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USE OF ELECTROENCEPHALOGRAPHY AND FACE BIOMETRICS FOR EVALUATION OF CHRISTMAS AROMATIC COMPOUNDS

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Abstract

The Christmas time is traditionally associated with the purchase of gifts and a specific shopping atmosphere. While we may not perceive it, it is also the result of multiple senses´ influencing at the same time that we either perceive or do not influence affect our mood, decision making, memories and overall feeling of buying. An important component of shopping atmosphere is aromatic air. Although the smell has in terms of perception (human perception) relatively low share in relation to sight or hearing. Its significance mainly lies in impact on memory and creating of associations. The research integrates the measurements of importance to use specific Christmas aromatic compounds for clients and their influence of human sense. Research objects

were chosen six samples typical for Christmas time. The main methods needed for obtained data in consumer neuroscience survey were used one biometrics (Facial Biometrics Recognition) and one neuroimaging (mobile Electroencephalograph) techniques in laboratory conditions. Except these, we verified three hypotheses by ANOVA and logistic regression statistics methods. The main goal of this research was a revelation of actual impact on micro emotions, valence, attention, emotional interest, frustration, relaxation, and engagement of clients/consumers.

Keywords

Aroma, Consumer Emotions, Consumer Neuroscience, Electroencephalography, Face Biometrics

1. Introduction

Scent marketing is defined as the aroma usage of mood setting, products promotion, or brand placement. Retailers place the fragrances to create the positive emotions for customers and ensure their satisfaction. Certain positive smells are also connected to bringing mood up, making more relaxed even when human is in a rush or is stressed out. A pleasant scent can appear to improve quite effectively the relatively bad mood of hurried customers (Couponsinthenews.com, 2016). Survey says that the customers are more prone to turn around and leave your store. This can sometimes be hard for the shop owner, but not to worry, there are many scent and aroma making businesses which can do analysis and mix up the perfect scent to match the merchandise and appeal to various customers (Cachero-Martínez and Vázques-Casielles, 2017; Gottschalk, 2018; Leenders et al. 2016; Orvis, 2016). The smells in general can generate affective responses because they are first processed in the human brain limbic system that is the center of emotions and memory (Doucé et al., 2014). According to Randhir et al. (2016); Bradford and Desrochers (2009); Lindstrom (2005) fragrances let down certain parts of the brain that are responsible for creating the emotions and memories.

Human nose can recognize and memorize up to 10,000 aromas, and up to 75 % of our emotions come from what we feel. From all the senses, a smell is only one with a direct connection to the brain. Researchers say that people remember 35 % of what they smell, compared to only 5 % of what they see, 2 % of what they hear, and only 1 % of what they are touch. For this reason, the fragrance makes a unique brand identity, strengthens the customer loyalty and enhances the perception of quality (Schutte, 2016). We, humans have five senses. They are touch, vision, hearing, taste and smell. The last, smell, is the strongest among them and

it takes the shortest route to our brain, going straight to our amygdala, which is the center for our emotions and memory, so you can act before you even think about it, unlike the other four senses, which take longer route, going from the part of our brain called brain stem to thalamus and finally to cerebral cortex. (Sweeney, 2009). Thalamus then behaves like clutch, shifting the information forward, finally to the part called cerebral cortex which is responsible for higher thinking, attention, logical thinking and getting things together, basically everything that sets us apart from mammals (Vlahos 2007).

Smell is a wide-open and fertile ground for marketers. According to the Sense of Smell Institute, the average human being is able to recognize approximately 10,000 different odors. Though there is success in this area to date, research that investigates odor's ability to affect human behavior is just in the beginning stages. Consequently, the concept of employing scents to influence consumer actions is becoming an increasingly attractive tool for marketers (Pierański, Borusiak and Horská, 2018).

Marketers interested in using scents rely on two physiological conditions which strongly impact the cognitive psychologically based premises of associative learning and emotional processing. First, smell is one of our most primal and deeply rooted senses and functions as our chemical alert system. It is hardwired to perceive whether the molecules around our bodies are beneficial or dangerous, a determination of fundamental importance to the survival of all forms of life. When a person smells something, the odor receptors produce an immediate, instinctive reaction. 75 % of emotions are generated by smell (Zaltman 2003; Vlahos 2007; Bell and Bell 2007). Scents are unique just like fingerprints. For thousands of years' humans have used the power of scents for their different purposes: protection, campout age, beauty, and characteristics.

Thanks to the brain and the sense of smell each place has its specific scent; each memory has its characteristic aromatic accent (Tarczydlo, 2013; Krishna, 2010; Štefániková et al., 2018). Thus, from a marketer's perspective, smell has an instantaneous good or bad effect on our emotional state which, as some research has shown, ultimately affects our shopping and spending behavior. Thus, the neurological substrates of olfaction are especially geared for associative learning and emotional processing. Marketers can link a scent with an unconditioned stimulus eliciting the desired response and eventually prompting a conditioned response from consumers (Šedík and Horská, 2018; Agarwal, 2019; Kurnia and Sulistiani, 2019). Scent marketing relies on the neuropsychological processing of olfactory stimuli in the human brain (Herz, 2002; Emsenhuber, 2009).

2. Methodology

The main aim of paper is to point out a perception of selected Christmas aromas used for aromatization in public business areas by the traditional feedback methods - questionnaire and by consumer neuroscience 'tools. Another goal of this paper is to obtain the information about concrete impact of fragrances on human emotions, which are able to optimize a selection and placing of specific aromatization in pre-Christmas period. The foundation secondary data we processed from available books sources of home and foreign authors, Scientifics papers, journals, online information, databased magazines, etc. Research objectives were six Christmas aromas (vanilla, orange, green apple, cinnamon, clove and fir (conifer tree) and respondents in questionnaire (200) and blind test (20) proceeding.

The level of impact on human emotions we realized through following devices:

- Mobile EEG (electroencephalogram), branded EPOC,
- HD camera LifeCam, branded Microsoft,
- Analytical software for micro emotions recognition on base of facial expression FaceReader^{TM} 7, branded Noldus.

Scope of study was detailed planned and then realized before Christmas in 2018 in timetable of 2 fully days through the questionnaire methods on a sample of 100 respondents and as *blind* test in laboratory conditions on sample of 20 people. All these 20 respondents personally were attended on aroma testing. A goal of questionnaire research was to find out a smell associations related to Christmas time based on a judgment. At first, participants was informed about the test proceeding and subsequently filled an *„Consent to the processing and storing personal data"*(GDPR) document, legislative approved by EU. Then, in different order, the probands smelled six samples, such as: vanilla, orange, green apple, cinnamon, clove and fir (conifer tree), while their emotions were monitored by FaceReader^{TM} 7 professional software for automatic recognition analysis of facial expressions and EEG (Figure 1).

After smelling each aroma sample, the respondents identified an aroma type based on personal judgment. Among each samples, the participants got the possibility to use a special solution for neutralization of their olfactory sense, so as not to be affected.

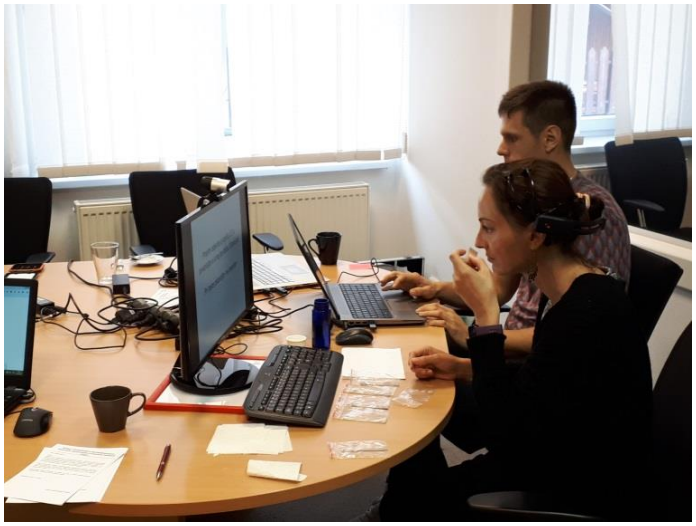

Figure 1: *Proceedings of Christmas Aromas 'Testing*
Source: Own Research, 2018

For final recorded data processing from questionnaire was used the descriptive and inductive statistics (ANOVA, Logistic regression). This statistics methods were analyzed in SAS program by 9.4 version and data processing using Microsoft Excel. Hypotheses formulations are following:

H0: Valence is the same in each samples

H1: Valence is different in each samples

H0: Valence and attention is the same

H1: Valence and attention is different

3. Result and Discussion

In general, it is known, that thinks which we can see or hear, we can memorize many days up to several weeks. Issues, which we feel, we are able to remember a year or many years. Worse it is with a recognition and identification of individual fragrances. From our questionnaire survey follows that almost population trust its smell abilities (90 %). Only few Slovaks (6 %) presented, that they are not able to recognize concrete odor (Figure 2).

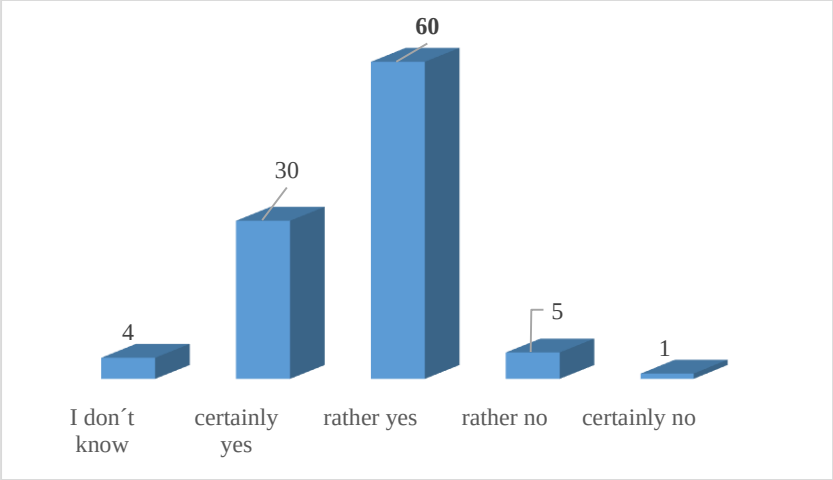

Figure 2: *Ability to Odor Recognize*
Source: Own Research, 2018

Answering on the question: *„ What scents are most associated with Christmas? "* was most often presented as cinnamon, conifer, citrus, mulled wine, clove, vanilla, apple, gingerbread, fried fish or cabbage soup (Table 1).

Table 1: *Top Aroma Associations with Christmas Time: Answers on the Questions „What Scents are most associated with Christmas? "*

Rank	Top 10 Aromas
1	*Cinnamon*
2	*Conifer*
3	*Citrus/ Orange*
4	*Mulled wine*
5	*Clove*
6	*Vanilla*
7	*Apple*
8	*Gingerbread*
9	*Fried fish*
10	*Cabbage soup*

Source: Own Research, 2018

From these top scents, six very simple recognized odors were selected (apple, vanilla, cinnamon, orange, clove and fir), which were subsequently analyzed by smell test on a sample of 20 participated people on November, 2018. Actually, nearly half (45 %) of tested probands had

the problem to recognize and identify each aroma. From selected one, easiest identified were following: orange (citrus), vanilla, cinnamon or clove (they are interchangeable), then a fir but thanks to that, the right answers as *„conifer* „or *„pine"* were valid too. They were often referred by respondents. A part of smell test was the monitoring of human brain activity and micro emotions by biometric facial recognition too, in order to obtain the information about unconscious influence of individual fragrances (Figure 3). The highest emotional engagement (0.66 score) was measured an *„apple"* scent, what probably did lowest ability of its recognition within of chosen aromas set.

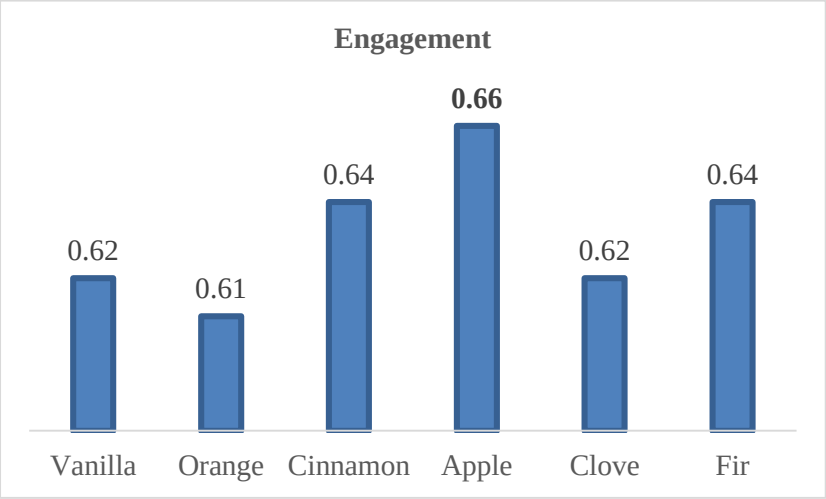

Figure 3: *Emotional Engagement by Aroma Impact*
Source: Own Research, 2018

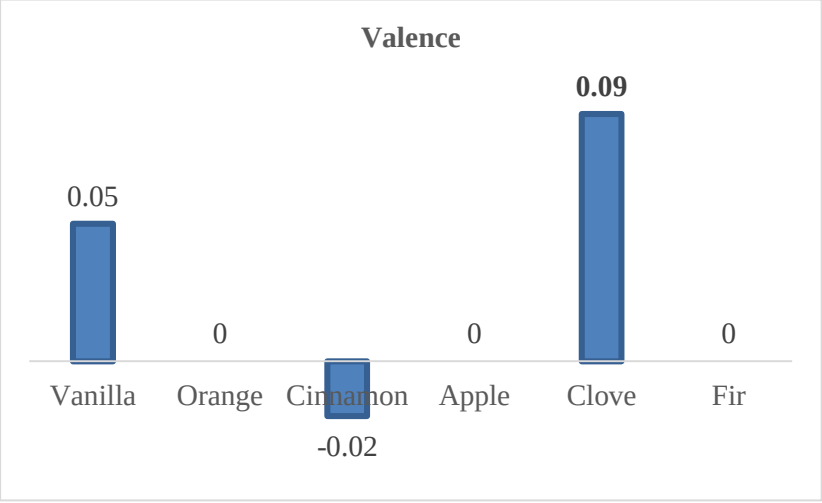

Figure 4: *Polarity of Emotions (Valence) by Testing of Each Samples*
Source: Own Research, 2018

On the Figure 4, it could be seen, then the most positive emotions of participants were induced by a clove (9 %) and vanilla (5 %), which determined the release and relax status, and then was associated with sweet and cakes. This is known for respondents, but in one moment they cannot rank and identified it. Vanilla odor is behaved like higher frustration or by feeling guilty for „snacking ".

Besides that, a clove aroma from Christmas smells caused the most positive human emotions and also it has highest influence on respondents´ release and relaxation (higher alpha brain activity). Despite of scent power, clove was by participants misunderstood with cinnamon, that was then reflected in a ratio of positive results in terms of attract an attention. The most marked cinnamon odor, the respondents 'negative emotions were measured, that was probably caused by various associations from childhood. Except this, within a sample, there were participants, when they smelled a cinnamon had positive senses. Conifer aroma (fir) aroused the highest attention (Figure 5) and concentration within all tested scents.

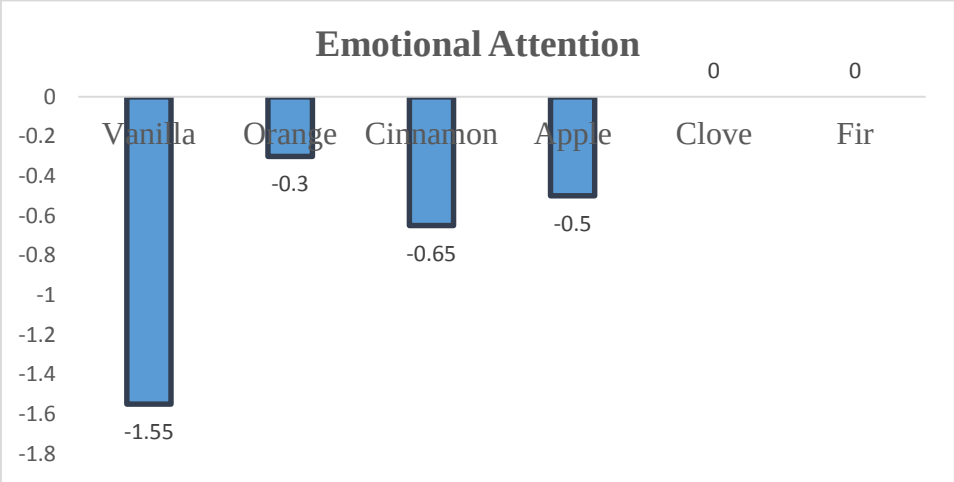

Figure 5: *Emotional Attention by Testing of Each Samples*
Source: Own Research, 2018

In addition to descriptive outputs, statistical test ANOVA (analysis of variance) examined whether there was a difference in valence between individual test samples (Table 2).

H0: Valence is the same in each samples
H1: Valence is different in each samples

Table 2: *Statistical Comparison of Valence by ANOVA*

Source	DF	Anova SS	Mean Square	F Value	Pr > F
sv1	5	0.108482	0.021696	0.47	0.7944
sv2	5	0.089167	0.017833	0.39	0.8573
sv3	5	0.033587	0.006717	0.14	0.9839
sv4	5	0.139232	0.027846	0.46	0.807
sv5	5	0.272411	0.054482	0.82	0.5364
sv6	5	0.19086333	0.03817267	0.71	0.6209

Source: Own Processing, Output from SAS program 9.4 - 2019

Table 3: *Statistical Comparison of Valence and Attention*

Sample	DF	t Value	Pr > |t|
Vanilla	19	2.94	**0.0085**
Orange	19	2.89	**0.0095**
Cinnamon	**19**	**0.89**	0.3852
Apple	**17**	**2**	0.0615
Clove	17	2.48	**0.024**
Fir	**18**	**-0.24**	0.8147

Source: Own Processing, Output from SAS program 9.4 - 2019

Since Pr value is in all samples higher than 0.05, hypothesis H0 in not rejected and therefore statistically did not confirm the difference in perception of individual samples. This fact can be largely due to a small sample of probands and time range of measurement. In order to find out the relationship between valence and attention, that each aromatic compounds cause, we provided a test (Table 3), which compares the dependence between level of emotional attention and engagement in the first second immediately after the smelling.

H0: Valence and attention is the same

H1: Valence and attention is different

In this case, statistically significant differences between valence (polarity of emotions) and attention was vanilla, orange and clove, which belonged to relatively simple recognized aromas. This fact was probably caused by sudden changes in valence monitored by the *„happiness* „of sample identification.

Using logistic regression (Table 4) we verified the dependence between correct fragrance classification and individual measured emotions (engagement, frustration, relaxation and excitement). The point estimate values of regression coefficients increase the likelihood of

identifying the right smell, but contrary negative values mean that the odds ratio is smaller than 1.

Table 4: *Values of Point Estimates Coefficients*

Odds Ratio Estimates			
Effect	**Point Estimate**	**95 % Wald Confidence Limits**	
z1	0.005	<0.001	160.293
z2	0.050	<0.001	>999.999
z3	**16.167**	<0.001	>999.999
z4	0.016	<0.001	>999.999
z5	**544.187**	0.035	>999.999
f1_0001	0.004	<0.001	503.026
f2	0.010	<0.001	>999.999
f3	39.326	<0.001	>999.999
f4	>999.999	0.332	>999.999
f5	<0.001	<0.001	96.324
r1	0.240	<0.001	381.708
r2	>999.999	0.480	>999.999
r3	0.166	<0.001	435.629
r4	55.357	0.002	>999.999
r5	<0.001	<0.001	0.620
v1	0.362	0.014	9.426
v2	0.571	0.008	39.461
v3	0.062	<0.001	4.958
v4	5.633	0.080	394.916
v5	3.773	0.166	85.796

Source: Own Processing, Output from SAS program 9.4 - 2019

If a value of point estimate coefficient is less than 1, no chance to identify a scent is raised. The likelihood of correct aroma identification increases with elapsed time in case of all measured emotions obtained from electroencephalograph data. This finding provides insight for further researches that should be focused on later period immediately after the smelling of sample.

4. Conclusion

In this study we focused on a survey of selected aromas ‘impact, standard for Christmas time thanks to using of questionnaire, biometric methods FaceReader™ 7 and mobile EEG as the real human emotions ‘measurement. Regarding to sample size, differences in odor perception (valence, attention) have not been statistically confirmed. However, relatively small changes in emotions in this case also denote a different perception of reality.

Statistically significant differences as well as likelihood of sample ‘correct identification was assumed to be true only in late time intervals immediately after smelling of each sample. Based on realized research, it can be presented, that combination of vanilla and clove could be suitable alternative for placing to public business areas.

Both fragrances do positive emotions, while clove aroma causes higher release (relaxation) too. At the same time, vanilla odor has mainly subconscious influence, it does not increase human attention, what can be seen in a form of pleasant feelings and effect from aromatized space. To research the influence of aroma through questionnaire is not real, because it not presents the relevant information.

The scents have principally subconscious effect and this is not possible to interpret only with questionnaire method. In general, it could be presented, that all tested Christmas aromas have significant impact on human emotional attention, while the most interested aroma was *„apple“*and at least was *„orange“*. Undoubtedly need to be taken into account the air quality in that place, which will be aromatized. In a future, we shall plan to realize parallel research with using of 32 channel electroencephalogram.

At the same time, we suppose to involve other methods, such as biometric methods of emotions recognition based on heart rate variability HRV measurement to obtain detailed information about individual smells ‘impact on emotions and perception. We will focus an attention on late time planning immediately after smelling, as well as on control of air quality factors. In the following of these steps, this research will be under way in the specialized unique space of the *„Consumer Studies Laboratory “*, which is fully equipped by infrastructure ready for realization researches.

5. Acknowledgements

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The main goal of APPV is to complexly reveal how are aromatic compounds sensed based on an interaction between explicit (sensory) and implicit analysis through consumer´s

neuroscience in real conditions of manufacturing plants, shops and in the sphere of services. The project is in its first year and it will last until the year 2022.

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