

We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

3,500

Open access books available

108,000

International authors and editors

1.7 M

Downloads

Our authors are among the

151

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com



Neuroimaging for the Affective Brain Sciences, and Its Role in Advancing Consumer Neuroscience

Peter Walla, Aimee Mavratzakis and Shannon Bosshard

Additional information is available at the end of the chapter

<http://dx.doi.org/10.5772/51042>

1. Introduction

To fully understand the driving behaviour of a car it is absolutely inevitable to investigate all its hidden parts underneath the surface and to find out what their functions are. To fully understand human behaviour we need to complete traditional behavioural measures with neuroimaging data that allow us to look inside the brain. Only via neuroimaging methodology do we have access to underlying brain processes that guide our behaviour without leading to any conscious reportable traces that show up in questionnaires. On top of that, especially when emotion-related explicit responses are required questionnaires provide us with biased responses due to cognitive influences. These responses can be far away from true underlying emotion-related information. The discrepancy between biased and unbiased emotion-related information processing is of utmost interest for both basic affective neuroscience and consumer neuroscience.

2. Emotion specificity in the brain revealed by functional Magnet Resonance Imaging (fMRI)

This section will begin by reviewing major milestones in emotion research achieved by way of fMRI. It focuses on advances in our understanding of the structures involved in the visual perception of emotion and how this has changed the way researchers look at the role of the amygdala, particularly its role in the coordination of emotion responses beyond the fear response. New leads in perception research using functional MRI methods are then reviewed including the possible primacy of cognition in emotion perception, as well as the often neglected role of the endocrine system in modulating perceptual ability.

2.1. Structural and functional organisation of emotion perception

The discrimination of affective signals in visual sensory input is thought to begin in the early stages of visual perception (LeDoux, 1996). The structures facilitating this are intertwined with visual processing to consistently produce rapid and sometimes unconscious emotional responses to the surrounding environment before the individual consciously recognises exactly what they are seeing (Whalen et al., 1998). The efficiency of visual-emotion discrimination despite its complexity has caught the attention of visual, perceptual and emotion researchers. The role of the amygdala in visual emotion discrimination is a primary focus in emotion perception research. The amygdala is a small almond size subcortical structure found bilaterally in the medial temporal lobe of mammalian brains. Neuroimaging studies show that neural pathways projecting from nuclei of the amygdala innervate multiple cortical and subcortical regions (Sah, Faber, De Armentia, & Power, 2003). All of these findings have obviously made the amygdala a primary region of interest for understanding the nature and organisation of emotion activity in the brain.

2.1.1. *The direct subcortical pathway model*

Modern theory suggests that the amygdala evolved early in the evolution of species as a mechanism specialised for rapidly detecting and responding to perceived threat (LeDoux, 1996), which has been described as an 'alarm signal' (e.g. Liddell et al., 2005; Tamietto & de Gelder, 2010). According to this theory, the neural communication of 'raw' or consciously unprocessed emotional information bypasses comprehensive visual processing stages, allowing the rapid transmission of threat signals to the amygdala via a pathway that crosses only the superior colliculus and pulvinar nucleus of the thalamus (see figure 1a). This adaptive function of this structural organisation is in line with the discovery of direct efferent connections from the amygdala to the hypothalamus, which coordinates autonomic and reflexive bodily responses to motivationally salient stimuli (Risold, Thompson, & Swanson, 1997) and which has long been recognised for its direct involvement in emotional behaviour (Swanson, 2000). This fear detection system is also found in less cortically developed mammals (LeDoux, 1996), suggesting that the direct subcortical processing pathway was an evolutionary achievement, and one that has been left unaltered across time and species due to its efficient design and salient purpose. This theory is also in line with findings from human studies focusing on emotion processing below the level of consciousness, where the subcortical alarm system was shown to operate independent of conscious awareness, presumably allowing for the preparation of motivational responses to threat even before such cues are consciously seen (Morris, Öhman, & Dolan, 1999; Whalen, et al., 1998). Despite the perseverance of the subcortical threat-detection pathway model, several phenomena challenge its comprehensiveness (A comprehensive discussion of these issues is provided by Pessoa & Adolphs, 2010). A central problem unaccounted for by this model of emotion processing is the modulation of early visual emotion processes by higher cognitive influences, which this section now turns to.

2.1.2. *Multiple pathways in early visual perception*

The functional capacity of the direct subcortical pathway model fails to adequately address possible mechanisms of this early cognitive interaction given that a main proposition of the model is that rapid subcortical processing involves the exclusive processing of affective signals, bypassing any higher cortical involvement. Pessoa and Adolphs (2011) in fact point out that there is no empirical evidence to suggest that affective information ‘bypasses’ cortically-bound circuits, but rather that multiple pathways are involved in the construction of visual emotion perception, and that each pathway likely specialises in selective attributes of information processing, but that none of these pathways involves the exclusive use of emotional information relative to other pathways.

There is general widespread agreement regarding the existence of an interaction between bottom-up and top-down factors in emotion processing (Gros, 2010; Ochsner et al., 2009). The New Look framework (Bruner, 1957) in particular states that the construction of perception is influenced by top down factors such as individual needs and expectations. While it is not yet known exactly what stage/s of visual perception are influenced by cognition it has been traditionally assumed that cognitive input influenced later categorisation stages of visual processing, and that earlier stages involved the pure bottom up extraction of basic features from sensory signals. Several recent experiments suggest, however, that top-down modulation by cognition may reach much deeper into the early visual stages of perception than current theory anticipates. Gilchrist and Nesberg (1952) showed that hungry individuals overestimated the brightness of pictures of food compared to other pictures, while more recently Radel and Clement-Guillotin (2012) extended this work by directly attributing the perceptual effect to an early perceptual processing stage. They examined differences in reaction times when hungry and satiated individuals were asked to identify food from non-food pictures as fast as possible and found that hungry individuals did recognise pictures of food fastest, directly pointing to an early unconscious level of semantic encoding that precedes the processing of motivationally relevant information.

In another recent study investigating the relationship between emotion word concepts and facial expression recognition, a direct interaction was found between higher semantic centres and early emotion perception. In this study, the authors temporarily inhibited accessibility of an emotion word via a technique called semantic satiation, whereby repeatedly saying the word (in this case 30 times) causes the temporary exhaustion of action potential generation along this region, thereby briefly inhibiting conscious access to the word. Using this technique, the researchers investigated whether semantically satiating an emotion word label such as ‘anger’ affected participants ability to recognise an angry face. Indeed they found that after 30 repetitions of the emotion word participants were slower to recognise an angry facial expression compared to when the word had not been satiated by repetition beforehand (Gendron, Lindquist, Barsalou, & Barrett, 2012), demonstrating the widespread and dynamic involvement of cortical areas in modulating emotion perception.

While these studies do not provide direct evidence for the involvement of the amygdala as an interception point of higher cognitive processes, there are many empirical examples demonstrating a correlational relationship between amygdala activity and cognitively based

emotion tasks (For a review see Phelps, 2006). In addition, it is known that there are extensive connections between the amygdala and multiple cortical regions (see figure 1). However, possibly one of the strongest cases supporting a primitive role for cognition in visual processing comes from recent imaging data of the visual cortex and amygdala, which this chapter now turns to.

2.1.3. The serial re-entry model of emotion discrimination in visual perception

An emerging theory of the discrimination of emotion content during visual perception is the idea that sequential stages of communication occur between the amygdala and the visual pathway via a 'serial re-entry' style of emotion processing. This concept is based on the idea that affective signals received early in the discrimination process travel through 'predictive pathways' that initiate and modulate the preparation of an appropriate bodily response via efferent amygdala projections. Serial modification of the affective response is thought to occur as the affective signal cascades along the visual pathway and the emotional nature of the inputted information becomes clearer.

Current empirical anatomical research provides support for the notion that the amygdala plays a key role in gauging emotional value of visual affective information, however it is still unclear which visual structures participate in this process and what their function may be. Accumulated analysis of previous research suggests that visual emotion discrimination is likely to occur hierarchically, with affective signals originating through rostral inferior temporal-amygdala interactions, an area that has been implicated in basic unconscious identity and semantic processing (See Storbeck, Robinson, & McCourt, 2006 for an indepth discussion) and response initiation originating later through amygdala-extra striatal interactions. Testing this kind of theory requires access to both temporal and spatial properties of processing events. However, the limitations imposed by scalp recorded electroencephalography have challenged researchers to develop novel ways to empirically demonstrate evidence of a re-entrant style of visual-emotion processing. Sabatinelli and colleagues (Sabatinelli, Lang, Bradley, Costa, & Keil, 2009) attempted to answer this question using rapid-sampling event-related-fMRI, a technique that, although not feasible for whole brain analysis, can be useful for examining a specific set of proximally located regions of interest. In this study, relative onset of activation of specifically defined regions along one plane were examined including the inferior temporal cortex, amygdala, medial occipital gyrus and calcarine fissure. They found relative differences in BOLD signal onset related to emotional valence at successive stages of visual processing including the inferior temporal cortex and the amygdala (See Figure 2). The data suggests that re-entrant input begins with connections between the inferior temporal cortex and the amygdala. Discrimination of emotional from non-emotional signals is evident by increases in BOLD activations to emotional stimuli located in the amygdala and the inferior temporal cortex (V2; Secondary occipital cortex) approximately ~1 second before emotional discriminatory activation is seen in the extra striatal cortex. Despite its anatomical placement early in the visual processing pathway, the primary visual cortex does not, however, respond to emotional stimuli, and is instead consistently activated by both emotional and non-emotional stimuli suggesting its non-involvement in emotion detection. Further to this, the

amygdala has been shown to have direct feed-forward and feed-back connections with not just subcortical structures but also multiple cortical structures located in the parietal cortex, the frontal cortex, cingulate cortex, orbito-frontal cortex (OFC) and the Insula. Therefore it is possible that at many stages of visual processing regions directly connected to the amygdala can influence emotional responses to visually perceived emotional stimuli.

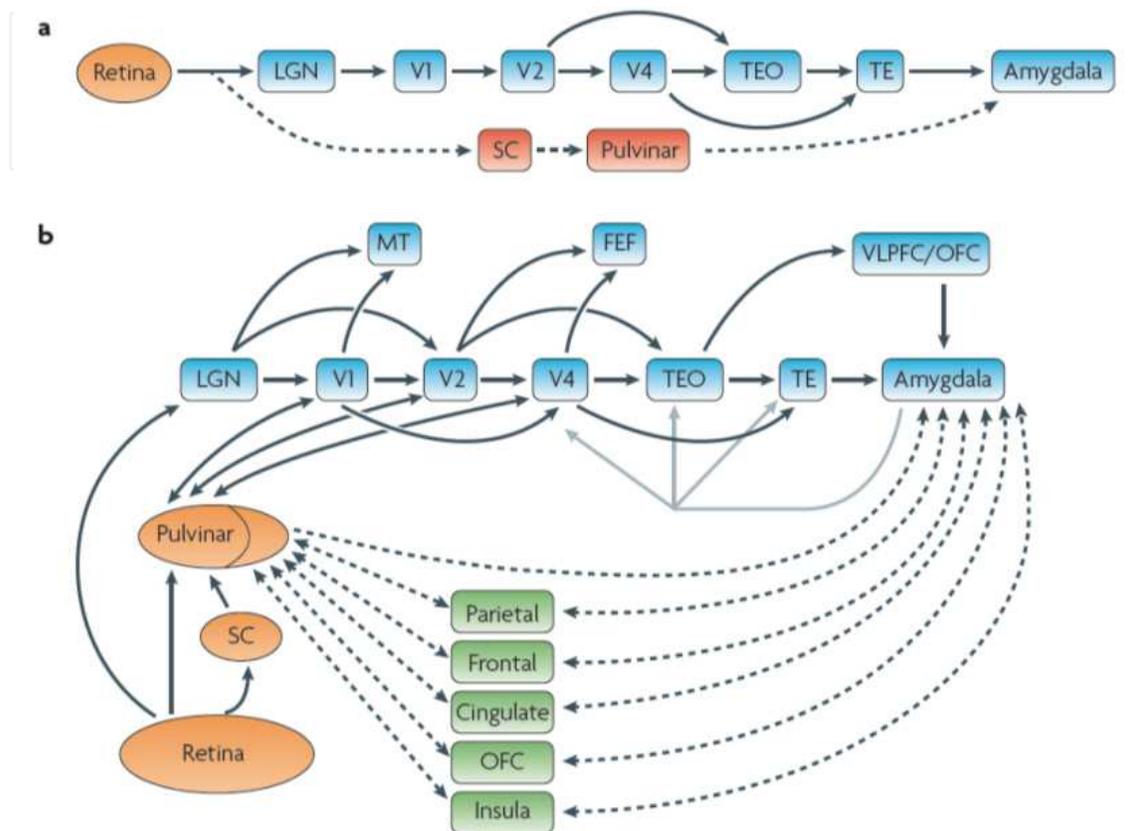


Figure 1. | Visual pathways. a | A traditional flowchart of visual processing typically emphasizes the LGN–v1–v2–v4–teO–te pathway, although the scheme is not strictly hierarchical. The amygdala, in particular, is a recipient of visual signals from the anterior visual cortex. According to the ‘standard hypothesis’, a subcortical pathway involving the superior colliculus and the pulvinar nucleus of the thalamus provides fast and automatic access to the amygdala. **b** | An alternative view of the flow of visual signals includes multiple pathways, including both alternative routes (for example, LGN to Mt) and shortcuts (for example, v2 to teO). Only some of these are shown. The flow of visual information may be more appropriately viewed in terms of ‘multiple waves’ of activation that initiate and refine cell responses at a given processing ‘stage’. For simplicity, feedback pathways, which are known to be quite extensive, have been omitted. The existence of such feedback pathways dictates, however, that a complex ebb-and-flow of activation sculpts the neuronal profile of activation throughout the visual cortex, and likewise the amygdala responses. Some of the connections between the pulvinar and visual cortex, and between the pulvinar and ‘associational’ areas, are also indicated. The line in the pulvinar is intended to schematically separate the medial pulvinar (to the right of the line) from the rest of the structure. FeF, frontal eye field; LGN, lateral geniculate nucleus; Mt, medial temporal area (also known as v5); OFc, orbitofrontal cortex; sc, superior colliculus; te, inferior temporal area te; teO, inferior temporal area teO; v, visual cortex; vLPFc, ventrolateral prefrontal cortex. Figure and caption adapted with permission from Pessoa, L. and Adolphs, R. (2010). Emotion processing and the amygdala: from a ‘low road’ to ‘many roads’ of evaluating biological significance. *Nature Reviews Neuroscience*, 11(11), 773–783.

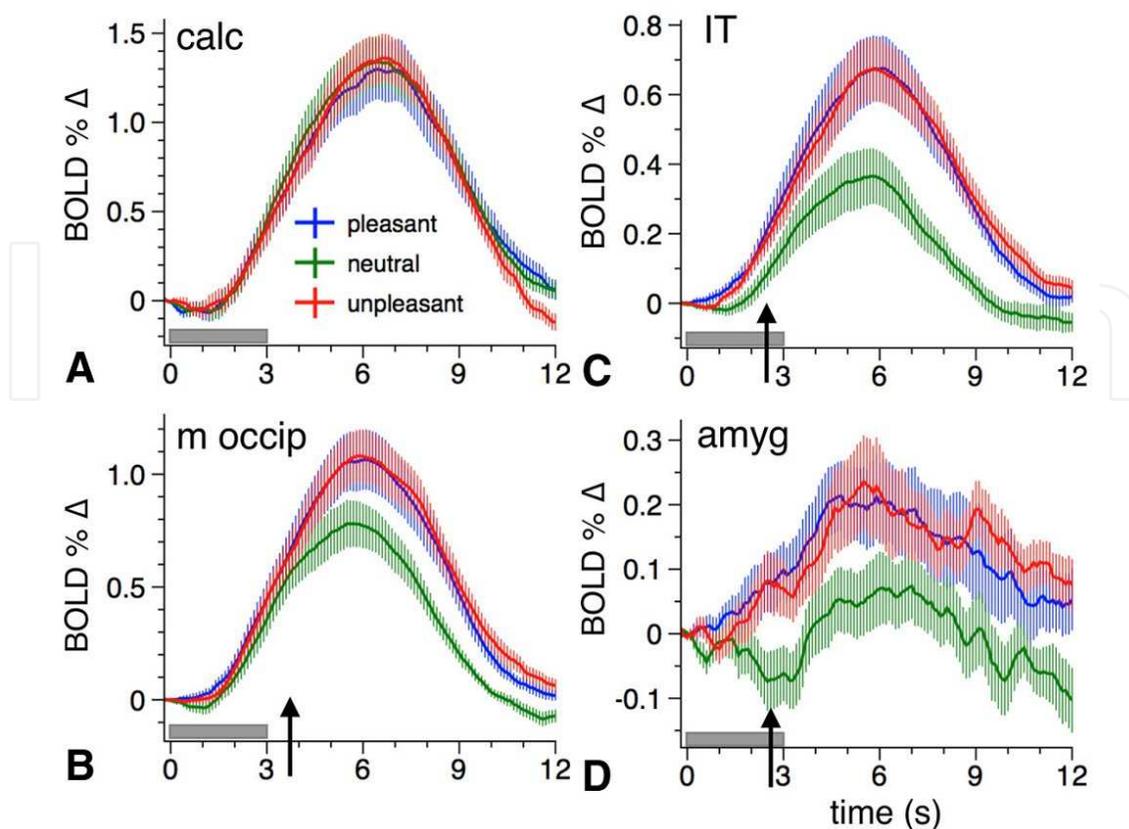


Figure 2. Average time courses (n17) of picture-driven BOLD signal in amygdala, inferotemporal cortex, middle occipital gyrus, and calcarine fissure. Blue and red lines represent pleasant and unpleasant pictures, and green represents neutral pictures. The gray bar on the abscissa signifies the picture presentation period. Arrows indicate the point at which BOLD signal during an arousing picture presentation is significantly greater activity than BOLD signal during neutral pictures. Figure and caption adapted with permission from Sabatinelli, D., Lang, P. J., Bradley, M. M., Costa, V. D. and Keil, A. (2009). The timing of emotional discrimination in human amygdala and ventral visual cortex. *The Journal of Neuroscience*, 29(47), 14864-14868.

2.2. Mediation of emotion perception by the endocrine system

Many homeostatic mechanisms function as feedback cycles. The hypothalamus is the principle structure that maintains homeostasis through its influence on the endocrine and autonomic nervous system. This dynamic system is only recently being investigated via brain imaging methods in terms of its influence on emotion-related information processing, and there is still much to learn regarding how the endocrine system interacts with and modifies the perception and expression of emotion. Nevertheless, this area of investigation presents a unique opportunity for understanding organisational and functional principles underlying emotion and motivated behaviour.

2.2.1. Hormones influence non-verbal emotional behaviour

Reproductive hormone levels have traditionally been associated with emotional behaviour. Researchers are now beginning to understand how this relationship unfolds in the brain. It

is already known that reproductive hormone receptors exist in amygdaloidal regions (Österlund & Hurd, 2001) and that hormones act on physiological processes, altering morphology, which in turn modifies behavioural expressions (See Becker et al., 2005 for an extended discussion). Several behavioural experiments have demonstrated a correlation between fluctuations in specific hormone levels and a perceptual bias towards recognition of threatening stimuli. For example, Pearson and Lewis (2005) reported highest accuracy for fear during the late preovulatory phase when estrogen levels are highest, and lowest accuracy for fear during the menstrual phase when estrogen levels are lowest. Raised progesterone levels have also been associated with a bias towards the recognition of threatening stimuli (Conway et al., 2007; Derntl et al., 2008a) suggesting that elevated progesterone levels are associated with increased sensitivity to facial cues carrying sources of threat or negative contagion. Derntl and colleagues also found a general ovulatory phase effect in females, further suggesting an evolutionary consistent relationship between pregnancy and increased behaviour consistent with protection and caution.

Recent examinations of the neural activity underlying hormonally-modulated perceptual biases have been performed during natural fluctuations in hormone levels and during controlled administration conditions, with the accumulated evidence to date suggesting an important role for reproductive hormones in modulating neural plasticity related to threat vigilance. For example, using BOLD fMRI, Van Wingen and colleagues (2007a; 2007b) found that the administration of a single dose of progesterone was associated with increased amygdala activity during an emotion matching task, but in an emotion memory task, administered progesterone was associated with decreased amygdala activity. Derntl and colleagues (2008b) found somewhat different effects when they separated female participants into two groups based on cycle phase: The early follicular phase (lower estradiol and lower progesterone levels) and the late Luteal phase (higher estradiol and higher progesterone levels). They reported a correlation between amygdala activation, recognition accuracy and female hormone levels such that amygdala activation was stronger during the follicular stage (low progesterone levels), coinciding with improved emotion recognition performance across five discrete emotion categories, including negative and positive emotions (Figure 3; Figure 4). According to the authors of the study, increased amygdala activity during the luteal phase is likely to be related to perceptual sensitivity biases towards threatening emotional stimuli, facilitating cautious behaviour associated with lower risk-taking. While during the follicular phase increased amygdala activity may be associated with heightened social awareness. At the behavioural level this may enable an underlying social advantage for fertile females in that the higher accuracy displayed during the fertile phase mediates more successful social interactions, a skill vital for selecting the best mate.

3. Section summary

This section has described some of the major advances in our understanding of what factors modulate emotion processing during visual perception as well as current leads in hormone and gender based emotion research. Current evidence holds that the amygdala acts not only as a hub for facilitating the rapid signalling of threatening stimuli to initiate hypothalamic

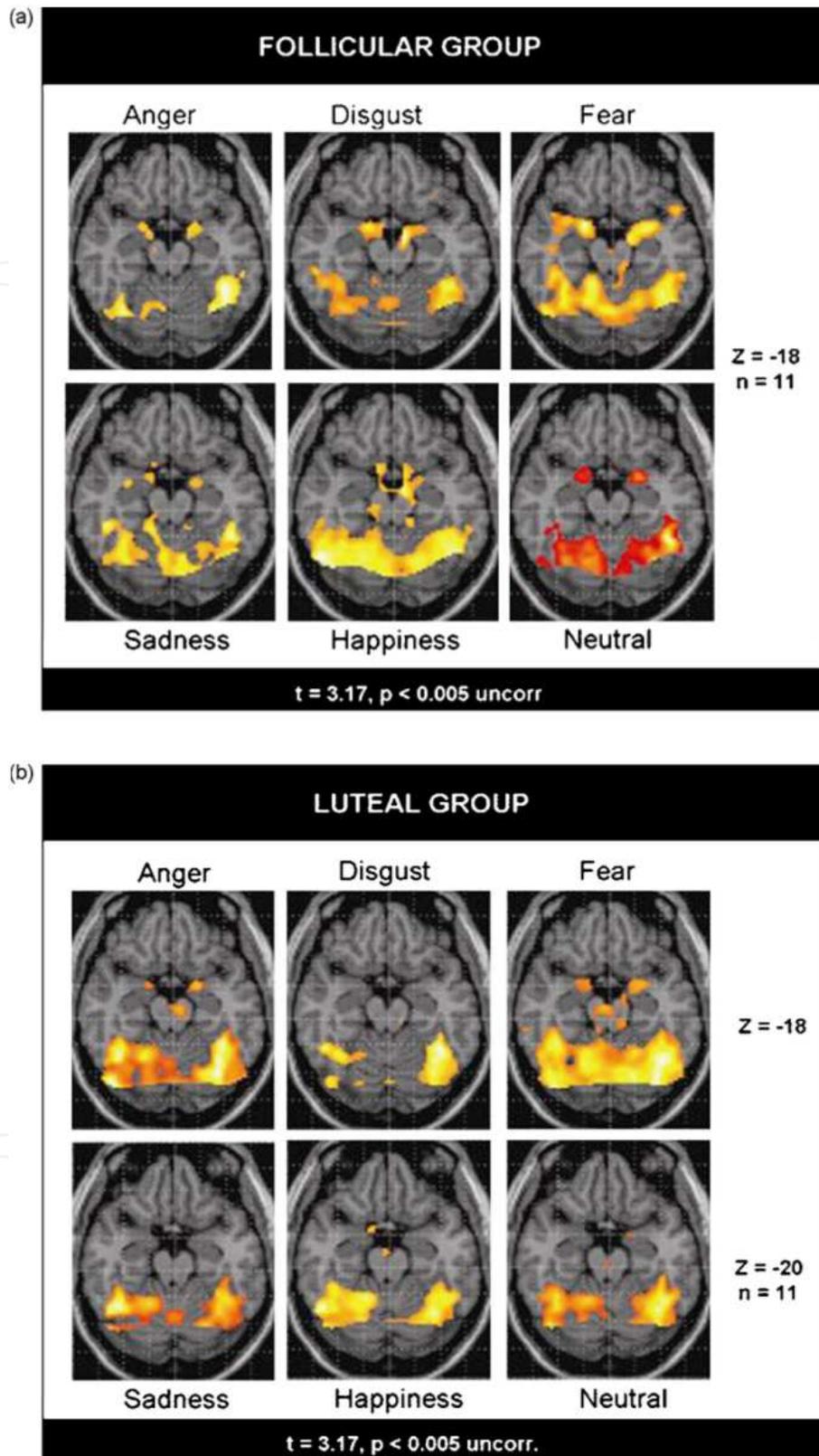


Figure 3. Results of whole-slab analysis showing activation maps of random effects analysis on one coronal slice ($Y = 0$) comprising the amygdala for FPG (a) and for LPG (b) (threshold: $t = 3.17$ and $p < 0.005$ uncorrected).

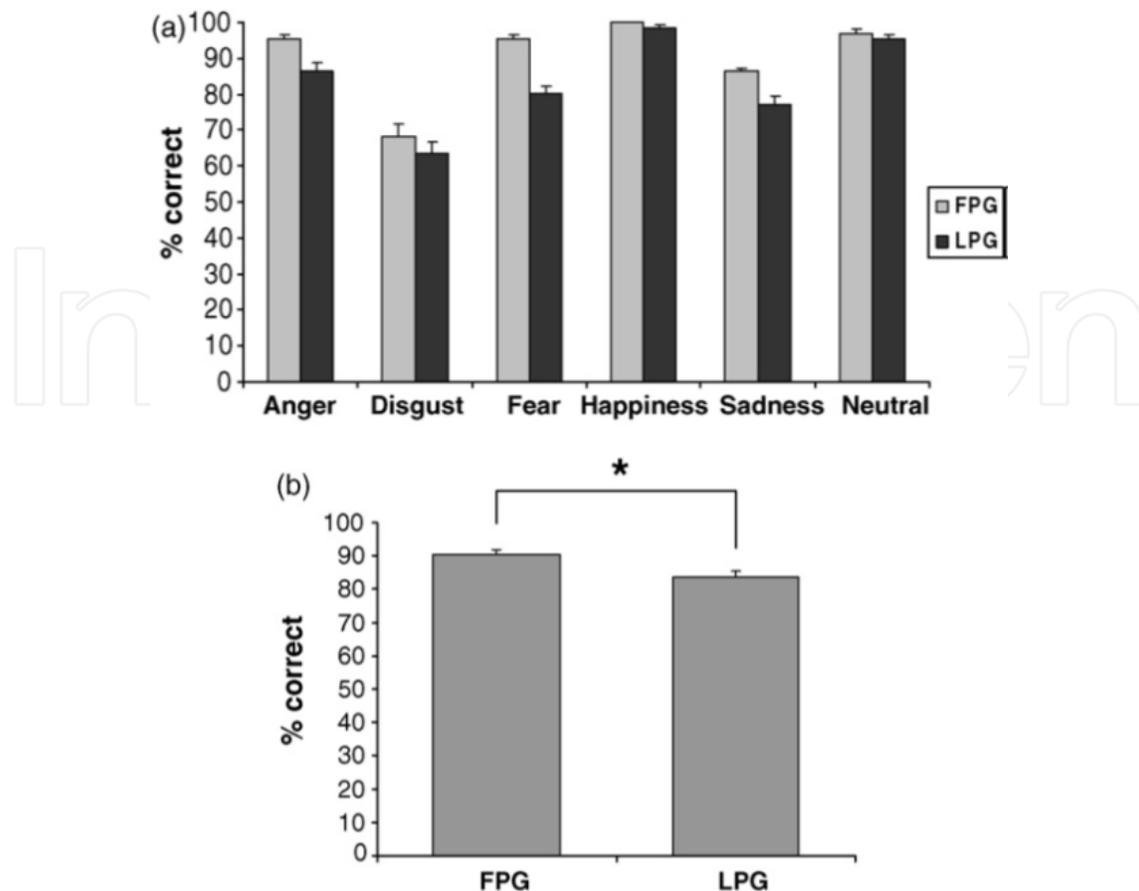


Figure 4. Recognition accuracy with standard error of mean for all emotions across females in the follicular phase (FPG) and females in the luteal phase (LPG) is presented in (a). Mean percent correct across all stimuli for FPG and LPG females are illustrated in (b). Results of the repeated measures ANOVA revealed a significant phase effect ($p = 0.011$) with a better performance of the FPG group—illustrated with an asterisk in (b) without any significant emotion-by-phase interaction ($p = 0.373$). Figures 3 and 4 and captions adapted with permission from Derntl, B., Windischberger, C., Robinson, S., Lamplmayr, E., Kryspin-Exner, I., Gur, R. C. and Habel, U. (2008). Facial emotion recognition and amygdala activation are associated with menstrual cycle phase. *Psychoneuroendocrinology*, 33(8), 1031-1040.

mediated autonomic responses, but also as a central relay station for the widespread communication of emotional information to areas throughout subcortical and cortical regions. Affective signals are now thought to originate from IT-amygdala interactions, with modulation and response formation occurring shortly thereafter via complex interconnections between the amygdala and successive stages of the visual system.

Modelling of the BOLD signal in ER-fMRI may be a valuable technique for better understanding the functional basis of emotion discrimination in visual perception based on the time course of BOLD related activity. It is also important to remember, however, that in evolutionary terms the most important objective of all affective neuroscience and perception is not the speed at which the first neural activation occurs, but the speed at which the first behavioural response occurs. De Gelder, Van Honk and Tamietto (2011) point out that these two events are not necessarily linked. In other words, it cannot be assumed that adaptive

behavioural responses will be explainable in terms of functions involving the first neural pathway to respond to the emotional stimuli. Rather, adaptive responses are more likely to be the result of the fastest pathway to initiate a biologically relevant motivational response, which may or may not be independent of initial activations. Better understanding the effect of hormones on the modulation of emotion perception is one avenue for increasing our understanding of the functional organisation underlying emotion perception, particularly given that this method is highly related to understanding principles of evolution, as well as understanding many underlying factors influencing social behaviours.

4. Neuromarketing/Consumer Neuroscience

Over the last few decades the merging of marketing with neuroscience has captured the attention of both the academic and corporate world. Neuromarketing enables marketers and researchers to better understand what consumers react to and how intense their reaction is. What makes it more interesting is that these questions can be answered without the need to explicitly ask the consumer for their opinion. Neuromarketing is able to tap into one's non-conscious and collect answers to questions such as: Is the colour, shape or smell of a particular product a good selling point? Although in its infancy, this new field has already had a major impact on the way many businesses market their products. With the formation of over 150 neuromarketing firms in the last 10 years, and almost 5000 times the number of Google searches between 2002 and 2004 (Figure 5; Plassmann, Zoëga Ramsøy & Milosavljevic, 2012) there is no surprise that this field has had such an impact across a vast number of disciplines.

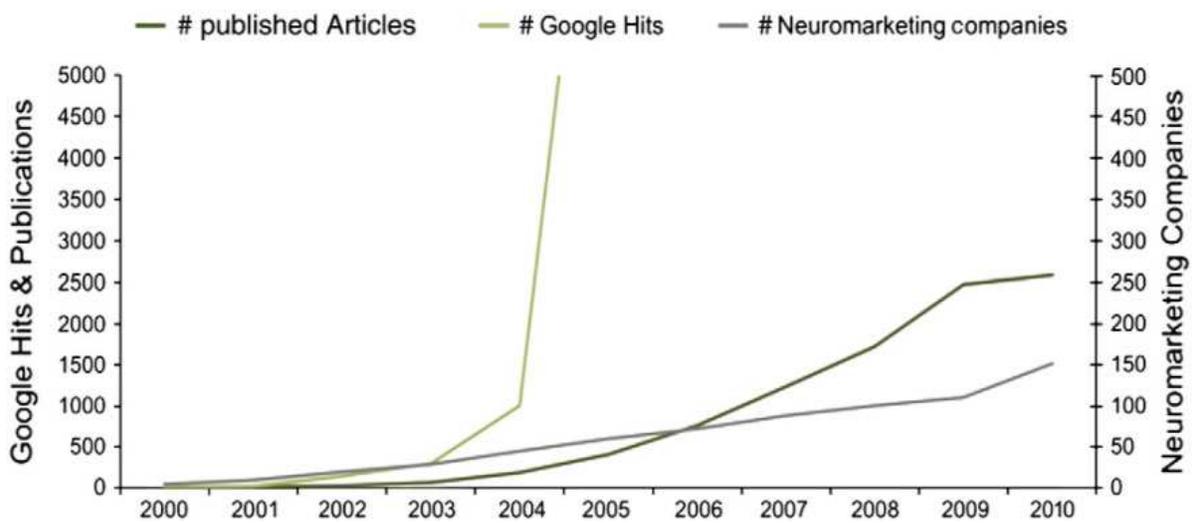


Figure 5. Graphical depiction of the increase in Google searches and published articles relating to neuromarketing as well as the increase in neuromarketing companies (plassmann et al., 2012; with permission).

Although it is undeniable that neuromarketing is a useful field of study, along with its success, has come a major dilemma pertaining to the way that it perceived by consumers and the media. Throughout this section, I will no longer refer to neuromarketing as such, but instead

as consumer neuroscience. Since the formation of neuromarketing, consumers and those alike have held the opinion that the aim of this field was force consumers to buy things that they do not want nor need. It is a common misconception that neuromarketing aims to find the 'buy button' in the brain (provided one actually exists). This is neither the current aim of neuromarketing/consumer neuroscience nor should it ever be. Instead, the term consumer neuroscience emphasises that this field aims to study the interactions between products, the market and consumers rather than an attempt to coerce consumers into buying products.

Before we can appreciate the field of consumer neuroscience, we must have an understanding of what neuroscience is and what it can bring to the field of marketing. Neuroscience, through studying the nervous system, seeks to better understand the biological basis of behaviour. However, according to Plassmann et al. (2012), due to the complex nature of consumer behaviour, it is essential that we focus specifically on systems neuroscience rather than cellular neuroscience. Systems neuroscience is a sub-discipline of neuroscience which focuses on how different neural circuits function, either together or separately. Rather than focusing on behaviour at a neuronal level, systems neuroscience focuses on both the cognitive and affective (emotional) aspects of consumer behaviour. It is common knowledge that much of our behaviour is driven by our unconsciousness (Chartrand, 2005). For this reason, it is justified that neuroimaging be used to better understand consumer behaviour.

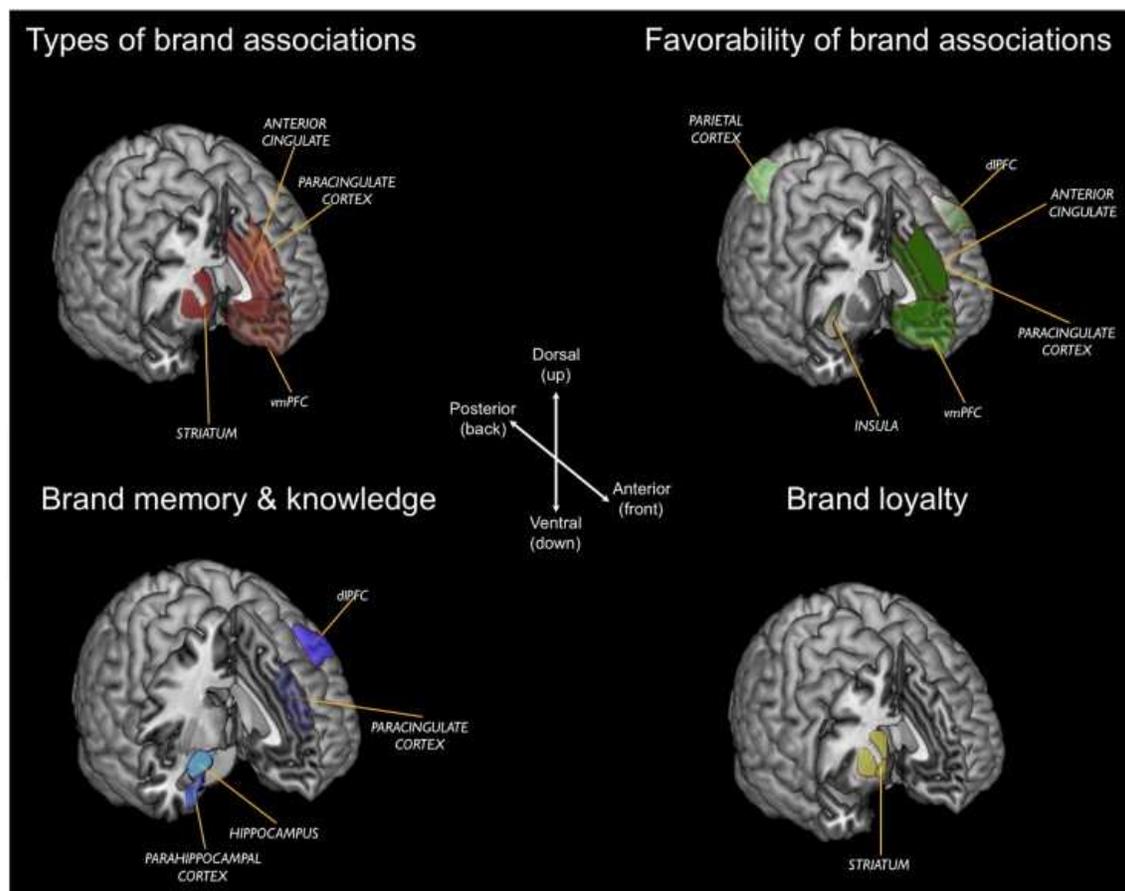


Figure 6. An excerpt taken from Plassmann et al. (2012) (with permission) depicting the many regions involved in the processing of brand information.

This section of the chapter will focus on how neuroimaging studies have identified specific neural circuits that are involved in the different aspects of the decision-making process. The figure above (Figure 6.) illustrates that the areas activated within the brain depending on the interaction that the consumer has with a brand. In many cases, several regions are responsible for the processing of a single cue. More specifically, the image gives a summary of the location of some of the processes that are involved in the psychology of brands (Plassmann et al., 2012).

In the following, we will focus on several current neuroimaging techniques and how their introduction into the field of marketing has influenced our understanding of consumer neuroscience. Branding, package design and labelling will be discussed because they are a major focus of a large number of studies. In addition, they are of particular interest to the marketing community because the results can be applied to the marketing of products and services.

4.1. Branding

When looking to purchase a product, brand name is an important factor, but plays only a partial role in the final decision made by the consumer. According to Keller and Lehmann (2006), consumers rely on well-known brands because they know that these brands are either of a higher quality or that the performance of the product is superior to that of the competition. Studies have shown that more often than not, it is only when a lesser-known brand is offered at a lower price, that they are chosen over well-known brands (Sethuraman & Cole, 1999).

In one of the most famous consumer neuroscience studies, McClure et al. (2004) revealed that in some cases, brand name is everything. In this study, a comparison between Coca Cola and Pepsi was made. Prior to the commencement of the study, it was established that there was roughly an equal preference for both Coca Cola and Pepsi. During the second phase of the experiment participants were shown either a picture of a Coke can prior to receiving Coke or a Pepsi can prior to receiving Pepsi. Participants that received Coke showed significant levels of activation in the dorsolateral prefrontal cortex (DLPFC), the hippocampus and midbrain. No such finding was reported when Pepsi was delivered after participants viewed a Pepsi can. Furthermore, when the delivery was preceded with a light instead of a Coke can, significant differences in activation were seen between the two forms of cues (Figure 7). According to McClure et al. (2004) suggest that the activation seen in the DLPFC, hippocampus and midbrain provides evidence that Coke possesses a greater wealth of cultural meaning than that associated with Pepsi.

As seen in the above study, functional magnetic resonance imaging (fMRI) is a useful means of measuring the significant levels of activation in the brain. As an area of the brain becomes more active, it requires more oxygen. It is these changes in oxygen levels that fMRI aims to measure. However, fMRI is not the only method utilised by researchers to understand how the brain reacts to stimuli. Another tool used to investigate brain activity within a consumer setting is the less prominent magnetoencephalography (MEG). In contrast to fMRI, MEG measures brain activity by recording the magnetic fields produced by the naturally occurring electrical currents in the brain. In a study conducted by Junghofer, Kissler, Schupp, Putsche, Elling and Dobel (2010), investigated which brain regions were responsible for the early

processing (>120ms) of man made stimuli. During the study, two separate measures of consumer behaviour were collected. Self-report data was collected from participants via a survey in which they expressed activities related to their consumer behaviour toward specific brands of shoes or motorcycles. Moreover, a brain-based measure was also collected in which participants were exposed to images of different brands of motorcycles and shoes. The most interesting finding presented by Junghofer et al., was the discrepancy between the self-report data and the data collected from the brain responses. Explicitly, self-report data showed a clear difference in consumer behaviour and brand expertise between each gender, however this was less evident from the results of the brain measures. Figure 8 shows that although activity in the occipito-temporal regions differed between males and females, many participants showed rather similar activation to both shoes and cars.

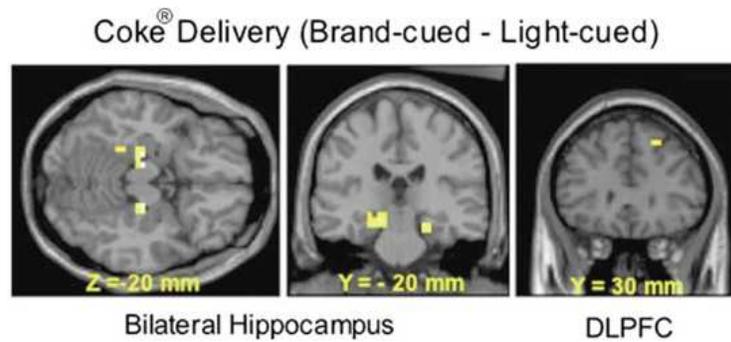


Figure 7. Significant activations between Coke delivered following an image of a Coke can and Coke delivered following the presentation of a light cue. Significant activations were found bilaterally in the hippocampus, the left parahippocampal cortex, midbrain and dorsolateral prefrontal cortex. These findings were exclusively found with Coke (McClure et al., 2004) (with permission).

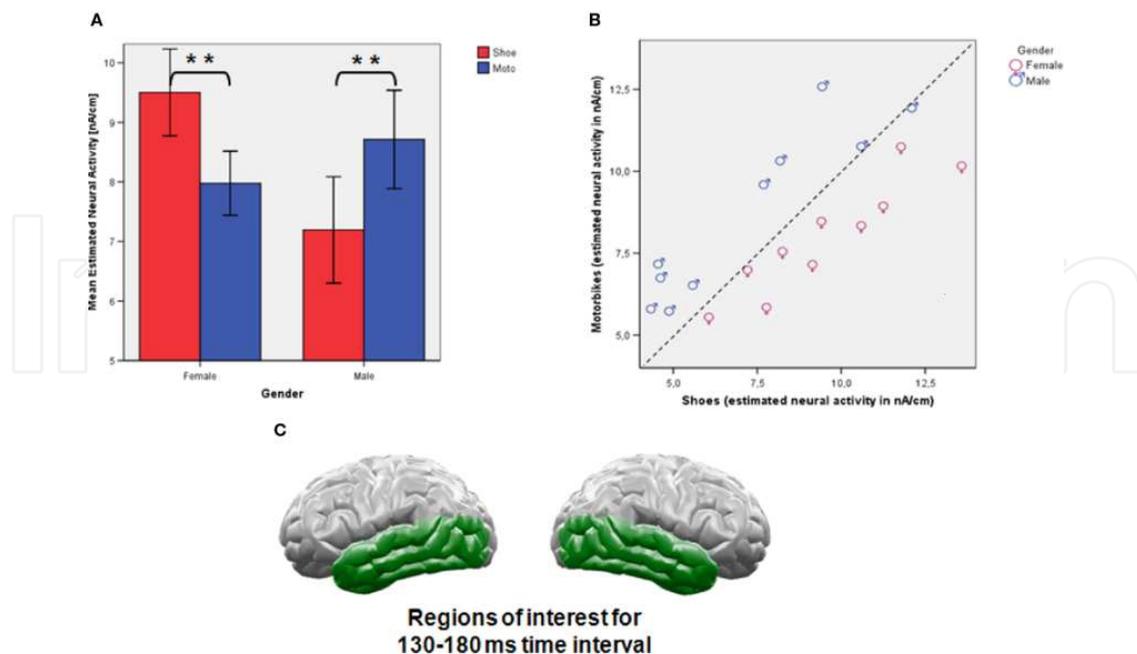


Figure 8. Image taken from Junghöfer et al. (2010) (with permission) indicating the difference in activation of the occipito-temporal cortex (except for the primary visual areas) in males and females when viewing motorcycles and shoes.

The study conducted by Junhöfer et al. (2010) present findings similar to those expressed in a number of pieces of research. It is repeatedly reported that a discrepancy exists between subjective and objective measures of consumer behaviour. From a marketing perspective, these findings illustrate the continuing problems that arise when consumers are asked questions in relation to their willingness to buy, rather than obtaining a response via subconscious processes.

In sum, the study conducted by McClure et al. (2004) presented findings that explain the success that Coca Cola has had over its rival, Pepsi. However, the only conclusions we can draw from this study is that there are strong neurocorrelates related to Coke, but not to Pepsi. Although we know that Coke has a greater wealth of knowledge associated with it in comparison to Pepsi, there is little we can do with these findings in terms of marketing. More specifically, we are unable to generalise the findings to that of other products, we are unable to draw conclusions as to why Coke has developed a greater amount of cultural meaning and Pepsi has not, and most importantly, we can not use these findings to improve Pepsi as a product to help it better compete with Coke.

In a similar manner, the study conducted by Junhöfer et al. (2010) have no immediate translational value, however, there is the possibility that these findings can help companies to better understand trends in consumer behaviour. Furthermore, these trends can then be used to assist in the development in activities related to their products. Again, the only conclusion that we are able to draw from this study is that a product liked by consumers may initiate activation in the occipito-temporal cortex. However, although this study may be seen as useless for companies that have already released their products onto the market, companies that are looking to release their product and wish to investigate how well it will compete with existing products may find this study more relevant.

The inability to conduct studies that are translational is a major issue that is repeated time and time again throughout the consumer neuroscience literature. However, consumer neuroscience is still in its infancy and hopefully, as the technology and methods are better understood, it becomes possible to generalise the findings of such studies to the field of marketing.

4.2. Package design and labelling

It should come as no shock that a more appealing product is capable of initiating a much more positive emotion. Previous studies have shown that individuals have been seen to express heightened levels of emotion toward attractive product packaging in comparison to unattractive product packaging (see Honea & Horsky, 2011). Have you ever wondered why when you buy something as expensive as a piece of jewellery, the packaging is usually made to look rather plain. Some products that are assumed to be of high value, highly experiential and have a positive influence on sensory systems, have been known to be presented in rather plain boxes as this neutralises the expectations of the individual, thus results in intensified subsequent emotions (Honea & Horsky, 2011). In addition to modifying the emotional responses of consumers, product aesthetics are able to alter the

expectations of consumers. In many cases, the effect that product aesthetics has on consumer behaviour can be seen without the use of any neuroimaging techniques. Simply, the modification of product packaging can be used to mislead consumers into believing that products are larger or hold more than they actually do. There are many reasons that companies modify the packaging of their products, however the focus of this section is not to report how product packaging is used to mislead consumers (European Parliament, 2012), but rather identify the areas involved in processing packaging using neuroimaging techniques.

So what happens at a non-conscious level that affects which products we find appealing and which of those we do not? When shopping, it is usually the case that the decisions we make are made non-consciously and in a matter of seconds (Milosavljevic, Koch & Rangel, 2011), so it is imperative that the product being marketed stands out from its competitors. So how do companies decide what their new product packaging should look like and whether or not the public will find them enticing? Well the answer lies with neuroscience. A new branch of neuroscience termed “neuroaesthetics” has been used to address the questions surrounding the way the brain is activated in the presence of product packaging. Given that much of consumer behaviour is driven by processes at a non-conscious level (Chartrand, 2005), it would be inappropriate to simply ask for a verbal response as to which product or packaging they would be more likely to purchase. Moreover, previous research has shown us time and time again that there are discrepancies between self-report measures (subjective measures) and neuroimaging measures (objective measures; Walla, Brenner & Koller, 2011).

Several studies conducted by Reimann, Zaichkowsky, Neuhaus, Bender & Weber (2010) investigated the effect that good aesthetic properties had on brain activity. Interestingly, the first two of their studies revealed that participants chose products with aesthetic properties more often than products with standard packaging, even when a well-known brand was used (Figure 9). It was also reported that participants took longer to make the choice that resulted in the product with the aesthetic packaging being chosen.

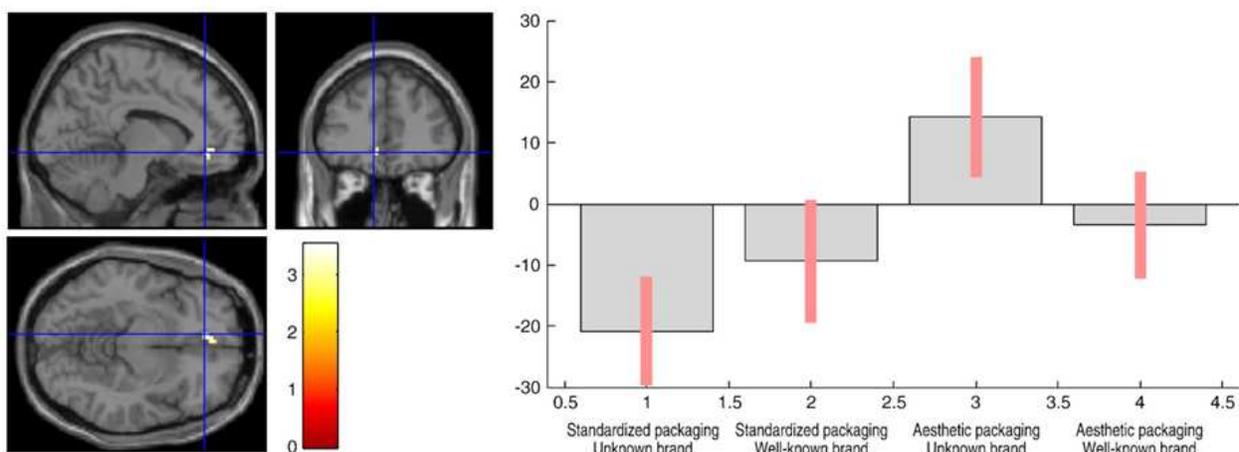


Figure 9. Left: Significant levels of activation in the vmPFC regarding brand and type of packaging (standardised vs. not standardised). Right: Percentage of activation change in the vmPFC (Reimann et al. 2010) (with permission).

To assess which regions of the brain were responsible for the increase in affective processes, Reimann et al. (2010) conducted an fMRI study and found that participants engage specific brain areas when assessing aesthetic package design. More specifically, significant increases in activation were seen in the ventromedial prefrontal cortex (vmPFC), the striatum (especially in the right nucleus accumbens) and also in the cingulate cortex (Figure 10). In addition, the heightened levels of activation in the vmPFC due to aesthetic packaging were witnessed for both well-known and unfamiliar brand names.

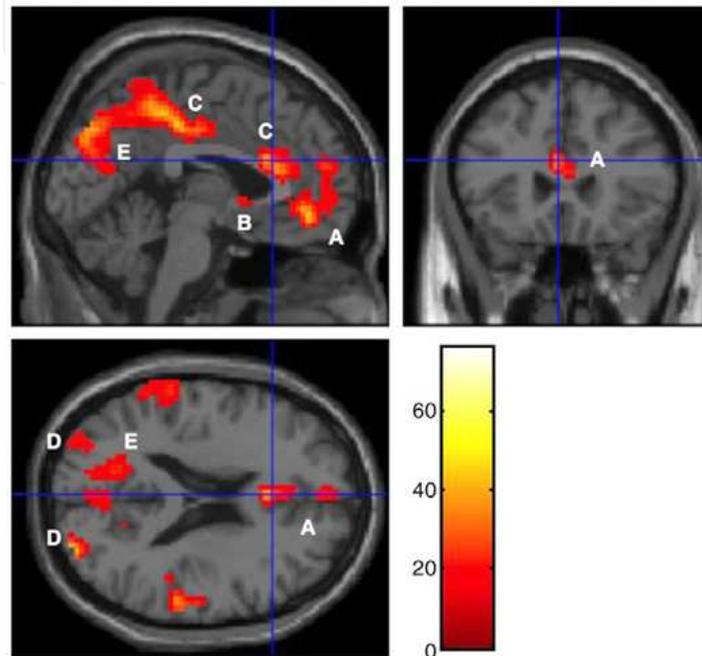


Figure 10. Significantly larger levels of activation in the vmPFC (A), striatum, particularly nucleus accumbens (B), cingulate cortex (C), primary visual cortices (D), and precuneus (E) during aesthetic product presentations (Reimann et al. 2010) (with permission).

Each of the abovementioned regions of the brain plays an important role in the processing of aesthetic features of products. The literature repeatedly shows that the vmPFC becomes activated when an individual is rewarded (McClure et al. 2004; Plassmann et al., 2012). In this case, the reward was considered to be when participants saw a product that possessed aesthetic properties. Similarly, the striatum (in this case the right nucleus accumbens) also plays a role in the processing of aesthetic properties. However, in contrast, the striatum becomes activated when participants anticipate a reward. According to Reimann et al. (2010) these regions of the brain work in sync at the point when the consumer views a product with aesthetics.

In another study that focused on the way that products are labeled rather than the way that the products are packaged, it was reported that in obese individuals, several regions of the brain are more highly activated when an item of food is perceived to be of a higher calorie content (Ng, Stice, Yokum & Bohon, 2011). During this study, an identical milkshake was delivered to obese and lean participants (based on their body mass index), however one was labeled as low fat and the other as regular. Obese participants were seen to show higher

levels of activation in the somatosensory, gustatory, and reward evaluation regions when presented with a regular milkshake versus an identical milkshake labeled 'low-fat'.

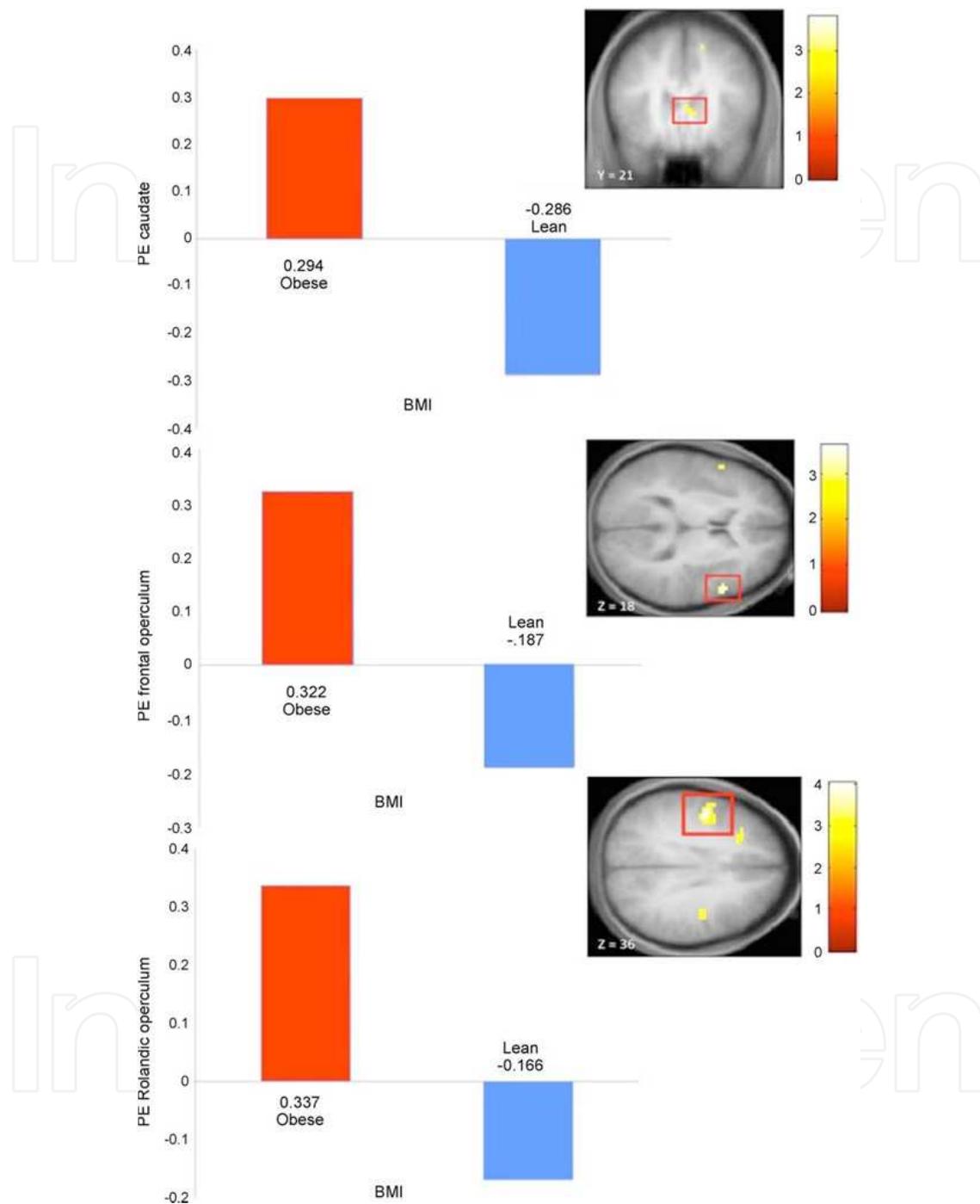


Figure 11. Difference in activation between lean and obese women. Activation of the caudate was due to anticipated intake of high-fat versus water. Activation of the frontal operculum was due to anticipated intake of high fat versus low fat milkshakes. Activation of the Rolandic operculum was due to the receipt of high fat versus low fat milkshake (Ng et al. (2011)) (with permission).

With regard to the obese individuals in their study, Ng et al. (2011) found significantly higher activation of the Rolandic operculum (gustatory cortex) and caudate. These areas were reported

as becoming activated when participants anticipated the intake of food. In addition, obese women were also seen to have a more active posterior cingulate gyrus and hippocampus, parahippocampal gyrus and vmPFC. Ng et al. stated that these areas may have been responsible for the encoding of the reward value. Figure 11 shows the difference in the activation of the caudate, operculum and Rolandic operculum between lean and obese women.

According to Ng et al. (2011), the findings from their study offer an explanation as to why obese people remain obese even when they focus on eating low-fat foods. When an individual eats a food that is high in calories, the reward experience during consumption increases the expectation of reward, thus eating continues and may result in overeating. In contrast, when eating low calorie foods, people may overeat in order to compensate for the relative reduction of pleasantness and reward.

This study provides an excellent example of the translational value of consumer neuroscience. Although it does not allow businesses to increase the monetary value of its products, it identifies why consumers behave differently depending on the labeling of the product. There is no doubt that the findings presented by Ng et al. (2011) may be beneficial to not only the health industry, but the way that supermarkets interact with consumers. Many supermarkets promote products that are 'low fat' with the expectation that consumers will buy these products and consume less calories, however it may be having the opposite effects.

Moreover, the study conducted by Ng et al. (2011) shows that obese people show more activation in several brain regions when they are not only expecting to receive food, but when eating something that is labeled as low fat rather than regular. Although the findings of Reimann et al. cannot be generalized to specific marketing contexts at present, the ability to generalize these findings to specific products and consumer scenarios will become better understood as this field continues to grow.

4.3. Final statement

It is undeniable that consumer neuroscience is of benefit to both the research and marketing world. However, it is possible that the technology reported within this chapter is not well enough understood to be able to generalise the findings to the field of marketing and have it result in benefits to a company. The studies presented above show a correlation between neuroimaging and buyer behaviour, however the ability to generalise these findings to specific consumer contexts is difficult. In the early development of consumer neuroscience, simply stating that neuroscientific methods were being used resulted in an increase in sales. From the studies provided throughout this summary, it can be speculated that the technology being used in consumer neuroscience studies may be far ahead of our comprehension. However there are more basic forms of neurophysiological technologies available which appear to be much more promising.

In addition to the use of fMRI or MEG within a consumer neuroscience setting, another recent development within this field is the use of startle reflex modulation (Walla, Brenner &

Koller, 2011). This method involves the presentation of several stimuli, some of which are associated with a loud startle probe designed to initiate a startle response in the participant. In humans, it is found that for pleasant or positive stimuli, the startle response is reduced in comparison to that witnessed when unpleasant or negative stimuli are presented. The startle reflex has been used within a marketing context (Walla et al., 2011; Grahl et al., 2012) and provides a direct measure of emotion that can be directly linked to a participant's like or dislike. In Walla et al.'s study (2011), it acknowledges that a discrepancy exists between participants' stated preference for a brand and what their startle reflex shows. In addition, it shows a significant difference in eye blink response between liked and disliked brands (Figure 12).

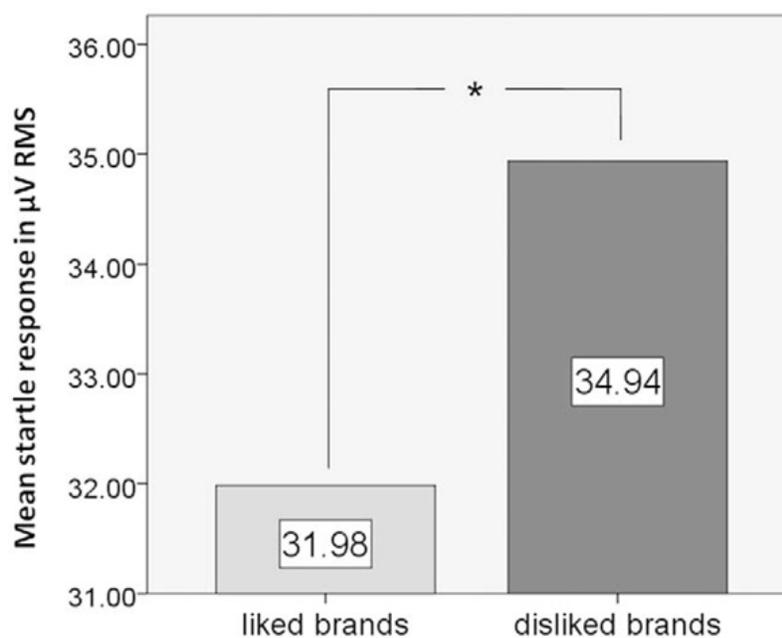


Figure 12. Mean eye blink response to liked versus disliked brands. (with permission)

It is plausible that the findings presented by Walla et al. (2011) indicate that physiological techniques may be more beneficial in the earlier stages of product development. Through the use of startle reflex modulation; it may be possible to determine whether or not consumers are likely to react positively to a product before it reaches markets. This process may also allow businesses to determine how to make their products more appealing before they are marketed. It is clear that the potential of neuroscience to benefit the marketing world is present, however it may be a few more years away.

Author details

Peter Walla, Aimee Mavratzakis and Shannon Bosshard

University of Newcastle, School of Psychology, Centre for Translational Neuroscience and Mental Health Research, Australia

5. References

- Becker, J. B., Arnold, A. P., Berkley, K. J., Blaustein, J. D., Eckel, L. A., Hampson, E., et al. (2005). Strategies and methods for research on sex differences in brain and behavior. *Endocrinology*, 146(4), 1650-1673.
- Bruner, J. S. (1957). On perceptual readiness. *Psychological review*, 64(2), 123.
- Conway, C., Jones, B., DeBruine, L., Welling, L., Law Smith, M., Perrett, D., et al. (2007). Salience of emotional displays of danger and contagion in faces is enhanced when progesterone levels are raised. *Hormones and Behavior*, 51(2), 202-206.
- Chartrand, T. L., (2005). The role of conscious awareness in consumer behaviour. *Journal of Consumer Psychology*, 15(3), 203–210.
- Derntl, B., Kryspin-Exner, I., Fernbach, E., Moser, E., & Habel, U. (2008a). Emotion recognition accuracy in healthy young females is associated with cycle phase. *Hormones and Behavior*, 53(1), 90-95.
- Derntl, B., Windischberger, C., Robinson, S., Lamplmayr, E., Kryspin-Exner, I., Gur, R. C., et al. (2008b). Facial emotion recognition and amygdala activation are associated with menstrual cycle phase. *Psychoneuroendocrinology*, 33(8), 1031-1040.
- de Gelder, B., van Honk, J., & Tamietto, M. (2011). Emotion in the brain: of low roads, high roads and roads less travelled. [10.1038/nrn2920-c1]. *Nat Rev Neurosci*, 12(7), 425-425.
- Gendron, M., Lindquist, K. A., Barsalou, L., & Barrett, L. F. (2012). Emotion words shape emotion percepts. *Emotion*. (Advance online publication. doi: 10.1037/a0026007).
- Gilchrist, J., & Nesberg, L. S. (1952). Need and perceptual change in need-related objects. *Journal of experimental psychology*, 44(6), 369.
- Gros, C. (2010). Cognition and Emotion: Perspectives of a Closing Gap. *Cognitive Computation*, 2(2), 78-85.
- Grahl, A., Greiner, U., & Walla, P. (2012). Bottle shape elicits gender-specific emotion: a startle reflex modulation study. *Psychology*, 3(7): in press.
- Honea, H., and Horsky, S. (2011). The power of plain: Intensifying product experience with neutral aesthetic context. Springer Science and Business Media.
- Junghöfer, M., Kissler, J., Schupp, H. T., Putsche, C., Elling, L., & Dobel, C. (2010). A fast neural signature of motivated attention to consumer goods separates the sexes. *Frontiers in Human Neuroscience*, 4, 179.
- Keller, K. L., & Lehmann, D. R. (2006). Brands and branding: Research findings and future priorities. *Marketing Science*, 25(6), 740.
- LeDoux, J. (Ed.). (1996). *The emotional brain*. New York: Simon & Schuster.
- Liddell, B., Brown, K., Kemp, A., Barton, M., Das, P., Peduto, A., et al. (2005). A direct brainstem-amygdala-cortical [] alarm'system for subliminal signals of fear. *Neuroimage*, 24(1), 235-243.
- McClure, S.M., Li, J., Tomlin, D., Cypert, K.S., Montague, L.M., and Montague, P.R. (2004). Neural Correlates of Behavioral Preference for Culturally Familiar Drinks. *Neuron*, Vol. 44, 379–387.
- Morris, J., Öhman, A., & Dolan, R. (1999). A subcortical pathway to the right amygdala mediating “unseen” fear. *Proceedings of the National Academy of Sciences*, 96(4), 1680.

- Ng, J., Stice, E., Yokum, S., & Bohon, C. (2011). An fMRI study of obesity, food reward, and perceived caloric density. Does a low-fat label make food less appealing? *Apetite*, 65-72.
- Ochsner, K., Ray, R., Hughes, B., McRae, K., Cooper, J., Weber, J., et al. (2009). Bottom-up and top-down processes in emotion generation. *Psychological science*, 20(11), 1322.
- Österlund, M. K., & Hurd, Y. L. (2001). Estrogen receptors in the human forebrain and the relation to neuropsychiatric disorders. *Progress in Neurobiology*, 64(3), 251-267.
- Pearson, R., & Lewis, M. B. (2005). Fear recognition across the menstrual cycle. *Hormones and Behavior*, 47(3), 267-271.
- Pessoa, L., & Adolphs, R. (2010). Emotion processing and the amygdala: from a 'low road' to 'many roads' of evaluating biological significance. [10.1038/nrn2920]. *Nat Rev Neurosci*, 11(11), 773-783.
- Pessoa, L., & Adolphs, R. (2011). Emotion and the brain: multiple roads are better than one. [10.1038/nrn2920-c2]. *Nat Rev Neurosci*, 12(7), 425-425.
- Phelps, E. (2006). Emotion and cognition: Insights from studies of the human amygdala. *Annual review of psychology*, 57, 27-53.
- Plassmann, H., Ramsøy, T. Z., & Milosavljevic, M. (2012). Branding the brain: A critical review and outlook. *Journal of Consumer Psychology*, 18-36.
- Radel, R., & Clément-Guillotin, C. (2012). Evidence of Motivational Influences in Early Visual Perception Hunger Modulates Conscious Access. *Psychological science*.
- Reimann, M., Zaichkowsky, J., Neuhaus, C., Bender, T., & Weber, B. (2010). Aesthetic package design: A behavioral, neural, and psychological investigation. *Journal of Consumer Psychology*, 20, 431-441.
- Risold, P., Thompson, R., & Swanson, L. (1997). The structural organization of connections between hypothalamus and cerebral cortex. *Brain Research Reviews*, 24(2), 197-254.
- Sabatinelli, D., Lang, P. J., Bradley, M. M., Costa, V. D., & Keil, A. (2009). The timing of emotional discrimination in human amygdala and ventral visual cortex. *The Journal of Neuroscience*, 29(47), 14864.
- Sah, P., Faber, E., De Armentia, M. L., & Power, J. (2003). The amygdaloid complex: anatomy and physiology. *Physiological reviews*, 83(3), 803-834.
- Schupp, H. T., Junghöfer, M., Weike, A. I., & Hamm, A. O. (2003). Attention and emotion: an ERP analysis of facilitated emotional stimulus processing. *Neuroreport* 14, 1107-1110
- Sethuraman, R., & Cole, C. (1999). Factors influencing the price premiums that consumers pay for national brands over store brands. *Journal of Product and Brand Management*, 8(4), 340-351.
- Storbeck, J., Robinson, M., & McCourt, M. (2006). Semantic processing precedes affect retrieval: The neurological case for cognitive primacy in visual processing. *Review of General Psychology*, 10(1), 41.
- Swanson, L. (2000). Cerebral hemisphere regulation of motivated behavior. *Brain research*, 886(1-2), 113-164.
- Tamietto, M., & de Gelder, B. (2010). Neural bases of the non-conscious perception of emotional signals. *Nature Reviews Neuroscience*, 11(10), 697-709.

- Walla, P., Brenner, G., & Koller, M. (2011). Objective measures of emotion related to brand attitude: A new way to quantify emotion-related aspects relevant to marketing. *Plos one*, 6(11).
- Whalen, P., Rauch, S., Etcoff, N., McInerney, S., Lee, M., & Jenike, M. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *Journal of Neuroscience*, 18(1), 411.
- Van Wingen, G., van Broekhoven, F., Verkes, R., Petersson, K., Bäckström, T., Buitelaar, J., et al. (2007a). Progesterone selectively increases amygdala reactivity in women. *Molecular Psychiatry*, 13(3), 325-333.
- van Wingen, G., van Broekhoven, F., Verkes, R. J., Petersson, K. M., Bäckström, T., Buitelaar, J., et al. (2007b). How progesterone impairs memory for biologically salient stimuli in healthy young women. *The journal of Neuroscience*, 27(42), 11416-11423.