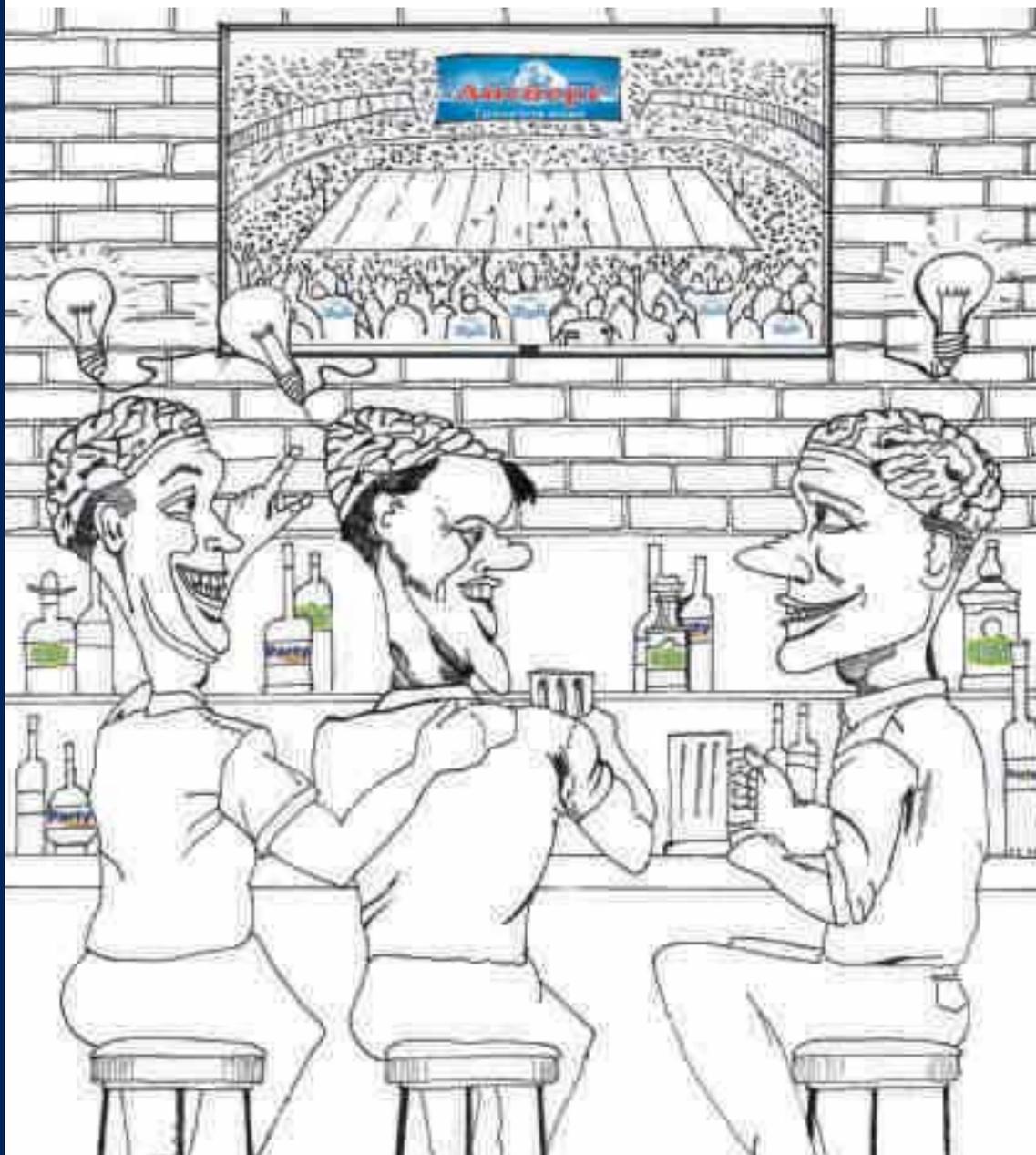


RUMEN IVAYLOV POZHARLIEV

Social Neuromarketing: The Role of Social Context in Measuring Advertising Effectiveness



Social Neuromarketing:

The role of social context in measuring advertising
effectiveness

Social Neuromarketing:

The role of social context in measuring advertising effectiveness

Sociale Neuromarketing:

De rol van de sociale context bij het meten van de effectiviteit van reclame
boodschappen

Thesis

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I started my Ph.D. in August 2012, one year after completing a Master of Science in Economics and Business, majoring in Marketing, at the Erasmus University Rotterdam (cum laude). I was working as a Business Development Manager (East Europe) for an Italian clothing company. I was on a business trip in Greece when I received a call from Willem who offered me a Ph.D. position at Erasmus School of Economics. I was pretty happy with my current job, but when I received the offer to join Willem I didn't hesitate a second to say yes.

I still remember his first lectures in Knowledge-Based Marketing (KBM) and his unique teaching style. I was so inspired that I immediately applied for the position of teaching assistant for the KBM class. The way he motivates and excites students during his lectures is unparalleled. I was so excited after his course that I decided to do my master thesis with him on emergent leadership and polymorphism of the DRD4 gene. I found the topic so stimulating that I hopped one day to be able to do more research on biological influence on human behavior. However, what really attracted me was something else. Willem was always talking about the social context and his role in shaping human behavior. I was also obsessed by the same topic and I was reading a lot about it. Thus, this Ph.D. position was like a dream come true. It gave me this unique opportunity to study marketing and consumer behavior in social context from behavioral and most importantly from neurophysiological perspective. After four years I can honestly say that this was the most amazing experience of my life. I've learnt so much about me and the world around me.

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Rotterdam, January 31, 2017

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CHAPTER 1: INTRODUCTION

“Advertising has become a part of the social fabric of society. It is expected and accepted by consumers. It is not, however, a phenomenon that is easily understood outside the context in which it occurs. Advertising research, borrowing from the recent traditions of experimental psychology, has a long history of examining advertising in isolation of its social context. While this approach has merit, it fails to capture the more theoretically interesting and more relevant interactions to which it contributes.” Stewart, 1992, p.13).

1.1. BACKGROUND AND MOTIVATION

The total ad spending in 2015 reached 569.65 billion dollars worldwide. The outlook for the global spending on paid media in the next five years remains optimistic and it is expected to reach 719.20 billion dollars by the end of 2019 (eMarketer.com). Such enormous spending should be informed by a significant effort in measuring the effectiveness of the advertising. Traditional methods based on self-reports for predicting the success of advertising largely depend on the willingness and ability of consumers to describe their levels of attention, emotions, preferences or future buying behavior in relation to the marketing campaign they have been exposed to. The application of self-reports for measuring consumers’ behavior, such as questionnaires and/or face-to-face or telephone interviews can lead to invalid results, due to limitations and biases inherent in conscious and

unconscious processes (Fisher, 1993). For example, unconscious processes occur below the awareness threshold; human consciousness starts to work approximately 300-400 ms after stimulus presentation, and thus cannot be reliably reported verbally, yet it is still processed by the human brain (Johansson et al., 2006; Libet, 2009). However, these unconscious processes may have considerable impact on consumer behavior (Zaltman, 2000). People sometimes have subtle feelings of knowing what they have experienced in relation to advertising exposure, although they may be unable to retrieve explicit information from their memory and thus express it in words. Likewise, the consumer's emotional experiences related to advertising are complex, often automatic processes which are difficult to capture in self-reports (Davidson 2004; Zajonc, 1980). The application of neurophysiological methods to study the effects of marketing stimuli on consumer behavior has seen enormous growth in the past few years. Neuromarketing, the use of neurophysiological and biological methods of research, offers direct access to the mental processes of consumers and thus it is often used as a method complementary to traditional self-reported measures (Ariel and Berns, 2010). Neuromarketing tools promise to reveal heretofore hidden processes in the consumers' "black box" and thus offset many weaknesses associated with traditional methods (Khushaba et al., 2013; Plassmann et al., 2007; Telpaz, Webb, and Levy, 2015). Neuromarketing methods include neurometrics such as electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), biometrics such as skin conductance, heart rate, respiration, eye-tracking and facial expressions, as well as psychometrics such as reaction

times. They offer safe, non-invasive access to consumer brain responses to such stimuli as print and television ads and movie trailers, for products, services and even political speeches (Boksem and Smidts, 2014; Falk et al., 2015; McClure et al., 2004; Pozharliev et al., 2015). Each neuromarketing tool has strengths and weaknesses which give them different advantages in studies of the specific content of advertising messages (Venkatraman et al., 2014). For instance, EEG offers high temporal resolution (on a millisecond timescale), significantly greater than that of fMRI (on a timescale of seconds), and thus is more effective in investigating ongoing consumer responses to different parts or scenes of TV ads, on a second-by-second timescale (Dmochowski et al., 2012). It is likely that certain moments of an ad (e.g. scenes with intense action or scenes demonstrating the advertised product) are more emotionally engaging or attract more attention compared to other scenes. Such scenes may need to be analyzed sequentially or in coordination with changing attention and feelings, rather than aggregating across an entire ad as often has to be done with some methods. Here, EEG has the advantage over fMRI as it is less expensive to use and may thus be more feasible for some studies and budgets. On the other hand, fMRI offers extremely high spatial resolution (2-3 mm), significantly greater than that of EEG (1-2 cm), and may thus be more appropriate when the exact localization of the brain response is a key for predicting ad success (Falk et al., 2012). However, due to low temporal resolution, fMRI often provides only aggregate measures for an entire stimulus and thus completely misses subtle temporal variations that might occur at multiple times during the viewing of ads. Therefore, it is crucial that researchers have a precise idea

of the key ad constructs that they want to study, as this will dictate which neuromarketing tools are best suited.

Much advertising research has been driven by the hierarchy of effects model, which suggests that advertising processes follow a specific temporal sequence, where the first step is typically to capture consumers' attention, followed by comprehension of the ad message, which then leads to feelings of desire for the advertised product or service, and eventually to a commitment to purchase (Barry and Howard, 1990). Recent research focuses on four key constructs which independently or in combination influence the effectiveness of an advertising message: attention, emotion, memory and purchase behavior (Pieters, Rosbergen and Wedel, 1999; Shapiro and Krishnan, 2001; Venkatraman et al., 2014).

Attention is a key construct for virtually all people engaged in designing and executing marketing campaigns (Milosavljevic and Cerf, 2008). Attention is defined as the mental mechanism that selects information for preferential treatment or processes above other available information (Plassmann, Ramsøy, and Milosavljevic, 2012). Past research in psychology and neuroscience recognizes two temporally distinct components of attention in advertising: (1) bottom-up or pre-attention and (2) top-down or focal attention (Pieters and Wedel, 2004). Both types of attention alone or in combination have a profound impact on consumer behavior, and thus identifying their properties in relation to advertising is a key task of successful marketing (Milosavljevic and Cerf, 2008; Pieters and

Wedel, 2007; Plassmann, Ramsøy, and Milosavljevic, 2012). Neuromarketing methods, such as eye tracking and EEG, offer more direct measures of attention compared to self-reports and provide marketers with a reliable tool to successfully distinguish between bottom-up and top-down attention in relation to marketing-relevant stimuli (Pieters and Wedel, 2007). For instance, a recent eye-tracking study on visual attention related to commercial effectiveness suggested that an essential requirement for fast-forward dynamic advertising that aims to create brand memory, positive brand attitude, and choice behavior is that the brand information should be located in the center of the visual field (Brasel and Gips, 2008). Another recent eye-tracking study found that the most effective position for an advertisement in a magazine is the bottom of the right-hand page, next to an article or illustration without too many colors (Smit, Boerman, and van Meurs, 2015). In EEG research on advertising, posterior alpha modulation has been related to attention processes such as visual gating during viewing of TV commercials (Rothschild et al., 1986). Numerous neuroscience studies allude to the importance of posterior alpha-band oscillations in attention-related processes, such as selective and spatial attention (Klimesch, 2012; Jensen and Mazaheri, 2010). A recent fMRI study found a negative correlation between the amount of attention for non-commercial broadcast ads, reflected by occipital activity and accuracy of recognition, suggesting that the “attention-grabbing” visual content of the ad could block the learning and retention of information in a commercial (Langleben et al., 2009). In another fMRI study, the amount of attention for a static photo was positively associated with the perceived attractiveness of the

product package, and thus favorable behavior toward the advertised brand (Stoll, Baecke, and Kenning, 2008).

A second important construct in marketing and advertising is emotion, often used as a synonym of affect (Bagozzi, Gopinath, and Nyer, 1999). An emotion is defined as "... a mental state of readiness that arises from cognitive appraisals of events or thoughts; has a phenomenological tone; is accompanied by physiological processes; is often expressed physically (e.g. in gestures, posture, facial features); and may result in specific actions to affirm or cope with the emotion, depending on its nature and meaning for the person having it" (Bagozzi et al., 1999, p. 184). In the advertising context, emotions are usually measured on two distinct dimensions: valence (positive versus negative) and arousal (moderate versus high physiological and subjective intensity), (Shapiro and MacInnis, 2002). Recent behavioral and neuroscience studies indicate that emotions play essential roles in the modulation of important responses to advertising such as attention and memory (Ambler and Burne, 1999; Vuilleumier, 2005; LaBar and Cabeza, 2006). Past advertising research has used a variety of self-reported approaches in analyzing consumer emotional engagement in relation to advertising materials, such as TV commercials, print and web ads (Sundar and Kalyanaraman, 2004). Recent neuroscience studies allude to the importance of frontal alpha-band oscillations in affective processes (Davidson, 2004). According to Davidson (2004), the approach/withdraw system is responsible for the emotion-related lateralization of frontal neural activity. This model of emotional frontal

alpha asymmetry is frequently used by researchers to study consumer emotional responses to TV ads. For instance, in recent EEG studies, Vecchiato et al. (2010, 2011) investigated viewers' emotional engagement with commercials incorporated into normal TV program content. Both studies reported greater right-frontal alpha power for more pleasant and liked commercials and greater left frontal power for unpleasant ones. A recent fMRI study also confirmed the importance of the frontal regions in emotional processing (Morris et al., 2009). Morris et al. examined brain responses toward TV commercials through a three-dimensional construct (pleasure, arousal, and dominance) of emotion. Using Advertisement Self-Assessment Manikins responses as a model for the fMRI data, they showed an association between bilateral activations in both the inferior frontal gyri, the middle temporal gyri and the pleasure response to the commercial. Furthermore, changes in the arousal levels were found in relation to the right superior temporal gyrus and the right middle frontal gyrus (Morris et al., 2009).

Memory is the third essential component that marketers consider when designing ads. Memory and past experience are strong drivers of consumer behavior, such as brand evaluation and consumer choice (Shapiro and Krishnan, 2001). Memory is usually related to three distinct cognitive processes: encoding, consolidation, and retrieval (LaBar and Cabeza, 2006). Over the past decades, advertising research has been mainly interested in factors that affect implicit and explicit retrieval processes used to determine the quality and features of ads (Shapiro and Krishnan, 2001).

Specifically, recall and recognition have been common measures of advertising effectiveness of print and television ads (Bagozzi and Silk, 1983). Consumers' purchase behavior is strongly influenced by past experiences via memory (Kronlund, Whittlesea, and Yoon, 2008). In a recent eye-tracking study on advertising, Wedel and Pieters (2000) investigated the role of eye fixations on memory for brands. Their findings indicate that systematic fixations to the brand and pictorial features of the printed ad support brand memory, while text fixations do not have any effect on subsequent memory. In addition, the study found negative associations between the amount of information obtained from an ad during fixation and the latency of brand memory. Rossiter et al. (2001) were the first researchers to use EEG to investigate brain locations of visual memory encoding in relation to dynamic visual stimuli. Their results suggest that short- to long-term memory transfer of information from TV commercials takes place in the left hemisphere. They concluded that the left frontal activation reflected by reduced alpha activity is a reliable predictor of which ad scenes will be better encoded in long-term memory and subsequently more easily recognized. These same frontal patterns of alpha activity in relation to memory encoding during the watching of TV commercials eliciting high subjective interest were also found in other recent EEG studies (Smith and Gevins, 2004). The association between frontal activity and memory in relation to advertisement content was also reported in fMRI studies (Langleben et al., 2009). Importantly, other fMRI studies suggest that memory processes (e.g. working memory) are not limited to single brain sites such as the prefrontal cortex (PFC), but to the

functional interactions of a network of brain regions such as the amygdala and hippocampal complex (D'Esposito, 2007; Phelps, 2004).

Likewise, consumer preference (e.g. for brands) is frequently used as direct correlates of subsequent purchase behavior (Cobb-Walgren, Ruble, and Donthu, 1995). However, consumers are not always capable of accurately predicting their future buying behavior due to novelty, context, and specificity of the product factors which change seemingly unpredictably (Loewenstein and Schkade, 1999). Recently developed alternative scales have tried to improve the ability to predict consumer behavior from self-reported preferences and intentions by considering biases in reporting and measurement (e.g. Mittal and Kamakura, 2001). Nonetheless, these studies still have limitations which hinder their predictability power (Chandon, Morwitz, and Reinartz, 2005). In search of better measures and higher predictability, academic and commercial research is more frequently employing neurophysiological methods to study the dimensions of advertising effectiveness. Predicting individual consumer responses (e.g. preferences) to TV ads in a pre-testing phase might lead to improving their success on a larger population level (MacKenzie et al., 1986). Using the traditional event-related potentials (ERP) approach, an EEG study suggested that the strength of long-term memory encoding for brand information reflected by greater left prefrontal activity may be used as an indicator for advertising effectiveness and thus of its ability to favorably affect consumer buying behavior (Silberstein and Nield, 2008). In an fMRI study on consumer behavior, Knutson et al. (2007) reported a

correlation between the nucleus accumbens (NCC) activity and a preference for a specific product.

In a recent fMRI study, Falk, Berkman and Lieberman (2012) examined whether neural responses of individuals to TV ads can predict general population behavior above and beyond self-reported measures. Their results suggest that TV campaign effectiveness on the large population level is better predicted by neural activity in the medial prefrontal cortex (MPFC) of people in a small group compared to self-reported judgments. MPFC activity accounted for 33% of the variance in the effectiveness of ad campaigns. Recently Falk et al. (2015) replicated their previous findings about the role of MPFC as a reliable predictor of TV campaign effectiveness. The results show that brain activity in MPFC in combination with self-reported measures accounted for 65% of the variance in the success of media campaigns. It is important to mention that both studies looked at the effectiveness of different advertising messages on changing participants' behavior in relation to the general use of certain type of health-related product. In these specific studies the effectiveness of the ad messages was measured in relation to changes of the consumers' health-related habits (e.g. use of sun screen lotions and quitting smoking). However, marketers are also interested in the effectiveness of advertising in promoting the use or purchase of a specific brand. Thus, including another dimension such as brand preference or brand choice might lead to a different (e.g. lower or higher) predictive power for the MPFC. Brand preferences and product choices are strongly influenced by social processes

(Escalas and Bettman, 2005). MPFC activity is frequently related to self-conscious processes and mind-reading which both play a key role in understanding others during social interaction (Dietvorst et al., 2009).

In a recent combined EEG and fMRI study, Dmochowski et al. (2014) attempted to find the neural correlates of individual preferences during TV ad viewing with an innovative inter-subject synchronization approach (Hasson et al., 2004). Their results indicate that individual preferences with TV ads are predicted by the level of inter-subject synchronization among viewers (Dmochowski et al., 2014). However, this neural synchronization predicted general population preferences measured by social media activity (e.g., Tweet rates and Nielsen ratings) more accurately (66% of the variance) than those of the individuals from whom the neural responses were collected (26% of the variance). Dmochowski et al. suggest that one reason for this unusual finding might be due to the social influence processes that are likely to take place in large groups in a real-life environment (Chan, Berger, and Van Boven, 2012; Fehr and Hoff, 2011). The EEG, fMRI and behavioral data were recorded from participants placed in complete isolation so that no social influence or social interaction process could occur. Here, in contrast, the population behavioral responses were collected outside the laboratory settings and thus social influence processes could have largely altered individual preferences toward the TV ads via social interactions or word-of-mouth. Indeed, individual behavior is highly susceptible to social processes such as social conformity, assimilation, compliance and persuasion (Algesheimer, Dholakia, and

Herrmann, 2005; Cialdini and Goldstein, 2004; Izuma, 2013). For instance, human memory, which widely affects consumer behavior and consumer brand choice, is largely susceptible to social influence (Edelson et al., 2011).

Importantly, sometimes consumers experience advertising in isolation from social context. For instance, when they watch TV alone at home, read a magazine in the park, or use their mobile phone on their way to work. On other occasions consumers are exposed to ad messages in a social context, while interacting with other people. For instance, when watching sports in a stadium or in a sports bar, before the start of a movie at the cinema, or when the whole family views a TV show in their living room at home. Experiencing advertising in different social contexts may influence the way consumers process it. When placed in a social context, people are both consciously and unconsciously influenced by social cues coming from other humans (Semin and Groot, 2013). Sometimes we converge and synchronize with others, sometimes we diverge from them (Earls, 2009). For instance, people behave differently when placed in public social settings (e.g., airports, sports stadiums, restaurants, hospitals), where they are more prone to converge in their actions with others because of widely accepted unwritten social rules and norms, compared to when they are completely alone (Earls, 2003; Pentland and Heibeck, 2008). Many behavioral studies have shown the importance of social context on modulating the way we perceive external stimuli (Asch, 1956). Processes

that naturally occur in a social context, such as social conformity, determine our behavior to a large extent.

The idea for this dissertation came to me after a conversation with the global consumer and market intelligence manager of a big international beverage company. In the beginning the manager shared information with me on the various traditional and new neuromarketing measures his company uses for pre-testing and in-market analysis of their ad campaigns. Next, he expressed his deep concern with the fact that most of the data for the market analysis were collected from consumers tested in social isolation. This was especially the case when neuromarketing tools were used to measure consumers' attention, emotional engagement, memory, or purchase intention in relation to the advertisement. Finally, he explained why the social context is so important for the success of their brand. Their product is often consumed in a social environment. As a result they intentionally advertise in places and through channels where their campaigns are more likely to be experienced in dynamic social settings. Finally, one of their main advertising objectives is to inform consumers that their brand has a social dimension which makes it suitable for all kinds of social occasions. The social dimension of a brand is extremely important, not only for advertisements of beverage products, but also for companies in all kind of industries.

Based on this first-hand feedback from the business I believe that marketers and neuroscientists who aim to deliver a complete and accurate

picture of the effectiveness of their advertising need to consider the social factors that influence consumers' cognitive processes.

1.2. OUTLINE OF THE DISSERTATION: EXPLORING CONSUMER'S COGNITIVE RESPONSES TO ADVERTISEMENT IN DIFFERENT SOCIAL CONTEXTS

In this dissertation, to examine how social processes influence consumers' cognitive responses to advertisement, I focus on the following key constructs: attention, emotion and memory. The different chapters in my dissertation all reflect upon the interaction between physiological processes, biological markers, personality traits and social context. Specifically, in Chapter 2, I focus on the simpler social situation, in which subjects are not engaged in active social interaction. My first objective is to explore the influence of social context in ad-free environment. I collect EEG recordings to measure task-free resting-state cortical brain activity under two conditions, alone (A) or together (T). In addition, I investigate whether psychological attachment styles shape human cortical activity differently in these two settings.

In Chapter 3, I focus again on simpler social situation, in which subjects are not engaged in active social interaction. Early studies defined the mere-presence effect as a non-interactive social situation where a second person, passively co-present, does not attempt to engage the first person in any way (Zajonc, 1965). Zajonc (1965) proposed that mere

presence is a sufficient condition for producing nondirective, nonspecific arousal: “In the presence of others, some degree of alertness or preparedness for the unexpected is generated, not because there is the anticipation of positive or negative incentives, or threat of evaluation, but simply because one never knows what sort of responses – perhaps even novel and unique – might be required for the individual” (p. 16). In this chapter I examine consumer cognitive processes in relation to advertising. Specifically, I investigate consumer brain responses underpinning passive viewing of luxury (high emotional value) versus basic (low emotional value) branded products when participants were alone or with another person.

In Chapter 4, I introduce simpler social interaction between participants. The study investigates processing of advertising material in sales-consumer settings. Past physiological evidence indicates that drawing inferences from the mind of another person is a well-defined brain process characterized by temporal and spatial properties. Therefore, I study brain responses during passive viewing (the consumer) of branded products and preference inferences (the sales consultant) from eye-related information. Using electroencephalogram (EEG) methods, event-related potentials (ERPs) were recorded while participants passively viewed pictures of branded products or tried to infer the product preferences of others from eye-related information. ERP amplitudes were examined in two time windows, corresponding to the P3 component and the late positive potential (LPP).

In Chapter 5, I argue that neurophysiological methods that aim to understand and predict advertising effectiveness should place participants in social settings in addition to the traditional manner of studying consumer brain responses to marketing-relevant stimuli in social isolation. I discuss previous traditional advertising research that examined the effects that social context and social interactions have on physiological processes during advertising viewing. Next, I talk about the various social processes affecting the way consumers experience advertising messages in real-world situations where the active human brain interacts with the social environment. Specifically, I consider the following social processes: mere presence, self-referential cognition, social cognition, social reward processing, social embarrassment and their interaction with the four key constructs in advertisement. I also discuss the hypothesized neural systems involved in cognitive processes related to advertising that may be influenced by social processes. Finally, I review some techniques applicable to multi-subject EEG and fMRI studies that marketers and neuroscientist can use to examine advertising effectiveness in social context. Examples of brain imaging setups for studying advertising effectiveness in social contexts are also provided.

In sum, my goal, with this dissertation, is to study whether different social processes affect the way people cognitively respond to the surrounding environment. As a marketer and social neuroscientist, I focus on the way consumers experience advertising messages in social context

versus social isolation. While the use of social neuromarketing methods to study advertising effectiveness come at the cost of increased complexity and methodological difficulties in data collection and data analyzes, they allow us to better understand the social effects on consumer behavior and brain responses to advertising messages.

1.3. DECLARATION OF CONTRIBUTION

In this section, I state my contribution to the different chapters of this dissertation an also acknowledge the contribution of other parties where relevant.

Chapter 1: The majority of the work in this chapter has been done independently by the author of this dissertation, and the feedback from the promoter has been included.

Chapter 2: The majority of the work in this chapter has been done independently by the author of this dissertation. The author formulated the research question, performed the literature review, designed the experiment, executed the data collection, conducted the data analysis, interpreted the findings, and wrote the manuscript. Clearly, at several points during the process, each part of this chapter was improved by implementing the detailed feedback provided by the promoter and the co-authors. This chapter has been published in *Frontiers of Human Neuroscience*, July, 2014, <http://dx.doi.org/10.3389/fnhum.2014.00486>. The author of this

dissertation is the second author of this paper, and the promoter is the first author.

Chapter 3: The majority of the work in this chapter has been done independently by the author of this dissertation. The author formulated the research question, performed the literature review, designed the experiment, executed the data collection, conducted the data analysis, interpreted the findings, and wrote the manuscript. Obviously, at several points during the process, each part of this chapter was improved by implementing the detailed feedback provided by the promoter and the co-authors. This chapter has been published in *Journal of Marketing Research*, August, 2015, <http://dx.doi.org/10.1509/jmr.13.0560>. The author of this dissertation is the first author of this paper, and the promoter is the second author.

Chapter 4: The majority of the work in this chapter has been done independently by the author of this dissertation. The author formulated the research question, performed the literature review, designed the experiment, executed the data collection, conducted the data analysis, interpreted the findings, and wrote the manuscript. Of course, at several points during the process, each part of this chapter was improved by implementing the detailed feedback provided by the promoter. This chapter has been published in *International Journal of Marketing Studies*, August, 2016, <http://dx.doi.org/10.5539/ijms.v8n4p1>. The author of this dissertation and the promoter are the only co-authors of this paper.

Chapter 5: The majority of the work in this chapter has been done independently by the author of this dissertation. Parts of this chapter are currently under review at a marketing journal. The author of this dissertation is the first author of this paper, and the promoter is the second author.

CHAPTER 2: “I AM RESTING BUT REST LESS WELL WITH YOU.” THE MODERATING EFFECT OF ANXIOUS ATTACHMENT STYLE ON ALPHA POWER DURING EEG RESTING STATE IN A SOCIAL CONTEXT

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2.1. INTRODUCTION

In neuroscience there is ongoing debate as to what exactly resting-state activity entails. Some studies suggest that resting state refers to introspective processes such as mind wandering (Mason et al., 2007; McKiernan et al., 2006). Other studies propose that resting state refers to self-reflection (Greicius and Menon, 2004; Buckner and Carrol, 2007; Moran et al., 2013), which could involve thinking of possible social interactions with others (Mitchell, 2006; Rilling et al., 2008).

Nevertheless, EEG oscillations, which might take place in different frequency ranges, are extremely structured and systematic even in the absence of specific goal-directed (resting-state) tasks. In EEG, alpha band activity is a well-known type of brain oscillation consistently observed during resting state and usually more pronounced over the parietal-occipital cortex (Scheeringa et al., 2012). However, despite more than 80 years of human EEG research, the exact functional role of alpha oscillations remains an open question. The amount of alpha activity in a given brain state (e.g.,

resting state versus attention during a task) is commonly regarded as an inverse index of cortical excitability (Mo et al., 2013). According to one of the most generally accepted theories, enhanced alpha power reflects an active mechanism for inhibitory top-down control (Klimesch et al., 2007). Cooper et al., (2006) and Sauseng et al. (2005) provide evidence for this theory, reporting enhanced alpha synchronization in tasks requiring internally oriented attention, such as mental imagery. This perspective suggests that enhanced alpha power in the posterior brain region is associated with decreased connectivity with other tightly connected brain regions (Scheeringa et al., 2012). One possible functional interpretation of this empirical evidence is that increased alpha power over posterior regions during tasks requiring internal attention might inhibit visual activity in order to preserve internal processes, such as self-referencing, from being disturbed by possible external sensory information (Mo et al., 2013). Most importantly, however, past research consistently reports strong relationships between alpha power and tonic alertness. Enhanced alpha band activity has been related to tonic maintenance of attentional resources (Dockree et al., 2007). Moreover, decreases in ongoing alpha power are associated with impaired behavioral performance (Makeig and Jung, 1995).

Research shows evidence for an existing constellation of brain areas known as the default mode network (DMN), including the medial prefrontal cortex and medial parietal cortex, which are more active during task-free resting state than during goal-directed tasks (Raichle et al., 2001; McKiernan et al., 2003; Fox et al., 2005; Moran et al., 2013). The DMN is

believed to reflect processes such as task-independent introspection and self-reflection, which usually occur during resting state (Buckner et al., 2008, Christoff et al., 2009). Interestingly, DMN activity corresponds to EEG power variations in different frequency bands. For instance, frontal and parietal DMN activity is associated with high alpha and beta band activity (Mantini et al., 2007; Hlinka, et al., 2010). Jann et al. (2009) reported enhanced alpha and beta oscillation related to DMN activity. All this research suggests the existence of a close relationship between the behavior of DMN and alpha band activity, especially in the resting state.

The level of BOLD (blood-oxygen-level dependent) activity in the DMN is strongly related to alpha power modulations over posterior brain regions. However, simultaneous EEG-fMRI sessions are required to establish this relationship. For the sake of simplicity and because of the exploratory character of our study, we seek to examine to what extent activation in the different EEG frequency bands is modulated by changes in the social context in which the task-free resting state condition is carried out. Thus, we focus exclusively on electrophysiological changes of brain activity and leave for future research more complex hemodynamic responses. Based on the empirical and theoretical evidence reported so far, we expect alpha band activity during resting state to be a reliable EEG indicator of tonic alertness or processes requiring internally oriented attention, such as mental imagery and self-reflection (Sadaghiani et al., 2010).

To date, resting state has been generally examined in a traditional single person fashion. Yet, researchers have recently recognized the need for a more socially valid approach to unraveling certain distinct patterns of ongoing brain activity. This reasoning resonates with the recent work of Schilbach et al., (2008) showing that resting state reflects people's self-conscious processes. Nevertheless, being self-conscious is socially situated and context dependent, which means that people often have to reason how they differ and relate to others depending on the social context. Schilbach et al., (2008) did not study resting state in a social context or variations in social conditions. It is perhaps questionable to expect that changes in social context, which might range from performing a goal-directed task to simply being awake in a resting state, sitting passively with another person, might modulate human brain activity in exactly the same way as occurs when one is alone. Many biological and physiological regulators may influence brain responses in social contexts. For example, in interpersonal relationships, human adults develop somewhat stable, trait-like individual differences commonly referred to as attachment styles (Mikulincer and Shaver, 2010). Considering the task-free resting-state condition, the main topic of our research, we believe that attachment systems might mediate ongoing brain activity in relation to changes in the social environment. Therefore, in our study, we decide to examine the resting state using EEG methods, with particular focus on whether human attachment styles affect resting state brain activations in different social contexts. Our paper builds upon Vrticka and Vuilleumier's (2012, p. 14) proposal that the study of neural correlates

of attachment styles should investigate people in a social context rather than in social isolation.

Attachment systems play a relevant role in the way people relate to other people, especially in cases of need. The attachment system is based on basic needs such as protection and security, and is usually activated in situations involving threat or distress. From a neurological perspective, attachment is an evolutionary hardwired system that is shaped during contact with early caretakers. It consists of reflexive avoidant and approach systems (affective evaluation network) that operate in a push-pull manner: e.g., under stress, people reflexively avoid negative stimuli and seek proximity with others to experience the neuroception of safety (Vrticka and Vuilleumier, 2012). Research shows that the early caretaker's reactions to their child's proximity seeking behavior develops into a person's working model of relationships with other people and produces "mental simulations of how other people would respond to their proximity seeking behavior" (Mikulincer, and Shaver, 2010). This type of social mentalization tunes the reflexive attachment system to requirements of the social environment (Vrticka and Vuilleumier, 2012).

Past behavioral research with mother-child relationships and adult relationships reveals that trait-like individual differences exist in two separate styles: namely, attachment insecurity and attachment security. Attachment insecurity occurs along two independent axes: attachment anxiety and attachment avoidance. Overall, three types of attachment styles

have evolved: secure, avoidant, and anxious. Under the first, securely attached individuals handle stress by seeking support from trusted people or by calling upon mental representations of support received in the past (Mikulincer, and Shaver, 2003). The second, avoidant attached style, is marked by a certain amount of self-reliance in social behavior. Avoidant individuals tend to deactivate their attachment system in socially stressful situations, and do not experience much negative feelings when rejected. Thus, their proximity seeking behavior is relatively low. Finally, anxious individuals are highly sensitive to both rejection and acceptance in socially stressful situations, which is manifested in hyperactivation of their attachment style when engaged interpersonally with others. However, despite extensive clinical and social psychological research, very little is known about the way in which attachment styles are represented in the brain. The few studies that have attempted to establish relationships between neural systems and attachment styles have mainly used indirect measures of brain activity such as fMRI. Generally, neuroimaging studies examine attachment styles in relation to processing emotional information or memory processes (Donges et al., 2012, Vrticka and Vuilleumier's 2008). Because of its high temporal resolution, ERP research has much promise for the study of attachment styles. Nevertheless, in most cases to date, ERP research has been limited to emotional and memory processes of individuals in non-social contexts (Escobar et al., 2013). In our study, we examine the social context in which the relationship between attachment style and neural activity occurs. We believe that the study of social behavior in the absence of any goal-directed task or redundant external

information provides a clear and well-defined experimental setting in which to study the possible influence of attachment style on brain activity.

Resting state per se is not well understood, especially in connection with changes in social context. However, some researchers argue that during resting state people reflect on whom they might interact with (e.g., Schilbach et al., 2008). This process involves a mental simulation of how they would respond to other people in a specific situation or how this other person would respond to them. A closer look at this social simulation implies that, for one individual to reflect upon how he would respond to another individual in a specific social situation, he needs to mentally elaborate on who that other person is (Schilbach et al. 2008).

One approach in this regard is the following. Resting with another person nearby, compared to resting completely alone, can be conceived as a social situation low on interpersonal feedback. Functioning in this minimal social context might activate the reflexive avoidant and approach system (affective evaluation network): e.g., “I am feeling uncertain about this minimal feedback.” Equally, such a situation is likely to provoke mental state representations (self-reflection) in relation to the other person: e.g., thoughts might occur such as “Why does this person not give me any feedback?” We know of only one study that has investigated the relationship between attachment styles and a person’s non-involvement in a task. Sloan et al., (2007, p. 4) showed that during sleep, anxious attached people exhibit an alpha power anomaly, indicating that attachment anxiety

is a marker of hypervigilance that increases individuals' sensitivity to harmful stimuli even during sleep.

As attachment styles reflect differences in mental simulation regarding their approach to interaction with others, for anxious attached people in a resting state, sitting passively beside each other, we can ask, if higher levels of tonic alertness will occur and be reflected in hyperactivation of their attachment style. In other words, could low social feedback in a resting state with another person be anxiety provoking, especially for people with an anxious attachment style, and might it in turn evoke mental simulations about the other person's judgments (e.g., "What does this other person think of me?").

On the other hand, we do not expect a similar process to occur for avoidant attached people because they are relatively insensitive to feedback from other people. Avoidant attached people generally prefer situations where they do not have to socialize or relate to others extensively. Hence, we do not expect that the alpha power will be moderated significantly by individuals' scores on avoidant attachment.

In this exploratory study we investigated the relationship between cortical brain oscillations occurring in different frequency bands and subjects' anxious and avoidance attachment styles, measured with psychological scales, by recording and comparing EEG data from two types of task-free resting state sessions: namely, a conventional A session where

the participant is alone and a less conventional T session where the participant is together with another subject.

2.2. MATERIALS AND METHOD

2.2.1. Subjects

Forty healthy female undergraduates from a Dutch University, ranging in age from 18 to 26 years (Age $M = 22.07$, $SD = 2.09$), took part in this study. Participants enrolled in the experiment in exchange for educational credit. All participants had normal or corrected-to-normal vision. Informed consent was obtained at the beginning of the experiment. Five participants were excluded from the analysis because of an excessively high percentage of artifacts (using a criterion of 75% or less artifact-free epochs). Thus, we analyzed electrophysiological responses (EEG) and attachment style data from 35 participants.

2.2.2. Questionnaire

After the EEG recording sessions, participants completed a questionnaire on attachment styles developed by Brennan, et al. (1998). Three anxious attachment items were used in a 7-point Likert scale with “very untrue of me/very true of me” as end-points and “neutral” as a mid-point. For the present sample, total scores of the three items on the anxious attachment scale ranged from 5.0 to 21.0 ($M = 10.92$, $SD = 3.54$), with Cronbach's α equal to .61 (see Appendix 1). Two avoidant attachment items (reversed coded) were used with the same 7-point Likert scale as used for anxious

attachment. Total scores on the avoidant attachment scale ranged from 6.0 to 14.0 ($M = 10.45$, $SD = 2.22$), with Cronbach's α equal to .81 (see Appendix 2).

Procedure

The experiment was conducted in two sessions (A and T conditions). For the A condition, EEG recordings were collected from participants sitting isolated in a dimly lit EEG laboratory. For the T condition, two participants sat together in the same EEG lab. Participants sat in comfortable chairs approximately 100 cm away from, and at eye level with a 40x30 cm Iiyama PC computer screen. In the T condition, the participants sat beside each other, both facing the computer screen. The order of the A and T conditions was counterbalanced. Participants interacted with each other during the installation of the EEG caps and in the period between the A condition and T condition sessions.

In both conditions, participants were shown a white fixation cross for two minutes, which was presented centrally on the computer screen using E-prime presentation software (Psychology Software Tools, Inc.). To reduce the number of EEG artifacts caused by eye movement, participants were instructed to relax and reduce blinking and other ocular movements during the experimental sessions.

2.2.3. Electrophysiological Recordings and Analysis

The electroencephalogram (EEG) was recorded continuously from 32 active Ag/AgCl electrode sites using a BioSemi 32-channel elastic head cap with standard international 10-20 system layout. In the T condition, EEG was recorded with two identical 32-channel EEG caps. Each cap signal was acquired from two separate, identical amplifiers (BioSemi Active-Two system AD-box) that were connected to each other and the same computer with optical cable. Flat-type active electrodes were attached to the right and left mastoids. Electrodes located on the outer canthi of each eye, as well as below and above the left eye, were attached to measure bipolar horizontal and vertical EOG activity. In addition, an active pin-type electrode (CMS, common mode sense) and a passive pin-type electrode (DRL, driven right leg) were used to compose a feedback loop for amplifier reference. Online, EEG was digitized at a sampling rate of 512Hz, 24-bit A/D conversion. Offline, we changed the sampling rate to 256 Hz.

Further offline processing was performed with Brain Vision Analyzer (Brain Products GmbH, Germany; www.brainproducts.com). Offline, the EEG signals were re-referenced to the average of the left and right mastoids. EEG data were band-pass filtered between 0.1Hz and 100Hz. Artifacts caused by ocular movements were removed by applying Independent Component Analysis (ICA) with Brain Vision Analyzer (for more details see Brain Products GmbH, Germany; www.brainproducts.com). Band rejection filtering for 50 Hz (notch filter)

was used to eliminate interference from the electricity network. After the ICA correction procedure, EEG signals were subjected to segmentation (2000 ms) and artifact-rejection processing. The artifact-rejection method consisted of excluding epochs with large amplitude (over $\pm 100 \mu\text{V}$). Additionally, two experienced EEG researchers (blind to the stimulation condition) screened the EEG recordings for residual contamination of the EEG epochs due to eye or muscle artifacts. As a result, only epochs (2000 ms) completely free from artifacts were considered for the following spectral analyses.

In both studied conditions (A and T), the two-minute resting state EEG data were segmented and analyzed in 2000 ms epochs. This process resulted in 60 epochs per condition, of which some 55 valid epochs in the A and 54 valid epochs in the T condition across the 35 subjects, on average, were subjected to further spectral analysis. Each set of artifact-free EEG data (2000 ms epochs) was subjected to fast Fourier Transform (FFT) analysis with a 10% Hanning window, performed by Brain Vision Analyzer (Brain Products GmbH, Germany; www.brainproducts.com). To ensure an adequate signal-to-noise ratio of the EEG data, at least 45 artifact-free segments were required from each subject (for each condition) for fast Fourier transformation and power spectral analysis. Absolute EEG band power (μV^2) for each of the selected scalp areas, Frontal (F3, Fz, F4), Central (C3, Cz, C4), Parietal (P3, Pz, P4) and Occipital (O1, Oz, O2) was calculated for Theta (4-8 Hz), Alpha (8-12 Hz), Beta (12-25 Hz) and Gamma (30-40 Hz) frequency bands which were defined based on a

conventional EEG sense (e.g., Jacobs and Lubar, 1989; Diego, et al., 2004; Hotz, et al., 2000). After the FFT procedure, the artifact-free epochs were averaged for each A and T condition separately.

2.2.4. Statistical Analysis

The following electrodes were used for the data analysis: Frontal (F3, Fz, F4), Central (C3, Cz, C4), Parietal (P3, Pz, P4) and Occipital (O1, Oz, O2). For the group comparisons we employed a mixed-design analysis of variance (ANOVA), with Condition (Alone, Together), Caudality (Frontal, Central, Parietal, Occipital), Laterality (Left, Middle, Right) and Frequency (Theta, Alpha, Beta, Gamma) as within-subject factors and Anxious Attachment score (Low, High) as a between-subject factor for each frequency band. In this approach, the Anxious attachment score was used as a grouping variable by means of a median split. The median-split approach allows a clear presentation of the repeated-measures results in both groups but has the statistical disadvantage that it may reduce power and lose information (MacCallum et al., 2002). Therefore, we also performed correlational analyses using the Anxious attachment score as a continuous variable. For the ANOVAs, we checked multivariate normal distribution with the Mauchly sphericity test, and applied the Greenhouse-Geisser correction, when appropriate. A p value of <0.05 was considered significant (Keeser et al., 2011). Significant interaction effects were followed by paired-sample t-tests. Bonferroni correction was implemented to adjust for

multiple comparisons. Statistics were analyzed with the IBM SPSS 13.0 software (Statistical Package for Social Sciences, SPSS Inc, Chicago).

2.3. RESULTS

2.3.1. Behavioral Results

Based on the attachment style scores, derived from the questionnaires, the 35 participants were assigned to high (HA) or low (LA) Anxious attachment. More precisely, based on median-split approach 17 participants were assigned to HA group (above versus below median scores = 11.00) and 18 to the LA group. The median split resulted in the following means for the HA group ($M = 13.94$ $SD = 2.41$) and LA group ($M = 8.16$ $SD = 1.65$). The order in which participants from different anxious attachment groups started the A versus T condition was counterbalanced. Nine HA group participants started the EEG experiment with A condition, while ten from the LA group started with T condition.

For the avoidance attachment style 17 participants were again assigned to high (HAV) and 18 participants to low (LAV) Avoidance attachment groups (based on above versus below median scores = 11.00). The median split resulted in the following means for the HAV group ($M = 8.30$ $SD = 1.31$) and LAV group ($M = 12.23$ $SD = 0.96$). Again, as for the anxious attachment style, the order in which participants from different avoidance attachment groups started the A versus T condition was counterbalanced.

Pairwise A versus T contrasts indicated that there was no significant difference between the number of eye blinks in A condition ($M = 38.37$ $SD = 24.83$) compared to T condition ($M = 41.00$ $SD = 22.95$), ($t(34) = -0.838$, $p = 0.408$). Pearson correlation revealed that the anxious attachment score did not correlate significantly with the number of eye blinks in A ($r = 0.12$, $p = 0.483$) or T ($r = -0.07$, $p = 0.656$) conditions. Avoidance attachment score also did not correlate significantly with the number of eye blinks in A ($r = 0.05$, $p = 0.736$) or T ($r = 0.04$, $p = 0.778$) conditions. Next, we tested whether the anxious attachment groups (HA and LA) have different avoidance attachment scores. A t-test indicated that there was no significant difference on avoidance attachment between HA ($M = 10.88$ $SD = 2.26$) and LA ($M = 9.77$ $SD = 2.23$) groups, $p = 0.572$. Finally, there was no significant correlation between anxious and avoidance attachment scales ($r = 0.13$, $p = 0.427$).

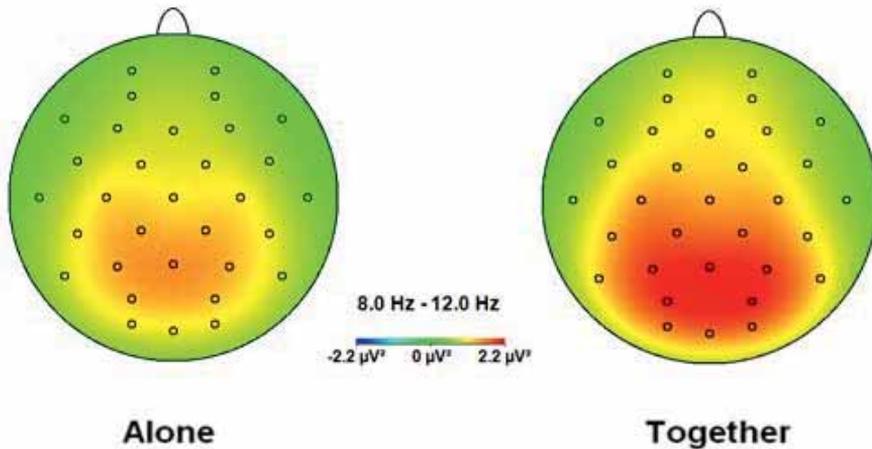
2.3.2. Electrophysiological Results

First, we tested whether there was a difference between HA and LA attachment groups with respect to the number of artifact-free epochs used for the electrophysiological analysis. T-test on the number of artifact-free epochs from the A condition revealed that there was no significant difference between the HA ($M = 55.47$ $SD = 4.12$) and LA ($M = 54.83$ $SD = 4.61$) attachment groups, $p = 0.646$. The same absence of significant difference was also found between HA ($M = 54.23$ $SD = 5.03$) and LA ($M = 53.33$ $SD = 5.58$) attachment groups, $p = 0.314$ with respect to the number

of artifact-free epochs in T condition. Finally, pairwise A versus T contrasts indicated no significant difference between the number of artifact-free epochs in A condition ($M = 55.14$ $SD = 4.33$) compared to T condition ($M = 53.77$ $SD = 5.26$), $p = 0.161$.

Repeated-measures ANOVA with Condition (Alone, Together), Caudality (Frontal, Central, Parietal, Occipital), Laterality (Left, Middle, Right) and Frequency (Theta, Alpha, Beta, Gamma) as within-subject factors and Anxious Attachment (Low, High) as between-subject factor on absolute EEG power revealed significant main effects for Condition [$F(1, 33) = 7.66$, $p = 0.009$], Caudality [$F(3,99) = 4.87$, $p = 0.007$] and Frequency [$F(3,99) = 84.57$, $p < 0.001$]. However, these main effects were qualified by second-order interactions of Condition x Anxious attachment [$F(1,33) = 15.75$, $p < 0.001$], Condition x Frequency [$F(3,99) = 5.41$, $p = 0.008$], Frequency x Caudality [$F(9,297) = 20.56$, $p < 0.001$] and by a third order interaction of Condition x Frequency x Anxious attachment [$F(3,99) = 5.68$, $p = 0.006$]. This third order interaction was further investigated by separate Condition x Anxious attachment ANOVAs for each frequency band.

Figure 1: *Topographic spectral mapping of absolute EEG alpha power in Alone vs. Together conditions. The increase in alpha power, marked strongly over the occipital-parietal cortex, is shown from the A to T condition.*



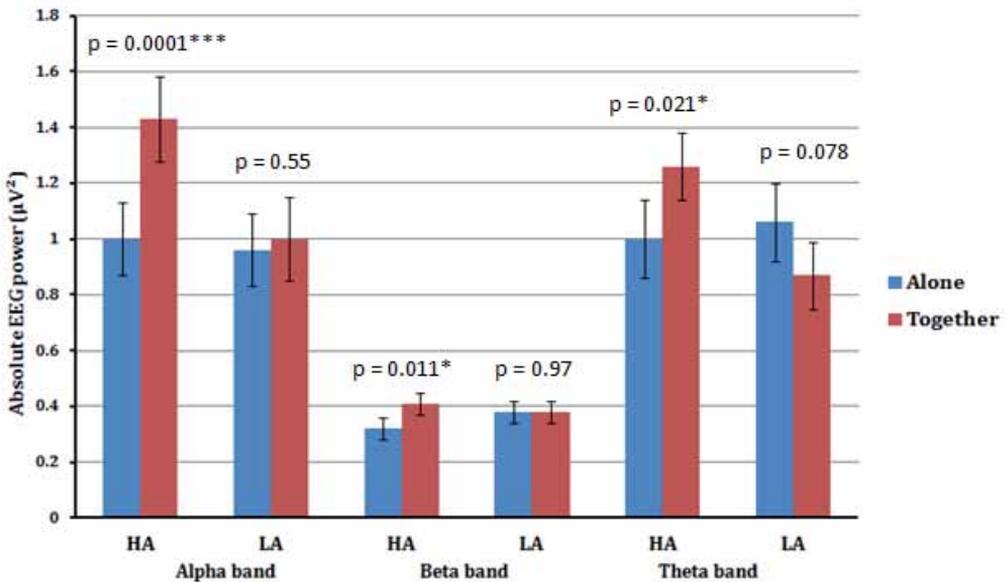
The ANOVA for the alpha band showed a significant main effect for Condition [$F(1.33) = 15.13, p < 0.001$], qualified by a significant interaction between Condition x Anxious attachment [$F(1.33) = 9.93, p = 0.003$]. The EEG alpha power was significantly lower in the A condition ($M = 0.98 SD = 0.53$) compared to the T condition ($M = 1.22 SD = 0.64$) (Figure 1). More precisely, we detected a significant difference between the A condition ($M = 1.00 SD = 0.52$) and the T condition ($M = 1.43 SD = 0.70$) for the HA group, ($t(16) = 4.41, p = 0.0001$) (Figure 2). No significant difference was detected when we compared the A condition ($M = 0.96 SD = 0.56$) and the T condition ($M = 1.00 SD = 0.52$) for the LA

group, $p = 0.55$ (Figure 2). In addition, we report significant main effect for Caudality [$F(3.99) = 12.69$, $p < 0.001$], with highest alpha value over parietal scalp areas ($M = 1.34$ $SD = 0.76$) and lowest alpha power over frontal areas ($M = 0.83$ $SD = 0.41$). However, this Caudality effect was not qualified by any significant interaction.

A significant main effect for Condition [$F(1.33) = 4.48$, $p < 0.042$], qualified by a significant interaction between Condition x Anxious attachment [$F(1.33) = 4.31$, $p = 0.046$] was also found in the beta frequency band. Again we detected a significant difference between the A condition ($M = 0.32$ $SD = 0.11$) and the T condition ($M = 0.41$ $SD = 0.14$) for the HA group, ($t(16) = 2.86$, $p = 0.011$). Additionally, there was no significant difference between the A condition ($M = 0.38$ $SD = 0.20$) and the T condition ($M = 0.38$ $SD = 0.16$) for the LA group, with $p = 0.976$ (Figure 2).

A significant interaction between Condition x Anxious attachment [$F(1.33) = 9.72$, $p = 0.004$] was also found in theta frequency band. Again we detected a significant difference between the A condition ($M = 1.00$ $SD = 0.44$) and the T condition ($M = 1.26$ $SD = 0.54$) for the HA group, ($t(16) = 2.56$, $p = 0.021$). Additionally, there was no significant difference between the A condition ($M = 1.06$ $SD = 0.66$) and the T condition ($M = 0.87$ $SD = 0.44$) for the LA group, with $p = 0.078$ (Figure 2). No significant interaction between Condition and Anxious attachment was detected in the gamma frequency band.

Figure 2: *Estimated marginal means (an average value from all four scalp areas) for alpha, beta and theta frequency bands of high anxious (HA) and low anxious (LA) attached participants in A (blue) versus T (red) conditions. Significant increase in alpha, beta and theta absolute powers from A to T condition is shown for high anxious (HA) attached participants. No significant difference across all frequency bands was detected between A and T conditions for low anxious (LA) attached participants.*



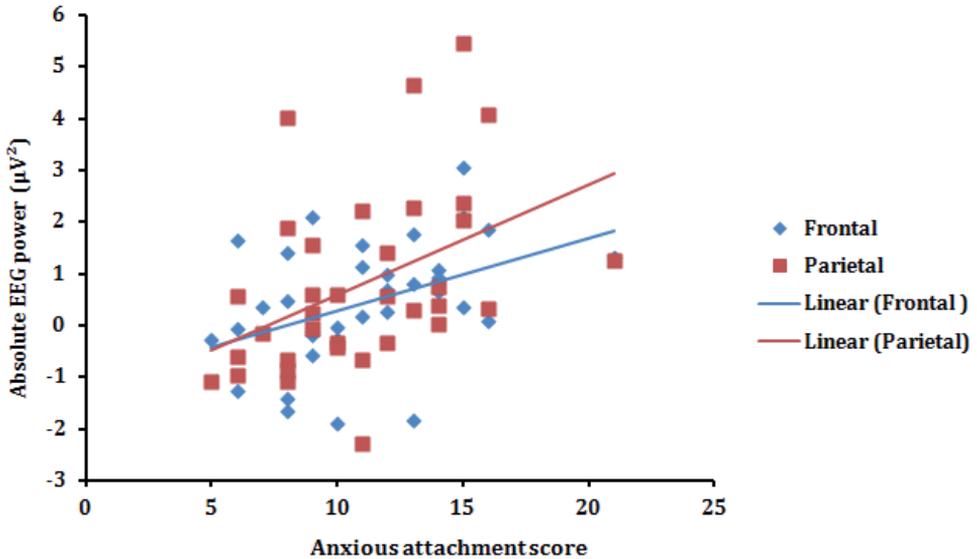
Repeated-measures ANOVA with Condition (Alone, Together), Caudality (Frontal, Central, Parietal, Occipital), Laterality (Left, Middle, Right) and Frequency (Theta, Alpha, Beta, Gamma) as within-subject factors and Avoidance attachment (Low, High) as a between-subjects factor

on the absolute EEG power did not reveal any significant interaction effects of Avoidance attachments with Condition, Electrode or Frequency.

2.3.3. Correlational Analysis

To further explore the association between alpha synchronization in the T versus A condition, we computed the correlation between the Anxious attachment score and the Condition effect for each of the four (Frontal, Central, Parietal, and Occipital) scalp areas (T minus A power). Pearson correlation revealed that Anxious attachment score correlated significantly with alpha synchronization in the Frontal ($r = 0.42$, $p = 0.011$) and Parietal ($r = 0.44$, $p = 0.009$) scalp areas (Figure 3). This positive correlation between Anxious attachment score and alpha power, especially in the posterior scalp locations, conforms with the results reported in the alpha band from ANOVA analysis. However, there were no significant correlations between Anxious attachment scores and condition effect in the other EEG frequency bands.

Figure 3: Scatterplot (with regression lines) of the anxious attachment score and the absolute alpha power (T minus A power) presented in the frontal (blue) and parietal (red) scalp areas.



2.4. DISCUSSION

As Vrticka and Vuilleumier (2012) recommend, the neural correlates of human attachment styles should be studied in a social context rather than in isolation, where the latter has been the typical practice in EEG studies on attachment to date (e.g., Zilber et al., 2007; Sloan et al., 2007; Zhang et al., 2008). Building upon Vrticka and Vuilleumier's (2012) insights, our main goal was to explore (a) the spatial distribution of EEG spectral powers when people are in A versus T resting-state condition, (b) how these

spectral powers vary between the A and T conditions, and (c) whether variations are shaped by the participants' anxious and avoidant attachment styles.

The result of our exploratory study clearly shows that participants experience enhanced alpha, beta and theta power when they are in the resting-state session together with another person compared to when they are alone. Most importantly, however, this result occurred only for high anxious attachment participants. No significant differences between the two resting-state sessions were found for the low anxious participants across all frequency bands studied. However, correlational analysis shows that this enhanced alpha power from A to T condition was associated with the participant's anxious attachment score only in the alpha frequency band and only over the frontal and parietal regions. In addition, behavioral results suggest that the present findings are not related to differences in the number of eye blinks between the two anxious attached groups (i.e., those in the A and T conditions) or possible correlation biases between anxious and avoidant attachment scales. Finally, we found no moderating effects of avoidance attachment style on the cortical brain activity between the two resting-state sessions.

It is vital to make a clear distinction between processes such as tonic alertness on the one hand and arousal and selective attention on the other (e.g., Oken et al., 2006). Arousal and selective attention are phasic reactions to specific stimuli, while tonic alertness is associated with nonselective

readiness for perception and action, which plausibly occurs in the absence of any goal-directed task (Sturm and Willmes, 2001). Past research reports negative correlations between activity in regions associated with the regulation of selective attention processes and alpha power (Capotosto et al., 2009; Laufs et al., 2003). More recent studies confirm these results and suggest that alpha synchronization over posterior brain regions in resting state might imply enhanced tonic alertness (Sadaghiani et al., 2010). Based on the result of the previously mentioned studies and considering the task-free resting state procedure implemented in our work, we believe that the present findings suggest increased tonic alertness is required for more active introspective processes in the T compared to the A condition, which is reflected by enhanced alpha synchronization, high over posterior regions. We further found this conditional effect to be more strongly pronounced for the high anxious compared to low anxious participants. Those high versus low in anxious attachment fail to have their need for approval met and become preoccupied with what other people might think about them when seated in silence beside another participant. Most importantly, however, this moderating effect of the anxious attachment style on the power of different EEG frequency bands during resting states in different social contexts was supported only for the alpha frequency band (frontal and parietal regions) which correlated highly with the participant's anxious attachment scores.

Interestingly, prior studies report that resting state with eyes open might involve some physiological changes in brain activity, such as

increased functional connectivity in the DMN (Chen, et al., 2013; Yan et al., 2009) and changes in synchronization patterns (Kuhnert et al., 2012). Non-verbal interactions, such as the simple mere presence of another person in close proximity, might be an essential and necessary condition for manifestation of attachment communication and attachment style activation. Mere presence with eyes open compared to eyes closed might create a more realistic and ecologically valid setting for the experimental condition where constant awareness of the current physical proximity of the other person is fundamental. In addition to the tonic alertness interpretation of our findings, in a recent study, Fransson (2005) proposed that in the resting state the brain is naturally predisposed to switch automatically between two opposite states: internally oriented versus externally oriented. This spontaneous process during an eyes open resting state is conceived as a basic, evolutionary survival mechanism, which might facilitate repeated suspensions of introspective and self-referential processes in order to reallocate more resources toward areas engaged in evaluating the external environment and responding appropriately to potential threats (Mo et al., 2013). This line of reasoning is strongly associated with the inhibition theory which might serve as a complementary interpretation to the previously discussed tonic alertness explanation of our results. More precisely, during an internally oriented resting state the enhanced alpha power for anxious attached people might provide protection for the internal information processing, such as might occur when one wonders “what the other person is thinking about me,” by blocking external interferences coming from surrounding sensory input. It seems plausible to expect that

the gating mechanism described above will be put in action only in the resting state with eyes open, which further supports the decisions made regarding the present experimental design. In line with our reasoning, Palva and Palva (2007) and Knyazev et al. (2011) suggest that enhanced alpha activity during resting state is associated with inhibition of external sensory perception and reduced attention, which might reflect internal mental processes.

In the context of the main tonic alertness interpretation of our findings, we find analogies with EEG-based research on anxiety that is different from and shouldn't be confused with anxious attachment style. For instance, Knyazev et al. (2006) suggests that enhanced posterior alpha activity in high anxious people reflects an increase in unspecific attention, which is evidence of higher general vigilance, especially in uncertain or social situations low on feedback. Klimesch (1999) arrives at a similar conclusion that enhanced alpha activity is associated with higher personal reactivity or readiness to adjust to external changes during resting state condition. Thus, this higher alpha power should not be perceived as an indicator of active inhibition, but more as a state of preparedness of a certain network.

Alpha oscillations might reflect several different brain processes such as active inhibition and tonic alertness which are both plausible explanations of our findings. Even though a combination of both processes (active inhibition and tonic alertness) seems like the most apparently valid

explanation of the present results, we believe that our findings reflect increased tonic alertness which is required for more active introspective processes or readiness to adapt to unexpected external alterations mainly because we find stronger empirical and theoretical evidence in support of this interpretation.

With respect to the enhanced beta power in T compared to A resting state condition, past research suggests a positive correlation between beta band activity and the intrinsic alertness network (Sadaghiani et al., 2010). Some studies report enhanced beta band activity to be associated with an active state of alertness rather than a more passive sustained tonic alertness (Kamiński, et al., 2012). However, we do not elaborate on beta and theta band activity since we did not find them significantly correlated with our participants' attachment score.

2.4.1. Limitations and Future Research

The limitations of our study and opportunities for future research deserve mention. First, due to its exploratory character the study uses a very small sample for studying an individual difference moderation. As a result of that the measure of the individual difference is rather impoverished. Therefore, the results of the study must be considered with caution.

Second, we analyzed the average absolute power values in different frequency bands between two resting-state sessions, namely placing the same person in an A condition versus T condition. Investigating the

temporal evolution and possible interactions between the resting-state conditions by means of Granger causality would be an obvious next step to undertake. However, this requires changes in the experimental design, such as longer resting-state time.

Third, adding and analyzing different biomarkers might reveal useful strategies for discovering subtle differences between participants in the different resting-state conditions. For instance, we could have examined whether heart rate for anxious attached people is likely to show greater variability and become lower in the dual conditions (Schmidt, et al., 1999).

Fourth, our participants were from an international university that attracts students from different nations and cultures. Cultural differences or similarities could have affected the interpersonal dynamics. In our sample, southern European students interacted with northern European students, and Dutch-Dutch pairs interacted as well. Future research could examine the effects of cultural differences on changes in the social context during resting states.

Finally, our sample included women only, but attachment styles may differ across gender (Del Giudice, 2011). Our study could be extended to males or a mix of both genders to investigate gender differences and cross-gender effects.

Appendix 1.

Anxious Attachment Style Scale (Brennan, Clark and Shaver, 1998)

1. I worry that others won't care about me as much as I care about them.
2. My desire to be very close sometimes scares people away.
3. I need a lot of reassurance that my partner loves me.

Appendix 2.

Avoidant Attachment Style Scale (Brennan, Clark and Shaver, 1998)

1. It helps to turn to my romantic partner in times of need. (Reversed measure)
2. I turn to my partner for many things, including comfort and reassurance.
(Reversed measure)

CHAPTER 3: MERELY BEING WITH YOU INCREASES MY ATTENTION TO LUXURY PRODUCTS: USING EEG TO UNDERSTAND CONSUMERS' EMOTIONAL EXPERIENCE OF LUXURY BRANDED PRODUCTS

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3.1. INTRODUCTION

Marketing scholars acknowledge that such instances of consumer behavior as allocating attention to branded products, seeking variety and making decisions are affected by the presence of other persons, who could be strangers, friends, family members or salespeople (Blazevic et al., 2013; Jayasinghe and Ritson 2013; White and Argo, 2011; Kurt, Inman, and Argo 2011; Yang and Allenby 2003; Ratner and Kahn 2002; Ariely and Levav 2000). Prior marketing research has studied changes in consumers' behaviors in individual versus social contexts, using a wide variety of explanations from different disciplines, such as sociology, anthropology, or social psychology (see Dahl *JCR website*). However, no previous research has investigated the underlying neural processes associated with consumers' adjustments to the social context. In the current study, we examined brain activity in participants who passively view pictures of basic versus luxury branded products, either alone or together with one other person. A study of brain responses to marketing relevant stimuli in the

alone versus together condition provides a window, complementary to self-reports, into the workings of consumers' minds (e.g., Yoon et al., 2006). These insights in turn allow marketing professionals to better understand the attention-allocation behavior of consumers which might eventually translate into more sales. Indeed, attention to marketing stimuli is a key issue for marketing professionals, because attention is scarce and breaking through the marketing communication clutter poses major challenges (e.g., Pieters, Wedel, and Zhang, 2007).

Two aspects of social context characterize our study. First, using electrophysiological recordings (EEG), we focus on people's attention allocation to branded products in the first second after picture onset (Plassmann, Ramsøy, and Milosavljevic, 2012). Specifically, we examine changes in consumers' brain responses during mere observation, which implies seeing or noticing salient cues, such as pictures of the product, brand logos and packaging and thus without concrete experience, such as sampling by tasting or actual usage (Han et al., 2010). Second, we focus on the situation where another person is passively co-present, which is defined as a non-interactive social or mere presence situation (Zajonc, 1965). Specifically, a social agent is physically present but does not attempt to engage the other person in any way.

The paper is organized as follows. First, using recent research by marketing and neuroscience, we report evidence on whether human brain responses to more emotionally significant stimuli (photos), which occurs

for luxury branded products, differentiates from brain responses to less emotionally involving stimuli, which happens for basic branded products. Second, we use social facilitation theory to explain how these brain differences might be modulated by social context. Third, we develop our hypotheses on whether exposure to pictures of luxury versus basic branded products is reflected differently in the early and late event-related potentials (ERPs) time windows and whether mere presence of another person can modulate the differences. Next, we present our material, including experimental set up, physiological and behavioral data collection, EEG recordings, and statistical procedures. Then, we report and examine the results. Finally, we discuss the theoretical and practical implications of our findings and make suggestions for future research.

3.2. THEORY

3.2.1. Luxury Branded Products and Emotion

We assume that luxury branded products can be conceived as emotionally significant stimuli. Emotional stimuli are known to direct attention so as to enable more detailed evaluation or to promote a response. Luxury products may evoke emotions that can be positive (rewarding; people want them) or negative (punishing; people avoid them).

As Kumar and Garg (2010) argue, luxury branded products induce positive emotions such as aesthetic enjoyment because of the aesthetic qualities of the brand logo or design. Moreover, the intangible perception of

luxury is strongly correlated with pleasure, happiness and inspiration (Dubois and Laurent, 1994; Sweeney and Soutar, 2001). In fact, when discussing their own relationship to luxury products, most consumers say that luxury goods make them dream of a better life (“I’m interested in luxury,” “Luxury products make life more beautiful,” “I like luxury”), (Dubois and Laurent, 1994, 1996). Pleasure and arousal of this sort are frequently reported as the two primary factors of motivation that activate human experience (Wundt, 1896; Bradley and Land, 2007).

Others argue that not all people (e.g., due to differences in standards of living) have positive experiences with luxury products (e.g., due to low budget constraints) and thus, depending on the situation (e.g., giving gifts to friends versus personal usage), consumers might not desire luxury goods. People with this frame of mind feel uneasy toward luxury goods and tend to characterize luxury products as overly frivolous, flashy, and useless (Dubois and Laurent, 1994, 1996). However, Dubois and Laurent (1994) suggest that most negative emotions are attributed to “others’ luxury”, whereas the positive ones are assigned to “my” luxury. Either way, when positive or negative emotions are triggered, they affect the vigor of the consumer’s attention to these stimuli (e.g., Dubois and Laurent, 1994, 1996; Ferrari et al., 2011; Griskevicius et al., 2010; Sweeney and Soutar, 2001).

3.2.2. ERP and Attention to Emotionally Significant Stimuli

Event-related potentials (ERPs) offer high temporal resolution which makes them a valuable technique to distinguish early perceptual reactivity from

more complex and elaborate emotional processes (Gardener, et al., 2013). Early ERPs, those occurring up to the first 300 ms after stimulus onset, are assumed to reflect reflex-like visual attention which presumptively promotes initial sensory encoding of emotionally significant stimuli (Junghöfer et al., 2001; Schupp et al., 2003, 2007). This early sensory encoding is likely to facilitate the setting-up of more sophisticated processing of emotional visual stimuli, presumably producing more elaborate emotional effect which is reflected in enhanced later ERP components such as the P3 and the Late Positive Potential (LPP, see Cuthbert et al., 2000). Here we will look at three components: the P2, the P3 and the LPP.

The P2 is a positive-going waveform in the 150-250 ms time window after stimulus onset. It is thought to index early selective attention. The P2 is modulated by emotional arousal and marks the onset of a persistent positive shift of the ERP waveform in response to affective stimuli (Amrhein et al., 2004; Olofsson et al, 2008).

The P3 is characterized by a positive-going waveform within the 250-450 ms latency range. Typically the P3 amplitude is modulated by task-relevance. However, affective stimuli also elicit increased P3 amplitudes (Cuthbert et al., 2000; Palomba, Angrilli and Mini, 1997). This bottom-up effect of motivationally relevant stimuli on the P3 may indicate automatic attention capture by these stimuli (Di Russo et al., 2006; Hajcak, MacNamara, & Olvet, 2010).

Considerable empirical evidence suggests that enhanced LPP amplitude is a reliable, replicable, temporally sensitive indicator of emotional processing (Cacioppo et al., 1994; Cuthbert et al., 2000; Hajcak et al., 2006; Keil et al. 2002; Schupp et al., 2003, 2007). The LPP is a long-lasting, positive slow wave, and is maximal over centro-parietal sites and peaking around 500-700 ms after stimulus onset (Cuthbert et al., 2000; Hajcak, MacNamara, and Olvet, 2010; Münte et. al., 2000; Olofsson et al., 2008). In particular, greater amplitude of the LPP is observed for emotionally significant (pleasant and unpleasant) compared to neutral visual stimuli (see Olofsson et al., 2008). Furthermore, in the context of affective perceptual processing, the LPP emotional effect is assumed to indicate sustained enhanced attention allocation and motivational significance to emotional visual stimuli (Bradley et al., 2003; Lang and Bradley, 2010).

Functional neuroimaging research in support of previous electrophysiological findings reports enhanced activity in the visual cortex when a person views emotional compared to neutral pictures, with more substantial differences in the right hemisphere compared to the left (Lang, Bradley and Cuthbert, 1998). Moreover, combined fMRI and ERP studies report that LPP reflects enhanced sustained processing of emotionally significant stimuli in visual cortices, resulting from re-entrant processes from the amygdala, of which the brain nuclei are known to be involved in emotional processing (Britton et al., 2006; Sabatinelli et al., 2007).

3.2.3. Mere Presence and Nondirective Arousal

Recently Argo et al., (2005, p. 211) proposed that marketing researchers should examine Zajonc's (1965) social facilitation theory as it might present "a more comprehensive theoretical explanation" for the effect of mere presence on consumer behavior in a social context. We draw on Zajonc's social facilitation theory, which consists of a four-step process: (1) the mere presence of others, (2) which evokes arousal (automatic physiological process), which (3) facilitates a dominant response (e.g., luxury branded products evoke emotions and consequently stimulate attention to them), and (4) expresses this either as increases in well-learned tasks or decreases in less-learned tasks (e.g., buying branded products impulsively versus buying a complex mortgage) (see Sabini, 1992, p. 71). Our passive viewing task excludes step (4), which might encompass easily accomplished behavior (e.g., impulse buying). Zajonc (1965) also suggests that mere presence, defined as non-interactive exposure, and thus giving little opportunity for competitive behavior or imitation, is a sufficient condition for causing nondirective and nonspecific arousal: "In the presence of others, some degree of alertness or preparedness for the unexpected is generated, not because there is the anticipation of positive or negative incentives, or threat of evaluation, but simply because one never knows what sort of responses – perhaps even novel and unique – might be required for the individual" (p. 16). Zajonc's theory of mere presence suggests that "being around people works like cup of coffee: It is stimulating." (Sabini, 1992, p. 71). Zajonc (1965) observes that mere presence is also influential

in the animal kingdom (e.g., among cockroaches and primate apes), pointing to the evolutionary roots of this facilitation process and thus indicating that it might occur at an unconscious level in humans.

We conceive of arousal as a physiological, unconscious process (e.g., Kroeber-Riel, 1979; Cacioppo, Berntson and Crites, 1996). This differs from the perspective maintaining that arousal is a subjective experience of energy mobilization and can be measured solely from self-reports (Di Muro and Murray, 2012, p. 547). Physiological arousal is not a specific process that can be reduced to the activation of one specific neural pathway, but essentially affects several neural pathways that ultimately all influence the vigor and direction of attention to what is emotionally significant in the environment for the perceiver (e.g., Robbins, 1997).

3.3. HYPOTHESES

As discussed above, luxury products might provoke both positive (attraction) and negative (avoidance) reactions. However, for most customers, luxury products typically elicit pleasure and desire when contemplated at a distance (passive viewing), compared to situations in which actual purchase is considered or experienced, where deliberation is involved, which might elicit negative emotions such as anticipatory guilt (Dubois and Laurent, 1994). For the experimental task in the current study, which involves only passive viewing of marketing-related stimuli and thus no specific buying decision is involved, luxury branded products are expected to evoke more intense emotions such as pleasure, joy, and desire

than basic branded products. It is important to acknowledge that basic branded products might also induce emotions, but generally with lower intensity than luxury ones. In order to test this prediction, we asked a sample of female undergraduates to appraise a set of pictures of luxury branded products versus a set of basic branded products, using a multiple-item scale which gauges customer's perceptions of the value of consumer durable products at the brand level (Sweeney and Soutar, 2001). More precisely, we investigated the emotional value dimension on a brand level to test if luxury branded product pictures scored higher on emotional value compared to basic branded product pictures (Sweeney and Soutar, 2001). Past research suggests that viewing luxury branded products elicits intense positive emotions such as pleasure, desire, and joy (Dubois and Laurent, 1994, 1996; Hagtvedt and Patrick, 2009; Kapferer, 1997; Sweeney and Soutar, 2001). Thus, we hypothesize:

Hypothesis 1: Pictures of luxury branded products, as opposed to basic branded products, will score higher on the emotional value dimension at a brand level.

Social facilitation theory suggests that the mere presence of others, even in complete absence of the possibility to engage in imitative or competitive behavior, is a sufficient condition for the occurrence of nondirective and nonspecific arousal that is likely to magnify an ongoing dominant response (Zajonc, 1965). The experimental task used in our study does not require action or overt behavior, only passive viewing of

marketing stimuli, and thus it conforms well with the hypothesis that the mere presence of others can produce nondirective arousal. Furthermore, as opposed to physical stimuli, social stimuli have a less systematic and thus less predictable effect on a person (Markus, 1978). Arousing stimuli typically elicit a more positive going ERP waveform, starting around 200 ms post stimulus onset (e.g., Amrhein et al., 2004). We expect that a more arousing social context (Together versus Alone) elicits a comparable ERP effect. Therefore, we hypothesize:

Hypothesis 2: More positive – going ERP amplitudes will occur for all components (P2, P3, LPP) in the Together condition as opposed to the Alone condition.

Finally, we explored whether participants manifest more emotionally motivated attention to pictures of luxury branded compared to basic branded products. As hypothesis 1 suggests, luxury branded products should possess greater emotional significance than basic branded products. However, we do not expect to see early ERP differences between the two brand types. Early ERP modulation over occipital sites is likely to reflect automatic selective attention (Bradley et al., 2007; Schupp et al., 2007). From a perceptual point of view, both luxury and basic brand pictures present similar content (e.g., chocolates, beverages, shoes, lingerie), thus we do not expect ERP brand-type differences for the P2 and P3 components. On the other hand, the LPP seems to reflect sustained attention to significant stimuli that is under conscious control. Numerous studies

have demonstrated that the LPP amplitude in response to stimuli of high emotional and motivational significance can be modulated by cognitive reappraisal (e.g., Hajcak and Nieuwenhuis, 2006). In other words, the LPP emotion effect may be dependent of how an individual appraises an emotional stimulus. Therefore, larger LPP amplitudes can be expected for luxury than for basic brand pictures. Thus, we predict that in the Together condition a greater allocation of attention to more emotionally significant stimuli (luxury branded products) compared to less emotionally significant stimuli (basic branded products) will be magnified by the arousal effect of the co-presence of others. This brand-type emotional effect, reflected in posterior LPP modulation, will likely constitute a dominant response under the framework of social facilitation theory (Zajonc, 1965). As previously discussed, viewing luxury branded products is likely to evoke more intense emotions, such as pleasure, joy, and desire, compared to viewing basic branded products, which should produce less intense emotions (Dubois and Laurent, 1994, 1996). As a result, we expect to observe more enhanced LPP amplitudes for luxury versus basic branded products in the Together condition, than in the Alone condition. Consequently, we hypothesize:

Hypothesis 3: Viewing luxury branded products compared to basic branded products will reliably enhance the LPP amplitude. The LPP brand effect will be larger in the Together than in the Alone condition.

3.4. METHOD

3.4.1. Participants

Forty healthy female (Age $M = 22.07$, $SD = 2.09$) undergraduates from a Dutch University participated in this study. Participants enrolled in the experiment in exchange for course credit. All participants had normal or corrected-to-normal vision. Informed consent was obtained at the beginning of the experiment.

3.4.2. Materials

Stimuli consisted of a pool of 120 pictures chosen from various product categories (chocolates, beverages, shoes, and lingerie). The pictures were selected by a group of five female students who received payment for this task. In a pre-test, 80 female undergraduates (Age $M = 20.16$, $SD = 2.35$) from a Dutch University were asked to classify the 120 branded pictures. They were invited to make a dichotomous choice and indicate which branded product pictures they perceived as luxury and which as basic. A branded product was considered luxury or basic if at least 90% of the respondents rated it as such. Based on the results of the pre-test, we create two categories of products: 60 luxury branded and 60 basic branded products. The 120 pictures were divided into two sets of 60 pictures (30 basic, 30 luxury in each set) which were each then assigned to either of the study conditions (Alone, or Together). On average 97% and 95% of the respondents classified both the 30 luxury branded products and the 30 basic

branded products as such in each Set 1 and Set 2, respectively. For more details on the two sets of 60 pictures (for further information, see Web Appendices A, B, C and D).

In addition, we investigated differences in perceptions of the emotional value of the luxury versus basic branded products. We used the well-established five-item measure, PERVAL (for further information, see Web Appendix E) to assess perceptions of the emotional value of a consumer durable product at brand level (Sweeney and Soutar, 2001). Sweeney and Soutar (2001) describe the emotional value dimension as “the utility derived from the feelings or affective states that a branded product generates.” As the next step, we created four sets of four branded products each. Two sets contained four randomly selected basic branded products (one chocolate, one beverage, one shoe, and one lingerie item). The other two sets included four randomly selected luxury branded products (one chocolate, one beverage, one shoe, and one lingerie item). We created two questionnaires, each featuring one set of basic, and one set of luxury, branded products. The order of the sets was alternated between the two questionnaires. Thus, one questionnaire started with an evaluation of the set of luxury branded products, while the other one started with an evaluation of the set of basic branded products. This was done to avoid order effects in the evaluation of the different sets. After viewing each set of four products, participants answered the five-item PERVAL scale. Each of the two questionnaires was answered by 30 female undergraduates from a Dutch University, who participated in exchange for a chocolate bar. In total 60

females participated (Age $M = 21.16$, $SD = 2.55$) took part in the PERVAL study.

3.4.3. Procedures

The experiment was conducted in two sessions (Alone and Together conditions). For the Alone condition, EEG recordings were collected from solitary participants completely isolated in a dimly lit, electrically shielded EEG laboratory. For the Together condition, two participants were together in the same EEG lab. Participants sat in comfortable chairs approximately 100 cm away from, and at eye level with, a 40x30 cm Iiyama PC computer screen. In the Together condition, the participants sat beside each other, both facing the computer screen. The order of the Alone and Together conditions was alternated. Participants interacted with each other during the installation of the EEG caps and in the period between the Alone condition and Together condition sessions. In all conditions, the leader of the experiment left the room, ensuring that his mere presence did not affect the findings.

In both conditions, participants were shown a succession of 60 pictures of branded products displayed centrally on the computer screen using E-prime presentation software (Psychology Software Tools, Inc). The pictures included 30 luxury branded products (food, beverages, shoes, and lingerie) and 30 basic branded products (food, beverages, shoes, and lingerie). The pictures were presented in random order, and each picture was viewed once only and in only one of the two conditions. The pictures

were perfectly counterbalanced across conditions. The first couple of participants viewed Set 1 in the Alone condition and Set 2 in the Together condition. The second couple viewed Set 2 in the Alone condition and Set 1 in the Together condition, and so on. Each picture was presented for 6000 ms with an interval of 2500 ms of fixation point (+) in the center of the computer screen between pictures. Participants were instructed to watch the visual stimuli without making any overt response or movement. To reduce the amount of ERP artifacts caused by eye movements, the participants were instructed to relax and reduce blinking and other ocular movements during the visual task studied in this experiment. Immediately after the two EEG sessions, participants completed a post-experiment questionnaire, reporting if they felt more comfortable watching the pictures of the branded products in the Alone or in the Together condition (Alone, No difference, Together with another person).

3.4.4. Electrophysiological Recordings and Analysis

The electroencephalogram (EEG) was recorded continuously from 32 active Ag/AgCl electrode sites using a BioSemi 32-channel elastic head cap with standard international 10-20 system layout. In the Together condition, EEG was recorded with two identical 32-channel EEG caps. Each cap signal was acquired from two separate, identical amplifiers (BioSemi Active-Two system AD-box) connected to each other and the same computer with optical cable. Flat-type active electrodes were attached to the right and left mastoids. Electrodes located on the outer canthi of each eye,

as well as below and above the left eye measured bipolar horizontal and vertical EOG activity. In addition, an active pin-type electrode (CMS, common mode sense) and a passive pin-type electrode (DRL, driven right leg) were used to compose a feedback loop for amplifier reference. Online, EEG was digitized at a sampling rate of 512Hz, 24-bit A/D conversion.

Further off-line processing was performed with Brain Vision Analyzer (Brain Products GmbH, Germany; www.brainproducts.com). Off-line, the EEG signals were re-referenced to the average of the left and right mastoids. EEG data were band-pass filtered between 0.1Hz and 30Hz. Artifacts caused by ocular movements were removed by applying Independent Component Analysis (ICA) with Brain Vision Analyzer (for more details see Brain Products GmbH, Germany; www.brainproducts.com). Next, EEG signals for each picture were segmented with 200 ms pre-stimulus (baseline) to 1000 ms post-stimulus ERP epoch. The ERP signals were defined relative to the mean of the 200 ms pre-stimulus baseline period. Each segment was subjected to artifact-rejection processing. The artifact-rejection method excluded epochs with large amplitude (over $\pm 100 \mu\text{V}$). EEG recordings were analyzed four times independently by two experienced EEG researchers (blind to the stimulation condition) with particular attention to residual contamination of the EEG epochs due to eye or muscle artifacts. As a result, only epochs completely free from artifacts were considered for the following statistical analyses. To ensure an adequate signal-to-noise ratio in the ERPs, subjects with fewer than 25 artifact-free epochs per condition (Alone, Together) in

each brand category (Basic, Luxury) were excluded from the analysis and were replaced (two subjects in total were replaced).

3.4.5. Statistical Analysis

Time-locked to the onset of each branded product picture, ERPs were averaged per participant for each type of brand category (Basic, Luxury) and separately for each condition (Alone, Together). Participants viewed 30 basic and 30 luxury pictures of branded products in each of the two conditions. Two different sets of 60 pictures were presented for Alone and Together sessions respectively (for further information, see Web Appendix A and Web Appendix B). The order of presentation of the two sets was alternated between the two conditions, as well as the order of the conditions. As a result, Average ERP waveforms were computed for 30 basic and 30 luxury pictures of branded products for each Alone and Together condition, respectively.

Past research suggests that the modulation of P2 and P3 amplitude to emotional visual stimuli is most distinct in the posterior scalp location (Carretie et al., 2001a, 2001b; Keil et al., 2002; Schupp et al., 2004). Moreover, previous studies found that emotional modulation of the LPP is most pronounced in the superior-posterior scalp locations, maximal at parietal electrodes (Cacioppo et al., 1994; Codispoti, et al., 2006; Cuthbert et al., 2000; De Cesarei and Codispoti, 2006; Sabatinelli et al., 2005, 2007; Schupp et al., 2007; Zilber et al., 2007). Posterior-lateralized modulation of early and late ERP amplitude to emotional visual stimuli was frequently

reported for both left and right hemispheres (Dolcos and Cabeza, 2002; Jünger et al., 2001; Keil et al., 2002; Schupp et al. 2003). Therefore, we did statistical analysis at nine subsequent electrodes sites: left (C3, P3, O1), midline (Cz, Pz, Oz) and right (C4, P4, O2).

In response to emotional visual stimuli, P2, P3 and LPP were quantified at the posterior scalp locations, basing the chosen time windows on previous research (see for comparable time windows Amrhein et al., 2004; Bradley et al., 2007; Carretie et al., 2001a; Cuthbert et al., 2000; Dolcos and Cabeza, 2002; Foti et al., 2008; Hajcak et al. 2006; Ikezawa, Corberra and Wexler, 2013; Keil et al. 2002) and visual inspection of grand-averages waveforms. The P2, P3, and LPP time windows area measures were evaluated with a three-way repeated measures analysis of variance (ANOVA): within-subjects factors were Brand (Basic, Luxury), Condition (Alone, Together), and Laterality (Left, Midline, Right). We controlled for multivariate normal distribution with the Mauchly test of sphericity, and applied the Greenhouse-Geisser correction, when appropriate (Gardener et al., 2013). A $p < .05$ was considered significant (Keeser et al., 2011). Significant interaction effects were followed by paired sample t-tests. Bonferroni correction was implemented to adjust for multiple comparisons. Statistics were analyzed with the IBM SPSS 13.0 software (Statistical Package for Social Sciences, SPSS Inc, Chicago).

3.5. RESULTS

3.5.1. Behavioral Results

Perceived Value of the Branded Products (PERVAL)

The results of the PERVAL questionnaires supported our first hypothesis. As expected, participant ratings on the emotion value dimension, on a seven-point rating scale (7 = 'Strongly agree') differed as a function of brand type. The ANOVA analysis with factors Questionnaire type (Luxury before Basic, Basic before Luxury) and Brand type (Basic, Luxury) revealed a significant main effect for Brand type [$F(1, 28) = 157.68, p < .001$]. Pairwise brand type contrasts indicated a significant difference on emotional dimension ratings between luxury branded products ($M = 5.91, SD = .93$) and basic branded products ($M = 2.90, SD = 1.12$), ($t(58) = 13.57, p < .001$). There was no significant main effect of Questionnaire [$F(1, 28) = .31, p = .57$], and the interaction effect between Questionnaire and Brand was also not significant [$F(1, 28) = .74, p = .39$]. Cronbach's alpha of the five items used to measure the emotional value dimension was $\alpha = .92$ for the set of basic branded products and $\alpha = .90$ for the luxury branded product set.

Self Report of Experienced Comfort between Conditions

Most participants in the EEG experiment reported that they felt no difference in comfort watching the branded product pictures in either the Alone or Together condition; Alone = 22.5%, No difference = 72.5%, Together with another person = 5%.

3.5.2. ERPs

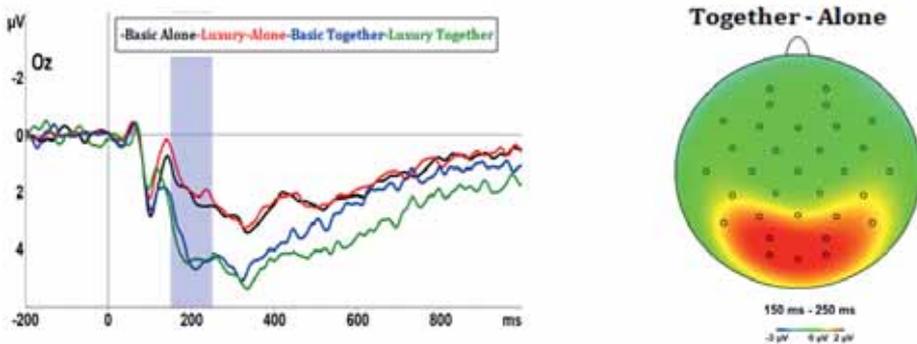
The overall shape of ERPs was similar for luxury and basic branded products across conditions (Alone, Together), and as expected it was characterized by P2, P3, and LPP components. We identified a condition effect for both luxury and basic branded product pictures: early posterior (parietal-occipital) distributed ERPs in Together condition were more positive-going than ERPs for Alone condition (see Figure 4, left panel). Importantly, however, and consistent with previous findings, we found an emotion effect: parietal distributed LPPs, showed strong positivity, from 500 to 700 ms after onset of the luxury branded product pictures (see Figure 3, left panel). There was no such enhanced positivity for basic branded product pictures. However, this emotion effect was shaped by the condition. Specifically, the emotional effect was present only in the Together condition, from 500 to 700 ms after stimulus onset (see Figure 3, left panel). To test these observations, ANOVAs were computed on ERPs from left (C3, P3, O1), midline (Cz, Pz, Oz), and right (C4, P4, O2) scalp areas, at the three time windows: P2 (150-250 ms), P3 (250-450 ms), and LPP (500-700 ms).

P2 (150-250 ms)

Repeated measures ANOVA on the P2 mean amplitude in the 150-250 ms time window, showed significant main effects of Condition [$F(1, 39) = 9.09, p = .004$] and Laterality [$F(2, 78) = 17.70, p < .001, \hat{\epsilon} = .885$]. The condition effect showed that P2 mean amplitude was significantly lower in

the Alone condition ($M = 1.39 \pm 2.23\mu\text{V}$) than in the Together condition ($M = 2.41 \pm 2.82\mu\text{V}$). Pairwise Laterality contrasts revealed that P2 mean amplitude was significantly different between Left ($M = 2.48 \pm 2.49 \mu\text{V}$) and Midline ($M = 1.65 \pm 2.45 \mu\text{V}$), ($t(39) = 5.18, p < .001$), and between Left ($M = 2.48 \pm 2.49 \mu\text{V}$) and Right ($M = 1.58 \pm 2.22 \mu\text{V}$), ($t(39) = 4.61, p < .001$) scalp areas. There was no significant difference between Laterality Midline and Right, $p = .641$. All pairwise comparisons were $p < .05$ (Bonferroni corrected). The main effects were not quantified by significant interaction effects. To summarize, the results indicated more enhanced P2 amplitude in the Together compared to the Alone condition over occipital scalp sites (see Figure 4, right panel).

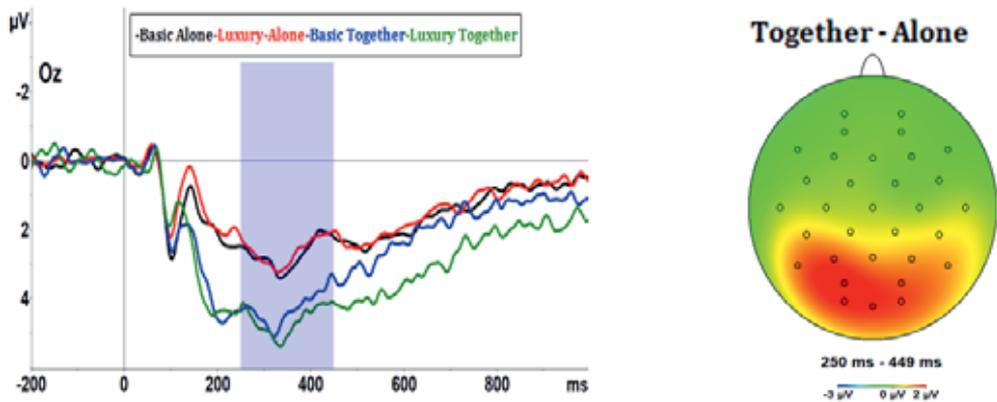
Figure 4: P2 CONDITION EFFECT: *The left panel depicts grand mean ERP waveforms from Oz electrode, elicited by viewing Basic products (Alone, Together) and Luxury products (Alone, Together). The right side depicts scalp topographies for the difference between conditions (Together minus Alone) within the interval marked by the blue-shaded area (150-250 ms) in the ERP plot. Mean P2 amplitude was significantly higher in the Together compared to the Alone condition in the occipital scalp locations (red).*



P3 (250-450 ms)

Repeated measures ANOVA on P3 mean amplitude in the 250-450 ms time window revealed significant main effects of Condition [$F(1, 39) = 6.03, p = .019$] and Laterality [$F(2, 78) = 14.17, p < .001, \hat{\epsilon} = .916$]. P3 mean amplitude was significantly lower in the Alone condition ($M = 2.01 \pm 2.80 \mu V$) than in the Together condition ($M = 3.17 \pm 3.23 \mu V$). Pairwise Laterality contrasts revealed that P3 mean amplitude was significantly different between Left ($M = 3.14 \pm 2.89 \mu V$) and Midline ($M = 1.96 \pm 2.88 \mu V$), ($t(39) = 6.16, p < .001$), and between Midline ($M = 1.96 \pm 2.88 \mu V$) and Right ($M = 2.67 \pm 2.46 \mu V$), ($t(39) = -3.18, p = .003$) scalp areas. There was no significant difference between Laterality Left and Right, $p = .07$. All pairwise comparisons are $p < .05$ (Bonferroni corrected). To summarize, the results indicated enhanced P3 amplitude in the Together condition compared to the Alone condition which was most robust over lateral parieto-occipital scalp sites (see Figure 5, right panel).

Figure 5: P3 CONDITION EFFECT: The left panel depicts grand mean ERP waveforms from Oz electrode, elicited by viewing Basic products (Alone, Together) and Luxury products (Alone, Together). The right side depicts scalp topographies for the difference between conditions (Together minus Alone) within the interval marked by the blue-shaded area (250-450 ms) in the ERP plot. Mean P3 amplitude is significantly higher in Together compared to Alone condition in the posterior (parietal-occipital) scalp location (red).



LPP (500-700 ms)

Repeated measures ANOVA with Condition (Alone, Together), Brand (Basic, Luxury), and Laterality (Left, Midline, Right) as within-subject factors on the LPP mean amplitude in the 500-700 ms time window revealed significant main effects of Laterality [$F(2, 78) = 9.67, p < .001, \hat{\eta}^2 = .976$] and Brand [$F(1, 39) = 13.58, p = .001$]. Pairwise Laterality contrasts revealed that LPP mean amplitude was significantly different between Left ($M = 3.23 \pm 2.44 \mu V$) and Midline ($M = 2.44 \pm 2.41 \mu V$), ($t(39) = 4.67, p < .001$), Left ($M = 3.23 \pm 2.44 \mu V$) and Right ($M = 2.80 \pm 2.10 \mu V$), ($t(39) = 2.24, p = .031$), and between Midline ($M = 2.44 \pm$

2.41 μV) and Right ($M = 2.80 \pm 2.10 \mu\text{V}$), ($t(39) = -2.02, p = .05$) scalp areas. LPP mean amplitude was significantly higher in Luxury ($M = 3.22 \pm 2.25 \mu\text{V}$) than in Basic ($M = 2.42 \pm 2.41 \mu\text{V}$). However, there was no significant main effect of Condition [$F(1, 39) = 2.55, p = .118$]. All pairwise comparisons are $p < .05$ (Bonferroni corrected).

Most importantly, these main effects were qualified by a third-order interaction Condition \times Brand \times Laterality [$F(2, 78) = 3.37, p < .040, \hat{\epsilon} = .992$]. Pairwise Basic versus Luxury contrast at each Laterality position revealed that the LPP Brand effect was significant for all lateral positions in the Together condition, with the LPP amplitude higher for Luxury compared to Basic. Particularly in Laterality “Left”, the LPP mean amplitude for Luxury ($M = 4.25 \pm 3.25 \mu\text{V}$) was significantly higher than Basic $M = (3.12 \pm 3.84 \mu\text{V})$, with $p = .013$. In Laterality “Midline”, the LPP amplitude for Luxury ($M = 3.59 \pm 3.38 \mu\text{V}$) was again significantly higher compared to Basic ($M = 2.07 \pm 3.56 \mu\text{V}$), with $p = .001$. Finally, in Laterality “Right”, the LPP amplitude for Luxury ($M = 3.92 \pm 3.08 \mu\text{V}$) was significantly higher than Basic ($M = 2.56 \pm 3.03 \mu\text{V}$), $p = .001$ (see Figure 3). However, the LPP Brand effect was not significant in any lateral positions for the Alone condition: Left, with $p = .341$, Midline, with $p = .374$ and Right, with $p = .927$, (see Figure 7). This implies that respondents had greater late parietal activation for Luxury branded products compared to Basic branded products when they were in the Together condition as opposed to the Alone condition (see Figure 6, right panel).

Figure 6: LPP EFFECT OF BRAND TYPE: The left panel depicts grand mean ERP waveforms from Pz electrode, elicited by viewing Basic products (Alone, Together) and Luxury products (Alone, Together). The right side depicts scalp topographies for the difference between brand type (Luxury minus Basic) waves for both Alone (left) and Together (right) conditions within the interval marked by the blue-shaded area (500-700 ms) in the ERP plot. There was no significant difference between the LPP amplitude of Basic and Luxury branded product pictures in the Alone condition. However, in the Together condition, LPP mean amplitude was higher for Luxury compared to Basic branded product pictures in the centro-parietal scalp locations (red).

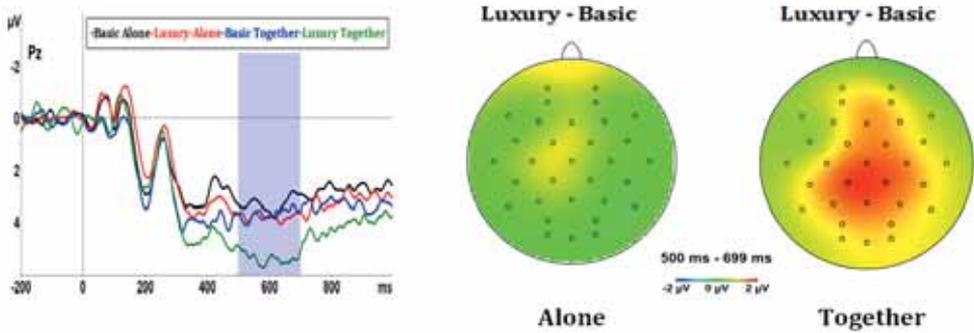
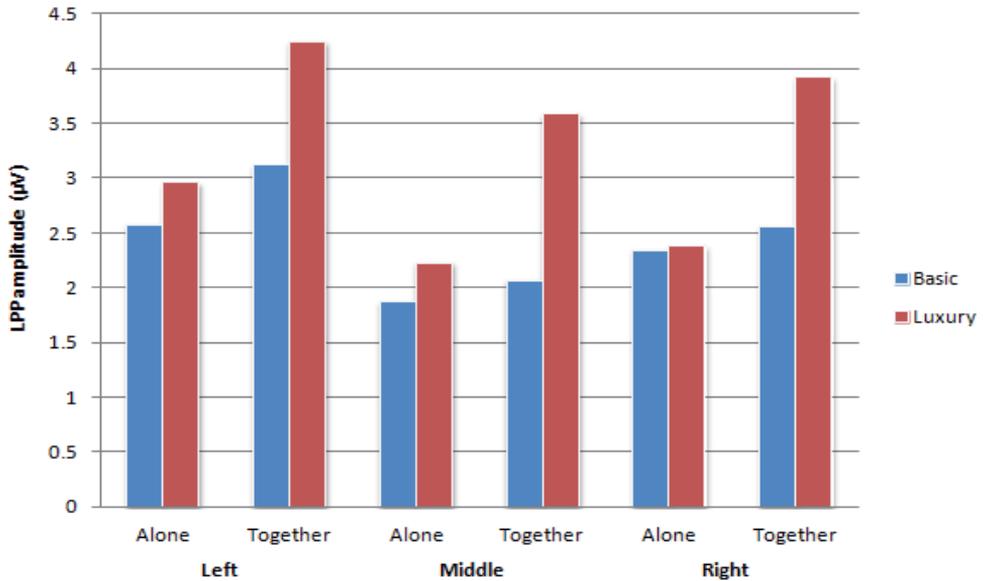


Figure 7: *LPP (500-700ms) MEAN AREA MEASURES FOR BASIC VERSUS LUXURY BRANED PRODUCTS AS A FUNCTION OF CONDITION (ALONE, TOGETHER) AND LATERALITY (LEFT, MIDDLE AND RIGHT): LPP mean amplitude was significantly different between Luxury and Basic branded product pictures only in Together for all three posterior Laterality areas. There was no significant difference between Luxury and Basic branded product pictures in the Alone condition.*



3.6. DISCUSSION

Our study primarily investigated whether attention allocation during passive viewing of emotionally significant marketing stimuli is modulated by the mere presence of others. In line with our first hypothesis, female undergraduates found that luxury branded products have higher emotional value than basic branded products. The physiological results partially supported our second hypothesis. The P2 and P3 amplitudes, but not the

LPP amplitudes, were reliably enhanced by the mere presence of others, regardless of the emotional significance of the presented marketing visual stimuli. Although all results were in the predicted direction, the main Condition effect of LPP didn't reach statistical significance. This suggests that the LPP is less sensitive to general nondirective arousal elicited by the social context, and probably more sensitive to sustained motivated attention elicited by actual emotionally significant stimuli. Finally, largely in line with our third hypothesis, viewing luxury branded products compared to basic branded product resulted in a more enhanced LPP amplitude in the Together versus the Alone condition. Although in the Alone condition the LPP is slightly larger for the luxury than for the basic brands, the difference didn't reach statistical significance. This suggests that in the present research, the luxury brands as such did hardly attract more sustained motivated attention than the basic brands. But as the interaction of brand type and condition clearly demonstrates, it is only in the Together condition that much more motivated attention is directed to the luxury than to the basic branded products.

Our results conform to previous studies in the basic literature, where LPP modulation during passive viewing of pictures was qualified as a key ERP index of attention allocation and motivational significance (Bradley, et al., 2007; Ferrari et al., 2011; Hajcak, et al., 2010). However, going beyond previous research, our findings suggest that motivated attention to emotionally significant marketing stimuli is modulated by social context, defined here as the condition of non-interactive mere presence of another

person. In terms of the temporal course of this effect, the LPP elicited by luxury branded product pictures compared to basic branded product pictures differed in the 500-700 ms time window after stimulus onset (e.g., De Cesarei and Codispoti, 2006, Dolcos and Cabeza, 2002, Hajcak et al., 2006). With regard to the spatial lateralization of the emotion effect, we found higher left and right hemisphere mean LPP amplitudes. Our results are consistent with previous basic research findings that report larger emotion effects over the right parietal-occipital sites (Dolcos and Cabeza, 2002, Jüngerhofer et al., 2001, Schupp et al. 2003). Consistent with our findings, Keil et al., (2002) present evidence for enhanced LPP mean amplitudes over the left postero-inferior/superior sites compared to the right postero-inferior/superior sites for emotional versus neutral visual stimuli. Importantly, however, all marketing stimuli used in our experiment are not completely neutral. Basic branded product pictures imply a certain level of emotional value, although this was significantly lower than the luxury ones, as suggested by the behavioral results. This made it more challenging to find significant ERP brand differences, thus providing a tougher test of hypotheses compared to non-marketing electrophysiological studies conducted to date. Furthermore, recent studies report evidence that emotional processing elicited by pictures, faces, and words may be similar in terms of their spatial and temporal characteristics (Kissler et al., 2007, Schacht and Sommer, 2009). Therefore, our findings likely generalize across different stimuli relevant to marketing communication.

Marketing is a social activity, and much work has already alluded to this dimension of consumer behavior (e.g., Argo et al., 2008). The physiological results of our study confirm the regulatory role of mere presence on consumers' behavior. In other words, people attend differently to visual marketing stimuli when viewed alone than in the co-presence of others. Our reasoning is based on social facilitation theory, which assumes that the arousal produced by the mere presence of the others amplifies the dominant response which in our case is the allocation of attention to emotionally significant marketing visual stimuli. Zajonc (1965) speculated that the arousal provoked by the mere presence of others is a physiological process occurring in the body and brain, especially in the autonomic nervous system, but he did not examine how arousal affects brain processes. Recently, Sara (2009) showed that attention behavior to stimuli is also affected by arousal processes involving the production of norepinephrine in the brainstem, which affects functioning of other parts in the brain. The fact that people pay attention to marketing stimuli differently when they are with other people fits well with earlier observations that have emerged in qualitative marketing research, such as the observation that consumers co-create the meaning of these stimuli with others (Schau, Muñiz, Arnould, 2009, for a good review). Note that Schau et al. (2009) base their work on research in social construction theory in sociology, covering longer periods than investigated in our study, such as people visiting baseball games on a regular basis. However, in our work, the two participants did not know each other and yet their co-presence affected their attention resources, even presumably unconsciously. One might assume

that this attention to emotionally significant stimuli, which was amplified by the simple social context, constitutes a baseline or foundation for the co-creation of meaning of marketing-related stimuli to which Schau et al., (2009) allude (see also Beckes and Coan, 2011). Zajonc (1965) emphasizes the evolutionary roots, observable even in insects, of social facilitation. Therefore, the modulation of attention resources toward emotionally significant visual stimuli in the mere presence conditions is most likely an unconscious process. In support of this conclusion, immediately after the experiment, we asked participants whether they felt that viewing the branded product pictures during the Alone and Together condition was the same or different (i.e., “equally comfortable”). Surprisingly perhaps, 72.5% of the participants answered they felt no difference between viewing the marketing visual stimuli in either condition. Thus, neuroscience can help us to uncover processes that people are not consciously aware of and thus complement traditional marketing research methods, such as self-reports which might be insensitive to attention and other processes and give misleading conclusions.

Perhaps the most interesting finding of our study was that when people viewed marketing relevant stimuli in the mere presence versus alone condition the more emotionally intense visual stimuli elicited higher LPP mean amplitudes. This increase in LPP amplitude might be conceived as a brain signature of the enhanced allocation of relevant processing resources to promote and speed up a proper response to stimuli carrying evolutionary significance (Lang et al., 1997). Fast preferential reactions to emotionally

significant stimuli are considered biologically adaptive as they usually stand for objects that, if experienced in reality, would most likely enhance or diminish one's personal well-being.

Practically, these findings have several implications for marketers. First, regardless of the level of emotional significance of the specific branded product, marketers should try to create social platforms where potential customers can experience brand advertising intensely. Social contexts are likely to enhance customer engagement because of increased nondirective arousal, such as nonspecific attention engagement with branded products, in a “behavioral manifestation that has a brand focus, beyond the purchase resulting from motivational drivers” (van Doorn, 2012 et al., p. 254). In retail settings, the mere presence of other consumers in designer outlets, such as Fox Town in Switzerland, where shoppers congregate, feelings of pleasure, desire, and joy may become amplified. In the digital age, mere presence might unfold even in virtual communities (e.g., Naylor, Lamberton, and West, 2012).

Second, more emotionally significant branded product pictures evoke more emotionally motivated attention, reflected by the superior-posterior LPP modulation, which is higher in the mere presence of others compared to being alone. Marketers of luxury branded products should exploit the amplifying effect of mere presence in emotionally significant visual stimuli (an instance perhaps of “social atmospherics”, Bitner, 1992), which is likely to motivate people to adjust their viewing behavior. For

example, when customers buy clothing, one idea to dress the sales consultants in the branded products on offer (e.g., sales consultants at the Prada retail stores are required to wear the company's clothes), so that clients can have the emotional experience of seeing other people in a dynamic kinesthetic way wearing what they could buy. When selling luxury branded products it might be appropriate to motivate customers to shop in groups (e.g., "Armani family and friends' sales program"), so that the mere presence of others enhances the customer's emotional experience with a certain brand. Store managers could hire people to show interest in the luxury branded products in group settings, analogous to the way that some presidential candidates organize town hall meetings full of supporters, stimulating the mere presence effect (see Turley and Milliman, 2000, for suggestions in the regard). Alternatively, some retailers might strategically choose to place their stores in close proximity to luxury stores (e.g., Designer Outlet Roermond, Netherlands). On the other hand, marketing people should be aware that for some consumers, merely seeing other people wearing luxury products might make them feel uneasy (e.g., Dubois and Laurent, 1994). Such consumers might experience envy or jealousy when surrounded by people wearing luxury products or watching people fascinated by luxury products (see limitations of our research below).

Third, our research shows the value and role of using neuroscience methods in consumer research. Most previous research was done with persons acting alone, and did not consider the possible effects of social context. However, the results of our work indicate that brain responses

during passive viewing of emotionally significant marketing stimuli differ between the alone and mere presence conditions. If brain responses in the alone condition are used to predict future behavior, whether related to marketing (Berns and Moore, 2012) or health (Falk, et al., 2010) contexts, then the neural signals gathered are likely to have low predictive validity (see Ariely and Berns et al., 2010; Venkatraman et al., 2012). The current findings resonate with earlier observations on using laboratory experiments to gauge advertising effectiveness and the elaboration of marketing messages. For example, Stewart (1992, p. 13) points out: “Advertising has become a part of the social fabric of society. It is expected and accepted by consumers. It is not, however, a phenomenon that is easily understood outside the context in which it occurs. Advertising research, borrowing from the recent traditions of experimental psychology, has a long history of examining advertising in isolation of its social context. While this approach has merit, it fails to capture the more theoretically interesting and more relevant interactions to which it contributes.” Introducing social context into the field of neuromarketing could help us gain a better understanding of the different brain processes taking place as people, alone or with others, view relevant marketing stimuli. These insights can help marketers make better predictions about consumer behavior; for instance, what happens when people are alone, with others in an interaction or in a group, or even with others virtually (online) likely involves different mental processes with different marketing implications (see Venkatraman et al., 2012 for a similar view).

Finally, the results of our study indicate that EEG might be a fertile method to study customer motivational engagement with emotionally significant marketing materials displaying branded products. Indeed, LPP is theoretically related to motivated attention, which is likely modulated by the emotional value of the visual stimuli. For example, marketing researchers can apply these implications to study the effectiveness of print ads. Imagine a marketing scenario that compares billboards or flyers. The neuromarketer might suggest that an ad that evokes the largest posterior LPP amplitude would also be the most likely to induce more emotionally motivated attention. A more productive and appropriate way to approach questions on the effectiveness of certain marketing materials might be to combine EEG methods with behavioral measures, such as self-reports. Going one step further, researchers in neuromarketing could take advantage of the temporal and spatial resolution of EEG and fMRI, respectively, with the aim of achieving higher predictive validity (Camerer, Loewenstein, and Prelec, 2005).

3.6.1. Future Research

Goals determine what people give attention to (Wang and Griskevicius, 2014; Plassmann, et al., 2012). Future research should look at whether goals in social context are likely to modify the way people attend to emotionally significant marketing stimuli such as luxury and basic branded products. For instance, instead of letting consumers only passively view pictures of products in an experiment, we could ask them if they wanted to

choose one product or buy shoes they could wear to a party or business meeting. This should modify their attention behavior, which is likely to be reflected by early or late ERP modulations, thereby eventually affecting liking, preferences, and choice.

Second, our sample consisted of female undergraduates, given that the pre-selected marketing visual stimuli were most relevant to women and we wished to avoid gender confounds and reduce resources needed to conduct our experiment. However, it would be interesting to do a similar study with male subjects viewing luxury versus basic branded products relevant to men, such as cars, sport watches, and business clothing. One research question could be: “Would males attend in the same way as females to gender-relevant stimuli (e.g., lingerie)?” Alternatively, “Would we find the same patterns in attention behavior using gender-relevant branded product pictures?” We could design different social contexts for viewing stimuli. For example, what would happen when males and females watch marketing stimuli together? Using the same marketing visual stimuli applied in our study, we could then discover if such emotional responses as embarrassment play a role at the level of attention in consumer choice (Dahl, et al., 2001)? Embarrassment, a self-conscious emotion that happens suddenly and in relation to the presented self, is assumed to be a biologically hard wired response indicating submission to a reference group (e.g., Keltner and Dahner, 1997). EEG research might explain embarrassment occurring in social context better than self-reports, because

it is less susceptible to evaluation apprehension and social desirability effects.

Finally, the participants in our study had a similar social status which obliges us to be cautious in generalizing our findings. Future research should investigate the role that social status might play in modulating consumer brain responses to emotionally significant marketing stimuli in different social contexts. Concretely, what could happen in social contexts, where subjects with a modest income have to watch marketing relevant products (e.g., luxury goods) with a person dressed in luxury brands and thus signaling higher social status is worthy of further study. Perhaps feelings of envy would emerge as they compare themselves and find that they are lower in status (e.g., Mandel, Petrova and Cialdini, 2006; Salovey and Rodin, 1984).

CHAPTER 4: PREFERENCE INFERENCES FROM EYE-RELATED CUES IN SALES-CONSUMER SETTINGS: ERP TIMING AND LOCALIZATION IN RELATION TO INFERRING PERFORMANCE AND OXYTOCIN RECEPTOR (OXTR) GENE POLYMORPHISMS

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4.1. INTRODUCTION

Social scientists acknowledge that the ability to identify the goals and internal states of other people is a key skill which facilitates our navigation into different social contexts. In this study we focus on specific sales-consumer settings where people taking the role of sales consultant infer other people's internal states and product preferences from external cues such as facial expressions and eye-related information in order to figure out what a consumer actually likes. This study investigated a number of questions related to the inferring process of others' product preferences by the salesperson. The first question addressed in the current study was related to the physiological processes associated with the inferring of others' product preferences from eye-related information. Specifically, the current study investigated whether these physiological processes are influenced by the salesperson's genetic makeup. To address these questions the current investigation explored the electro physiological differences between preference inferences from eye-related information versus passive

viewing of branded products. Moreover, this study examined variation in a candidate gene, the oxytocin receptor (*OXTR*) gene, known to affect social cognition (Skuse et al., 2014; Smith et al., 2014) as one possible source of differences in cortical brain activity between preference inferences from eye-related cues compared to passive viewing of branded products. Finally, the inferring performance of each individual was used as behavioural validation of the EEG recordings.

4.2. THEORY

4.2.1. Social Inference

Humans are social creatures. They have the natural crave to connect with other humans (Lieberman, 2014). In order to establish social interaction in quick and efficient manner humans need to understand the thoughts, intentions, preference, goals and behaviors of other people around them (Lieberman, 2014). When we meet people for the first time, we normally make quick and unintentional impressions about them. On other occasions, we deliberately attempt to identify traits and behaviors in others which might give us the opportunity to know something about their personality. For instance, in a sales-customer interaction, a sales consultant will try to infer the preferences of a customer regarding product characteristics (i.e., color, brand, size). What are the possible sources of information to look at?

According to the social neuroscience literature, social inferences can be drawn in two ways. First, it can be automatic and spontaneously

associative, taking very little mental effort by using previously acquired knowledge and engaging basic cognitive operations such as similarity and associations (Adolphs, 2009; Ma et al., 2011). For instance, a sales consultant seeing a customer's face contract in an expression of disgust when eating a dark chocolate might come to the intuitive spontaneous conclusion that the customer did not like the taste. Similarly, a sales consultant observing a customer who persistently looks at one pair of shoes for a prolonged time will automatically infer that the customer is interested in these shoes. Second, the symbolic system expresses a more advanced intentional approach that employs reasoning procedures that rely on logical standards (Adolphs, 2009; Keysers & Gazzola, 2007). A sales consultant viewing a customer who is not displaying overt behavioral information might need to use deeper reflective reasoning about what this person would like to buy. For instance, the sales consultant might use other external cues such as clothing, gender, ethnic background, age, weight and integrate all this information consciously using logical reasoning to infer the preferences. However, making a clear distinction between the two processes, especially in sales-customer interaction, is extremely difficult because social inference is often neither strictly intuitive and spontaneous nor strictly reflective and conscious.

The main goal of the current study is not to solve the puzzle of the dual-processes approach (spontaneous versus intentional inferences) in relation to social cognition. No matter how one looks at this question, it appears that both sets of processes contribute to social cognition,

specifically to the preference inferences of others. Temporal and spatial brain activity differences in the two processes, especially in relation to trait and goal inferences, have been the focus in social neuroscience research of the past decade (Ma et al., 2011; Van der Cruyssen et al., 2009; Van Duynslaeger et al., 2008; Van Overwalle et al., 2012). The current study speculates that in sales-customer interactions the sales consultant make use of both spontaneous and intentional inferences by integrating them in one common inference system, because they need all the available information to infer as quickly and accurately as possible the customer's preferences (Keysers & Gazzola, 2007).

Many previous neuroscience studies on social cognition and social inference involved a single person performing a social inference task in relation to reading information (sentences) or viewing face images displayed on a computer screen. Following Schilbach et al.'s (2013) suggestion, this investigation try to overcome the spectatorial gap in past social neuroscience research. By inducing a real social interaction between two people (second-person neuroscience) this study is trying to “go really social” (Hasson et al., 2012; Schilbach et al., 2013).

4.2.2. Eye-Related Social Inference

Recent social science and neuroscience studies emphasized the important role of the eyes in social inference and social attention (Nummenmaa & Calder, 2009; Senju & Johnson, 2009). In general, if you need to infer what another person is attending or thinking, you usually look to their eyes

(Stephen, 2010). In particular, the human gaze represents an important, valuable social signal, which is interpreted with other face-related cues as well as the social context (George & Conty, 2008). For instance, others' gaze direction to certain products generally reveals their direction of attention and focus of interest (George & Conty, 2008). But the human gaze contains far more information than just the direction of others' attention. For instance, Stephen (2010) suggests that gaze following is an essential, evolutionarily developed ability, "which allows humans to understand what another individual is seeing by means of analyzing their body, head and eye posture and then internally imagine or expressively mimic their perspective and thus associate their observable, physical point of view to their private, internal mental states." Stephen argues that this sophisticated ability is part of our natural behavior that is expressed effortlessly and automatically. Previous studies suggest that as people naturally and in a reflex-like manner look at the object of the surrounding space which they prefer, their gaze direction can be undoubtedly regarded as a preference for the object of attention (George & Conty, 2008; Shimojo et al., 2003). In sales-consumer interactions eye-related cues (i.e., eye movements, number of fixations, mean dwell times, pupil dilation) can be used to infer not only consumers' direction of attention toward a certain product but also to infer current preferences and intentions (Nummenmaa & Calder, 2009; Venkatraman et al., 2014). For instance, several studies suggest that fewer fixations in combination with longer dwell times during ad viewing are likely to reflect more detailed cognitive processing (Horstmann, et al., 2009).

Past studies on social inference from eye-related cues based mainly on optical stimuli usually presented as a picture, animation, or short movie clip on a computer screen. In contrast, as mentioned above, our study measured physiological responses in relation to social inferences (product preferences) from eye-related information during a real interactions between two people (second-person neuroscience), instead of using static images or dynamic movie presentations. According to Pönkänen et al., (2010), although facial expression are capable of evoking physiological and psychological processes related to a person's mental state, it cannot influence the perceiver physically. The results of the Pönkänen study indicate a difference on the physiological level, measured by electroencephalography (EEG), between processing gaze-related information from seeing a live face as opposed to pictorial stimuli. Following their suggestion, this study investigates social inference processes from live eye-related information rather than using images or movie clips. There are only a few EEG studies of brain responses to gaze direction. Importantly, to our knowledge, no previous EEG study, particularly ERP research, has used eye-related information for social inference.

4.2.3. ERP

Event-related potentials (ERPs) offer high temporal resolution of neural activity. This makes ERPs valuable for exploring the timing of brain-processing differences between intentional inferences of other person's

preferences from eye-related information and passive observation of generic products. ERPs are electrophysiological responses to a specific cognitive, sensory or motor event. They reflect information processing operations, where temporally distinct ERP waveform components represent different functions in this process. Some ERP components have been of particular interest to social cognition in the past 30 years. One is the P3, characterized by a positive-going waveform within the 250-450 ms latency range (Olofsson et al., 2008). P3 is composed of two temporally distinct sub-components: P3a and P3b. Evident in frontal scalp locations, P3a has frequently been associated with novelty (unexpected event) and is assumed to reflect involuntary attention (Polich, 2007). In contrast, P3b (the focus of the current study and henceforth referred to as P3) appears at posterior-parietal scalp locations (Ibanez et al., 2012). Past electrophysiological studies suggest that posterior-parietal P3 amplitude reflects attention allocation, working memory and other higher level psychological processes required for social cognition tasks (Ibanez, et al., 2012; Kok, 2001). Typically, the P3 amplitude is modulated by task relevance and reaches the highest amplitudes at parietal scalp locations. P3 amplitude is extremely sensitive to the motivational significance of the visual stimulus, which in turn is highly influenced by the task context in which it occurs. For instance, stimuli requiring an overt response frequently elicit higher P3 amplitudes than stimuli which do not require response (e.g., Nieuwenhuis et al., 2005).

The LPP is a long-lasting, positive slow wave, maximal over centro-parietal sites and becomes evident between 500 and 700 ms after stimulus onset (Cuthbert et al., 2000; Olofsson et al., 2008). Past EEG studies suggest that LPP reflects sustained attention allocation and motivational significance to salient relevant stimuli (Hajcak, MacNamara, & Olvet, 2010; Pozharliev et al., 2015). Enhanced LPP amplitude was found in relation to visual stimuli perceived as silent due to the task context, such as targets (Azizian, Freitas, Parvaz, & Squires, 2006). Most importantly, LPP amplitude is frequently reported to be larger for human faces compared to scenes and object images which implies that faces possess a unique significance that is unequaled by other categories of visual stimuli such as generic products (Ferri, Weinberg, & Hajcak, 2012; Weinberg & Hajcak, 2010). Similar studies conclude that images showing human faces appear to attract attention more easily than images without faces (Ito & Cacioppo, 2000).

Previous ERP studies on social inferences have focused on various social targets such as goals, intentions, traits, situational circumstances and external causes of events. For instance, studies of spontaneous and/or intentional trait inferences (actor's traits) have found enhanced P3 and LPP amplitude in relation to trait identification processes (Van Duynslaeger et al., 2008; Van Overwalle et al., 2012). Moreover, goal inference processes were also reflected by P3 amplitude modulation usually made prior to traits inferences (Van der Cruyssen et al., 2009). None of these studies, however, investigates preference inferences from eye-related information.

4.2.4. *OXTR* Polymorphism

Oxytocin (OT) is a neuropeptide synthesized in the hypothalamus which is known to affect brain processes, especially those involved in social processing and behavior (Bartz and Hollander, 2006; Bos et al., 2012; Rodrigues et al., 2009). OT intranasal administration resulted in better performance of inferring mental states from the eye region, measured with the “Reading the Mind in the Eyes Test” (RMET) (Domes et al., 2007; Luminet et al., 2011). It enhanced affective empathy and increased social learning (Hurlemann et al., 2010) and increased attention to the eye region of faces, reflected by prolonged eye gaze (Guastella et al., 2008). A key factor of its functionality is the OT receptor, a protein encoded by the *OXTR* gene that is located on chromosome 3p25 (Inoue et al., 1994). One specific SNP of *OXTR* (rs53576) has been frequently associated with social behavior. In particular, individuals homozygous for the G allele (GG genotype) compared with carriers of the non-GG (AA, AG genotypes) alleles are known to have higher human social recognition skills (Skuse et al., 2011), enhanced sociality (Tost et al., 2010; Wu & Su, 2014), and display higher behavioral and dispositional empathy (Rodrigues et al., 2009; Smith et al., 2014). In addition, individuals homozygous for the G allele were found to show higher nonverbal prosocial behavior such as increased total gaze time toward the eye region than carriers of the A allele (Kogan et al., 2011).

4.2.5. *OXTR Polymorphism and ERP*

Little ERP research is conducted on brain responses in relation to oxytocin administration, especially on normal healthy individuals. For instance, enhanced late positive potential (LPP) amplitudes were found after oxytocin compared to placebo administration (Huffmeijer et al., 2012). The authors of the same study suggested that OT administration increased attention to the feedback stimuli, reflected by late positive potentials (LPP) and enhanced the processing of emotional faces reflected by the vertex positive potential. However, to our knowledge, there is no previous ERP research on social inference in relation to the *OXTR* gene variation. Our study investigated the relation between OT receptor gene variation and ERP responses during preference inferences from eye-related information compared to passive viewing of branded products.

4.3. OBJECTIVES AND HYPOTHESES

4.3.1. *ERP*

Previous ERP studies report enhanced P3 amplitude in relation to performing an active task as opposed to passive stimulus processing (Polich, 2007). Moreover, higher posterior P3 and LPP amplitudes were frequently reported to reflect attention allocation (Hajcak, MacNamara, & Olvet, 2010; Kok, 2001; Pozharliev et al., 2015). Preference inference from eye-related information requires active involvement and enhanced attention to be performed quickly and efficiently. On the other hand, passive viewing

reflects passive stimulus processing which does not involve active task engagement or overt responses and thus requires less attention allocation with respect to preference inference. Most importantly, past neurophysiological studies suggest that P3 and LPP amplitudes are larger for human faces compared to scenes and objects images, which implies that faces possess a unique significance that is unequaled by other categories of visual stimuli, such as generic products (Allison et al., 1999; Ferri, Weinberg, & Hajcak, 2012; Weinberg & Hajcak, 2010). Similar studies also conclude that images showing human faces appear to attract attention more easily than images that do not present faces (Ito & Cacioppo, 2000). In the current experiment, active preference inference was done from eye-related cues which involved face processing. Thus, we hypothesize that higher ERP amplitudes will occur for P3 and LPP components during preference inference from eye-related cues as opposed to passive viewing of branded products.

4.3.2. OXTR Polymorphism

Individuals homozygous for the G allele (GG genotype) compared with A carriers (AA, AG genotypes) show higher levels of theory of mind (ToM) performance (Wu & Su, 2014), exhibit higher nonverbal intelligence (Lucht et al., 2009), and display higher behavioral and dispositional empathy (Rodrigues et al., 2009; Smith et al., 2014). ToM is defined as the ability to attribute mental states such as intentions, preferences, desires and beliefs to other people as a way of interpreting and predicting social behavior

(Premack & Woodruff, 1978). Thus, we hypothesize higher preference inference performance will be reflected by higher numbers of correctly inferred trials from eye-related cues for individuals with the *OXTR* GG genotype compared to A carriers.

Previous studies suggest that gazing behavior is associated with brain processes such as attention, and information processing (Georgescu et al., 2013; Haxby et al., 2000; Nummenmaa & Calder, 2009). According to Kogan et al., (2011) individuals with *OXTR* GG genotype exhibit longer gaze duration to the eye region than A carriers. As mentioned, past neurophysiological evidence suggests that ERP (P3 and LPP) amplitudes are enhanced during human face processing (i.e., eye region) as opposed to object processing (Ferri, Weinberg, & Hajcak, 2012; Weinberg & Hajcak, 2010). Thus, we hypothesize that higher ERP amplitudes will occur for P3 and LPP components during preference inference from eye-related cues as opposed to passive viewing of products for individuals with the *OXTR* GG genotype compared to A carriers.

4.4. METHOD

4.4.1. Participants

Fifty male and 42 female (Age $M = 23.84$, $SD = 1.99$) of mixed ethnicity (80.4% Caucasian, Asian 9.8%, and 9.8% other or multiple ethnicities) undergraduates from a Dutch university participated in this study. Initial analyses confirmed that *OXTR* variations did not significantly interact with

gender. Participants enrolled in the experiment in exchange for course credit. All participants had normal or corrected-to-normal vision. Informed consent was obtained from each participant before the experiment and the study was authorized by the university's Ethics Committee.

4.4.2. Materials

Stimuli consisted of a pool of 64 pictures chosen from various product categories (chocolates, non-alcoholic beverages, chips and cakes). The pictures were selected by a group of four male and four female undergraduates (Age $M = 23.50$, $SD = 1.85$) from a Dutch university who received payment for this task. They were also asked to create 460 different pairs of the previously selected 64 products.

4.4.3. Procedures

Before the start of the EEG sessions two participants were invited to sit in two separate rooms. Each was shown pairs couples of randomly selected real products that they could touch and feel. They were asked to select one of each pair according to personal preference. To assure that participants would choose in accordance with their real preferences they were told that as a part of the experiment they could win each of their choices. After participants had made their choices they were invited to the EEG lab. The experiment was conducted in two sessions (Sales Consultant and Consumer condition). Participants were informed about the rules of the game and each played both roles, having been assigned to a role in random order. In both

sessions, EEG recordings were collected simultaneously from both participants who were accommodated in an isolated, dimly lit, electrically shielded EEG laboratory. Participants sat beside each other in comfortable chairs approximately 100 cm away from, and at eye level with a 40x30 cm Iiyama PC computer screen. The participant in the Sales Consultant role faced the other participant while the Consumer faced the computer screen. Participants interacted with each other during the installation of the EEG caps and in the period between the two sessions. In all sessions, the leader of the experiment left the room, ensuring that his presence did not affect the findings.

In both sessions, participants were shown a succession of five pictures representing two products each, randomly assigned from the 460 variations created for this experiment. Pictures displayed the one product on the left and the other on the right of the computer screen using E-prime presentation software (Psychology Software Tools, Inc). The pictures shown included branded products that corresponded to the real choices that each participant in the Consumer role had made before the EEG registration sessions. Presented in random order, each picture was viewed once only and in only one of the two conditions. Each picture was presented for 10000 ms followed by 6000 ms response time. The Sales Consultant was instructed to observe the face, particularly the eye region of the Consumer to infer their preferred product of the two options. The Sales Consultant was specifically asked to look for eye-related cues that might signal the

Consumer's choice, and was given examples of eye-related cues to look for, such as gaze behavior, dwell times and eye movements.

Consumers were instructed to relax and watch the products on the computer screen without revealing their preference. They were specifically instructed to keep their eyes on one product at a time and occasionally shift their gaze to each of the two products. They were not told how long to spend looking at each product. During the response time Sales Consultants were invited to select Left or Right for the product on the screen which they believed was the Consumers' choice. To insure that Sales Consultants did their best to infer the Consumers' preferences they were told that for each correctly inferred trial they would earn one Euro. To ensure that Consumers did not facilitate the Sales Consultant by intentionally revealing their preferences, they were informed that they would win the preferred product if the Sales Consultant could not infer the correct choice. An interval of 10000 ms of fixation point (+) was presented in the center of the computer screen before the next picture. After the end of the first session participants switched chairs and played the other role following the exact same procedure. Immediately after the two EEG sessions, participants were informed about their performance and receive the corresponding amount of money and products.

4.4.4. Electrophysiological Recordings and Analysis

The electroencephalogram (EEG) was recorded continuously from two identical 32 active Ag/AgCl electrode sites using a BioSemi 32-channel

elastic head cap with standard international 10-20 system layout. Each cap signal was acquired from two separate, identical amplifiers (BioSemi Active-Two system AD-box) connected to each other and the same computer with optical cable. Flat-type active electrodes were attached to the right and left mastoids. Electrodes located on the outer canthi of each eye, as well as below and above the left eye measured bipolar horizontal and vertical EOG activity. In addition, an active pin-type electrode (CMS, common mode sense) and a passive pin-type electrode (DRL, driven right leg) were used to compose a feedback loop for amplifier reference. Online, the EEG was digitized at a sampling rate of 512Hz, 24-bit A/D conversion.

Further off-line processing was done with Brain Vision Analyzer (Brain Products GmbH, Germany; www.brainproducts.com). Off-line, the EEG signals were re-referenced to the average of the left and right mastoids. EEG data were band-pass filtered between 0.1Hz and 30Hz. Artifacts caused by ocular movements were removed by applying Independent Component Analysis with Brain Vision Analyzer (for more details see Brain Products GmbH, Germany; www.brainproducts.com). Next, EEG signals for each picture were segmented with 200 ms pre-stimulus (baseline) to 2000 ms post-stimulus ERP epoch. The ERP signals were defined relative to the mean of the 200 ms pre-stimulus baseline period. Each segment was subjected to artifact-rejection processing. The artifact-rejection method excluded epochs with large amplitude (over ± 100 μ V). EEG recordings were analyzed four times independently by two experienced EEG researchers (blind to the stimulation condition) with

particular attention to residual contamination of the EEG epochs due to eye or muscle artifacts. As a result, only epochs completely free from artifacts were considered for the following statistical analyses. To ensure an adequate signal-to-noise ratio in the ERPs, subjects with fewer than four artifact-free epochs per condition (Sales Consultant, Consumer) were excluded from the analysis and were replaced (four subjects in total were replaced).

4.4.5. Genotyping

All genotyping was performed blind to demographic and clinical data. Buccal swabs were obtained from each subject. Genomic DNA was isolated from the samples using the Chemagic buccal swab kit on a Chemagen Module 1 workstation (Chemagen Biopolymer-Technologie AG, Baesweiler, Germany). DNA concentrations were measured using the Quant-iT DNA Assay kit (Invitrogen, Breda, the Netherlands). The average yield was 4 µg of genomic DNA per buccal swab sample.

SNP marker rs53576 [Celera ID: C 3290335 10] was genotyped using TaqMan® SNP Genotyping Assays (Applied Biosystems, Foster City, CA, <http://www.appliedbiosystems.com>). TaqMan® PCR reactions were done with Universal Master Mix Amperase® UNG, 0.25L TaqMan probe mix and 2.25L of water for a 5L total volume. The PCR conditions for the TaqMan® SNP Genotype Assays were: one AmpErase® step at 50.0 °C for 2 min, one enzyme activation step at 95.0 °C for 10 min, and 40 alternating cycles of denaturation at 92.0 °C for 15 s and reannealing and

extension at 58.0 °C for one minute. All PCR reactions were performed on a Perkin Elmer 9700 Thermocycler (Applied Biosystems, Foster City, CA). The fluorescence intensity of the final PCR product was measured using an LjL Analyst AD fluorescence microplate reader (LjL Biosystems, Sunnyvale, CA, <http://www.moleculardevices.com>) using LjL Criterion-Host Software.

Respondents were divided in two groups on the basis of their *OXTR* (rs53576) genotype. The first group were individuals with two copies of the G allele (G homozygotes; n=39; 42.4%) and the second group were individuals with both one copy of the A allele (A heterozygotes (A/G); n=37; 40.2%) and two copies of the A allele (A homozygotes (A/A); n=16; 17.4%). No sex differences could be detected. The genotype distribution does not deviate from the Hardy-Weinberg equilibrium: HWE: $\chi^2 (1) = 1.855, p = .17$.

4.4.6. Statistical Analysis

Time-locked to the onset of each pair of branded product pictures, ERPs were averaged per participant separately for each role (Sales Consultant, Consumer). Participants viewed five pictures of two branded products in each role, and average ERP waveforms were computed for the five trials for each role, respectively.

To examine the topography effect, statistical analyses were done with the 12 subsequent electrode sites: left (F3, C3, P3, O1), midline (Fz,

Cz, Pz, Oz), and right (F4, C4, P4, O2). These 12 electrodes allowed for analyses of Laterality (Left, Midline, Right) and Caudality (Frontal, Central, Parietal, Occipital).

According to the social task performed in this study, P3 and LPP were quantified at the posterior scalp locations, basing the chosen time windows on previous research (for comparable time windows see Ferri, et al., 2012; Olofsson et al., 2008; Polich, 2007; Weinberg & Hajcak, 2010) and visual inspection of grand averages waveforms.

Measures of the P3 and LPP time-windows area were evaluated with repeated ANOVAs: within-subjects factors were Role (Sales Consultant, Consumer), Caudality (Frontal, Central, Parietal, Occipital), and Laterality (Left, Midline and Right) and between-subject factors were Genotype (AA/AG, GG) and Inference Performance (Low, High). We controlled for multivariate normal distribution with the Mauchly test of sphericity, and applied the Greenhouse-Geisser correction, when appropriate (Gardener et al., 2013). A p value of $< .05$ was considered significant. Significant interaction effects were followed by paired sample t -tests. Bonferroni correction was implemented to adjust for multiple comparisons. Statistics were analyzed with the IBM SPSS 13.0 software (Statistical Package for Social Sciences, SPSS Inc, Chicago).

4.5. RESULTS

4.5.1. Behavioral Results

Based on the number of correctly inferred trials, derived from the game performance, the 92 participants were assigned to high (HI) or low (LI) inferring group. Based on the median-split approach, 51 participants were assigned to HI group (above versus below median scores = 3.00) and 41 to the LI group. The median split resulted in the following means for the HI group ($M = 3.60$ $SD = 0.70$) and LI group ($M = 1.53$ $SD = 0.71$).

In addition, pairwise comparison between the number of correctly inferred trials versus the number of unable to hide preference trials revealed significant differences between the amount earned money in Euro ($M = 2.68$ $SD = 1.24$) compared to the number of products earned ($M = 2.31$ $SD = 1.24$), ($t(91) = 2.030$, $p = 0.045$). This indicates that participants were slightly better at inferring than not inferring other people's preferences ($M = 0.36$ $SD = 1.74$).

4.5.2. Genetic Results

Based on the individual genetic profile the 92 participants were assigned to A/A ($n = 16$), G/G ($n = 39$), and A/G ($n = 37$) genotypes. Based on previous studies on *OXTR* variation in relation to social inference (Domes et al., 2007; Luminet et al., 2011; Rodrigues et al., 2009) we decided to aggregate the A/As and A/Gs in one group which we called AA/AG group

($n = 53$; 47.6%). Thus, the following statistical analysis was performed with the two genotype groups AA/AG and GG ($n = 39$; 42.4%).

Pairwise AA/AG versus GG contrasts for the HI group indicated no significant difference between the number of correctly inferred trials for AA/AG ($M = 3.58$ $SD = 0.71$) compared to GG group ($M = 3.65$ $SD = 0.67$), ($t(49) = -0.345$, $p = 0.732$). In addition, pairwise AA/AG versus GG contrasts for the LI group indicated no significant difference between the number of correctly inferred trials for AA/AG ($M = 1.54$ $SD = 0.73$) compared to GG group ($M = 1.52$ $SD = 0.69$), ($t(39) = 0.085$, $p = 0.933$).

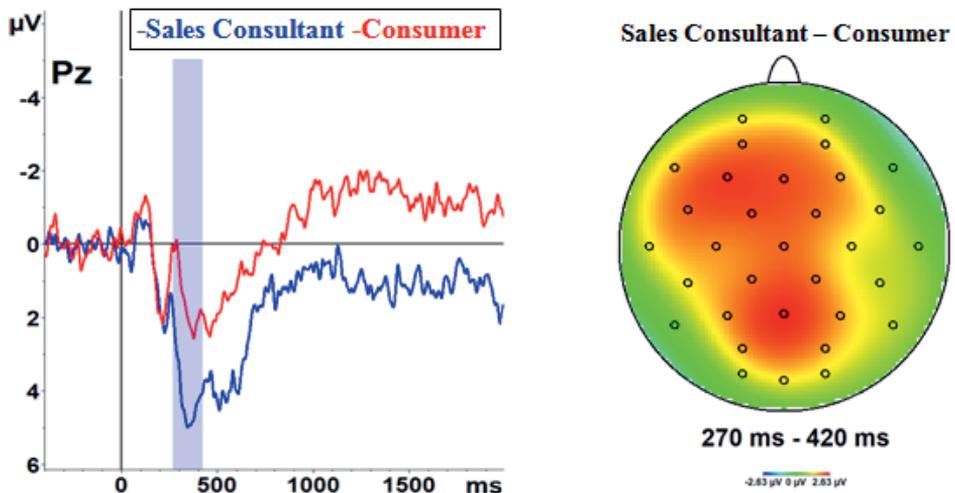
4.5.3. ERPs

The overall shape of ERPs was similar across Roles (Sales Consultant, Consumer), and as expected it was characterized by P3 and LPP components. We identified a role effect: early posterior distributed ERPs in Sales Consultant condition were more positive-going than ERPs for Consumer condition. Importantly, however, and consistent with previous findings, we found a genotype effect shaped by the specific role: posterior distributed P3 and LPP showed strong positivity, after inferring trial onset for individuals with *OXTR* GG genotype in the Sales Consultant relative to the Consumer role. There was no such enhanced positivity for AA/AG genotype across roles. To test these observations, ANOVAs were computed on ERPs from left (F3, C3, P3, O1), midline (Fz, Cz, Pz, Oz), and right (F4, C4, P4, O2) scalp areas, at the three time windows: P3 (270-420 ms), early LPP (500-700 ms), late LPP (1200-1800ms).

P3 (270-420 ms)

Repeated ANOVA measures on P3 mean amplitude in the 270-600 ms time window revealed significant main effects of Role [$F(1, 88) = 4.67, p = .033$], Caudality [$F(3, 264) = 98.43, p < .001, \hat{\epsilon} = .631$], and Laterality [$F(2, 176) = 6.82, p = .001, \hat{\epsilon} = .930$]. P3 mean amplitude was significantly higher for Sales Consultant ($M = 2.33 \pm 6.06\mu V$) than Consumer ($M = 0.51 \pm 5.07\mu V$), (Figure 8). Pairwise Caudality contrasts revealed that P3 mean amplitude was significantly different between Frontal ($M = -1.28 \pm 4.10 \mu V$) and Central ($M = -0.44 \pm 4.23 \mu V$), ($t(91) = -3.45, p = .001$), between Frontal ($M = -1.28 \pm 4.10 \mu V$) and Parietal ($M = 3.26 \pm 4.98 \mu V$), ($t(91) = -10.60, p < .001$), between Frontal ($M = -1.20 \pm 4.05 \mu V$) and Occipital ($M = 4.19 \pm 4.52 \mu V$), ($t(90) = -11.31, p < .001$), between Central ($M = -0.44 \pm 4.23 \mu V$) and Parietal ($M = 3.26 \pm 4.98 \mu V$), ($t(91) = -11.72, p < .001$), between Central ($M = -0.42 \pm 4.25 \mu V$) and Occipital ($M = 4.19 \pm 4.52 \mu V$), ($t(90) = -11.00, p < .001$), and between Parietal ($M = 3.33 \pm 4.97 \mu V$) and Occipital ($M = 4.19 \pm 4.52 \mu V$), ($t(90) = -2.91, p = .004$) scalp areas. Pairwise Laterality contrasts revealed that P3 mean amplitude was significantly different between Left ($M = 1.64 \pm 3.90 \mu V$) and Midline ($M = 1.03 \pm 4.33 \mu V$), ($t(91) = 4.11, p < .001$), and between Right ($M = 1.58 \pm 3.81 \mu V$) and Midline ($M = 1.03 \pm 4.33 \mu V$), ($t(91) = 2.93, p = .004$) scalp areas. There was no significant difference between Laterality Left and Right, $p = .746$. All pairwise comparisons are $p < .05$ (Bonferroni corrected).

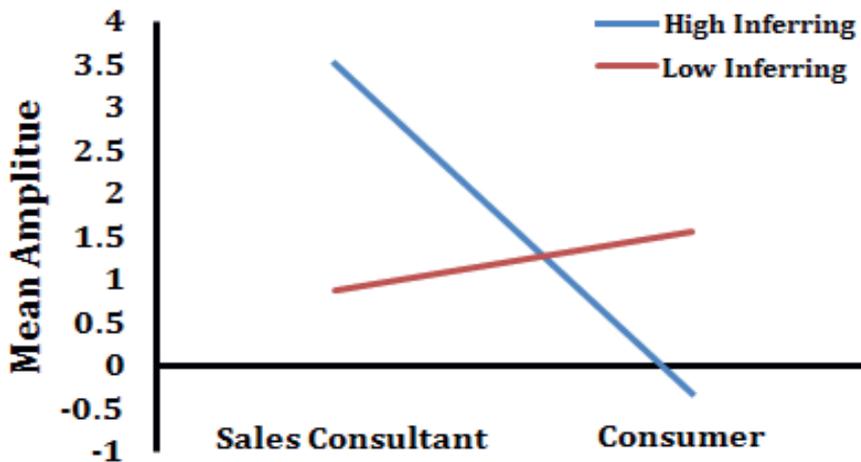
Figure 8: P3 role effect: The left panel depicts grand mean ERP waveforms from Pz electrode, elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer). The right side depicts scalp topographies for the difference between Roles (Sales Consultant minus Consumer) within the interval marked by the blue-shaded area (270-420 ms) in the ERP plot. Mean P3 amplitude was significantly higher in the Sales Consultant compared to the Consumer role (red).



These main effects were qualified by a second-order interaction of Role x Inferring Performance [$F(1, 88) = 8.61, p = .004$]. Pairwise Sales Consultant versus Consumer contrast revealed that the P3 Role effect was significant in the High Inferring group, with P3 amplitude higher for Sales Consultant compared to Consumer (Figure 9). Particularly, the P3 mean amplitude for Sales Consultant ($M = 3.50 \pm 6.13 \mu V$) was significantly

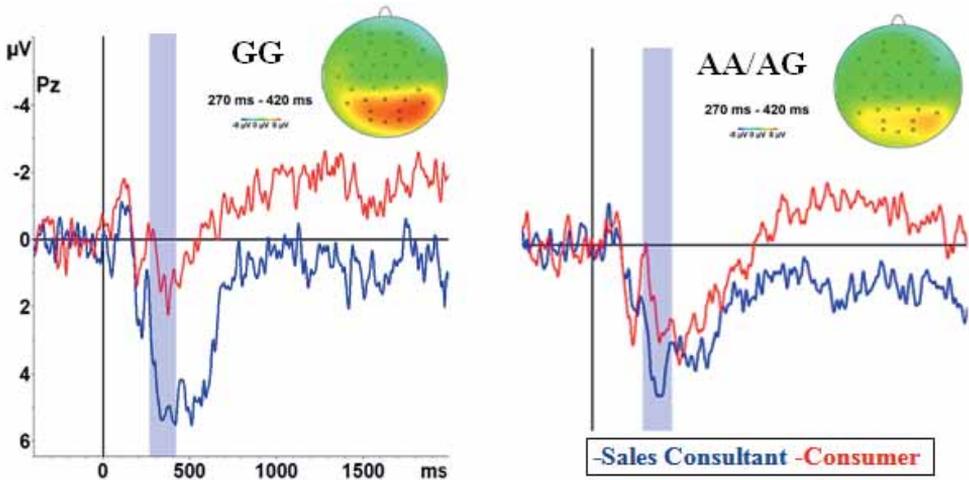
higher than Consumer ($M = -0.33 \pm 4.94 \mu V$), with ($t(50) = 3.62, p = .001$). However, the P3 Role effect was not significant in the Low Inferring group, mean amplitude for Sales Consultant ($M = 0.87 \pm 5.71 \mu V$) and Consumer ($M = 1.55 \pm 5.09 \mu V$), with ($t(40) = -0.55, p = .585$), (Figure 9). This implies that respondents had greater activation for Sales Consultant compared to Consumer when they were in the High Inferring group as opposed to the Low Inferring group.

Figure 9: *P3 inference effect: The plot depicts mean P3 amplitude for High Inferring group (blue) and Low Inferring group (red), elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer). Mean P3 amplitude was significantly higher in the Sales Consultant compared to the Consumer role in the High Inferring group as opposed to Low Inferring group.*



Most importantly, the main effects were also qualified by a third-order interaction of Role x Caudality x Genotype [$F(3, 264) = 3.75, p = .030$]. Pairwise Sales Consultant versus Consumer contrast at each Caudality position revealed that the P3 Role effect was significant for Parietal and Occipital scalp areas for Genotype “GG”, with the P3 amplitude higher for Sales Consultant compared to Consumer role (see Figure 10, left panel). Particularly in Caudality “Parietal”, the P3 mean amplitude for Sales Consultant ($M = 5.24 \pm 7.52 \mu V$) was significantly higher than Consumer ($M = 1.51 \pm 6.58 \mu V$), with ($t(38) = 2.48, p = .017$). In Caudality “Occipital”, the P3 mean amplitude for Sales Consultant ($M = 5.85 \pm 7.32 \mu V$) was again significantly higher compared to Consumer ($M = 2.41 \pm 6.41 \mu V$), with ($t(37) = 2.14, p = .038$), (see Figure 10, left panel). However, the P3 Role effect was not significant in Caudality “Frontal” with $p = .078$ and “Central” with $p = .199$ for the Genotype “GG”. Furthermore, the P3 Role effect was not significant in any caudality positions for the AA/AG genotype: Frontal, with $p = .101$, Central, with $p = .177$, Parietal, with $p = .337$, and Occipital, with $p = .733$ (see Figure 10, right panel). This implies that respondents had greater P3 activation for Sales Consultant compared to Consumer when they were carrying the GG genotype as opposed to the AA/AG genotype only in the posterior (parieto-occipital) scalp areas.

Figure 10: *P3 genotype effect: The left panel depicts grand mean ERP waveforms from Pz electrode, elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer) for genotype GG. In the upper right corner, scalp topographies for the difference between Roles (Sales Consultant minus Consumer) within the interval marked by the blue-shaded area (270-420 ms) in the ERP plot. The right side depicts exactly the same for genotype AA/AG. Mean P3 amplitude was significantly higher in the Sales Consultant compared to the Consumer role in the posterior (parietal-occipital) scalp locations only for the genotype GG (left panel, in red on the scalp topographies).*

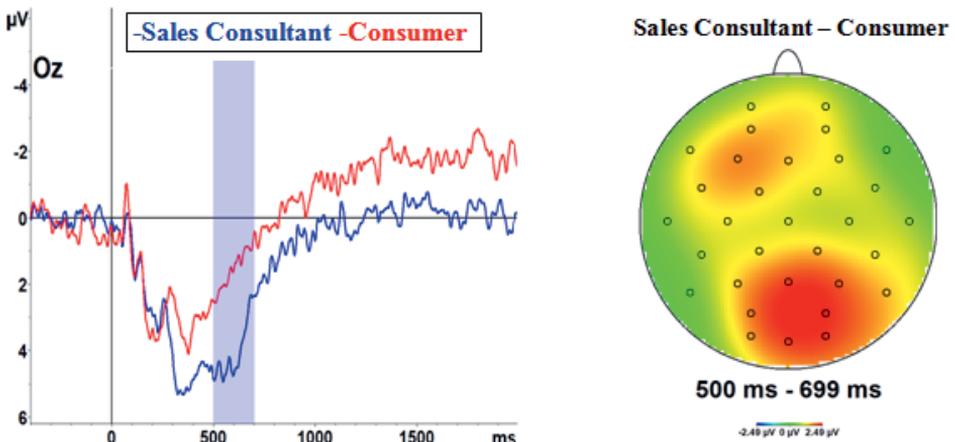


LPP (early window: 500-700 ms)

Repeated ANOVA measures on early LPP mean amplitude in the 500-700 ms time window revealed significant main effects of Role [$F(1, 88) = 4.50, p = .037$], Caudality [$F(3, 264) = 99.03, p < .001, \hat{\epsilon} = .644$], and Laterality

[$F(2, 176) = 6.69, p = .002, \hat{\epsilon} = .919$]. Early LPP mean amplitude was significantly higher in Sales Consultant ($M = 1.56 \pm 6.38\mu\text{V}$) than in Consumer ($M = -0.15 \pm 5.09\mu\text{V}$), (Figure 11, left panel). Pairwise Caudality contrasts revealed that early LPP mean amplitude was significantly different between Frontal ($M = -2.17 \pm 4.62 \mu\text{V}$) and Central ($M = -0.49 \pm 4.64 \mu\text{V}$), ($t(91) = -6.95, p < .001$), between Frontal ($M = -2.17 \pm 4.62 \mu\text{V}$) and Parietal ($M = 2.64 \pm 4.54 \mu\text{V}$), ($t(91) = -13.03, p < .001$), between Frontal ($M = -2.17 \pm 4.62 \mu\text{V}$) and Occipital ($M = 2.85 \pm 4.51 \mu\text{V}$), ($t(91) = -11.52, p < .001$), between Central ($M = -0.49 \pm 4.64 \mu\text{V}$) and Parietal ($M = 2.64 \pm 4.54 \mu\text{V}$), ($t(91) = -11.96, p < .001$), and between Central ($M = -0.49 \pm 4.64 \mu\text{V}$) and Occipital ($M = 2.85 \pm 4.51 \mu\text{V}$), ($t(91) = -8.48, p < .001$) scalp areas. There was no significant difference between Parietal ($M = 2.64 \pm 4.54 \mu\text{V}$) and Occipital ($M = 2.85 \pm 4.51 \mu\text{V}$), ($t(91) = -0.74, p = .460$) scalp areas. Pairwise Laterality contrasts revealed that early LPP mean amplitude was significantly different between Left ($M = 0.91 \pm 4.15 \mu\text{V}$) and Midline ($M = 0.28 \pm 4.57 \mu\text{V}$), ($t(91) = 4.02, p < .001$), and between Right ($M = 0.91 \pm 4.01 \mu\text{V}$) and Midline ($M = 0.28 \pm 4.57 \mu\text{V}$), ($t(91) = 3.07, p = .003$) scalp areas. There was no significant difference between Laterality Left and Right, $p = .999$. All pairwise comparisons are $p < .05$ (Bonferroni corrected).

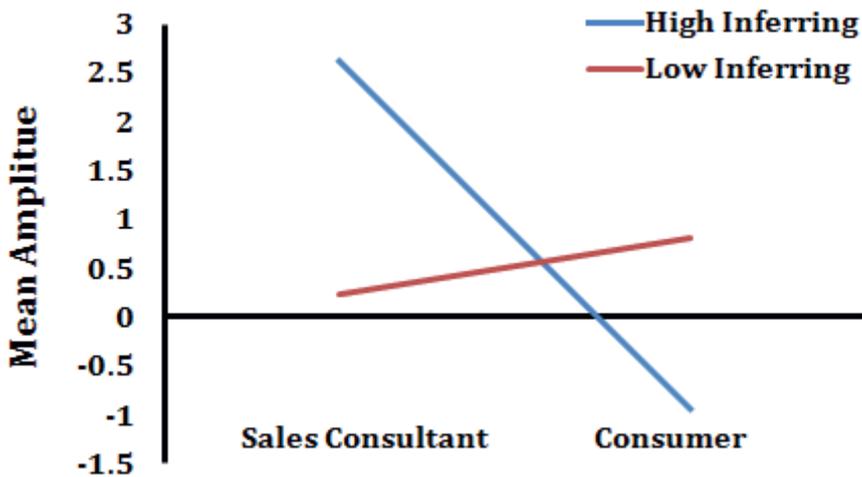
Figure 11: *LPP (500-700 ms) role effect: The left panel depicts grand mean ERP waveforms from Oz electrode, elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer). The right side depicts scalp topographies for the difference between Roles (Sales Consultant minus Consumer) within the interval marked by the blue-shaded area (500-700 ms) in the ERP plot. Mean LPP amplitude was significantly higher in the Sales Consultant compared to the Consumer role in the posterior (parietal-occipital) scalp location (red).*



These main effects were qualified by a second-order interaction of Role x Inferring Performance [$F(1, 88) = 7.90, p = .006$] and Role x Caudality [$F(3, 264) = 3.36, p = .044, \hat{\epsilon} = .578$]. Pairwise Sales Consultant versus Consumer contrast revealed that the early LPP Role effect was

significant in the High Inferring group, with early LPP amplitude higher for Sales Consultant compared to Consumer (see Figure 12). Particularly, the early LPP mean amplitude for Sales Consultant ($M = 2.63 \pm 6.48 \mu\text{V}$) was significantly higher than Consumer ($M = -0.93 \pm 4.72 \mu\text{V}$), with ($t(50) = 3.01, p = .004$). However, the early LPP Role effect was not significant in the Low Inferring group, mean amplitude for Sales Consultant ($M = 0.23 \pm 6.07 \mu\text{V}$) and Consumer ($M = 0.81 \pm 5.42 \mu\text{V}$), with ($t(40) = -0.53, p = .597$), (see Figure 12). This implies that respondents had greater activation for Sales Consultant compared to Consumer when they were in the High Inferring group rather than the Low Inferring group. Pairwise Sales Consultant versus Consumer contrast at each Caudality position revealed that the early LPP Role effect was significant for Parietal and Occipital scalp areas, with early LPP amplitude higher for Sales Consultant compared to Consumer (see Figure 11, right panel). Particularly in Caudality “Parietal”, early LPP mean amplitude for Sales Consultant ($M = 3.71 \pm 6.95 \mu\text{V}$) was significantly higher than Consumer ($M = 1.57 \pm 5.87 \mu\text{V}$), with ($t(91) = 2.24, p = .027$). In Caudality “Occipital”, early LPP mean amplitude for Sales Consultant ($M = 3.95 \pm 6.95 \mu\text{V}$) was again significantly higher compared to Consumer ($M = 1.75 \pm 5.78 \mu\text{V}$), with ($t(91) = 2.32, p = .022$), (see Figure 11, right panel). Furthermore, the early LPP Role effect was not significant in caudality positions: Frontal, with $p = .090$ and Central, with $p = .272$.

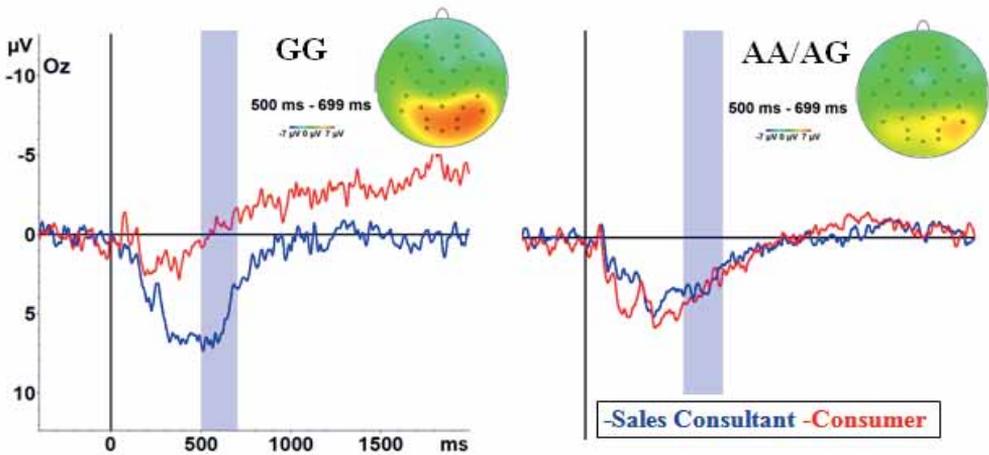
Figure 12: *LLP (500-700 ms) inference effect: The plot depicts mean LLP amplitude for High Inferring group (blue) and Low Inferring group (red), elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer). Mean LLP amplitude within the interval (500-700 ms) was significantly higher in the Sales Consultant compared to the Consumer role in the High Inferring group as opposed to Low Inferring group.*



Most importantly, the main affects were also qualified by a third-order interaction of Role x Caudality x Genotype [$F(3, 264) = 8.00, p = .001$]. Pairwise Sales Consultant versus Consumer contrast at each Caudality position revealed that the early LPP Role effect was significant for Parietal and Occipital scalp areas for Genotype “GG”, with the early LPP amplitude higher for Sales Consultant compared to Consumer (see Figure 13, left panel). Particularly in Caudality “Parietal”, the early LPP

mean amplitude for Sales Consultant ($M = 4.50 \pm 7.63 \mu V$) was significantly higher than Consumer ($M = 0.13 \pm 6.58 \mu V$), with ($t(38) = 2.68, p = .011$). In Caudality “Occipital”, the early LPP mean amplitude for Sales Consultant ($M = 5.02 \pm 7.93 \mu V$) was again significantly higher compared to Consumer ($M = -0.12 \pm 6.48 \mu V$), with ($t(38) = 3.11, p = .004$), (see Figure 13, left panel). However, the early LPP Role effect was not significant in Caudality “Frontal” with $p = .354$ and “Central” with $p = .365$ for the Genotype “GG”. Furthermore, the early LPP Role effect was not significant in any caudality positions for the AA/AG genotype: Frontal, with $p = .146$, Central, with $p = .528$, Parietal, with $p = .658$, and Occipital, with $p = .979$, (see Figure 13, right panel). This implies that respondents had greater early LPP activation for Sales Consultant compared to Consumer when they were carrying the GG genotype as opposed to the AA/AG genotype only in the posterior (parieto-occipital) scalp areas.

Figure 13: *LPP (500-700 ms) genotype effect: The left panel depicts grand mean ERP waveforms from Oz electrode, elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer) for genotype GG. In the upper right corner, scalp topographies for the difference between Roles (Sales Consultant minus Consumer) within the interval marked by the blue-shaded area (500-700 ms) in the ERP plot. The right side depicts exactly the same for genotype AA/AG. Mean LPP amplitude was significantly higher in the Sales Consultant compared to the Consumer role in the posterior (parietal-occipital) scalp locations only for the genotype GG (left panel, in red on the scalp topographies).*



LPP (late window: 1200-1800 ms)

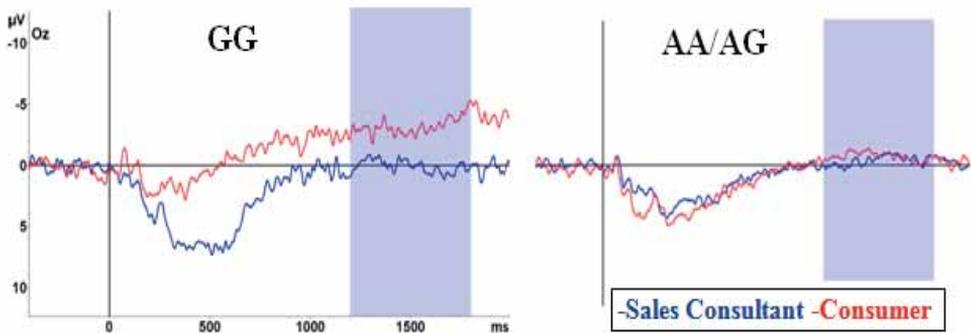
Repeated ANOVA measures on late LPP mean amplitude in the 1200-1800 ms time window revealed significant effects of Caudality [F (3, 264) =

4.13, $p = .013$, $\hat{\epsilon} = .771$]. Pairwise Caudality contrasts revealed that late LPP mean amplitude was significantly different between Frontal ($M = -0.41 \pm 4.00 \mu\text{V}$) and Parietal ($M = 0.35 \pm 4.07 \mu\text{V}$), ($t(91) = -2.63$, $p = .010$), between Central ($M = -0.35 \pm 4.03 \mu\text{V}$) and Parietal ($M = 0.35 \pm 4.07 \mu\text{V}$), ($t(91) = -3.07$, $p = .003$), and between Parietal ($M = 0.35 \pm 4.07 \mu\text{V}$) and Occipital ($M = -0.61 \pm 4.31 \mu\text{V}$), ($t(91) = 3.66$, $p < .001$) scalp areas. There was no significant difference between Frontal and Central, with $p = .807$, between Frontal and Occipital, with $p = .552$, and between Central and Occipital, with $p = .450$ scalp areas.

The main effect was qualified only by a third-order interaction of Role x Caudality x Genotype [$F(3, 264) = 3.87$, $p = .042$]. Pairwise Sales Consultant versus Consumer contrast at each Caudality position revealed that the late LPP Role effect was significant for Occipital scalp areas for Genotype “GG”, with the LPP amplitude higher for Sales Consultant compared to Consumer (see Figure 14, left panel). Particularly in Caudality “Occipital”, the LPP mean amplitude for Sales Consultant ($M = 0.27 \pm 6.48 \mu\text{V}$) was significantly higher compared to Consumer ($M = -2.40 \pm 5.91 \mu\text{V}$), with ($t(38) = 2.41$, $p = .021$), (see Figure 14, left panel). However, the late LPP Role effect was not significant in Caudality “Frontal” with $p = .981$, “Central” with $p = .835$, and “Parietal” with $p = .100$ for the Genotype “GG”. Furthermore, the LPP Role effect was not significant in any caudality positions for the AA/AG genotype: Frontal, with $p = .071$, Central, with $p = .260$, Parietal, with $p = .126$, and Occipital, with $p = .472$, (see Figure 14, right panel). This implies that respondents

had greater late LPP activation for Sales Consultant compared to Consumer when they were carrying the GG genotype as opposed to the AA/AG genotype only in the occipital scalp areas.

Figure 14: *LPP (1200-1800 ms) genotype effect: The left panel depicts grand mean ERP waveforms from Oz electrode within the interval marked by the blue-shaded area (1200-1800 ms), elicited by preference inferring from eye-related cues (Sales Consultant) and passive viewing of branded products (Consumer) for genotype GG. The right side depicts exactly the same for genotype AA/AG. Mean LPP amplitude was significantly higher in the Sales Consultant compared to the Consumer role in the occipital scalp locations only for the genotype GG.*



4.6. DISCUSSION

This study investigated the relationship between a well-known SNP in the oxytocin receptor (*OXTR*) gene and individual behavioral differences, measured by inferring performance, as well as physiological differences,

measured by ERPs, in preference inferences from eye-related cues as opposed to passive viewing of branded products. The results revealed higher P3 and early LPP amplitudes for preference inferences from eye-related cues as opposed to passive viewing of branded products. Although we found no individual differences in preference inferences performance, in relation to the rs53576 variant of the *OXTR* gene we found enhanced P3 and early LPP amplitudes during preference inferences from eye-related cues compared to passive viewing of branded products for the High Inferring group as opposed to the Low Inferring group. Finally, in line with our last hypothesis, the results revealed higher posterior distributed P3 and LPP amplitudes for preference inferences from eye-related cues as opposed to passive viewing of branded products for individuals homozygous for the G allele, as opposed to those carrying an A allele for the rs53576 variant of the *OXTR* gene.

4.6.1. Theoretical Implications

Previous ERP research discusses multiple determinants of the P3 amplitude in relation to the experimental task and stimuli used in each study. For instance, early studies hypothesized that P3 reflects allocation of perceptual/central resources as opposed to response-related processing (see Kok, 2001). However, this suggestion is mainly based on dual-task studies. Another important factor influencing the P3 is task relevance, which can be defined as amount of attention allocation and processing capacity to the specific task or stimulus (Kok, 2001). Several ERP studies have found enhanced P3 amplitude in relation to performing active task as opposed to

passive stimulus processing (Polich, 2007). In a recent study Pitts et al., (2014) studied P3 in relation to task relevance and visual awareness. The authors suggest that P3 reflects specific post-perceptual processes required for the execution of certain active task but not uniquely for consciously perceiving the visual stimuli. When subjects were not specifically asked to report on certain visual stimuli, P3 was not enhanced even for trials with conscious perception. In contrast, when subjects were asked to provide specific information on task-relevant stimuli, enhanced P3 amplitude was observed. When doing the preference inference task as opposed to passive viewing of products subjects were instructed to focus their attention on a specific stimulus feature (eye region) and provide information on the stimuli after each trial. Thus, it can be assumed that the lower P3 amplitude in the passive viewing of branded products reflects a task-irrelevant condition in which subject did not have to report on the visual stimuli and thus those stimuli could have been completely ignored or could have attracted less attention resources.

In relation to the later ERP component, higher posterior LPP amplitudes were frequently reported to reflect allocation of capacity-limited resources such as sustained attention allocation to motivationally salient environmental visual stimuli (Hajcak, MacNamara, & Olvet, 2010; Kok, 2001). For instance, newborn infants prefer to direct their attention to faces or face-like objects compared to other objects which suggests that this preference for faces is a natural ability of evolutionary importance (Valenza et al., 1996). By 2 months old, infants already display a preference for

looking at the eye region over other regions of the human face (Maurer, 1985). Recent neurophysiological studies found enhanced posterior distributed LPP for human faces compared to object images indicating that faces carry motivationally salient significance that is unparalleled by other categories of visual stimuli (Weinberg & Hajcak, 2010). Similarly, a recent study found that images showing people attract more sustained attention, reflected by larger posterior LPPs, than images without people (Ito & Cacioppo, 2000). In particular, enhanced parietal LPP amplitude was found only for neutral images containing faces with neutral expressions and neutral background as opposed to neutral images without faces (Ferri, Weinberg, & Hajcak, 2012). This LPP effect was less prominent or inexistent when the visual stimuli possessed strong emotional content (i.e., threatening images with faces in an attack scene versus images without faces showing hands holding weapons). In the current experiment preference inference was actively done from eye-related cues which also involved face processing. Moreover, when playing the Consumer the participant was specifically instructed to keep their facial expression neutral and not reveal preference explicitly.

Based on this evidence we suggest that the enhanced LPP in the preference inference role compared to the passive viewing role reflects sustained attention allocation to facial processing, i.e., eye-related regions as opposed to passive viewing of branded products. Several studies suggest that the eyes are the primary source used by others who want to extract some social information, especially in real scenes (Birmingham et al.,

2008). The attention to the eyes in a social context where social information needs to be derived is defined as social attention (Birmingham et al., 2008; Langton et al., 2000). Thus, the sustained attention, reflected by the enhanced ERPs, observed during trials involving preference inferences from eye-related cues as opposed to passive viewing of branded products in a real social context can be interpreted as socially motivated attention.

Differentiating task-related effects on the P3 versus the LPP poses some difficulties, especially in the 300 to 1000 ms time range following stimulus onset. Past ERP studies quantify P3 and LPP components in relation to various experimental paradigms in different time windows (see Olofsson et al., 2008). Importantly, both peak and area measures of P3 and LPP components can be indifferent to component overlap and thus complicate further the specific distinction of components that share spatial and temporal features (Hajcak, MacNamara, & Olvet, 2010). However, the longer duration, also observed in the current results, of the LPP suggests at least some temporal distinction from the P3. In relation to both ERP components, it can be argued that the dynamic social setting and complex structure of the experimental task used in our study requires a cautious interpretation of P3 and LPP results in terms of underlying physiological processes and related resources.

The interpretation of the P3 and LPP role effect in terms of processing capacity and attention allocation could partially explain the enhanced mean amplitudes for these two components during preference

inference compared to passive viewing for the High Inferring group as opposed to the Low Inferring group. Based on the results we assume that higher level of attention and/or higher processing resources are required for increased inferring performance. However, this suggestion is somewhat speculative because of the limited number of trials used in the current experiment which inevitably includes the risk that the inferring performance of each participant is a result of chance.

On the other hand, the results showed no individual differences in preference inference performance, measured by the number of correctly inferred trials, in relation to the rs53576 variant of the *OXTR* gene. Although there is no previous research on social preference inferences in relation to the rs53576 variant of the *OXTR* gene some past studies suggest that individuals homozygous for the G allele (GG genotype) compared with A carriers (AA, AG genotypes) display better ToM performance (Wu & Su, 2014). Individuals homozygous for the G allele of rs53576 compared to A-allele carriers were also found to be more adept at inferring mental states of others displayed by higher performance on the RMET (Rodrigues et al., 2009). One possible explanation for not finding modulation of the preference inference performance by *OXTR* gene is the limited number of trials implemented in the study. As already discussed, performing only five inferring trials significantly reduces the possibility to have enough variation within our behavioral data and increases the risk of them occurring by chance. Creating a real social situation, such as a real-life sales-consumer context, which includes real social outcomes, such as winning real money

and preferred products involves some trade-off. Designing an experiment with 30 or more trials and using 90 or more participants would be extremely difficult to manage because of the enormous amount of financial resources needed for the real social outcomes, such as money and products. From a logistic point of view, having enough real branded products in stock so that participants can see, touch and take them at the end of each session would require conducting the experiment in a supermarket which might be a nice idea for future research. Recently developed wireless EEG equipment, such as Emotiv EPOC EEG, might be a useful tool to investigate sales-consumer interaction in a supermarket or a shop context. Another possible explanation for not finding any influence of *OXTR* variation on the behavioral measures of preference inferences performance is related to the divergent findings reported by previous studies. As already discussed, individuals with one or two copies of the A allele (AG/AA) display lower levels of inferring others' mental states, as measured by RMET (Rodrigues et al., 2009). In contrast, in a recent study A-allele carriers gave fewer incorrect answers when evaluating face images as measured by RMET (Lucht et al., 2013). Both studies used the same test, but the reported results were in disagreement regarding the risk allele.

However, the results of the current study indicate higher posterior distributed P3 and LPP amplitudes for preference inferences from eye-related information as opposed to passive viewing of branded products for individuals homozygous for the G allele, as opposed to those carrying an A allele of the *OXTR* gene. From an early age humans preferentially look at

the face and eye region compared to objects (Valenza et al., 1996). It has been suggested that viewing faces is rewarding (Hayden et al., 2007). Individuals homozygous for the G allele compared with A carriers show enhanced prosocial behavior and higher levels of empathy (Rodrigues et al., 2009; Smith et al., 2014; Tost et al., 2010). In particular, recent study reports that individuals homozygous for the G allele display higher increased total gaze time to the eye region than carriers of the A allele (Kogan et al., 2011) which might suggest that they experience face processing and particularly looking at others' eyes as more rewarding.

Furthermore, previous EEG studies report higher P3 and LPP amplitudes for human faces (i.e., eye region) as opposed to object processing (Ferri et al., 2012; Weinberg & Hajcak, 2010). In line with past evidence, the current study interprets the enhanced ERP amplitudes for the GG participants in relation to preference inference from eye-related cues as opposed to passive viewing of branded products as enhanced responsiveness toward the socially relevant stimuli. Previous P3 and LPP studies suggest that this enhanced responsiveness toward the face and eye region reflects physiological processes such as attention allocation and information processing which in the context of the current study might be interpreted as socially motivated attention (Hajcak, et al., 2010; Haxby et al., 2000; Kok, 2001; Nummenmaa & Calder, 2009). GG individuals display higher levels of prosocial behavior and empathy, which is expressed in increased attention allocation toward people's eye region from which they try to infer information about their preferences, emotional behavior

and mental state (Langton et al., 2000). This increased socially motivated attention effect was also observed for the later LPP time window (up to 2 sec.), suggesting that it was sustained as opposed to being just an early automatic response. However, in the later LPP time window the difference between preference inferences and passive viewing was only present when the effect of the *OXTR* gene variants were taken into account, suggesting that the social attention allocation was strongly modulated by the participant's genetic profile, especially in relation to the later more sustained and conscious aspect of it.

For A-allele participants there was no ERP difference between viewing human face during the preference inference task and passively viewing branded products. The A allele of the rs53576 has been associated with reduced physiological responsiveness to social support (Chen et al., 2011). In agreement with past research, the ERP results of the current study indicate the A allele compared to GG individuals pay less attention or alternatively socially motivated attention to others' face and eyes which might reflect their lower level behavioral manifestation of prosociality (Kogan et al., 2011; Rodrigues et al., 2009; Smith et al., 2014). The results also suggest that A carriers might be less sensitive to reward-relevant features of the human face or just find face and eyes processing less rewarding compared to GG individuals (Marsh et al., 2012). The difference between GG and A individuals in relation to attention allocation during social inference as opposed to passive viewing of objects might be explained by the influence of *OXTR* gene variations on the function and

structure of specific brain regions, such as the hypothalamus and the amygdala, which have been frequently associated with sensitivity to social reward (Tost et al., 2010). For instance, A-allele carriers show reduced amygdala activation during face processing (Tost et al., 2010). Finally, several studies have reported an association between attention deficit and failure to look at the other's eye region (e.g. Adolphs et al., 2005; Dalton et al., 2005). Failure to look at the eye region denies the brain important visual-social information and may suggest general insensitivity to (or avoidance of) social stimuli (Shepherd, 2010).

4.6.2. Limitations and Future Research

First, physiological responses in relation to social inferences from eye-related cues were measured in a real interaction between two people (second-person neuroscience) seated beside each other. Showing real faces live, instead of images or movie clips, this study tried to replicate naturally an actually occurring sales-consumer interaction. Our experimental setting gives participants (sales consultant) more freedom to use and interpret the eye-related and/or face-related information to make proper social inferences. The main limitation of this approach is the restricted control over the experimental condition and the participants' behavior and performance during the experimental task. Using static images or dynamic movie presentations allows for better control over participants' behavior, leading to more straightforward interpretation of the findings, but inevitably it involves unnatural social inference. In addition, previous EEG research

frequently reported ERP differences between processing gaze-related information from seeing a live face as opposed to pictorial stimuli (Pönkänen et al., 2010). However, there is always a trade-off to be made, because the benefits of one approach are the limitations of another and vice versa.

Second, male and female participants took part in our investigation. Previous findings suggest that on average women respond more strongly than men to social information (Geary, 1998). For instance, women follow gaze more than men (Bayliss et al., 2005). Other biological factors, especially associated with sex differences (i.e., hormones) that were not examined in the current study might have influenced the physiological findings.

Finally, the ERP results in this study were based on the averages of five trials. Using 30 or more preference-inferring trials would have improved the signal-to-noise ratio and thus the reliability of our results. However, given that our experimental task attempted to replicate real social interaction with real social outcomes (i.e., winning money or products at the expense of others) 30 or more trials would have been challenging to obtain for financial and, importantly, logistics reasons. Despite these limitations, which call for a cautious interpretation of the results, we believe our findings agree closely with reported physiological evidence and contribute to the research on *OXTR* gene variations in relation to social attention in the dynamic social context.

CHAPTER 5: CONCLUSION

5.1. TRADITIONAL MARKETING RESEARCH AND SOCIAL CONTEXT

In past years marketing research on consumer behavior focused on studying advertising effectiveness in relation to its textual content, audiovisual features, and the media context in which the ad appears (De Pelsmacker, Geuens, and Anckaert, 2002; Malthouse, Calder, and Tamhane, 2007). Most of these studies do not consider the social dimension of advertising and minimize the role that the social interactions of the audience might have on such physiological processes as attention allocation, emotional engagement and memory (Kamins et al., 1989; Mick and Buhl, 1992). Only recently have marketing researchers made attempts to overcome this theoretical gap by examining the effects that social context and social interactions have on physiological processes during advertising viewing (e.g., Jayasinghe and Ritson 2013; Puntoni and Tavassoli, 2007; Puntoni, Hooge, and Verbeke, 2015; Raghunathan and Corfman, 2006).

Ritson and Elliott (1999) were among the first to provide insights on the role of social settings and group interaction in advertising. In a more recent study, Jayasinghe and Ritson (2013) investigated the influence of everyday domestic social environments and interpersonal family interactions on the way consumers process TV ads. They concluded that the context in which the message is consumed has a significant impact on consumers' engagement practices. Some studies have found that

experiencing ad messages in social contexts enhances sensory processing and memory. For instance, Csikszentmihalyi and Kubey (1981) report that co-viewing is a more emotionally engaging experience than solitary viewing. Further support for the positive impact of viewing ads in the presence of others was found in a recent article reporting on the effects of social context on advertising memory (Puntoni and Tavassoli, 2007). Puntoni and Tavassoli (2007) showed that recall of words in print ads appealing to social desirability occurs faster when participants are in the presence of another passive person compared to when alone. Moorman et al. (2012) found that watching a sports event on TV in the company of other people enhances the amount of attention paid to the commercials shown in the context of that program. This increased attention reflects deeper levels of ad processing which eventually should lead to improved recall performance of ad content. The authors suggest that watching sports events in social contexts enhances commercial exposure because individuals are less inclined to switch channels during the commercial breaks. Thus, they implicitly assume that watching commercials is a social activity, because people seemingly have a need to talk about what they have been exposed to previously.

However, social context was also found to have a negative impact on consumers' engagement practices. For instance, viewing ad messages in the presence of a male friend was found to have a negative impact on ad liking (Fisher and Dubé, 2005). Two other studies examined the effects of co-viewing on advertising effectiveness (Bellman et al., 2012; José-

Domingo, 2015). Both studies provide evidence for the negative effect of co-exposure on advertising effectiveness. José-Domingo (2015) proposed that ad consumption in a social context leads to activation of within-person goals, which directly influences consumer behavior, as well as activation of person-environment goals, which affects consumption directly or through social interaction (Ariely and Levav, 2000).

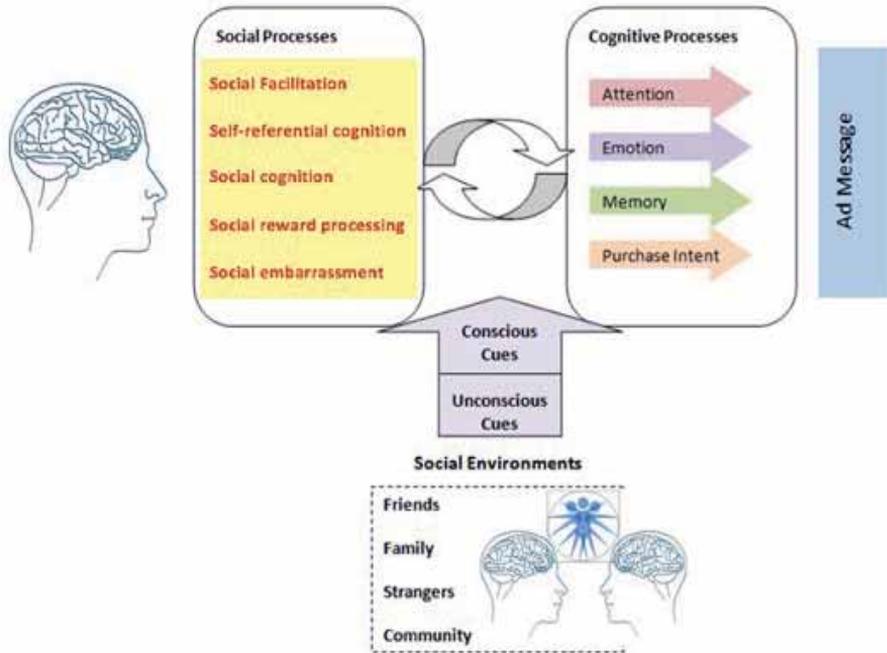
Despite the undeniable impact that social context and interactions have on the way we experience advertising messages, neuromarketing research has largely neglected this extremely important contextual variable (Bakalash and Riemer, 2013). The reasons are clear and understandable. Social interactions are complex because people interact both asynchronously and asymmetrically. Interactions entail manifold dynamics and develop over time as a series of events that usually are extremely hard to predict and manipulate experimentally (Hasson et al., 2012). The complexity and unpredictability of dynamic social settings do not give researchers sufficient control over experimental conditions, which makes data analysis extremely difficult. In addition, including another set of social stimuli, such as the face, body, gestures and smell of another person(s) makes the interpretation of consumer neurophysiological responses to ad messages more challenging (Semin and Groot, 2013). Both experimental design and the required data analysis methods must accommodate this complexity which makes the task of the researcher challenging. However, this complexity is actually present in the way consumers process advertising messages in daily life, and thus marketers risk missing key

processes and misrepresenting evidence if they try to oversimplify the role of social context when studying the effectiveness of marketing-relevant stimuli.

5.2. SOCIAL PROCESSES INFLUENCING ADVERTISING EFFECTIVENESS AND ASSOCIATED NEURAL SYSTEMS

Humans observe others' reactions to objects or situations to assign them a value or establish their importance. For instance, people look at other people when deciding what type of food to eat, what brand of car to buy, what style of clothes to wear, what kind of people (e.g., political candidates, actors, sports figures) to like or dislike. As previously discussed, various conscious and unconscious social signals shape the way people perceive and process external input such as advertising (Moorman et al., 2012; Semin and Groot, 2013). Thus, attention allocation to a billboard or emotional engagement with a TV ad might be modulated by social processes (e.g., social facilitation, self-referential cognition, social cognition, social embarrassment, and social reward processing) that are taking place when viewing advertising materials in social context (Figure 15).

Figure 15: *Social processes affecting the way consumers experience advertising messages in real-world situations where the active human brain interacts with the social environment*



A simpler social situation, in which consumer cognitive processing of advertising can be modulated by the presence of another physical body or brain, is when subjects are not engaged in active social interaction. Social facilitation is defined as a tendency for individuals to behave or perform differently when in the mere presence of others (Zajonc, 1965). Early studies defined the mere-presence effect as a non-interactive social situation where a second person, passively co-present, does not attempt to

engage the first person in any way (Zajonc, 1965). Zajonc (1965) proposed that mere presence is a sufficient condition for producing nondirective, nonspecific arousal: “In the presence of others, some degree of alertness or preparedness for the unexpected is generated, not because there is the anticipation of positive or negative incentives, or threat of evaluation, but simply because one never knows what sort of responses – perhaps even novel and unique – might be required for the individual” (p. 16).

Marketing academics recognize that instances of consumer behavior such as allocating attention to branded products and making decisions can be influenced by the presence of other persons, who could be strangers, friends, family members, or salespeople (Jayasinghe and Ritson 2013; White and Argo, 2011; Kurt, Inman, and Argo 2011; Yang and Allenby 2003; Ariely and Levav 2000). In a recent EEG study, Pozharliev et al. (2015) studied the modulation of attention allocation to ad materials in relation to different social settings (e.g. alone vs. mere presence). The authors found enhanced ERPs when participants were viewing marketing-relevant stimuli together with another person compared to when they were viewing them alone. They suggested that the presence of another person increases attention allocation and the motivational significance that consumers give to marketing-relevant materials, especially to those with strong emotional value. Interestingly, mere presence seems to influence the unconscious cognitive processing of advertising materials as people declare no difference between being alone and in social context (Pozharliev et al., 2015). Another recent EEG study suggests that the mere presence of

another person in close proximity during a task-free resting state condition is sufficient to increase the level of tonic alertness, which is required for more active introspective processes such as self-referential thinking (Verbeke et al., 2014).

Thinking about others requires first and foremost thinking about one's self, i.e. self-referential cognition (Ames et al., 2008). For instance, when a woman walks down the street with friends or family and passes a billboard showing an attractive female model in lingerie, she may think about how others will perceive this ad or what others will think of her if she pays too much attention to it. However, before considering the opinion of her friends or family members the woman may think about how important is for her to pay attention to this specific ad message. Receiving feedback from the audience may elicit reflected self-appraisal and social comparison which requires more thinking about one's own reaction in relation to the behavior of the group members. Comparing one's personal reward of experiencing the ad to possible social feedback from friends or family will most likely determine the way that she will cognitively process the information of the ad (Fliessbach et al., 2007). Interestingly, self-referential cognition recruits brain regions that are involved in thinking about others (i.e. mentalizing), specifically the MPFC and PCC/PC (Gusnard et al., 2001; Mitchell, Banaji, and MacRae, 2005; Northoff, 2006).

Being in a social context makes us think about the mental states and motivations of other physically present people. For instance, imagine a

woman sitting in a beauty parlor waiting for her appointment, watching a big TV screen that shows various programs (e.g., fashion show, talk show, and cooking show) with several commercials breaks. At one point, an ad showing a new cosmetic product or a perfume or clothing brand that the woman likes appears on the screen. Again, the dynamic social context may prompt her to think about how others will perceive this ad or what others will think of her if she pays too much attention to it. In addition, viewing how other members of the audience experience the ad (e.g., facial expression, gesture, body posture, and gaze direction) may stimulate her to think about what motivates their behavior. These socially-evoked processes will inevitably influence the way she processes the ad. Past neuroimaging studies have shown that thinking about others' intentions, motivations, feelings, and thoughts activates a network of brain regions (mentalizing network), including the MPFC, bilateral tempoparietal junction (TPJ), inferior frontal gyri, precuneus/posterior cingulate cortex (PCC/PC), temporal poles and the amygdala (Dietvorst et al., 2009; Lieberman, 2013; Mitchell et al., 2005; Saxe and Kanwisher, 2003). Moreover, social cognition requires the use of other brain systems such as the mirror neuron system (MNS) and superior temporal sulcus that are involved in visual processing of biological motion and gaze detection (Allison, Puce, and McCarthy, 2000; Gallese and Goldman, 1998; Rizzolatti and Sinigaglia, 2010). According to Vittorio Gallese, direct simulation of the motor state of another person (motor resonance) instead of pure conceptual reasoning is what automatically allows us to understand the mental state of that person (Gallese, Keysers, Rizzolatti, 2004). Thus, grasping another's intentions,

thoughts, feelings is conceived as a two-step process that begins with identifying *what* this someone is doing (low-level motor intentions/MNS) which makes possible to understand *why* (high-level reasons/mentalizing) they are doing it (Lieberman, 2013). Both self-referential thinking and social cognition (i.e. mentalizing) are essential for complex socially-elicited processes such as processing social reward and social embarrassment.

Past neuroscience studies suggest that the presence of other people can imply a positive experience resulting from social rewards (Lieberman and Eisenberger, 2008). Moreover, social pleasure as opposed to the pleasure experienced when satisfying physiological needs (e.g., eating a burger, drinking a coffee) is not a conscious experience (Lieberman, 2013). In addition, some studies have shown that our brain longs for positive feedback from others (Davey et. al., 2010; Guyer et al., 2011) Thus, the social feedback that we receive before, during and after viewing an ad can change the way we process it (Fliessbach et al., 2007). For instance, imagine a person watching a commercial break during a network-televised game in a sports bar. This person receives positive social feedback from other clients in the bar, such as cues that others support his team, understand his excitement or agree with his reactions to the referee's decisions (Morelli, Torre, and Eisenberger, 2014). This will most likely influence the way he cognitively processes the commercials, especially compared to the opposite situation where he does not feel appreciated or liked by the audience. Likewise, seeing others who have already given positive social feedback watching a certain advertising message with

interest and excitement may encourage him to pay more attention, memorize more information or become more emotionally involved (Campbell-Meiklejohn et. al., 2010). Perhaps the good experience others have while viewing the ad may transfer to him, often without his conscious awareness. Past neuroimaging studies have shown that social rewards activate a network of brain areas composed of the ventral medial prefrontal cortex (VMPFC) and ventral striatum (Davey et. al., 2010; Izuma, Saito, and Sadato, 2008; Lieberman, 2013).

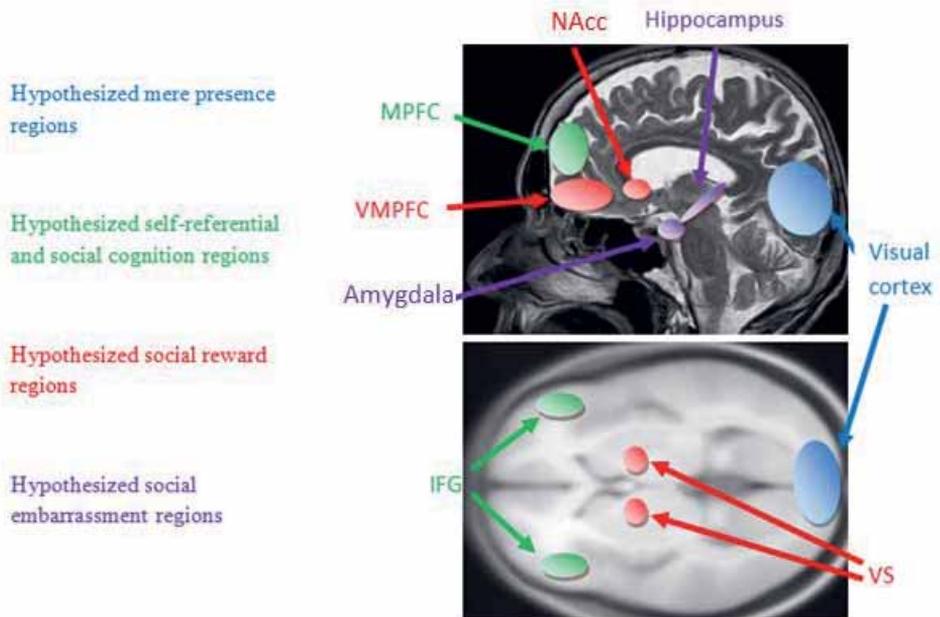
Embarrassment is a strong social phenomenon that is extremely important for marketers, because advertising viewing is often experienced in social context (Puntoni et al., 2015). Embarrassment is a publicly elicited, self-conscious emotion that manifests when social events endanger one's social identity (Miller, 1996). In some cases embarrassment comes as a result of one's own actions (Verbeke and Bagozzi, 2003). For instance, when buying condoms in the presence of other people, making mistakes when interacting with a customer or slipping on a wet floor at work (Dahl, Manchanda, and Argo, 2001; Verbeke and Bagozzi, 2003). Yet, in other cases people feel embarrassed even when they are not personally responsible for the socially embarrassing episode (Lewis, 2000). For instance, a person can feel embarrassed when stared at or when they are the focus of unwanted public attention. Both, what *we do* and who *we are* can lead to feeling embarrassment. This is especially relevant when consumers experience socially sensitive advertising. Feeling embarrassed can change both the valance and intensity of the emotional engagement with certain

advertising material (Puntoni et al., 2015). Due to the strong correlation between the key constructs of advertising effectiveness, socially provoked embarrassment is likely to influence other aspects of ad processing, such as memory and attention. For instance, viewing socially sensitive commercials (e.g., condoms, drugs, feminine hygiene products) in the presence of other people can lead to lower attention allocation or emotional engagement due to viewers' concerns with others' opinions or the situational appropriateness of certain behavioral expressions (e.g., smile, disgust, hand gesture, gaze direction). A consumer will likely avoid paying attention to potentially embarrassing advertising especially when the other people in his vicinity do not share his social identity. Recent fMRI studies indicate that feeling embarrassment activates MPFC, left posterior superior temporal sulcus, central network structures of mentalizing, anterior insula, hippocampus and visual cortex (Paulus et al., 2014; Takahashi et al., 2004). As stated above, most of these regions are associated with other social processes such as Theory of Mind and social cognition (Dietvorst et al., 2009).

Importantly, most brain regions associated with social processes (e.g., social cognition, self-referential cognition, social reward processing, social embarrassment), including the VMPFC, TPJ, ventral striatum, and amygdala are also involved in neural value computations when choices between material goods are made (Ruff and Fehr, 2014). Ruff and Fehr (2014) speculated about the existence of a unified mechanism for motivational control of behavior that may include brain regions associated

with the processing of both social and non-social factors. We propose that hypothesized neural systems involved in cognitive processing of advertising materials may be influenced by social processes that are experienced in simple or complex social settings (Figure 16).

Figure 16: *Hypothesized neural systems involved in cognitive processes related to advertising effectiveness that may be influenced by social processes. Attention: VMPFC = ventral medial prefrontal cortex, Visual cortex (occipital alpha); Emotion: amygdala, IFG = inferior frontal gyri; Memory: MPFC = medial prefrontal cortex, amygdala, hippocampus; Purchase intent/desire: VS = ventral striatum, VMPFC, NAcc = nucleus accumbens*



We have made the first step in this direction by showing that the level of attention measured over visual sites is modulated by the social settings (e.g. mere presence) in which the ad is experienced (Pozharliev et al., 2015). In dynamic social settings the interaction between neural systems engaged in cognitive and social processes is likely to be more complex and less linear. For instance, ventral striatum and VMPFC are known to respond to a variety of rewarding stimuli, including primary (e.g. product), secondary (e.g. money), and social rewards (Bartra, McGuire, and Kable, 2013). We propose that activation of these brain regions may be modulated by the social context in which the advertisement is experienced (Zaki, Schirmer, and Mitchell, 2011). Other brain regions frequently related to memory such as the amygdala and hippocampus are also related to social processes such as social embarrassment (Paulus et al., 2014; Takahashi et al., 2004).

We argue that all four core constructs used for measuring the effectiveness of advertising campaigns are likely to be influenced, all together or separately, by social processes that occur in real-life conditions. We propose using neurophysiological methods in both social context and social isolation as a complementary tool to self-reported measures because including social context in studying marketing campaign effectiveness may enhance the predictive power of the study. A step in this direction might be to compare the differences or similarities in consumer behavior and consumer brain responses to advertising material when consumers are

placed in a social environment or involved in social interactions versus when alone.

5.3. TECHNIQUES FOR SOCIAL NEUROMARKETING: MULTI-SUBJECT EEG/fMRI

Despite the evident methodological difficulties in data collection (e.g., study design and statistical analysis of neurophysiological data gathered in active social settings), the past decade has seen some growth in neuroscience studies that investigate brain correlates during dynamic social interactions (Dumas et al., 2011; King-Casas et al., 2005). Most of this research has been done in relation to economic games, verbal communication, or during coordination of simple motor movements (i.e., button pressing) using the “hyperscanning technique” (for a review, see Hasson et al., 2012; Babiloni and Astolfi, 2014). In neuroscience “hyperscanning” is used to describe a simultaneous recording of neurophysiological activity from multiple subjects. The hyperscanning data analysis approach suggests that social exchange occurs in nonlinear, complex manners via inter-subject behavioral and/or neurophysiological synchronization. The choice of method for analyzing recorded data simultaneously from multiple individuals depends on the properties of the data (neuroelectrical vs. hemodynamic), the domain of interest (frequency vs. time domain), and type of interconnection between multiple brains. The most frequently used hyperscanning methods in time domain analysis include the Pearson correlation, coherence and Granger-based correlation (King-Casas et al., 2005; Schippers et al., 2010), whereas the most

employed frequency-based methods are Partial Directed Coherence (Babiloni et al., 2007), the Estimator Phase Shift (Tognoli et al., 2007), and the Principal Locking Value (Dumas et al., 2010).

In a pioneer fMRI hyperscanning study, Montague et al. (2002) played a simple deception game between two interacting subjects to study a social decision process, thus showing for the first time the advantages that this technique can offer in capturing brain synchronization during dynamic social exchanges. Hyperscanning has been used on some of the emotional and cognitive processes of major interest in advertising, such as attention allocation, emotional engagement, and shared intentions. For instance, a hyperscanning setup was employed in a recent investigation of the synchronized flow of emotions between the brains of romantic partners communicating via facial expressions (Anders et al., 2011). The results indicate that there is a temporal delay in the flow of affective information between two communicating brains. Importantly, this delay decreased over time, suggesting that the two communicating brains were “tuning in” to each other. Hyperscanning fMRI has also been used in studying joint attention and the neural correlates of shared intentional states between interacting brains (Saito et al., 2010). Another important study investigated the effects of previous social interaction in subjects who already knew each other before the experiment, on the brain synchronizations processes between individuals during the Trust Game (Tomlin et al., 2006). Interestingly, the results showed that the observed pattern of activity during the social exchange process could be achieved only in the presence of a

“living” partner. Finally, a recent hyperscanning study demonstrated the important role that social comparison plays in reward processing in the human brain (Fliessbach et al., 2007). The fMRI hyperscanning method has been successfully used between two scanners located in different US states via broadband internet connections which remove boundaries on the way marketers can study neural activations in relation to advertising in dynamic social settings (King-Casas, 2005). Nevertheless, MRI does not offer optimal conditions for testing consumer brain activations in relation to advertising in everyday social settings (e.g., in bars, living rooms, cinemas, etc.) or during dynamic social interactions, due to the constraints that the scanning equipment poses on subjects’ natural movements, the very strong acoustic noise present in the scanner and the lack of real physical presence of another social entity inside the scanning environment.

Multi-subject EEG has also seen growth in the past decade and has gradually become the most frequently used tool for hyperscanning studies in social neuroscience (e.g., Babiloni and Astolfi, 2014). The idea of studying brain recordings from two or more people simultaneously dates back to the 1960s when Duane and Behrendt (1965) performed multi-subject EEG experiments in an attempt to find evidence for the existence of “extrasensory” communication between individuals. The new method Duane and Behrendt (1965) employed was strongly criticized for its poor statistical approach to data analysis, which together with other EEG problems at the time hampered its further application and development. Only recently has multi-subject EEG been re-introduced to examine the

brain activity of multiple subjects in relation to motor and cognitive interaction (Dumas et al., 2010; Tognoli et al., 2007). The results of these studies show evidence of an active right centro-parietal network during appreciation and understanding of other people movements. These findings correspond with the results of other hyperscanning studies which suggest that this right centro-parietal area, together with prefrontal cortices and right tempo-parietal junction (TPJ), might constitute a cerebral network that promotes changes of behavior to improve affective and temporal synchronization with others (Anders et al., 2011; Astolfi et al., 2011; Dumas et al., 2010; Schippers et al., 2010; Tognoli, et al., 2007).

Hyperscanning EEG and fMRI techniques should prove useful for studying consumer brain responses to advertising materials that are usually experienced in dynamic social contexts (e.g., stadiums, cinemas, bars, family living rooms, etc.) where social communication takes place as two or more individuals initiate reactions from each other while processing advertising materials (Hari and Kujala, 2009). As discussed above, hyperscanning methods offer various ways to study social dynamics during exposure to advertising materials, because they can efficiently capture the nonlinear complex inter-subject neural synchronizations that occurs between two or more individuals. For instance, one plausible and frequently occurring scenario is where two or more consumers are simultaneously viewing a TV commercial (e.g., in a living room or a stadium). During the first 10 seconds of the commercial, no viewer shows any form of emotional reaction to it, and thus no explicitly overt social exchange happens between

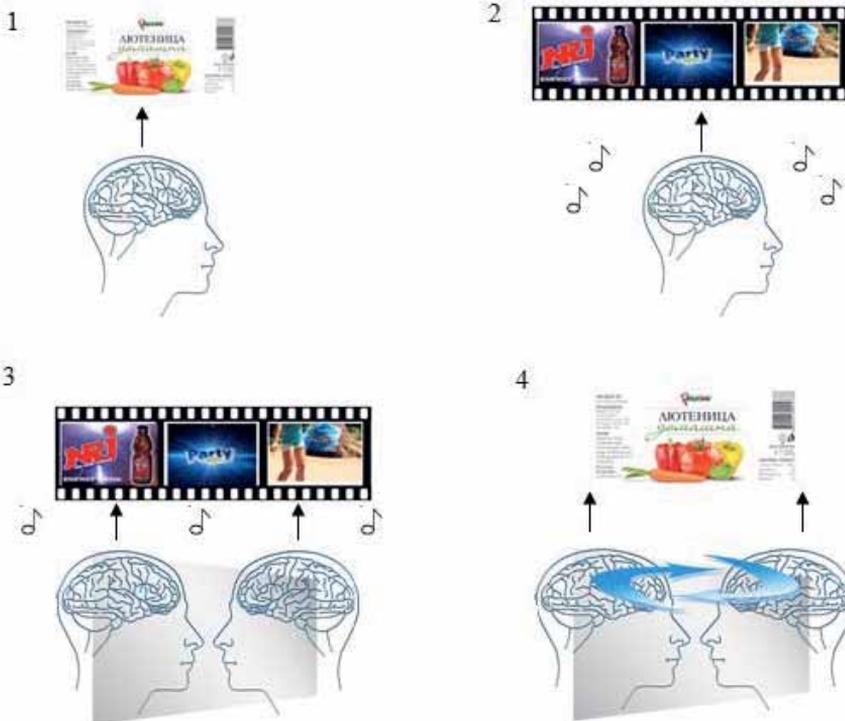
the parties. Later, around the 30 second point of viewing, one viewer starts to express certain emotions, such as surprise or delight with the advertisement, in a series of spontaneous, usually unarticulated sounds (e.g., uncontrolled laughter) often occurring together with corresponding bodily movements and facial expressions (e.g. smiles, cheerful gestures, etc.). The last 10 second of the commercial are experienced as neutrally as in the beginning. In this particular situation an interesting research question might be to investigate whether the emotional reactions expressed by one viewer changes the way in which other viewers process the ad (e.g., as manifest in attention allocation, emotional engagement, memory encoding or preferences). Hyperscanning techniques can offer a valuable tool to explore both the temporal and social dynamics of this ongoing social communication and the way it affects the cognitive and emotional processing of all viewers of the ads. The neurophysiological results of participants who experienced the ad in such a dynamic social context can be compared with results of participants who process the same advertising material alone. This comparison might provide marketers with a more complete picture about the exact way in which certain TV ads affect emotional and cognitive processes (attention, memory, preference) in social settings.

Inter-subject correlation (ISC) analysis has been extensively used in studying offline brain synchronization on a group level. Previous fMRI and EEG studies found it an appropriate and efficient technique to calculate inter-brain synchronization (e.g., functional and effective connectivity)

across regions within two or more brains (Dmochowski et al., 2012; Hasson et al., 2004). Importantly, ISC can be used to examine brain synchronicity between persons during active social interaction as well as in mere-presence social settings, especially in relation to natural and dynamic advertising materials (Dmochowski et al., 2012, 2014).

The social neuromarketing approach discussed herein suggests that brain responses to advertising materials should be measured in varying social contexts ranging from simple mere-presence conditions to settings that include active social exchanges (Figure 17).

Figure 17: *Examples of brain imaging setups for studying advertising effectiveness in social contexts. (1) Single-person setup where subjects passively view static picture, e.g., printed ads, billboards, magazine ads, newspaper ads, and banner ads. (2) Single-person setup where subjects passively view dynamic stimuli, e.g., TV commercial, online ad video, movie trailer. (3) Mere presence setup where two subjects passively observe static or dynamic advertising without active interpersonal interaction. (4) Two-person setup where people are involved in real-world social interaction (e.g., hand gestures, facial expressions, conversations), while viewing static or dynamic advertising messages.*



5.4. CONCLUDING REMARKS

In this dissertation I have explored the interaction between physiological processes, biological markers, personality traits and social context. My main goal was to study the influence of different social contexts on the cognitive processes associated with experiencing advertising material. In order to achieve my goal I have used a combination of traditional advertising measures, personality traits, genetic profiles and the EEG method. I have used theories from different fields such as advertising, cognitive psychology, marketing and social neuroscience. In addition, I have used different social contexts. In Chapter 2, I have started with the simpler mere presence situation in a task-free experiment. In the following chapters I have varied the social condition and/or the experimental task. In Chapter 5, I reviewed traditional advertising research on social context and I discussed the possible interactions between social and cognitive processes during ad viewing. I now very briefly summarize the results from each chapter.

5.4.1. Summary of Main Findings

In Chapter 2, I start my investigation by using simpler mere presence social context. I measure task-free resting-state cortical brain activity in 35 participants under two conditions, alone or together (mere presence). In addition, I study whether psychological attachment styles will affect cortical activity differently in these two social settings. By collaborating with the Erasmus Behavioral Lab, I had access to two EEG systems which

allowed me to collect EEG recordings from two participants simultaneously. The results of this study indicate that social context matters and that participants' cortical activity is moderated by the anxious, but not avoidant attachment style. I found enhanced alpha, beta and theta band activity in the together rather than the alone resting-state condition, which was more pronounced in posterior brain regions. I further found a positive correlation between anxious attachment style and enhanced alpha power in the together versus alone condition over frontal and parietal scalp regions. I found no significant correlation between the absolute powers registered in the other two frequency bands and the participants' anxious attachment style. The results of my first study support my main hypothesis that even in a task-free resting-state, setting the social context makes a difference. Specifically, I believe that the present findings suggest increased tonic alertness that is required for more active introspective processes in the together compared to alone condition. The results of this study encouraged me to continue exploring the influence of social contexts on cortical brain activity in various marketing-related tasks.

In Chapter 3, I use the same mere presence social settings, but I replace the task-free resting-state condition with an advertising-related task. Specifically, I study electrophysiological consumer brain responses underpinning passive viewing of luxury (high emotional value) versus basic (low emotional value) branded products when participants are alone or with another person. By collaborating with the Erasmus Behavioral Lab, I had access to two EEG systems which allowed me to collect EEG recordings

from two participants simultaneously (twenty pairs in total). Conforming to social facilitation theory and using electroencephalogram methods, I recorded event-related potentials while female participants passively viewed pictures of luxury and basic branded products. I examined event-related-potential amplitudes in three time windows, corresponding to the P2 and P3 components and the late positive potential (LPP). Dissimilar brain responses occurred in the Together but not the Alone condition for the P2 and P3 components over visual cortex sites. The LPP amplitude was higher for luxury than for basic branded products, but only in the Together condition, suggesting that the presence of another person magnifies the emotional effect of brand type. Taken together, the results suggest that LPP amplitude during passive viewing of relevant marketing images reflects increased attention allocation and motivational significance, both enhanced by the presence of another person, to stimuli with higher emotional value. For marketers, the results of this second study suggest that social contexts are likely to enhance customer engagement because of increased nondirective arousal, such as nonspecific attention engagement with branded products. For instance, in retail settings, the mere presence of consumers in places where shoppers congregate may amplify feelings of pleasure, joy, and desire.

In Chapter 4, I have studied the brain process of drawing inferences from the mind of another person (i.e. goals, intentions, and beliefs) in sales-consumer settings. Specifically, I investigated the brain responses during passive viewing (consumer's role) of branded products (i.e. chocolates,

chips, non-alcoholic beverages) and preference inferences (sales consultant's role) from eye-related information. By collaborating with the Erasmus Behavioral Lab, I had access to two EEG systems which allowed me to collect EEG recordings from two participants simultaneously (46 pairs). By using EEG methods, I recorded event-related potentials (ERPs) while participants passively viewed pictures of branded products versus when trying to infer the other person's product preferences from eye-related information. I examined ERP amplitudes in two time windows, corresponding to the P3 component and the late positive potential (LPP). I found dissimilar brain responses for preference inferences versus passive viewing for the P3 and LPP components, whose amplitudes were greater for preference inferences compared to passive viewing. In addition, I found enhanced P3 and LPP amplitudes for preference inferences compared to passive viewing for the High Inferring performance (HI) as opposed to the Low Inferring performance (LI) group. Finally, enhanced posterior P3 and LPP amplitudes were found for preference inferences, compared to passive viewing for the GG as opposed to the A-allele carrier individuals of the oxytocin receptor (*OXTR*) gene. Taken together, the results suggest that posterior P3 and LPP amplitude during preference inferences from eye-related cues as opposed to passive viewing of branded products reflects the increased socially motivated attention allocation required for the social inferring task, for the GG compared to A-allele carrier individuals. For managers, the results of this study suggest that higher attention allocation of sales consultants during sales-consumer interaction may lead to better understanding of customers' needs which will likely translate in better

customer service. For social neuroscientists, the current findings indicate that someone's genetic makeup can affect his socially motivated behavior, especially in a social inferring task.

In Chapter 5, I review previous traditional advertising research that examined the effects of social context on physiological processes during advertising viewing. The main conclusion of the chapter is that marketers who aim to understand and predict advertising effectiveness can benefit from placing participants in social settings in addition to the traditional manner of studying consumer brain responses to marketing-relevant stimuli in social isolation. I already showed that social context makes a difference in various marketing-related settings and therefore that marketers should take it into account when measuring advertising effectiveness. I also discuss the impact that different social processes might have on consumer's cognitive experience with advertising material in real-world situations such as being in a bar with friends, or watching TV at home with family. In addition to the mere presence effect studied in Chapter 2 and 3, here I consider self-referential cognition, social cognition, social reward processing, social embarrassment and their interaction with cognitive processes such as attention, emotion, and memory. I also discuss hypothesized neural systems involved in cognitive processes related to advertising that may be influenced by social processes. Finally, I review some techniques applicable to multi-subject EEG and fMRI studies that marketers and neuroscientists can use to examine advertising effectiveness

in a social context. Examples of brain imaging setups for studying advertising effectiveness in social contexts are also provided.

5.4.2. Limitations and Suggestions for Future Research on Advertising Effectiveness

This dissertation is not without limitations, which offer opportunities for future research. I tried to minimize methodological limitations and increase validity and reliability. Nevertheless, there are still a lot of areas which can be explored and improved in future academic studies or business projects.

First, although in all studies I collected EEG data from two participants simultaneously, I never looked at the continuous interaction between the brain responses of each pair of subjects separately. The main goal of this dissertation was to prove that the co-presence of others' influence on the cognitive processing of ad messages, and I did that by looking at the simpler social settings in which no interaction was allowed. Social interactions are complex because people interact both asynchronously and asymmetrically. However, this complexity of social influence is actually present in the way consumer's process advertising messages in daily life, and thus both experimental design and the required data analysis methods, must accommodate this complexity. This is a really challenging task and future studies could look at whether changes in the brain activity of one consumer affect the cognitive processing of ad messages of other consumers. For instance, imagine a person watching a commercial break during a network-televised game in a sports bar. Perhaps

the good experience others have while viewing the ad may transfer to him, often without his conscious awareness. Hyperscanning methods in the time domain analysis such as Granger-based correlation could be extremely useful for capturing this transfer of positive experience and detecting a change in the way the ad has been experienced. By doing this marketers could minimize the risk of missing key processes and misrepresenting evidence when studying the effectiveness of marketing-relevant stimuli. A second methodological limitation of this dissertation concerns the amount of trials and the number of participants in each experiment. Specifically, the results in Chapter 4 are based on the average of only five trials. A higher number of experimental trials and more participants will definitely improve the signal-to-noise ratio and thus increase the reliability of the results.

Second, in this dissertation I studied consumer physiological responses to advertising in relation to attention, emotion and memory. I followed the temporal sequence of processes outlined in the hierarchy of effect model. I did not have more time to explore the last key construct of advertising effectiveness, namely purchase behavior or consumer preference. Future research should look at the neurocorrelates of change in consumer purchase behavior or brand preferences as a result of variations in the social context. It might be the case that consumers prefer a particular brand only in a specific social context (e.g. in the presence of friends) and buy a different brand when they shop alone. In addition, goals determine what people pay attention to and goals in a social context are likely to

modify the way people attend to products. For instance, instead of letting consumers only passively view pictures of products in an experiment, we could ask them if they wanted to choose one product or buy a dress they could wear to a party or business meeting.

Third, I used the EEG method, personality traits and genetic profiles to study how social processes influence consumers' cognitive responses to marketing stimuli. Future studies should look at other biometrics such as hormonal responses, heart rate, respiration rate and skin conductance responses. For instance, the social context may regulate the level of a specific hormone that influences the way consumers cognitively process an ad. Other methods such as fMRI and eye-tracking could be extremely useful for studying social context influence on ad processing in relation to a specific ad construct. Eye-tracking can measure the number of fixation and dwell times used as a direct measure of attention to an ad message.

Finally, the data for this dissertation were collected from participants who were placed in laboratory settings. However, in daily life, an advertisement is never experienced in lab settings. Modern neuroamarketing tools offer new possibilities to investigate real-life social environmental effects in studying consumer engagement with ads. Future research should try to study consumer's responses to ad messages in everyday life situations. For instance, marketers can use modern wireless EEG equipment to study how consumers process advertising when they

watch a football game at the stadium versus when they watch the same game alone at home.

SUMMARY IN ENGLISH

In this dissertation, I focus on the influence of social context on consumers' cognitive responses to marketing stimuli. Specifically, I examine the interaction between cortical brain activity, attachment styles and genetic makeup in different social settings. First, I examine the interaction between cortical brain activity and attachment styles in task-free resting-state condition. My goal is to study the effects of social context on cortical brain activity in ad-free environment. I find that social context affects task-free resting-state cortical brain activity and that this effect is modulated by participant's attachment style. The results suggest increased tonic alertness that is required for more active introspective processes in the social compared to alone condition. Second, I study cortical brain responses to advertising in non-interactive social situation. I find increased attention allocation and motivational significance, both enhanced by the presence of another person, to pictures of luxury branded products. These results suggest that social context enhances customer engagement because of increased nondirective arousal, such as nonspecific attention engagement with branded products. In retail settings, the mere presence of consumers in places where shoppers congregate may amplify feelings of pleasure, joy, and desire. Third, I investigate the interaction between cortical brain activity and participant's genetic makeup in sales-consumer settings. I find increased socially motivated attention during preference inferences from eye-related cues as opposed to passive viewing of branded products for the GG compared to A-allele carrier individuals. This implies that someone's

genetic makeup can affect his socially motivated behavior. Finally, I argue that marketers who aim to understand and predict advertising effectiveness can benefit from placing participants in social settings in addition to the traditional manner of studying consumer brain responses to marketing-relevant stimuli in social isolation.

NEDERLANDSE SAMENVATTING (SUMMARY IN DUTCH)

Ik richt me in dit proefschrift op de invloed van de sociale context op de cognitieve processen die consumenten hebben bij marketingstimuli. In concreto betekent dit dat ik binnen verschillende sociale contexten onderzoek doe naar de wisselwerking tussen corticale hersenactiviteiten, hechtingsstijlen en de genetische aanleg van consumenten. Als eerste onderzoek ik de wisselwerking tussen corticale hersenactiviteit en hechtingsstijlen in een taakvrije “resting-state” conditie. Mijn doel hierbij is om de effecten van de sociale context op de corticale hersenactiviteit te bestuderen, zonder dat hierbij marketingstimuli worden getoond. Hierbij stelde ik vast dat de sociale context invloed heeft op de corticale hersenactiviteiten die kenmerkend zijn voor een taakvrije “resting state” en dat deze corticale hersenactiviteiten worden gemoduleerd door de mate waarin de deelnemer een angstige hechtingsstijl heeft. Deze resultaten wijzen op een verhoogde tonische alertheid, hetgeen nodig is bij actievere introspectieve processen in een sociale versus een alleenconditie. Als tweede bestudeer ik de corticale hersenenreacties als consumenten naar afbeeldingen van luxueuze versus niet-luxueuze merkartikelen kijken in sociale versus alleencondities. Deze studie toont aan dat, in vergelijking met een alleenconditie, er in een sociale conditie verhoogde aandacht is en ook een grotere gemotiveerdheid om waarde toe te kennen als de proefpersoon samen met iemand anders naar afbeeldingen van luxueuze merkartikelen kijkt. Deze resultaten wijzen erop dat de sociale context de

klantbetrokkenheid verhoogt: er is een stijging van de opgewondenheid zoals een niet-specifieke aandacht voor de merkartikelen. Deze bevinding zou erop kunnen duiden dat, in een winkelomgeving, gevoelens van genot, vreugde en verlangen enkel en alleen door de aanwezigheid van andere consumenten versterkt worden. Ten derde onderzoek ik de wisselwerking tussen corticale hersenactiviteiten en de genetische aanleg van de deelnemers bij interacties tussen verkopers en klanten. Hierbij stel ik vast dat als een verkoper de voorkeuren van een klant probeert te achterhalen via de klant zijn oogbewegingen richting merkartikelen de sociaalgemotiveerde aandacht van de verkoper groeit in tegenstelling tot het louter passieve bekijken van merkartikelen van de klant door de dragers van het GG allel, in vergelijking met de AG/AA-allelen van het *OXTR* gen. Dit houdt in dat iemands genetische aanleg zijn sociaal gemotiveerde aandacht beïnvloedt. Tot slot betoog ik dat marktonderzoekers die ernaar streven om via hersenactiviteiten de effectiviteit van reclameboodschappen beter te begrijpen en te voorspellen, er beter aan doen consumenten in een sociale context te plaatsen in plaats van de traditionele en geïsoleerde individuele benadering die nu vaak wordt gebruikt.

ОБОБЩЕНИЕ (SUMMARY IN BULGARIAN)

В тази дисертация, аз се фокусирам върху влиянието на социалния контекст на познавателните реакции на потребителите към маркетингови стимули. По-конкретно, разглеждам взаимодействието между мозъчната активност, личностните черти, като привързаност към семейството и приятелите, и генетичните особености на потребителите в различни социални ситуации. Първо, изследвам взаимодействието между мозъчната активност и личностните специфики на потребителите в ситуация на пълен покой. Основната ми цел е да анализирам ефекта на социалния контекст върху мозъчната дейност в среда без реклами. Резултатите показват, че дори и в ситуация на пълен покой, социалния контекст оказва влияние върху мозъчната активност на потребителя и че този ефект се регулира от личностните му характеристики като привързаност към семейството и приятелите. Резултатите показват още повишени нива на тонизираност и бдителност, нужни за по-активните интроспективни процеси в присъствието на други хора в сравнение със ситуация когато човек а напълно сам. Второ, изучавам мозъчните реакции на потребителите към рекламни материали в неинтерактивна социална ситуация. Намирам че потребителите обръщат повече внимание и отдават по-голямо значение на рекламни материали изобразяващи луксозни маркови продукти когато те се намират в присъствието на друг човек. Резултати предполагат, че присъствието на друг човек повишава внимание и емоционалната ангажираността на клиентите с

марковите продукти в резултат от увеличена ненасочена възбуда. В търговията на дребно, самото присъствие на потребители на места, където купувачите се събират може да усилва чувството на удоволствие, радост и желание. Трето, изследвам взаимодействието между мозъчната активност и генетичните характеристики на участниците в ситуация на покупко-продажба на стоки. Резултатите показват че генетичните характеристики на продавач консултанта, който изучава предпочитанията на клиента наблюдавайки лицевите му реакции, определят социалното мотивирано внимание което той ще обърне на клиента по време на процеса на покупко-продажба. Това означава, че генетичният профил на човек оказва влияние на социално мотивираното му поведение. В заключение, твърдя че маркетинг специалистите които се стремят към качествена и акуратна оценка на рекламната ефективност трябва да тестват потребителските мозъчни реакции към даден рекламен материал не само в социална изолация, но и в релевантна социална среда, която наподобява в най-голяма степен ежедневните ситуации в които потребителя е изложен на рекламен стимул.

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About The Author

Rumen Pozharliev was born on January 7, 1983 in Plovdiv, Bulgaria. He obtained his undergraduate degree, il *Triennio* (a 3-year degree), in Economics of International Markets and New Technologies (*CLEMIT*), from Bocconi University, Milan, Italy in 2006. After finishing his undergraduate degree, Rumen started, together with a friend, an import and retail business, based in his hometown. In 2010, he decided to move to Rotterdam and complete a Master of Science in Economics and Business, majoring in Marketing, at the Erasmus University Rotterdam (cum laude).



In August 2012, Rumen started his Ph.D. at the department of Economics and Business (Marketing) of the Erasmus School of Economics. During his Ph.D., Rumen taught in Neuromarketing and Branding at the Erasmus School of Economics. Rumen's research interests include advertising effectiveness, social neuroscience, and neuromarketing. In particular, Rumen applies neurophysiological and biological methods to understand the influence of different social processes, such as mere presence, on the neural and biological systems involved in cognitive

processes, such as attention and memory, related to advertising effectiveness.

Rumen's work has been published in *Journal of Marketing Research* and *Frontiers in Human Neuroscience*. In May 2016, Rumen presented his work at the *European Marketing Academy Conference (EMAC)* hosted by Norwegian Business School (BI), Oslo, Norway. In addition to his research, he also supervised many master thesis projects. Next to his academic activities, Rumen maintains a strong passion for football and occasionally visits the home games of his favorite team Juventus, Turin.

PORTFOLIO

WORKING PAPERS

Pozharliev, R., Verbeke, W., & Bagozzi, R. (currently under second review). Social Neuromarketing: Neurophysiological measures of advertising effectiveness in social context. *Journal of Advertising*.

Pozharliev, R., & Verbeke, W. (work in progress). Salivary testosterone and alpha-amylase responses to advertising of luxury products in different social contexts.

Verbeke, W., Belschak, F., Bagozzi, R., **Pozharliev, R.**, & Ein-Dor, T. (work in progress). Why some people just “Can’t get no” satisfaction: Secure versus insecure attachment styles affect one’s “Style of being in the social world”.

PUBLICATIONS

Verbeke, W., & **Pozharliev, R.** (2016). Preference inferences from eye-related cues in sales-consumer settings: ERP timing and localization in relation to inferring performance and oxytocin receptor (*OXTR*) gene polymorphism. *International Journal of Marketing Studies*, 8(4), 1-19.

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Verbeke, W., **Pozharliev, R.**, Van Strien, J., & Bagozzi, R. (2015). Andere mensen beïnvloeden de manier waarop we naar merkproducten kijken. *Marketing Online*, www.marketingonline.nl

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TEACHING CREDENTIALS

Sole Lecturer, Erasmus University, Netherlands	Evaluation
Branding (MSc, ± 120 students): 2016	4/5

Co-lecturer, Erasmus University, Netherlands

Neuromarketing (MSc, ± 120 students): 2014, 2015	4/5
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Socio-neuro-economics (BSc, ± 80 students): 2015	4/5
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Master Thesis supervision, Marketing, Erasmus University, Netherlands: ± 20 students

TEACHING INTEREST

Neuromarketing, Consumer Neuroscience, Consumer Behavior, Brand Management, Advertising, Marketing Research, Introduction to Marketing and Marketing Management

UNIVERSITY ACTIVITIES

Academic conferences with presentation

European Marketing Academy Conference (EMAC): 2016
Special Interest Group: Past-present-future of consumer neuroscience
“Neurophysiological measures of advertising effectiveness in social context”

Attended conferences without presentation

Marketing Science Conference (INFORMS): 2016

Erasmus University Behavioral Lab (EBL), 2012-current

Organizing and managing behavioral and neurophysiological lab experiments.

DOCTORAL COURSEWORK

Fall 2013	Advanced Statistical Methods
Fall 2013	Behavioral Decision Theory
Fall 2013	Experimental Methods in Business Research
Spring 2013	Neuroimaging 2: Haemodynamic Methods
Spring 2013	Statistical Methods
Spring 2013	R basics
Spring 2013	Research Methodology and Measurement
Fall 2012	Neuroimaging 1
Fall 2012	Advanced Math: Cognitive Neuroscience
Fall 2012	Tool-kit of Cognitive Neuroscience

SELECTED MASTER COURSEWORK

Marketing Models and Large Datasets, Knowledge-Based Marketing, Marketing Research and Analysis, Branding and Advertising, Seminar Retailing, Seminar Strategic Marketing

The ERIM PhD Series

The ERIM PhD Series contains PhD dissertations in the field of Research in Management defended at Erasmus University Rotterdam and supervised by senior researchers affiliated to the Erasmus Research Institute of Management (ERIM). All dissertations in the ERIM PhD Series are available in full text through the ERIM Electronic Series Portal: <http://repub.eur.nl/pub>. ERIM is the joint research institute of the Rotterdam School of Management (RSM) and the Erasmus School of Economics at the Erasmus University Rotterdam (EUR).

Dissertations in the last five years

Abbink, E.J., *Crew Management in Passenger Rail Transport*, Promotors: Prof. L.G. Kroon & Prof. A.P.M. Wagelmans, EPS-2014-325-LIS, <http://repub.eur.nl/pub/76927>

Acar, O.A., *Crowdsourcing for Innovation: Unpacking Motivational, Knowledge and Relational Mechanisms of Innovative Behavior in Crowdsourcing Platforms*, Promotor: Prof. J.C.M. van den Ende, EPS-2014-321-LIS, <http://repub.eur.nl/pub/76076>

Akin Ates, M., *Purchasing and Supply Management at the Purchase Category Level: strategy, structure and performance*, Promotors: Prof. J.Y.F. Wynstra & Dr E.M. van Raaij, EPS-2014-300-LIS, <http://repub.eur.nl/pub/50283>

Akpinar, E., *Consumer Information Sharing*, Promotor: Prof. A. Smidts, EPS-2013-297-MKT, <http://repub.eur.nl/pub/50140>

Alexander, L., *People, Politics, and Innovation: A Process Perspective*, Promotors: Prof. H.G. Barkema & Prof. D.L. van Knippenberg, EPS-2014-331-S&E, <http://repub.eur.nl/pub/77209>

Almeida e Santos Nogueira, R.J. de, *Conditional Density Models Integrating Fuzzy and Probabilistic Representations of Uncertainty*, Promotors: Prof. U. Kaymak & Prof. J.M.C. Sousa, EPS-2014-310-LIS, <http://repub.eur.nl/pub/51560>

Bannouh, K., *Measuring and Forecasting Financial Market Volatility using High-frequency Data*, Promotor: Prof. D.J.C. van Dijk, EPS-2013-273-F&A, <http://repub.eur.nl/pub/38240>

Ben-Menahem, S.M., *Strategic Timing and Proactiveness of Organizations*, Promotors: Prof. H.W. Volberda & Prof. F.A.J. van den Bosch, EPS-2013-278-S&E, <http://repub.eur.nl/pub/39128>

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Bliek, R. de, *Empirical Studies on the Economic Impact of Trust*, Promotor: Prof. J. Veenman & Prof. Ph.H.B.F. Franses, EPS-2015-324-ORG, <http://repub.eur.nl/pub/78159>

Blitz, D.C., *Benchmarking Benchmarks*, Promotors: Prof. A.G.Z. Kemna & Prof. W.F.C. Verschoor, EPS-2011-225-F&A, <http://repub.eur.nl/pub/22624>

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Gkougkousi, X., *Empirical Studies in Financial Accounting*, Promotors: Prof. G.M.H. Mertens & Prof. E. Peek, EPS-2012-264-F&A, <http://repub.eur.nl/pub/37170>

Glorie, K.M., *Clearing Barter Exchange Markets: Kidney Exchange and Beyond*, Promotors: Prof. A.P.M. Wagelmans & Prof. J.J. van de Klundert, EPS-2014-329-LIS, <http://repub.eur.nl/pub/77183>

Hekimoglu, M., *Spare Parts Management of Aging Capital Products*, Promotor: Prof. R. Dekker, EPS-2015-368-LIS, <http://hdl.handle.net/1765/79092>

Heij, C.V., *Innovating beyond Technology. Studies on how management innovation, co-creation and business model innovation contribute to firm's (innovation) performance*, Promotors: Prof. F.A.J. van den Bosch & Prof. H.W. Volberda, EPS-2012-370-STR, <http://repub.eur.nl/pub/78651>

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Heyden, M.L.M., *Essays on Upper Echelons & Strategic Renewal: A Multilevel Contingency Approach*, Promotors: Prof. F.A.J. van den Bosch & Prof. H.W. Volberda, EPS-2012-259-STR, <http://repub.eur.nl/pub/32167>

Hoever, I.J., *Diversity and Creativity*, Promotor: Prof. D.L. van Knippenberg, EPS-2012-267-ORG, <http://repub.eur.nl/pub/37392>

Hogenboom, A.C., *Sentiment Analysis of Text Guided by Semantics and Structure*, Promotors: Prof. U. Kaymak & Prof. F.M.G. de Jong, EPS-2015-369-LIS, <http://hdl.handle.net/1765/79034>

Hogenboom, F.P., *Automated Detection of Financial Events in News Text*, Promotors: Prof. U. Kaymak & Prof. F.M.G. de Jong, EPS-2014-326-LIS, <http://repub.eur.nl/pub/77237>

Hollen, R.M.A., *Exploratory Studies into Strategies to Enhance Innovation-Driven International Competitiveness in a Port Context: Toward Ambidextrous Ports*, Promotors: Prof. F.A.J. Van Den Bosch & Prof. H.W. Volberda, EPS-2015-372-S&E, hdl.handle.net/1765/78881

Hoogendoorn, B., *Social Entrepreneurship in the Modern Economy: Warm Glow, Cold Feet*, Promotors: Prof. H.P.G. Pennings & Prof. A.R. Thurik, EPS-2011-246-STR, <http://repub.eur.nl/pub/26447>

Hoogervorst, N., *On The Psychology of Displaying Ethical Leadership: A Behavioral Ethics Approach*, Promotors: Prof. D. de Cremer & Dr M. van Dijke, EPS-2011- 244-ORG, <http://repub.eur.nl/pub/26228>

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In this dissertation, I focus on the influence of social context on consumers' cognitive responses to marketing stimuli. Specifically, I examine the interaction between cortical brain activity, attachment styles and genetic makeup in different social settings. First, I examine the interaction between cortical brain activity and attachment styles in task-free resting-state condition. My goal is to study the effects of social context on cortical brain activity in ad-free environment. I find that social context affects task-free resting-state cortical brain activity and that this effect is modulated by participant's attachment style. The results suggest increased tonic alertness that is required for more active introspective processes in the social compared to alone condition. Second, I study cortical brain responses to advertising in non-interactive social situation and motivational significance, both enhanced by the presence of another person, to pictures of luxury branded products. These results suggest that social context enhances customer engagement because of increased nondirective arousal, such as nonspecific attention engagement with branded products. In retail settings, the mere presence of consumers in places where shoppers congregate may amplify feelings of pleasure, joy, and desire. Third, I investigate the interaction between cortical brain activity and participant's genetic makeup in sales-consumer settings. I find increased socially motivated attention during preference inferences from eye-related cues as opposed to passive viewing of branded products for the GG compared to A-allele carrier individuals. This implies that someone's genetic makeup can affect his socially motivated behavior. Finally, I argue that marketers who aim to understand and predict advertising effectiveness can benefit from placing participants in social settings in addition to the traditional manner of studying consumer brain responses to marketing-relevant stimuli in social isolation.

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