). Of chameleons and consumption: the impact of mimicry on choice and preferences. *Journal of Consumer Research, 34*(6), 754-766. doi: 10.1086/522322

Tantam, D. (2003). The challenge of adolescents and adults with Asperger syndrome. *Child and Adolescent Psychiatric Clinics, 12*(1), 143-163, vii-viii. doi: 10.1016/S1056-4993(02)00053-6

Terrace, H. S. (2005). Metacognition and the Evolution of Language. In H. S. Terrace & J. Metcalfe (Eds.), *The Missing Link in Cognition: Origins of Self-reflective Consciousness* (pp. 84–115). New York: Oxford University Press.

Terrace, H. S., Petitto, L. A., Sanders, R. J., & Bever, T. G. (1979). Can an ape create a sentence? *Science, 206*(4421), 891-902. doi: 10.1126/science.504995

Thompson, C. J., & Haytko, D. L. (1997). Speaking of fashion: consumers' uses of fashion discourses and the appropriation of countervailing cultural meanings. *Journal of Consumer Research, 24*(1), 15-42. doi: 10.1086/209491

Tobach, E., Greenberg, G., Radell, P., & McCarthy, T. (1989). Social behavior in a group of orang-utans (Pongo pygmaeus abelii) in a zoo setting. *Applied Animal Behaviour Science, 23*(1-2), 141-154. doi: 10.1016/0168-1591(89)90014-2

Tobach, E., & Porto, N. (2006). Note on social behavior of long-term captive female orangutans (Pongo pygmaeus abellii). *Psychological Reports, 98*(1), 177-183.

Todd, P. M., & Gigerenzer, G. (2003). Bounded rationality to the world. *Journal of Economic Psychology, 24*(2), 143-165. doi: 10.1016/S0167-4870(02)00200-3

Tourangeau, R., & Yan, T. (2007). Sensitive questions in surveys. *Psychological Bulletin, 133*(5), 859-883. doi: 10.1037/0033-2909.133.5.859

Tsakiris, M., Costantini, M., & Haggard, P. (2008). The role of the right temporo-parietal junction in maintaining a coherent sense of one's body. *Neuropsychologia, 46*(12), 3014-3018. doi: 10.1016/j.neuropsychologia.2008.06.004

Uddén, J., Folia, V., Forkstam, C., Ingvar, M., Fernandez, G., Overeem, S., et al. (2008). The inferior frontal cortex in artificial syntax processing: an rTMS study. *Brain Research, 1224*, 69-78. doi: 10.1016/j.brainres.2008.05.070

Ursu, S., & Carter, C. S. (2005). Outcome representations, counterfactual comparisons and the human orbitofrontal cortex: implications for neuroimaging studies of decision-making. *Cognitive Brain Research, 23*(1), 51-60. doi: 10.1016/j.cogbrainres.2005.01.004

van Schaik, C. P., Ancrenaz, M., Borgen, G., Galdikas, B., Knott, C. D., Singleton, I., et al. (2003). Orangutan cultures and the evolution of material culture. *Science, 299*(5603), 102-105. doi: 10.1126/science.1078004

van Schaik, C. P., & van Hooff, J. A. (1996). Toward an Understanding of the Orangutan's Social System. In W. C. McGrew, L. F. Marchant & T. Nishida (Eds.), *Great Ape Societies* (pp. 3-15). Cambridge: Cambridge University Press.

Vandenberghe, R., Price, C., Wise, R., Josephs, O., & Frackowiak, R. S. (1996). Functional anatomy of a common semantic system for words and pictures. *Nature, 383*(6597), 254-256. doi: 10.1038/383254a0

Vaneechoutte, M., & Skoyles, J. R. (1998). The memetic origin of language: modern humans as musical primates. *Journal of Memetics - Evolutionary Models of Information Transmission, 2*(2), 84-117.

Veloutsou, C., & Moutinho, L. (2009). Brand relationships through brand reputation and brand tribalism. *Journal of Business Research, 62*(3), 314-322. doi: 10.1016/j.jbusres.2008.05.010

Villringer, A., & Chance, B. (1997). Non-invasive optical spectroscopy and imaging of human brain function. *Trends in Neuroscience, 20*(10), 435-442. doi: 10.1016/S0166-2236(97)01132-6

Volz, K. G., Kessler, T., & von Cramon, D. Y. (2009). In-group as part of the self: In-group favoritism is mediated by medial prefrontal cortex activation. *Social Neuroscience, 4*(3), 244-260. doi: 10.1080/17470910802553565

Wade, A. R. (2002). The negative BOLD signal unmasked. *Neuron, 36*(6), 993-995. doi: 10.1016/S0896-6273(02)01138-8

Wandell, B. A., Brewer, A. A., & Dougherty, R. F. (2005). Visual field map clusters in human cortex. *Philosophical Transactions of the Royal Society B, 360*(1456), 693-707. doi: 10.1098/rstb.2005.1628

Wangenheim, F. v., & Bayón, T. (2007). The chain from customer satisfaction via word-of-mouth referrals to new customer acquisition. [10.1007/s11747-007-0037-1]. *Journal of the Academy of Marketing Science, 35*(2), 233-249. doi: 10.1007/s11747-007-0037-1

Warren, J. D., & Griffiths, T. D. (2003). Distinct mechanisms for processing spatial sequences and pitch sequences in the human auditory brain. *The Journal of Neuroscience, 23*(13), 5799-5804. doi: 23/13/5799 [pii]

Weygandt, M., Stark, R., Blecker, C., Walter, B., & Vaitl, D. (2007). Real-time fMRI pattern-classification using artificial neural networks. *Clinical Neurophysiology, 118*(4), e114-e114. doi: 10.1016/j.clinph.2006.11.265

Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., & Jenike, M. A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *The Journal of Neuroscience, 18*(1), 411-418.

Whiten, A. (2000). Primate culture and social learning. *Cognitive Science: A Multidisciplinary Journal, 24*(3), 477-508. doi: 10.1207/s15516709cog2403_6

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., et al. (1999). Cultures in chimpanzees. *Nature, 399*(6737), 682-685. doi: 10.1038/21415

Whiten, A., & van Schaik, C. P. (2007). The evolution of animal 'cultures' and social intelligence. *Philosophical Transactions of the Royal Society B, 362*(1480), 603-620. doi: 10.1098/rstb.2006.1998

Windmann, S., Kirsch, P., Mier, D., Stark, R., Walter, B., Gunturkun, O., et al. (2006). On framing effects in decision making: linking lateral versus medial orbitofrontal cortex activation to choice outcome processing. *Journal of Cognitive Neuroscience, 18*(7), 1198-1211. doi: 10.1162/jocn.2006.18.7.1198

Wise, R. J., Scott, S. K., Blank, S. C., Mummery, C. J., Murphy, K., & Warburton, E. A. (2001). Separate neural subsystems within 'Wernicke's area'. *Brain, 124*(Pt 1), 83-95. doi: 10.1093/brain/124.1.83

Woolrich, M. W. (2008). Robust group analysis using outlier inference. *Neuroimage, 41*(2), 286-301. doi: 10.1016/j.neuroimage.2008.02.042

Woolrich, M. W., Behrens, T. E., Beckmann, C. F., Jenkinson, M., & Smith, S. M. (2004). Multilevel linear modelling for FMRI group analysis using Bayesian inference. *Neuroimage, 21*(4), 1732-1747. doi: 10.1016/j.neuroimage.2003.12.023

Woolrich, M. W., Jbabdi, S., Patenaude, B., Chappell, M., Makni, S., Behrens, T. E., et al. (2009). Bayesian analysis of neuroimaging data in FSL. *Neuroimage, 45*(1 Suppl), S173-S186. doi: 10.1016/j.neuroimage.2008.10.055

Woolrich, M. W., Ripley, B. D., Brady, J. M., & Smith, S. M. (2001). Temporal autocorrelation in univariate linear modeling of FMRI data. *Neuroimage, 14*(6), 1370-1386. doi: 10.1006/nimg.2001.0931

World Health Organization. (2007). International Statistical Classification of Diseases and Related Health Problems (ICD-10) - F84.5 Asperger's syndrome 10th. Retrieved 2009-03-25, 2009, from http://www.who.int/classifications/apps/icd/icd10online/?gf80.htm+f845

Worsley, K. J. (2001). Statistical analysis of activation images *Functional MRI: An Introduction to Methods*. New York: Oxford University Press.

Wright, N. D., Claiborne, C. B., & Sirgy, M. J. (1992). The effects of product symbolism on consumer self-concept. In J. F. Sherry Jr. & B. Sternthal (Eds.), *Advances in Consumer Research* (Vol. 19, pp. 311-318). Provo, UT: Association for Consumer Research.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46*(3), 441-517. doi: 10.1006/jmla.2002.2864

Yoon, C., Gutchess, A. H., Feinberg, F., & Polk, T. A. (2006). A functional magnetic resonance imaging study of neural dissociations between brand and person judgments. *Journal of Consumer Research, 33*(1), 31-40. doi: 10.1086/504132

Young, L., Dodell-Feder, D., & Saxe, R. (forthcoming). What gets the attention of the temporo-parietal junction? An fMRI investigation of attention and theory of mind. *Neuropsychologia*. doi: 10.1016/j.neuropsychologia.2010.05.012

Young, L., & Saxe, R. (2008). The neural basis of belief encoding and integration in moral judgment. *Neuroimage, 40*(4), 1912-1920. doi: 10.1016/j.neuroimage.2008.01.057

Zald, D. H. (2003). The human amygdala and the emotional evaluation of sensory stimuli. *Brain Research Reviews, 41*(1), 88-123. doi: 10.1016/S0165-0173(02)00248-5

Zaltman, G. (1995). USA Patent No. 5,436,830. U. S. Patent.

Zaltman, G. (2003). *How Customers Think: Essential Insights into the Mind of the Market*. Boston: Harvard Business School Press.

Zink, C. F., Tong, Y., Chen, Q., Bassett, D. S., Stein, J. L., & Meyer-Lindenberg, A. (2008). Know your place: neural processing of social hierarchy in humans. *Neuron, 58*(2), 273-283. doi: 10.1016/j.neuron.2008.01.025