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Scientific Article

“The influence of scent on the selection of products in a binary choice task”

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Contents

Abstract

Past studies in the field of Neuromarketing led to contradicting results about the effect of scent on consumer behavior. The present study contributes to previous research by investigating the effect of scent on spatial attention and consumer behavior in the decision-making process. To achieve this aim, an experiment was conducted in which the electroencephalography (EEG) of 27 participants was measured while they performed a binary choice task. Participants were shown a presentation of pairs of wine labels ans asked to choose their preferred one, while the background scent was manipulated (neutral scent, lavender scent, peppermint scent). Results showed that the incongruent scents of lavender and peppermint did not have a significant effect on spatial attention (analyzed with Posterior Contralateral Negativity), reaction time, as well as on the preference for a specific product label. However, the visual presentation of labels did have a significant effect on both participants' spatial attention and their preference for a label. Interestingly, results suggested that even though spatial attention was affected by a specific label, this label did not end up being the preferred one, regardless of the background scent.

The present study confirms the results of previous studies suggesting that although the scent does not show a significant effect on consumer responses to retail environments, attractive packaging plays an important role in attracting consumers' attention.

1. Introduction

Buying decisions are affected, among other things, by how consumers interpret a product's quality, as well as by consumers' personal product preferences. Kotler and Keller (2016) describe five stages of the consumer buying decision process. The third stage includes the evaluation of alternatives, in which consumers process information to make a final value judgement before making a buying decision. A consumer's belief and personal preferences play an important role in the evaluation of alternatives (Kotler & Keller, 2016). Personal product preferences are influenced by a variety of factors, including factors that are related to an individual itself, such as lifestyle and culture, and factors that are closely related to a product's properties, which can be intrinsic and part of the actual product or extrinsic when they are related to the product. However, people may be confronted with multiple aspects that might affect a person's product preference and buying decision. Therefore, peoples' attention is required to attend to the important visual parts. According to Carrasco (2011), "attention allows us to selectively process the vast amount of information with which we are confronted, prioritizing some aspects of information while ignoring others by focusing on a certain location or aspect of the visual scene" (p. 1484). The information that an individual attends to has a great impact on an individual's buying behavior. Marketing research is used by researchers to get a better understanding of buying behavior and the buying decision process. However, with traditional marketing techniques, such as surveys, researchers often fail to analyze the processes happening in the consumer's brain, which might result in a conflict between the research findings and consumers' actual behavior (Agarwal & Dutta, 2015). Traditional market research techniques are dependent on self-report processes which often involve various types of biases, for instance, response bias, self-assessment bias, and researcher bias. To research and analyze cognitive and neural processes for a better understanding of consumer decision making and behavior during buying situations, researchers can make use of neuromarketing techniques which are expected to give a more objective picture of participants' preferences whilst performing, as with this study, a binary choice task. Neuromarketing, also referred to as consumer neuroscience, aims to study the effects of advertising and marketing on an individual's brain (Agarwal & Dutta, 2015). Various techniques in the field of neuromarketing, such as electroencephalography (EEG), enable the recording of people's brain activity revealing what areas of the brain are activated in specific situations, including decision-making whilst performing a binary choice task.

Visuospatial attention is defined as the ability to focus on and process stimuli a person is surrounded with (Posner and Peterson, 1990, as cited in Ickx, Bleyenheuft, & Hatem, 2017). It enables us to prioritize what we process and helps to process selected information at a given spatial location. Although packaging plays an important role in attracting visuospatial attention, once an individual's spatial attention (used interchangeably with visuospatial attention in this research) is secured, this attention might be affected by other stimuli, such as scent. In previous studies, various researchers have determined the importance of scent as an influencing factor of a consumer's attention and behavior (Madzharov, Block, & Morrin, 2015; Mattila & Wirtz, 2001; Morrin & Chebat, 2005; Morrison, Gan, Dubelaar, & Oppewal, 2011; Spangenberg, Crowley, & Henderson, 1996). However, limited research is done on the effects of scent on spatial attention towards the observation of objects. By gaining insight into the effects of scent on spatial attention, information is expected to be gathered on whether scent could be a useful stimulus for attracting potential consumers' attention in retail environments.

This leads to the following research question "What is the influence of scent on the selection of products during a binary choice task?". By answering this research question, this study aims to provide information on whether scent can influence consumers' visuospatial attention and consumers' behavior, including the effect scent might have on reaction time to choose a preferred product and whether there is an effect of scent on a pattern for a product preference, during buying decision processes. To get a better insight into the study's participants' preferences during buying situations, we were interested in the role of emotional and cognitive states, such as attention, emotion, and motivation, in the buying decision process. For this research, including the measurement of emotional and cognitive states, EEG was found to be a suitable technique.

The present study is built on the research carried out by Alvino (2018), in which EEG and behavioral measures were used in an experiment to measure participants' individual choices for product external cues; wine bottle labels. Alvino's (2018) results suggested an influence of the presented wine bottle labels on participants' attention as well as their preferences. However, it was observed that visual attention towards a specific label did not necessarily result in a preference for the same label (Alvino, 2018). By adding the external cue of scent, the present study investigated whether changes in particpants' visuospatial attention and behavior is modulated by scent.

The main research topic of the present study is the effect of scent on a neurophysiological index for attention, the Posterior Contralateral Negativity (PCN), which can be derived from the electroencephalogram (EEG) data (Eimer, 1996; van der Lubbe, Jaśkowski, Wauschkuhn, & Verleger, 2001). In addition to the effect of scent on attention, the reaction time for choosing a preferred visual stimulus as well as the proportion in which a preferred stimulus was chosen, was analyzed.

To achieve the aim of this research, while performing a binary choice task individually, the brain activity of 27 participants was recorded with electroencephalography (EEG).

2. Background, literature review, and theory development

For a better understanding of this study, key dimensions and knowledge areas of this research are discussed further below. Key topics, such as neuromarketing, attention, and electroencephalography (EEG), will be explained in detail before these concepts are used to measure and understand the effects of scent on a customer's attention and behavior in purchase situations.

2.1 Definitions

Neuromarketing

In this study, a combination of neuromarketing techniques was used to investigate the effect of scent on visuospatial attention and behavior. Neuromarketing, also referred to as consumer neuroscience, is an emerging marketing field that combines psychology, neuroscience, and economics. Kenning and Plassmann (2005) define neuromarketing as "the application of neuroscientific methods to analyze economically relevant brain processes and to understand economical behavior". People cannot perceive and process all the information they are confronted with, instead, one must be selective and ignore irrelevant information (Carrasco, 2011). However, since this process happens subconsciously, people usually are not aware of why they make a certain decision or why they prefer something specific over something else. With information on the working of the brain, insights into marketing and consumer behavior, such as the buying decision process, can be generated (Agarwal & Dutta, 2015; Lee, Broderick, & Chamberlain, 2007; Plassmann, Venkatraman, Huettel, & Yoon, 2015).

The main reason for the use of neuromarketing by researchers is to determine consumers' behavior and emotions when they are exposed to a certain product and external stimuli (Ariely & Berns, 2010). Neuromarketing includes imaging research, meaning that neuroimaging techniques are used for market research (Lee et al., 2007). Neuroimages are images of brain activity, created by noninvasive techniques, such as computerized tomography. With neuromarketing techniques, the effect of different marketing stimuli, such as visual or audio, can be measured by investigating changes in the brain activity of potential consumers when being exposed to these stimuli. The measured data can be analyzed and the results can be used to evaluate consumer behavior, among others (Murugappan, Murugappan, Balaganapathy, & Gerard, 2014). By using neuromarketing results for various marketing purposes, such as, developing advertisements, news campaigns, and improving in-store experiences, it is expected to attract consumers' attention to the goods and services they seek.

Attention

One characteristic that can be measured with techniques in the field of neuromarketing, such as with electroencephalography (EEG), to enable better predictions in the buying decision process, is spatial attention. Spatial attention is defined as the selective aspect of perception and it plays a crucial role in decision-making processes (Gidlöf, Anikin, Lingonblad, & Wallin, 2017). Not all visual information perceived at once can be processed by a human being. Attention is a process in which an individual focuses on certain environmental aspects, while at the same time excluding other aspects (Carrasco, 2011). Spatial attention is a key component of the purchase process, leading to retailers undertaking actions that attract the attention of potential buyers (Puccinelli et al., 2009). When considering the visuospatial attention in a retail environment, one must be aware that attention is likely to be focused on products with attractive packages (Koukos & Selame, 2002). Especially when an individual is unable to differentiate products based on their quality and characteristics, the decision about which product option to buy, often is determined by cues that attract the individual's attention, like a product's design, aesthetics, and packaging (Clement, 2007; Pieters, Warlop, & Wedel, 2002). Not only do visual aspects such as packaging have a great effect on spatial attention, other stimuli, such as scent might affect attention as well.

Scent

Individuals' emotions such as pleasure, and behaviors such as approach, are influenced by various environmental stimuli, the scent is one of them (Gkaintatzis, Constantinides, Karantinou, & Van der Lubbe, 2019). Previous studies focusing on the effects of scent on an individual indicated mixed or inconsistent results (Bao & Yamanaka, 2015; Bosmans, 2006; Chebat & Michon, 2003; Krishna, Lwin, & Morrin, 2010; Mitchell, Kahn, & Knasko, 1995; Morrin & Ratneshwar, 2000; Spangenberg et al., 1996). In the past, the effect of the scent has been researched in various ways, resulting in various outcomes. Although scent seems to have an effect on consumer responses to food retail environments which is expected to result in increases in sales, according to Bone and Ellen (1999) experimental research often shows null effects and no significant effects on consumer responses to retail environments. In contrast to Bone and Ellen's (1999) findings, previous studies have indicated that odors are likely to create and change emotional and behavioral reactions from consumers (Donovan & Rossiter, 1982; Michon & Chebat, 2004). Although there is rather short-term memory for scent itself, scent can be an effective way to increase long-term product memory (Morrin, Krishna, & Lwin, 2011; White & Treisman, 1997). Morrin and Ratneshwar (2000) investigated the effect of scent on brand evaluations. Results showed that environments that included a scent that was experienced as pleasant by participants, affected evaluations of (mainly unfamiliar or unpopular) brands as well as a recall for unfamiliar brands. In this case, scent played a moderating role (Morrin & Ratneshwar, 2000). Furthermore, various researchers indicated that cognitive reactions are stimulated by atmosphere scents (Chebat & Michon, 2003; Krishna et al., 2010; Spangenberg et al., 1996). Thus, scents may have an impact on cognitive processes, including an increase in attention (Krishna et al., 2010). However, to achieve this effect, researchers have different opinions on whether the scent should be congruent with the product class, or whether the scent should be experienced as pleasant while at the same time being incongruent with the product class (Bosmans, 2006; Mitchell et al., 1995). Other researchers also noted that there might be a difference in the effect of congruent or incongruent scents on various other responses, such as attitudes, perceptions, behavior and memory.

In addition to the expected general effects of scent on purchasing behavior, a difference in the effect might occur, depending on what odor is used. Bao and Yamanaka (2015) discovered the difference between stimulating scents and relaxing scents. For this research, the scent of peppermint, lavender, and a neutral scent was used. For the "neutral" scent, no specific scent was introduced to the room the experiment took place in. Peppermint is described as a stimulatory and arousing scent, whereas lavender is thought to be sedative (Ilmberger et al., 2001; Spangenberg et al., 1996). However, also regarding specific scents, the opinions of researchers vary. In one study, lavender was found to increase alertness accuracy, while at the same time an increase in the participants' level of feeling relaxed could be noted (Diego, Jones, Field, Hernandez-Reif, Schanberg, Kuhn, McAdam, Galamaga, & Galamaga, 1998). In contrast, in a different study lavender was found to even decrease one's level of attention (Moss, Cook, Wesnes, & Duckett, 2003). As cited by Morrin and Ratneshwar (2000), arousal is linked to a person's alertness or drowsiness. Therefore, it might be expected that the arousing scent of peppermint might affect the participants' level of alertness in this experiment. Stimulating scents, such as peppermint, can have positive and negative effects on emotions. In the study of Bao and Yamanaka (2015) a stimulating scent rose the participants' level of arousal while playing an arousing game as compared to playing the game without being exposed to a stimulating scent. This is in line with Barker et al. (2003) who state that mint scents have a positive effect on participants' scores when performing cognitive tasks that affect one's attentional process.

2.2 Challenges in Neuromarketing

Just like any other marketing tool, neuroimaging tools also entail technical and ethical issues and limitations. Firstly, experiments using neuromarketing tools are usually carried out in artificially created environments, such as laboratories. In such artificially created environments, the complexity of the real world and the buying process is simplified and the stimuli used for the experiment are easy to be controlled by the researchers (Koschate-Fischer & Schandelmeier, 2014). For the present research, electroencephalography (EEG) was applied. EEG might be used to measure brain activity while a participant in an experiment is exposed to marketing stimuli. With its high temporal resolution, EEG is of high interest for neuromarketing research (Vecchiato et al., 2011). However, EEG also knows some limitations. An important issue that must be considered is the experimental settings; depending on the placement of electrodes, the results of hemispheric lateralization might differ. Other experimental settings, such as lighting, room temperature and smell need to be kept as constant and similar as possible for each participant. Additionally, the participant should not be distracted and should not move a lot while the data is being collected (Wang & Minor, 2008).

Neuromarketing is also the subject of ethical debates. Most ethical debates are related to risks of harm, including immediate effects on consumers and long-term effects on society, and to violations of rights, including rights to privacy, autonomy, and dignity, among others. Neuromarketing has been used, in addition to traditional marketing techniques, to get insights into brain activity to forecast choices and decisions in purchase situations. Therefore, it might be believed that neuromarketing will enable the complete prediction of all consumers' choices and buying decisions, even before these choices and decisions are made by consumers (Stanton, Sinnott-Armstrong, & Huettel, 2017; Venkatraman et al., 2015). Neuromarketing (as well as any other marketing technique) might provide information about how to, for instance, present products in an irresistible manner, that might make consumers more or less likely to buy a product, therefore, it is argued that consumers' attention might be manipulated affecting the degree of freedom when making decisions. However, although being influenced by the environment consumers find themselves in, in the end, consumers will remain entitled to make their own buying decisions (Stanton et al., 2017).

3. Methodology

By conducting an experiment in which participants were presented with different wine labels, it was aimed to determine the effect of scent on visuospatial attention while at the same time assessing whether Posterior-Contralateral Negativity (PCN) parameters can be useful in estimating a person's visuospatial attention level for a specific label in a specific scent condition. To achieve this objective, spatial attention was measured by focusing on electroencephalography (EEG) lateralization in the parieto-occipital area (electrode positions PO7 and PO8). In this experiment, participants performed a binary choice task in which they indicated their preferred wine bottle label whilst the background scent was being manipulated. While performing this task, the brain activity was measured with EEG in order to determine whether the allocation of a participant's focused spatial attention was affected by these various scent conditions. With the measured EEG data, the relation between the participants' visuospatial attention and decision-making could be determined. In case there was a relation, it is investigated whether this relation was modulated by scent.

3.1 Participants

Twenty-seven volunteers were recruited to take part in the experiment. The participants of this experiment had similar characteristics, including the same age category, 20 years to 35 years old, being bachelor and master students, or graduates of a higher educational level. Similar characteristics of the participants were required to make the results better comparable and more reliable. Participants were asked to fill out a questionnaire concerning their characteristics, such as age and gender, and regarding their health and mental state to ensure that the gathered data would be useable and reliable. Participants should not have a history of neurological illness or damage, no blindness, no psychiatric disorder, and should not recently have used drugs or consumed a large amount of alcohol.

3.2 Procedure

The experiment was built up in such a manner, that all volunteers took part in the experiment individually. Each participant was invited for one session in which he/she was exposed to all three scent situations. After the participant arrived at the lab, the participant was informed about the details of the experiment and received more specific instructions. Written informed consent was obtained from the participant. Before applying the EEG electrodes, as well as between the different scent conditions, the participant was asked to fill out an additional questionnaire regarding his/her current state of emotions. With this questionnaire pleasure, arousal, dominance, stimulus screening ability, attention, and the big five personality traits (including openness, conscientiousness, extraversion, agreeableness, and neuroticism) could be measured. These questionnaires were not taken into further consideration in this research but will be used for future research to analyze the changes in emotions based on the change in background scent.

For the EEG measurements, a lab including all instruments necessary to experiment, was used. The measurement required two computers – one for presenting the binary choice task (programmed with Presentation software) and one for recording the EEG data. Both computers were connected to the BrainVision ActiChamp Amplifier. For recording and analyzing the data, the programs BrainVision Recorder and BrainVision Analyzer were used.

3.3 Task

After attaching the EEG cap to the participant's head, the participant was asked to perform a binary choice task while being exposed to three scent conditions – no scent, peppermint scent, lavender scent. To get a better insight into the effects of scent on the participants' arousal, the order of the different scent conditions varied per participant. In each condition, the participant was asked to watch a presentation showing a variety of four wine bottles with different labels, on the presentation computer screen. Two labels were displayed simultaneously on the left and right sides of the computer screen. Participants were instructed to choose the preferred wine bottle spontaneously, by pressing the left button (meaning the label presented on the left side of the screen was preferred) or by pressing the right button (meaning the label presented on the right of the screen was preferred). For each scent condition, the participants were shown the same presentation.

3.4 Materials and Stimuli

Participants were exposed to two classes of stimuli, wine labels, and scent. Participants were sitting in front of a computer screen that showed a presentation of four different wine bottle labels. During the binary choice task, the participant was presented with two labels simultaneously, one label on the left side, one label on the right side of the computer screen. After indicating their preferred wine bottle by using the left and right CTRL keys of the keyboard, a different combination of two of the four labels was presented. The second stimuli consisted of various scent conditions. By introducing a peppermint and lavender scent with a scent machine, the background scent was manipulated. The scent machine works on the vaporization of etheric oils. Depending on the scent condition required, the peppermint or lavender oil was inserted into the scent machine. Once the binary choice task started, the scent machine was turned on and the vaporization of the inserted etheric oil started. After one and a half minutes, the vaporization automatically paused for two minutes before it automatically started to run again for one and a half minute. After that, the scent was so intense that the scent machine was turned off while the scent stayed noticeable for the remaining time of the binary choice task. For each participant, the settings of the machine were kept consistent to ensure comparable scent conditions. For the third scent condition, the neutral condition, the scent machine was not used.

3.5 Electroencephalographic (EEG) Measurements

While watching the presentation, the participant selected the preferred wine bottle by using the keypad. EEG was used to determine a neurophysiological index of spatial attention of the participants. The focus was on Posterior-Contralateral Negativity (PCN), also known as N2-posterior contralateral (N2pc). PCN is used for reflecting the moment-to-moment deployment of visual-spatial attention (Jolicoeur, Brisson, & Robitaille, 2008). For this research, the participant was exposed to the visual stimulus of wine bottles with different labels, which were expected to affect the participants' visuospatial attention. PCN data was derived from the EEG and then analyzed, to determine whether a specific wine bottle was preferred and caught the participant's spatial attention. By presenting two visuals on the left and right side of a computer screen, both visual fields of the participants were stimulated. A systematic difference would therefore indicate that there is a selection of one of the labels presented. Increased negativity in the visual area (posterior electrodes) contralateral to the visual stimulus was expressed by PCN in a time window of approximately 100 to 300 ms after the stimulus, in this case, wine bottles, was presented to the participant (Jolicoeur et al., 2008; Vossel et al., 2014). In general, PCN can be used to indicate the participants' spatial attention (Van der Lubbe, Jaśkowski, Wauschkuhn, & Verleger, 2001). For each scent condition, the PCN was measured.

The participants' brain activity was recorded continuously from the following 30 active Ag/AgCl electrode sites: AFz, AF3, AF4, AF7, AF8, F5, F6, FCz, FC3, FC4, FT7, FT8, C3, C4, C5, C6, CPz, CP3, CP4, TP7, TP8, P1, P2, P5, P6, POz, PO3, PO4, PO7, and PO8 using an EasyCap-62 channel cap with a standard international 10–20 system layout.

3.6 Behavioral Measures

Participants had to choose their preference of the presented labels by using the left or right CTRL key of the keypad. This was recorded to determine the preferred label for each participant, as well as the reaction time to choose a preferred label and the proportion chosen of the presented labels under each scent condition.

3.7 Analysis of the Data

The gathered EEG data were analyzed with "Brainvision Analyzer version 2.2" software. This software can be used for the analysis of a variety of neurophysiological data and it is easy to use, reliable, and fast (Brain Products, 2019). The analyzed data does not contain personally identifiable information that can be traced back to specific participants.

For the analysis, epochs in the continuous data were marked at 500 ms prior up to 2000 ms after the pair of wine labels was presented, while an initial baseline was set from -500 ms to 0 ms before the stimulus. EEG was corrected for eye movement-related artifacts via artifact rejection, and Ocular Correction ICA (Independent Component Analysis). Channels within segments that contained changes exceeding 50 μV/ms, trials with amplitude differences of more than ± 250 μV, as well as segments with low activity (amplitude differences did not exceed 0.5 μV in 100ms), were removed. After the Ocular Correction, another baseline correction was applied (again -500 to 0 ms) and another artifact rejection was applied (criteria were set to remove trials with differences of more than ± 150 μV). In the end, lateralized EEG potentials as a function of the to-be-attended side were determined for all homolog electrode pairs and each label pair under each scent condition. With these lateralized potentials, PCN values for two time windows (100 to 200 ms and 200 to 300 ms post-stimulus), reaction time data and proportion chosen data were created for the statistical analysis. The time windows were chosen since PCN can be measured within a short time window after the stimulus was presented. PCN seems to be triggered within a time window of 150 to 200 ms after a stimulus is presented (Töllner, Müller, & Zehetleitner, 2012; Töllner, Zehetleitner, Gramann, & Müller, 2011). By using time windows of 100 to 200 ms and 200 to 300 ms post-stimulus, potential changes in PCN are expected to be captured. With this statistical analysis, changes in PCN latencies and deviations were monitored.

3.8 Statistical Analysis

For the analysis of the EEG and behavioral data the program SPSS was used to perform a repeated measured ANOVA. Different sessions were analyzed based on the three different scent conditions – no/neutral scent (N), peppermint scent (P) and lavender scent (L). Since this research includes multiple comparisons and it was unknown whether there would be differences between the various conditions, Bonferroni was used for the comparison of main effects. For the analysis, associated Degree of freedom, F-values, P-values, Means and Partial Eta Squared were reported. Mauchly's Test of Sphericity was analyzed to report the correct degree of freedom for the averaged tests of significance. In case the sphericity assumption was violated, Greenhouse-Geisser corrected results were reported. To compare contrasts between effects the various and labels and scents might have, Tests of Within-Subjects Contrasts were carried out.

4. Results

This section describes the results that were obtained from EEG and behavioral data. Statistical analyses were performed via a repeated measures ANOVA, in order to analyze if there were differences in the means of the participants' spatial attention (measured in posterior contralateral negativity; PCN), reaction time (RT) measured in milliseconds with regard to choosing a preferred label of the pair of labels presented, and the proportion chosen (PC) of all of the four wine labels that were included in the presentation.

4.1 EEG Results

A repeated measures ANOVA was performed in order to compare the participants' brain activity that was recorded under each scent condition, in two different time windows (100 to 200 ms and 200 to 300 ms post-stimulus).

Firstly, the results in Table 4.1 show that there were differences in the means of participants' measured PCN, meaning participants spatial attention was affected by either scent, the presented wine bottle labels, or a combination of the two. PCN measured at 100 to 200 milliseconds after the pair of labels was presented, showed a negative PCN for the label of Alturis, under all three scent conditions. The second time window, 200 to 300 ms, showed a negative PCN for both labels, Los Boldos and Alturis. This suggests that, initially, participants' visuospatial attention is only focused on Alturis, but subsequently, participants also attended to Los Boldos, regardless of the scent condition.

Table 4.1: *Means of the participants' PCN measured in* μV *for each of the three scent conditions, measured in two different time intervals after the stimulus (wine labels) was presented.*

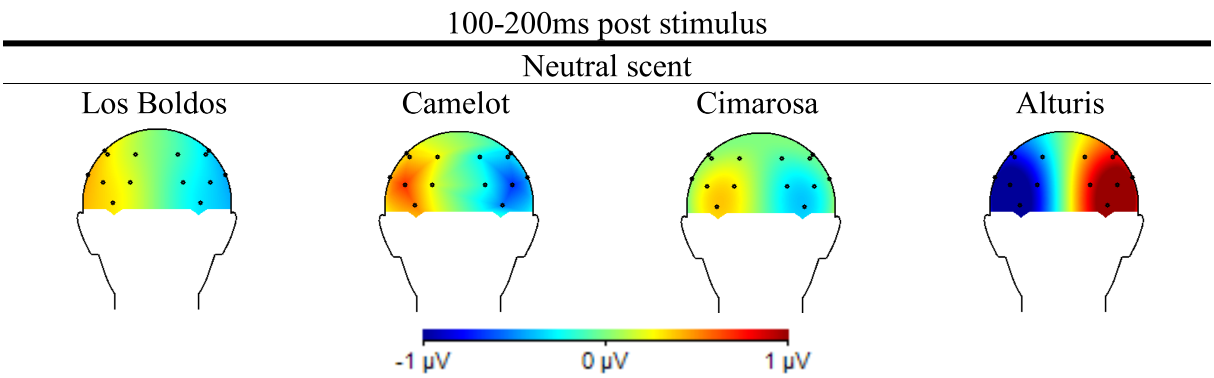
100-200ms post-stimulus

	Mean	95% Confidence Interval	
Neutral scent condition		Lower	Upper
Los Boldos	0.302	-0.002	0.606
Camelot	0.538	0.226	0.850
Cimarosa	0.343	-0.008	0.695
Alturis	-1.169	-1.516	-0.822
Lavender scent condition			
Los Boldos	0.467	-0.007	0.940
Camelot	0.453	0.098	0.808
Cimarosa	0.002	-0.441	0.444
Alturis	-0.912	-1.186	-0.639
Peppermint scent condition			
Los Boldos	0.078	-0.277	0.433
Camelot	0.627	0.391	0.863
Cimarosa	0.429	0.116	0.743
Alturis	-1.131	-1.566	-0.696

200-300 ms post-stimulus

	Mean	95% Confidence Interval	
Neutral scent condition		Lower	Upper
Los Boldos	-0.552	-.0995	-0.109
Camelot	0.114	-0.377	0.603
Cimarosa	0.857	0.440	1.273
Alturis	-0.410	-0.768	-0.052
Lavender scent condition			
Los Boldos	-0.205	-0.819	0.409
Camelot	0.154	-0.427	0.735
Cimarosa	0.336	-0.269	0.941
Alturis	-0.272	-0.637	0.092
Peppermint scent condition			
Los Boldos	-0.821	-1.228	-0.413
Camelot	0.356	-0.028	0.741
Cimarosa	0.620	0.315	0.925
Alturis	-0.158	-0.554	0.238

Figures 4.1 and 4.2 present a visual overview of the changes in the average PCN of participants. They reflect the results presented in Table 4.1. The topographies are based on interpolation by spherical splines with an order of splines of 4. A scaling with a minimum of -1 µV and a maximum of 1 µV was used.



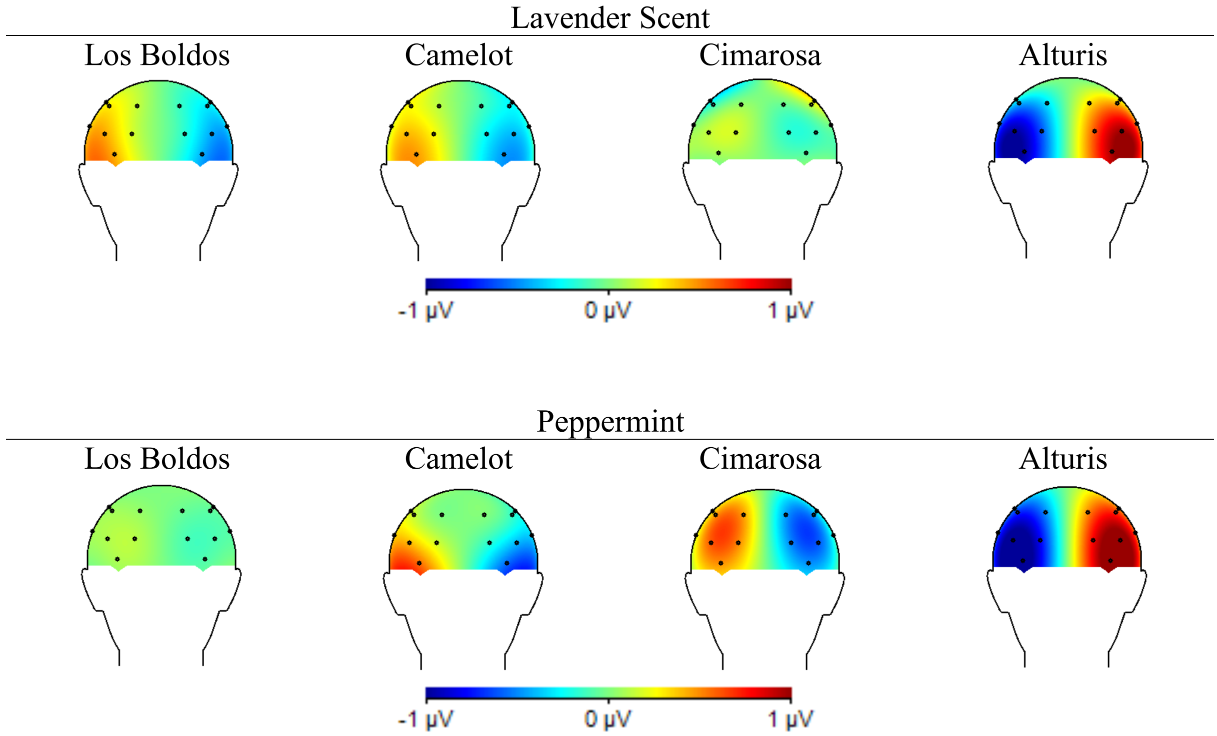
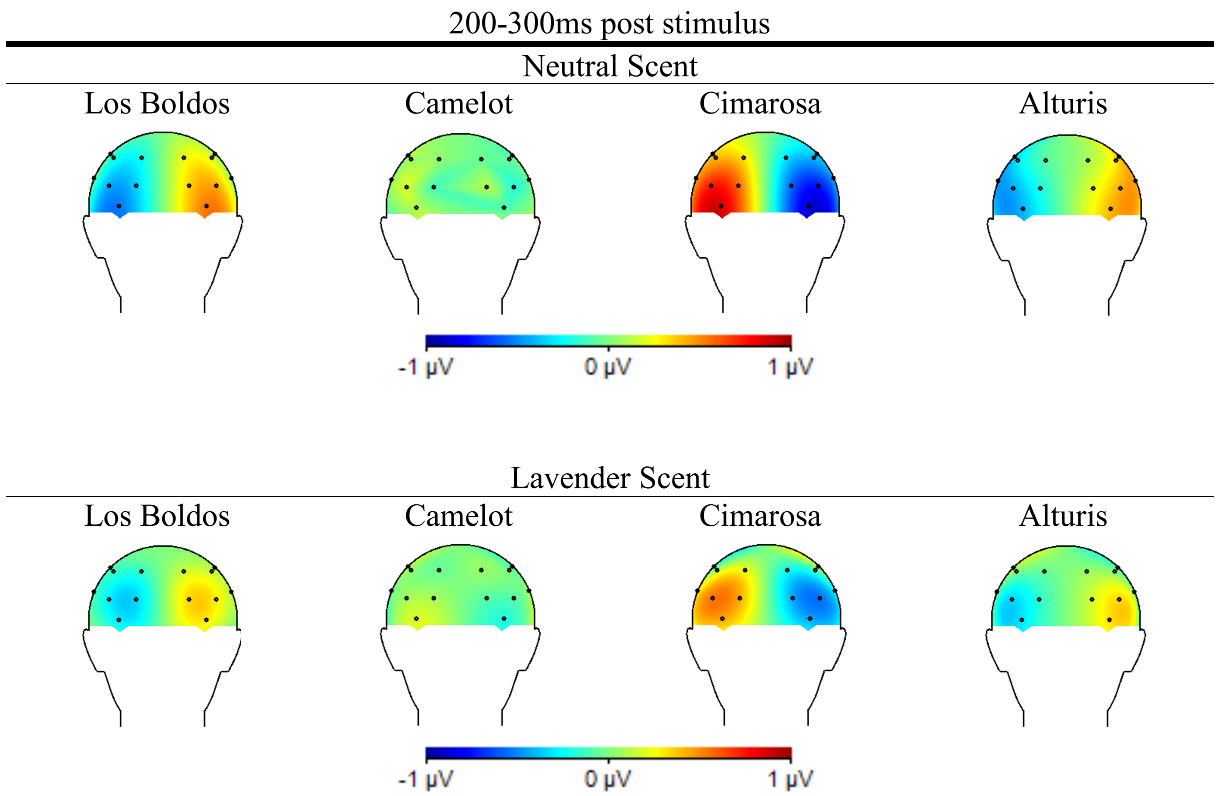


Figure 4.1: *Topographies of the average PCN of participants, 100-200 ms post-stimulus, for each label under three scent conditions. Contra-ipsilateral activity is projected on the left hemisphere.*



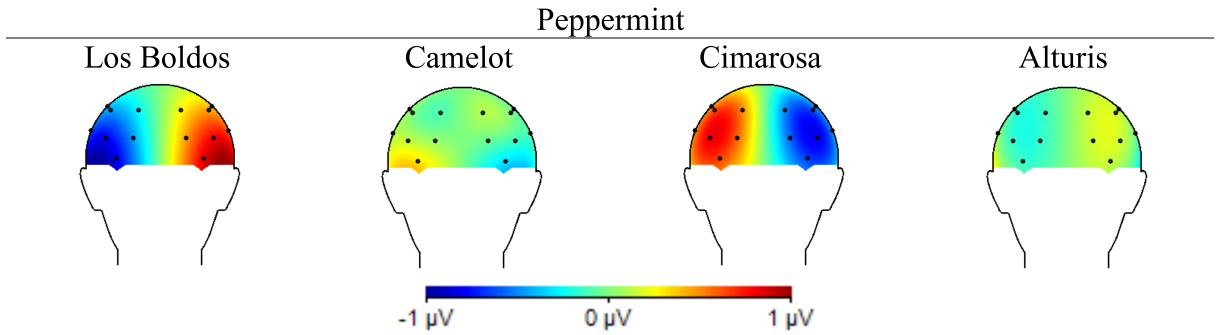


Figure 4.2: *Topographies of the average PCN of participants, 200-300 ms post-stimulus, for each label under three scent conditions. Contra-ipsilateral activity is projected on the left hemisphere.*

As presented in Table 4.2, the repeated measures ANOVA revealed that there was a significant difference in the means of the participants' PCN. Regardless of the time window, the results suggest that Scent does not have a significant effect on PCN in the first time window ($F(2,52) = 0.44$, $p = 0.647$), nor in the second time window ($F(1.39,36.14) = 0.67$, $p = 0.467$). However, the Label stimulus does show a significant effect on PCN in both time windows ($F(3,78) = 28.86$, $p < 0.0001$) and ($F(3,78) = 7.72$, $p < 0.0001$). Although Partial Eta Squared indicates a large effect size of Label on PCN during the second time window ($\eta_p^2 = 0.229$), the effect size is smaller when more time passes (first time window $\eta_p^2 = 0.526$). Interaction between Scent and Label was not significant, meaning that spatial attention automatically was focused on Alturis and it was not modulated by scent.

Table 4.2: *Results of the repeated measures ANOVA analysis. Participants' PCN measured in* μV *during the binary choice task while being exposed to three scent conditions. Measured in two time windows.*

100-200 ms post-stimulus

Conditions	Correction	df	Mean Square	F	p-value	Partial Eta Squared
Scent	Sphericity Assumed	2	0	0.439	0.647	0.017
Label	Sphericity Assumed	3	42.768	28.855	0.0001	0.526
Scent*Label	Sphericity Assumed	6	1.044	1.184	0.317	0.044

200-300 ms post-stimulus

Conditions	Correction	df	Mean Square	F	p-value	Partial Eta Squared
Scent	Greenhouse-Geisser	1.39	0.001	0.666	0.467	0.025
Label	Sphericity Assumed	3	20.607	7.72	0.0001	0.229
Scent*Label	Sphericity Assumed	6	1.765	1.313	0.254	0.048

To gain more insight, the effect the combinations of the labels had on participants' PCN was analyzed in Table 4.3. When considering the PCN 100-200 ms data, the presented combinations of Alturis with all other labels resulted in a significant effect on participants' PCN, ($F(1,26) = 38.17$, $p < 0.0001$) combined with Los Boldos, ($F(1,26) = 76.71$, $p < 0.0001$) combined with Camelot, and ($F(1,26) = 41.63$ $p < 0.0001$) combined with Cimarosa. While the combination of Los Boldos and Camelot ($F(1,26) = 2.17$, $p = 0.153$) and the combination of Los Boldos and Cimarosa ($F(1,26) = 0.01$, $p = 0.908$) did not show a significant effect on PCN in the first time window.

Data revealed that the combination of Los Boldos and Alturis only have a significant effect on participants' PCN in the first time window ($F(1,26) = 38.17$, $p < 0.0001$), as time passes, the effect is not significant anymore ($F(1,26) = 1.31$, $p = 0.263$). When participants were presented with a combination of the labels of Alturis and Camelot or Alturis and Cimarosa, the labels' effect on PCN was significant, regardless of the time window. Los Boldos combined with Camelot ($F(1,26) = 5.44$, $p = 0.028$) or Cimarosa ($F(1,26) = 16.23$, $p < 0.001$) only showed a significant effect on PCN in the latter time window.

Table 4.3: *Contrast in participants' PCN measured in* μV *based on the combination of the labels. Measured in two time windows.*

100-200 ms post-stimulus

Labels	df	Mean Square	F	p-value	Partial Eta Squared
Los Boldos vs. Camelot	1	1.785	2.167	0.153	0.077
Los Boldos vs. Cimarosa	1	0.016	0.014	0.908	0.001
Los Boldos vs. Alturis	1	49.437	38.171	0.0001	0.595
Alturis vs. Camelot	1	70.01	76.71	0.0001	0.747
Alturis vs. Cimarosa	1	47.688	41.626	0.0001	0.616

200-300 ms post-stimulus

Labels	df	Mean Square	F	p-value	Partial Eta Squared
Los Boldos vs. Camelot	1	14.545	5.437	0.028	0.173
Los Boldos vs. Cimarosa	1	34.482	16.226	0.0001	0.384
Los Boldos vs. Alturis	1	1.634	1.309	0.263	0.048
Alturis vs. Camelot	1	6.429	4.36	0.047	0.144
Alturis vs. Cimarosa	1	21.103	15.78	0.001	0.378

4.2 Behavioral Results

Reaction Time

Table 4.4 presents the mean reaction time in milliseconds of 27 participants concerning each chosen label within each scent condition. Reaction time increased when participants were exposed to the Lavender scent condition, as well as an increase in reaction time could be noted when Cimarosa was presented to the participants. However, as presented in Table 4.5, the effects of scent ($F(2,52) = 0.15$, $p = 0.858$), label ($F(1.78,46.45) = 2.16$, $p = 0.132$) and scent*label ($F(3.22,83.66) = 0.66$, $p = 0.592$) on reaction time were not significant.

Table 4.4: *Means of the participants' reaction time to choose the preferred wine label, measured for each of the three scent conditions.*

		95% Confidence Interval	
Neutral scent condition	Mean	Lower	Upper
Los Boldos	549.99	479.20	620.77
Camelot	562.23	488.04	636.42
Cimarosa	597.57	505.04	690.10
Alturis	601.04	499.18	702.90
Lavender scent condition			
Los Boldos	563.27	487.15	639.38
Camelot	586.96	502.93	670.99
Cimarosa	629.81	525.74	733.88
Alturis	594.88	505.83	683.94
Peppermint scent condition			
Los Boldos	566.75	491.11	642.39
Camelot	573.85	498.98	648.72
Cimarosa	595.26	505.48	685.03
Alturis	583.35	500.62	666.07

Table 4.5: *Results of the repeated measures ANOVA analysis. Participants' reaction time during the binary choice task while being exposed to three scent conditions.*

Conditions	Correction	df	Mean Square	F	p-value	Partial Eta Squared
Scent	Sphericity Assumed	2	8192.327	0.154	0.858	0.006
Label	Greenhouse-Geisser	1.786	59208.714	2.157	0.132	0.077
Scent*Label	Greenhouse-Geisser	3.218	6405.938	0.656	0.592	0.025

Proportion Chosen

Table 4.6 suggests that, with each scent condition, Los Boldos had the highest proportion chosen (PC), meaning, when Los Boldos was presented, it was chosen more often than the other labels. This would suggest, that regardless of the scent condition, Los Boldos was the preferred one.

Table 4.6: *Means of the participants' proportion chosen measured for each scent condition.*

Scent condition and label		95% Confidence Interval	
Neutral scent condition	Mean	Lower	Upper
Los Boldos	67.48	57.39	77.57
Camelot	49.54	39.79	59.29
Cimarosa	43.75	34.62	52.88
Alturis	46.99	39.34	54.64
Lavender scent condition			
Los Boldos	62.35	52.70	71.99
Camelot	53.58	43.31	63.86
Cimarosa	44.47	33.33	55.61
Alturis	43.98	36.82	51.15
Peppermint scent condition			
Los Boldos	65.51	54.73	76.28
Camelot	54.42	44.65	64.19
Cimarosa	40.51	30.70	50.32
Alturis	44.68	37.92	51.44

Table 4.7: *Results of the repeated measures ANOVA analysis. Proportion chosen of the wine labels presented to the participants during the binary choice task while being exposed to three scent conditions.*

Proportion Chosen						
Conditions	Correction	df	Mean Square	F	p-value	Partial Eta Squared
Scent	Sphericity Assumed	2	21.333	0.417	0.661	0.016
Label	Greenhouse-Geisser	2.21	10979.252	4.718	0.01	0.154
Scent*Label	Sphericity Assumed	6	176.843	0.736	0.622	0.028

As presented in Table 4.7, Scent ($F(2,52) = 0.42$, $p = 0.661$), as well as the interaction of Scent and Label ($F(6,156) = 0.74$, $p = 0.622$), did not have a significant effect, only Label showed a significant effect ($F(2.2,57.45) = 4.72$, $p = 0.01$) on Proportion Chosen, with a rather large effect (η_p^2=0.154). As stated earlier, initially participants had a preference for Alturis (with the time frame of 100-200 ms post-stimulus), with the second time frame (200-300 ms post-stimulus), participants showed a preference for both, Los Boldos and Alturis. Based on the PCN data in Table 4.3, it could be expected that Alturis would show the highest PC since it attracted the highest attention in both time windows, however, PC data showed that Los Boldos was chosen more often as the preferred one during the binary choice task.

Comparing the presented combination of Los Boldos with either Camelot, Cimarosa or Alturis, Los Boldos showed a significant effect on Proportion Chosen, ($F(1,26) = 4.24$, $p = 0.05$) combined with Camelot, ($F(1,26) = 7.92$, $p = 0.009$) combined with Cimarosa, ($F(1,26) = 10.69$, $p = 0.003$) combined with Alturis.

Table 4.8: *Contrast in participants' Proportion Chosen based on the combination of the labels.*

Proportion Chosen					
Labels	df	Mean Square	F	p-value	Partial Eta Squared
Los Boldos vs. Camelot	1	4284.301	4.238	0.05	0.14
Los Boldos vs. Cimarosa	1	13306.588	7.915	0.009	0.233
Los Boldos vs. Alturis	1	10684.396	10.688	0.003	0.291
Alturis vs. Camelot	1	1437.227	1.228	0.278	0.045
Alturis vs. Cimarosa	1	143.732	0.298	0.59	0.011

5. Conclusions and Discussion

Consumer Neuroscience, also referred to as Neuromarketing, applies neuroscientific methods for the analysis of economically relevant brain processes, as well as for understanding economical behavior (Kenning & Plassmann, 2005). With the help of electroencephalography (EEG), a technique applied in neuromarketing, the visual allocation of (spatial) attention can be studied to analyze how external stimuli, such as scent, are processed in the brain and how such external stimuli might affect consumers' (spatial) attention and preferences.

The present study aims at investigating the effect scent has on spatial attention and consumer behavior in the decision-making process. The effect is determined by analyzing data that was gathered from 27 participants who took part in an experiment individually. While performing a binary choice task, brain activity was measured and recorded with electroencephalography (EEG). Another objective was to investigate whether Posterior Contralateral Negativity (PCN) data can be useful for future Neuromarketing research focusing on the effect of external stimuli on visuospatial attention. By researching the effect scent has on spatial attention, as well as the effect it has on the reaction time of individual preferences, it is contributing to the theoretical and practical aspects of Neuromarketing.

Results showed no significant effect of Scent on either PCN (measurement for spatial attention), reaction time, or proportion chosen (indicating a preference for a specific wine label). However, the results showed a significant effect of Label on PCN. Initially, only the label of Alturis had a significant effect on PCN (in the first time window that was measured 100 to 200 ms post-stimulus), however, the data of the second time window (200 to 300 ms post-stimulus) showed an additional significant effect of Los Boldos on PCN.

When considering the combinations of the labels that were presented to the participants during the binary choice task, the combination of Alturis and Camelot, as well as the combination of Alturis and Cimarosa, showed a significant effect on PCN in both time windows. Los Boldos combined with either Camelot or Cimarosa only showed a significant effect on PCN in the latter time window. The combination of Los Boldos and Alturis had a significant effect on PCN, 100 to 200 ms after this combination was presented to the participant. Since Alturis showed a signicifant effect on PCN in both time windows, and Los Boldos only showed a significant effect in the second time window, the effect of the combination of Alturis and Los Boldos on PCN in the first time window, might suggest that the initial effect of Alturis on spatial attention was taken over by the effect of Los Boldos on participants' spatial attention. This could be due to the colors and shapes used in the design of the label of Los Boldos.

Although results indicated an effect on participants' reaction time, neither Scent nor Label showed a significant effect on reaction time. However, results indicated a significant effect of Label on Proportion Chosen. It was suggested that Los Boldos showed a significant effect on PC compared to all other labels. Interestingly, even though Alturis had a significant effect on participants' PCN in both time windows and Los Boldos only showed a significant effect on PCN in the second time window, Los Boldos seemed to be the preferred label based on the PC data. This could indicate that Alturis had a feature that attracted participants' attention, however, this feature was not appreciated since Los Boldos was the preferred label.

All in all, the results suggested that scent does not have a significant effect on either PCN, reaction time, or proportion chosen. Additionally, results showed that even if spatial attention is affected by an object, it does not necessarily result in a preference for this object, regardless of the background scent.

The results of the present research are partly in line with, as well as contributing to existing literature. Past research showed contradicting results. According to various researchers, attractive packaging play an important role in attracting consumers' attention (Clement, 2007; Koukos & Selame, 2002; Pieters et al., 2002). This is in line with the findings of the present research which indicated a significant effect of the label (being part of the package) on participants' spatial attention and preference for a specific label. The present study confirms the findings of Bone and Ellen (1999) who stated that scent shows no significant effect on consumer responses to retail environments in experimental settings. Additionally, the results of this research could not confirm that scents are likely to create and change emotional and behavioral reactions from consumers as was claimed by previous studies (Donovan & Rossiter, 1982; Michon & Chebat, 2004). The inconsistent and mixed results of the present and previous studies, prove that the effect of scent on an individual remains a topic that still needs attention and additional research.

Although this research did not prove the expected effects of scent on visuospatial attention and behavior, it suggests that EEG is useful for studies to analyze the effect of external stimuli on spatial attention and individual preferences for products. In addition to the present analysis, EEG data could be analyzed further and in a different way. Additional results, such as variances in participants' state of mind or differences in how information is encoded by a human's brain due to background scent, might be discovered.

Research limitations:

The present study has a few limitations that could be addressed in future studies. Although the chosen scents do not show a significant effect on visuospatial attention, they might have significant effects on other cognitive and behavioral functions. This can be researched via neuromarketing techniques but also traditional techniques, for instance with the questionnaires that were gathered during the present study. Additionally, future research can investigate whether different scents result in a significant effect on PCN. It could be researched whether arousing or relaxing scents, other than the ones that were used for this experiment, show a significant effect on PCN and behavior, or whether the scent should be congruent with the object that is being used for the experiment to result in a significant effect on PCN and behavior. Finally, future studies might consider comparing different categories of products instead of one product, as with wine labels in the present study. A potential future study might indicate that scent does have a significant effect on visuospatial attention when participants are presented with multiple product categories (e.g. different types of bread and wine bottle labels) instead of solely one product category as is the case with the present study.

Appendices

Appendix A – Wine Bottle Labels

Los Boldos

Camelot

Cimarosa

Alturis

Appendix B – Informed Consent

Informed Consent Form

Project Title:
Consumer Neuroscience

Purpose of this Study:
The purpose of this research is to measure cognitive, emotional and behavioral responses with neuromarketing methods and surveys.

Procedure:
You will participate in an experiment lasting approximately 2 hours. You must be at least 18 years old to participate. During the experiment you will be exposed to two situations, one without smell, one with a wine or wine-coherent smell. In both situations your neurological activity will be measured while you are watching a presentation showing wine bottles on a computer screen. In this presentation, you will see different wine bottles and you are asked to choose your preferred wine bottle (based on the bottles' looks).

Participants to be Excluded from the Experiment:
People with medical electrical devices in their body, external devices in their body, skin diseases, blindness and deafness, blood clotting disorder, neurological disorder, psychiatric disorder and those who had recently drugs or large amount of alcohol, cannot participate in the research. People with these characteristics are likely to influence the measured data, leading to unreliable results. To ensure trustworthy research results based on reliable data, people with the above-mentioned conditions are excluded from the study.

Potential Risks and Discomforts:
There are no obvious physical, legal or economic risks associated with participation in this study. You do not have to answer any question you do not wish to answer. Your participation is voluntary and you are free to discontinue your participation at any time.

Potential Benefits:
Participation in this study does not guarantee any beneficial results to you. However, as a result of participating, you may have a better understanding of neuromarketing methods and surveys. Completion of the experiment will be compensated in form of SONA credit points.

Confidentiality:
Your privacy will be protected to the maximum extent allowable by law. No personally identifiable information will be reported in any research product. Moreover, only trained research staff will have access to your responses. Within these restrictions, results of this study will be made available to you upon request.

Right to Withdraw:
Your participation in this research is completely voluntary. You may choose not to take part at all or you may stop participating at any time.

Information of the investigator:
A.G. Melis
a.g.melis@student.utwente.nl
+31 616 27 11 16

____________________________ ____________________________

Signature Date

Appendix C – Participant Information

Consumer Neuroscience experiment: Participant Information

Please fill in the following questionnaire:

Name:

Nationality:

Age:

Gender: Male female Other

Do you have medical electrical devices in your body (e.g. Pacemaker)?	YES	NO
Do you have external devices in your body (e.g. Hearing Aid)?	YES	NO
Do you have metal objects on your head?	YES	NO
Do you wear a pair of jewelry?	YES	NO
Do you have a skin disease that affects your head?	YES	NO
Do you have a blood clotting disorder that causes hemophilia or medication?	YES	NO
Do you have removable piercings in your face?	YES	NO
Do you have diagnosed learning disorder?	YES	NO
Have you been diagnosed with a neurological disorder?	YES	NO
Have you been diagnosed with a psychiatric disorder?	YES	NO
Do you take medication on a regular basis?	YES	NO
Did you drink alcohol excessively or use drugs excessively recently?	YES	NO
Did you drink alcohol or drink drugs last night?	YES	NO
Did you drink coffee today (two hours or few before the experiment)?	YES	NO
Have you washed your hair today?	YES	NO
Did you use hair gel after washing your hair?	YES	NO
Do you wear make-up?	YES	NO
Do you see normal or do you use an aisle (e.g. contact lenses)?	YES	NO

Appendix D – Order of Scent Conditions per Participant

Participants Row

3!= 6

1. No – Lavender – Peppermint
2. No – Peppermint – Lavender
3. Lavender – Peppermint – No
4. Lavender – No – Peppermint
5. Peppermint – Lavender – No
6. Peppermint – No – Lavender

7. No – Lavender – Peppermint
8. No – Peppermint – Lavender
9. Lavender – Peppermint – No
10. Lavender – No – Peppermint
11. Peppermint – Lavender – No
12. Peppermint – No – Lavender

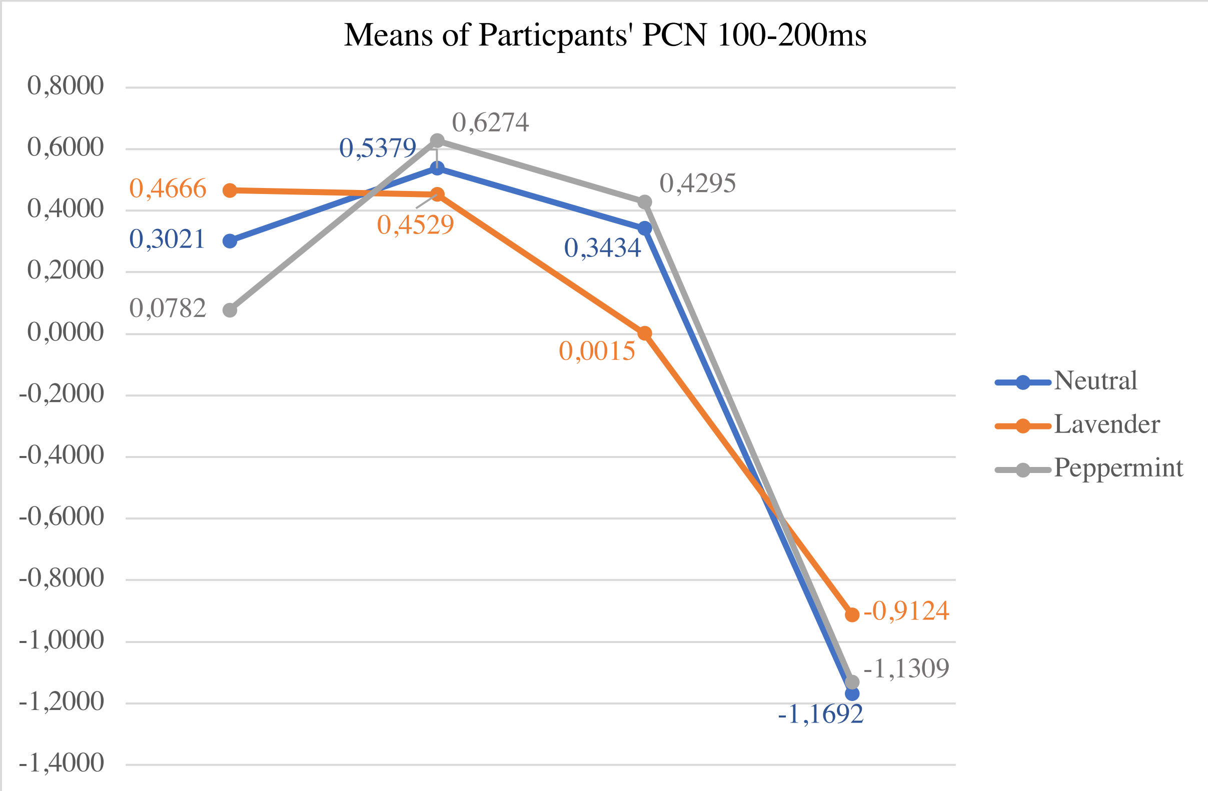
13. No – Lavender – Peppermint
14. No – Peppermint – Lavender
15. Lavender – Peppermint – No
16. Lavender – No – Peppermint
17. Peppermint – Lavender – No
18. Peppermint – No – Lavender (HML)

19. No – Lavender – Peppermint
20. No – Peppermint – Lavender
21. Lavender – Peppermint – No
22. Lavender – No – Peppermint
23. Peppermint – Lavender – No
24. Peppermint – No – Lavender

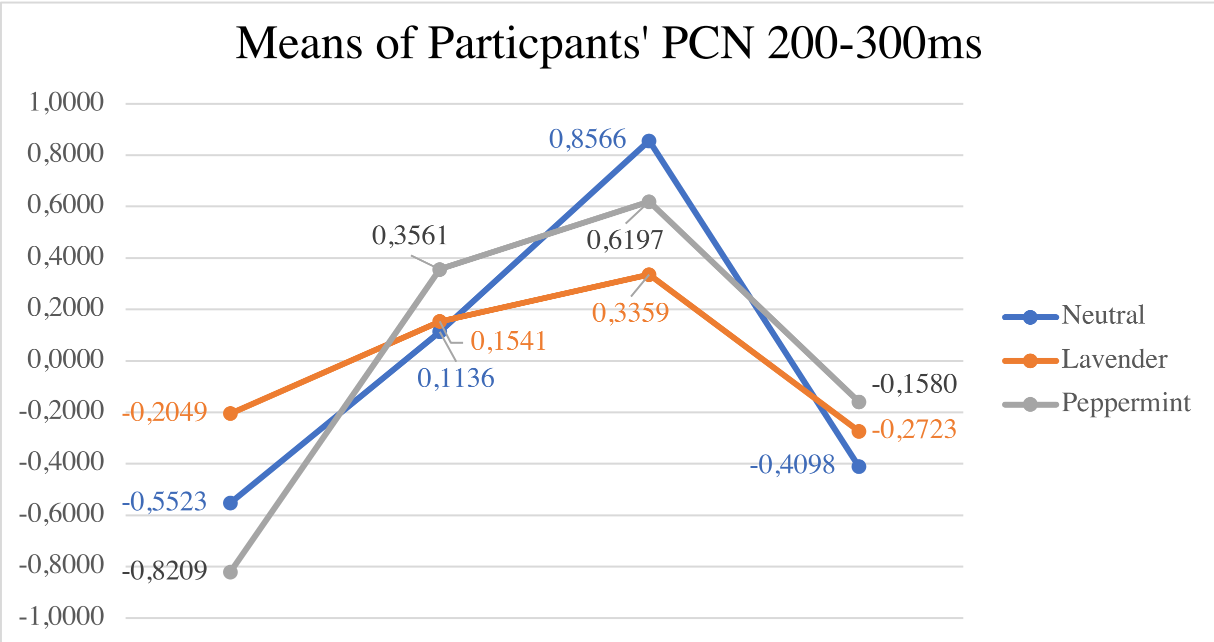
25. No – Lavender – Peppermint
26. No – Peppermint – Lavender
27. Lavender – Peppermint – No
28. Lavender – No – Peppermint
29. Peppermint – Lavender – No
30. Peppermint – No – Lavender

Appendix E – Profile Plots

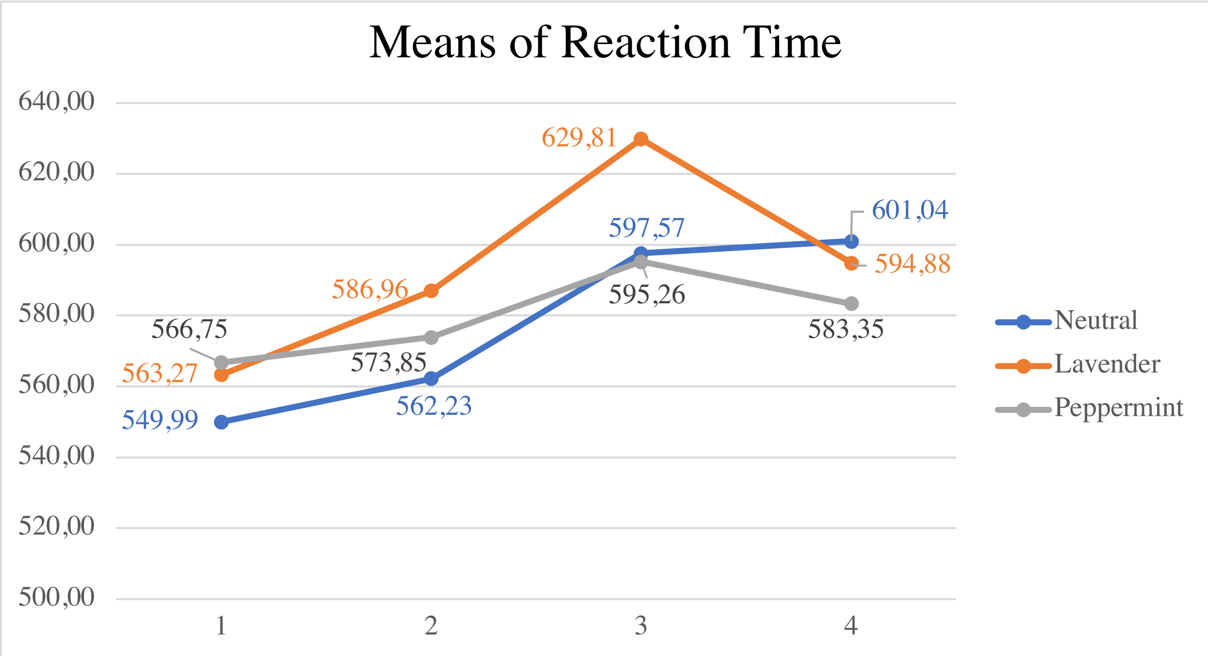
Means of participants' PCN under each scent condition, 100-200ms after visual stimulus was presented.



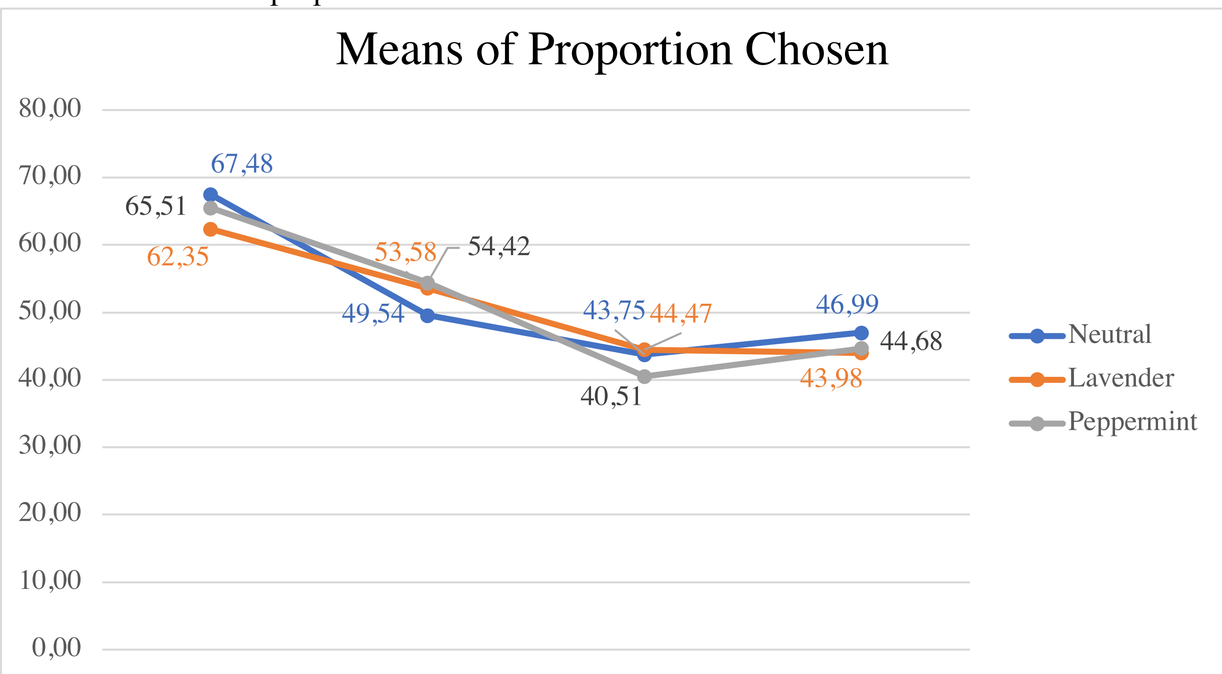
Means of participants' PCN under each scent condition, 200-300ms after visual stimulus was presented.



Means of the participants’ reaction time for choosing a label during the binary choice task, under each scent condition.



Means of the chosen proportion of the wine labels under each scent condition.



Appendix F – Pictures of the Experiment

Figure F.1: *The picture shows the researcher adding gel to the electrodes of the EEG cap a participant is wearing.**

Figure F.2: *The picture shows a participant doing the binary choice task.**

* permission of the participant to use these photos was received

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