

# Innovative approaches to examining consumer preferences when choosing wines

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**Abstract:** Consumer neuro-science is a new field in marketing, which aims to predict the consumer behaviour and to obtain information about feelings and preferences based on the physiological changes. We can objectively reveal our inexplicable behaviour to which we are not able to answer using a questionnaire in the traditional market research. An accurate measurement enables marketers to compare the response during research, such as the impact moments associated with a particular product or brand, how they react to different marketing stimuli. The paper aims to assess the current possibilities of the interdisciplinary examination of wines as well as to identify new opportunities for the current utilization of the knowledge of modern research methods. The research was conducted by measuring the electrical activity of the brain through the electroencephalography (EEG) and the software platform for analysing facial expressions. The research objective was the recognition of consumer emotions during the tasting of eight kinds of blank samples of wine. Using the interdisciplinary research, we identified facial expressions (happiness, sadness, disgust, neutral emotions, anger and surprise) that were captured immediately after tasting each type of test wines and the electrical activity in the brain based on which we have identified the valence of consumers. The achieved results confirm that neuro-marketing can be a useful tool that will help manufacturers and sellers to offer products that truly and not only in appearance satisfy customers. Ideally, this should lead to more a satisfied and better functioning market supply and demand and market positioning.

**Keywords:** brand, consumer, EEG, emotion, FaceReader, innovation, neuro-marketing, white wine

Agricultural companies and wine manufacturers are operating in the environment with a high level of competition and therefore it is essential for them to retain and even improve their market position to reach a higher production process efficiency (Bielik and Hupkova 2011; Raz et al. 2008). This led some manufacturers and retailers to try creating a positive emotional connection to their brand, product, and point of sale (Malär et al. 2011). Given that over 70% of purchasing decisions are made at the point of sale, it is necessary to overcome the emotional gap and to offer customers a positive experience (Garrido-Morgad and González-Benito 2015). Moreover, the wine sector (as a part of the agrarian and food sector as the key sectors of any economy around the world (Svatoš 2008), is in many European countries a sector of a great importance, the Slovak wine market including, where additionally we can observe the positive development of the annual consumption of wine per inhabitant in terms of volumes, but also of the culture and habits of drinking. According to the

research of Kučerová (2014), consumption of wine in Slovakia does not reach the EU average, which is approximately 33 litres per inhabitant. That provides space for the further growth potential of the wine market in Slovakia.

The biggest challenge of marketing from the very beginning of its existence is to understand the consumer (Paluchová and Kleinová 2014). Marketers are constantly trying to find new tactics to influence the consumer behaviour and to stimulate their demand. In the past, until the nineties of the last century, the functioning and processes of human brain were largely unknown. Therefore, at the Harvard University the study of sensorimotor, cognitive and emotional reactions to various stimuli taking place in the human brain was started (Světlik 2012). One of the possible adaptation techniques following the current trends is to refrain from the frequently used methods of market research and to focus on the understanding of the target group. Mass marketing is now disappearing and the companies are trying to target a specific market

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segment. Innovative marketing methods, which help build new ways for marketing, are then applied on the target group (Frey 2011).

In the world full of emotions (Vysekalová et al. 2011), neuro-marketing deals with the functioning of human brain in the terms of neuroscience and applies the knowledge within marketing (Plessis 2011; Dooley 2012). Neuro-marketing techniques allow us to view what is happening in the human brain. Persons who are subject of the current research are presented with images, provided with information on problem solving, they are listening to sounds and so on and at the same time, their brain activity is measured using the brain scans (Warmbier 2008). Perceptual constructs are generally multidimensional, integrating multiple physical and cognitive dimensions to generate coherent behavioural preferences. In the sensory processing, the idea of the multidimensional integration has long been used to frame a range of questions about the cross-modal interactions in the physiological and behavioural responses (Stein et al. 1996; Wallace and Stein 1997; Armony and Dolan 2001; Laurienti et al. 2003). This same multidimensional perspective has also been developed for the olfactory and gustatory processing, where the detection, discrimination, and perceived intensity of stimuli are not only the functions of the primary physical properties (odours, flavours) but they are also modulated “cross-modally” by the visual input (Gottfried and Dolan 2003), auditory input, and current reward value (Gottfried et al. 2003).

It is expected that the understanding of the way how the human brain works and reacts can make marketing more effective. There is no doubt that wine marketing is an area where not only the economic but also the non-economic factors, such as emotions and hidden reactions of a customer, play a decisive role. Even in the current era when it seems that the economic indicators are of a great importance and affect both the business and consumer decisions (Bielik 2014), there are also hedonistic values that can affect choosing a bottle of wine for special occasions or demonstrating some specific, non-economic values, e.g. the environmental ones (Olsen et al. 2012). The affect that the consumers experience also cannot be adequately measured by the self-reported verbal indicators due its complexity (Zajonc 1980; Panksepp 1998; Davidson 2004). Therefore, the neuro-marketing methods are proposed to measure the hidden consumer reactions at the process of buying but also consuming certain

products. They can also help with identifying proper retail solutions and specific in-store parameters (Nagyová et al. 2014), if appropriate.

## MATERIAL AND METHODS

The main objective of this paper is to define and evaluate new opportunities of obtaining information from consumers, while utilizing the knowledge of modern research methods – testing the dry white wine Pinot Gris, through the neuro-imaging methods of measuring the brain activity EEG and the biometric measurement methods of the micro emotions software FaceReader.

The methods used for the evaluation and interpretation of results, statistical methods:

– **Method of analysis:** In neuro-marketing research, eight blank samples of dry white wines Pinot Gris of different brands were tested (sample 1 – Víno Nitra, 2 – Vindevie Rimavská Sobota, 3 – Peter Podola, Kopčany, 4 – Château Topoľčianky, 5 – Vinárství Zaječí, 6 – Vinitory Premium, Dvory nad Žitavou, 7 – Movino, Veľký Krtíš and 8 – Vinanza, Vráble). The research was conducted in the sensory laboratory at the Department of Storing and Processing of Plant Products, the Faculty of Biotechnology and Food Sciences of the Slovak University of Agriculture in Nitra. It was attended by 22 respondents (7 men and 15 women). They were professors and students from the Faculty of Economics and Management and the Faculty of Biotechnology and Food Sciences. The respondents put on their heads a portable electroencephalograph that senses the brain activity in the real time and sends the information to the control centre software. At the same time, a web camera was placed in front of the respondents, capturing the facial expressions of six basic emotions (happiness, sadness, anger, disgust, surprise, neutral emotions) that were recorded by the FaceReader software. Before tasting a sample of white wine, the respondents were provided with a form to indicate their sex and the intensity of flavours: sour, sweet, bitter, acerb, on the scale from 1 to 9, and the evaluation of the overall impression on the scale from 1 to 9. After tasting each sample, the respondents rinsed their mouth with clean water. The time course for each sample was about 2 minutes. None of the respondents knew the brand of the sample they tasted.

– **Synthesis method:** The method was used when forming conclusions based on the acquired knowledge.

– **Selected biometric methods of measuring micro emotions:** Using the FaceReader software, we evaluated the micro emotions (happiness, sadness, anger, disgust, surprise, neutral emotions) based on the uncontrolled facial expressions and mimic elements while drinking the wine samples. The recognition of emotions was performed in the real time by evaluating the visual records of the faces of respondents in the natural environment without any human intervention. The accurate measurement allowed us to compare the responses during the neuro-marketing research as the impact moments associated with the product.

– **Selected neuro-marketing methods of the EEG:** Using the electroencephalograph device, we recorded the neuronal activity in the upper layer of the cortex, which to a certain stimulus (drinking wine samples) produced a very small electric current, called the brain wave, joined with impulses. Electrodes which sense signals from the neurons were placed on the respondent's skull. The waves or disturbances are absorbed by small time intervals, up to 10 000 times per second. Within the measurement of the response to the stimuli communication, we recorded in particular the data of the brain activity in the field of emotions (engagement/boredom, immediate agitation/irritation, frustration, meditation). From the moment of drinking a wine sample, the values obtained in emotions were recorded every five seconds.

– **Selected mathematical – statistical methods:**

(1) For a graphical representation of the first part of the neuro-marketing research – sensory comparison of various white wines, we used the Kruskal-Wallis test. This test is used with selections which differ significantly from the normal distribution, i.e. depending on the detection of a quantitative and qualitative variable. It is used when a quantitative variable does not have a normal distribution. It is particularly sensitive in the case of different displacements of the individual distribution functions. The test statistic has the following form (Corder et al. 2009):

$$Q_k = \frac{12}{N(N+1)} \sum_{i=1}^r \frac{T_i^2}{n_i} - 3(N+1)$$

where  $Q_k$  represents the Kruskal-Wallis test,  $N$  is the compound selection of the range  $n_1 + \dots + n_r$  and  $T_i$  is the sum of the sequence of values which belong to the  $i^{\text{th}}$  selection ( $i = 1, \dots, r$ ). In this case,  $T_1 + \dots + T_r = N(N+1)/2$  has to be valid. The result of the Kruskal-Wallis test is a boxplot.

(2) For the graphical representation of the second part of the neuro-marketing research – recognition of

facial expressions by FaceReader, we used descriptive statistics, where the task is to create an overview of the collected data.

*A. Solvency position:* To determine the value, near which the values of the variable in the examined group are placed and moving.

*Arithmetic mean:* It is calculated as the sum of all values divided by their number, as defined by Rimarčík (2007):

$$\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i$$

where  $\bar{x}$  is the arithmetic mean,  $x_i$  is the value of  $x$  in the  $i^{\text{th}}$  unit and  $N$  is the file range.

*B. Variability rate:* Variability characterizes the way variable values in the file resemble or differ.

*Standard deviation:* It is defined as the positive square root of the variance. It shows how the average in the given set of values deviates from the arithmetic mean character, as defined by Rimarčík (2007):

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2}$$

where  $\sigma$  is the standard deviation,  $\bar{x}$  is the arithmetic mean,  $x_i$  is the value of  $x$  in the  $i^{\text{th}}$  unit and  $N$  is the file range

*Avg + std* – means the mean + standard deviation, in the graph, it is for illustration only, to see how they deviate from the average values, as it is based on the average values;

*Avg – std* – means the mean – standard deviation, it is not often seen in the graph because it has a value of 0 and shows how the values deflected from the average value in the opposite direction, they are in the graph for illustration only;

*Max* – maximum represents the highest value;

*Min* – minimum represents the lowest value.

## RESULTS AND DISCUSSION

Taste stimulation is one of the senses that triggers the mirror neurons the easiest. Mirror neurons show a certain empathy that people feel towards other people and are able to imagine how they feel. Thanks to the mirror neurons, consumers can buy things they see other people buy by an unconscious imitation. If the customers see a tasty product that they have tasted before and they like it, it stimulates their desire for such a product, and most importantly, it stimulates them to an actual purchase. It is therefore necessary

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to consider the taste as a sensory element of marketing, because the positive emotions influenced by the taste create long-term customer associations in the memory, which stimulate them to buy a certain product. Because of the fact that the sale of wine is a food segment, which is subject to certain specific criteria of the consumer choice, we decided to carry out a laboratory research on the consumer recognition of emotions during tasting of eight wines, as Mitchell and Greator (1988) found out that the taste of the wine is the major risk that concerns consumers most. Thompson and Vourvachis (1995) also came to the conclusion that taste was the most highly correlated attribute related to the wine choice, as they expected beforehand, as it is frequently the key attitudinal factor in the studies of the wine choice. The basic sensory wine characteristics include the appearance of wine, its smell and taste. The comprehensive picture of the evaluated sample is further characterized by other descriptors of each of these properties. In our case, the overall impression was evaluated by taste, as it is a crucial sense of making the final judgment of the wine evaluation. Taste sensation is caused by the irritation of taste receptors by the compounds dissolved in the saliva. We get the optimum sensation when assessing the taste of wine if the wine comes into contact with all the parts of the mouth. A tongue as a tactile organ assesses the fullness and the wine viscosity. Taste receptors on the surface of the tongue recognize the basic flavours (sour, sweet, bitter, acerb) and their mutual combinations.

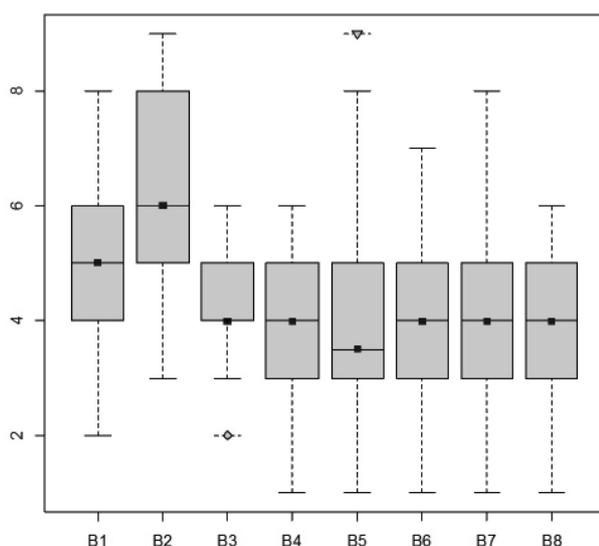


Figure 1. Boxplot of the evaluation of wine

Source: own processing

The flavour intensity was evaluated on a weak, moderate and strong level. By tasting, we can evaluate the age and health of wine and at the same time its consistency and the presence of the most important components. Taste sensations of the respondent persist even after swallowing the wine. The chewing motion highlights these feelings. Based on the taste, the respondents rated the overall impression of each brand of the Pinot Gris white wine on a scale from 1 to 9.

Following the boxplot (Figure 1), we can see that 50% of the respondents identified the overall rating of B2 wine Vindevie by less than 6 (or range of either 4 or 3), and 50% identified it by more than 6 (the range 7 or 8, and in some cases even 9). On the other hand, 25% of the research participants rated this wine at a lower scale than 5, whereas 75% at less than 8. The highest value given to the wine B2 was 9, the lowest one 3.

In the case of the sensory evaluation of the overall impression of the particular tested wines of the sample B4 Château Topolčianky, based on the boxplot, we can see that 50% of the respondents rated the wine on a scale higher than 4 and 50% of the research participants on a scale lower than 4. Also, based on the first quartile boundaries, it can be seen that 25% of the respondents rated the wine even at a lower scale than 3. By contrast, based on quartile 3, we see that 75% of the total number of respondents evaluated the sample B4 on a scale lower than 5. The highest value that was assigned to this wine is 6 and the lowest is 1. Similarly, the respondents evaluated also the wine samples B6 Vinitory Premium, B7 Movino and B8 Vinanza, but they differ in the individual maximum values assigned to them. Samples B3 Peter Podola and B5 Vinářství Zaječí are specific, because we measured the extreme levels that eventually affected the mean value. Finally, the best overall evaluation among all samples was given to the sample B2 Vindevie, but at the same time it was evaluated most differently by the respondents. On the other hand, the most consistently evaluated sample was the sample B3 Peter Podola.

Then we recognized the micro expressions, immediately after tasting each type of the test wines, similarly as in the 2004 preferences of the Coca-Cola versus Pepsi were tested (McClure et al. 2004) but with using a different neuro-marketing method.

From the measured values in the individual samples of wine tasting, we created the average for the entire test sample in order to identify the presence of different types of emotions when testing the blank wine

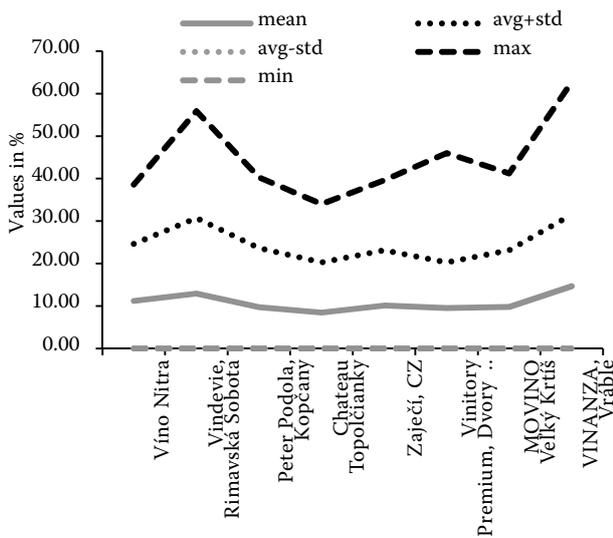


Figure 2. Emotion – Happiness

Source: own processing

samples, as when positive and negative emotions were recognized when testing juices (Danner et al. 2014) by using the same technique (FaceReader). To illustrate how the values deflected, we also indicate the standard deviation. The standard deviation cannot be negative – if it is not visible in the graph, it means that it has a 0 value.

The positive emotion – happiness (Figure 2) – is reaching the highest values for the wines Vinanza, representing 14.68% and Vindevie, representing 12.92%. In the case of both wines, also the maximum values (max) were recorded, which in the case of Vindevie represents 55.9% and in the case of Vinanza represents

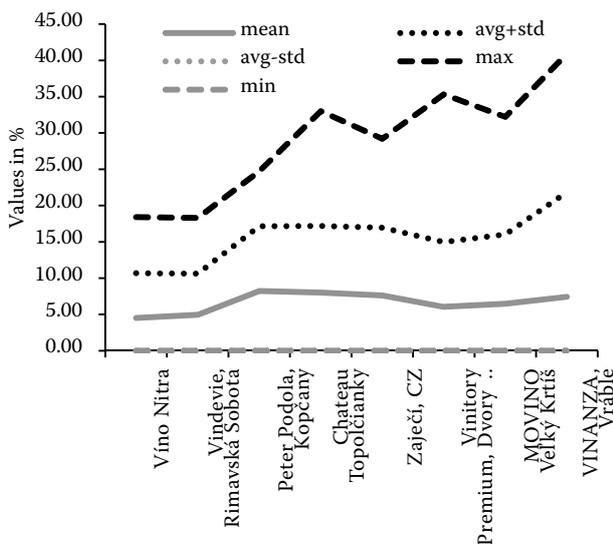


Figure 4. Emotion – Anger

Source: own processing

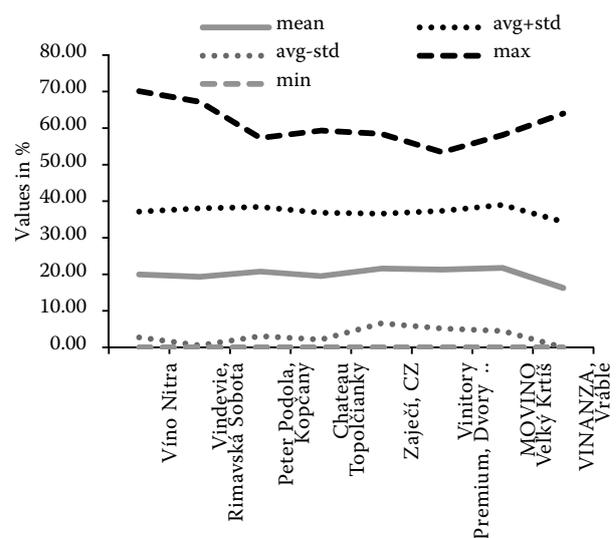


Figure 3. Emotion – Sadness

Source: own processing

62.7%. The lowest mean of positive emotion (happiness) was recorded with the Château Topolčianky, representing 8.46%. At the same time, the lowest maximum value (max) was also recorded with the Château Topolčianky, representing 34%.

The negative emotion – sadness (Figure 3) – is reaching the highest values for the wine Zaječí CZ, representing 21.6%, and for the wine Movino, representing 21.6%. The maximum values (max) of negative emotions were reached by the VINO NITRA, which represents 70.1%, the Vindevie, representing 67.2% and the wine Vinanza, representing 64%. The lowest mean of this emotion was recorded with the wine Vinanza, representing 16.3%. The mean of the wine Château Topolčianky was around 19.5% and the maximum value (max) represents 59.3%. The lowest maximum value (max) of the negative emotion (sadness) was recorded with the Vinitory Premium, representing 53.4%.

Anger as a negative emotion (Figure 4) is reaching the highest values for the wines Peter Podola, representing 8.22%, and the Château Topolčianky, which represents 8.01%. The maximum values (max) of this emotion were achieved by the wine Vinanza, which represents 40.9%. The lowest average value of this emotion was recorded with the wines VINO NITRA, which represents 4.5%, and the Vindevie, representing 4.95%. The mean of the wine Château Topolčianky was 8.01% and the maximum value (max) represents 33%. The lowest maximum value (max) of the negative emotion (anger) was recorded for the wines VINO NITRA, which represents 18.4%, and Vindevie, representing 18.3%.

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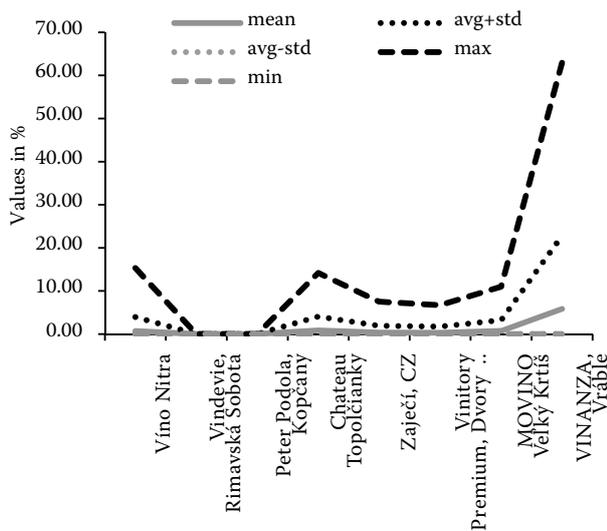


Figure 5. Emotion – Disgust

Source: own processing

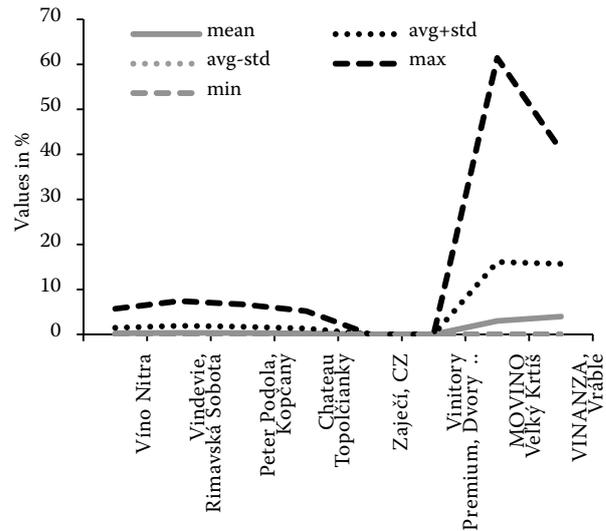


Figure 6. Emotion – Surprise

Source: own processing

The negative emotion – disgust (Figure 5) – is reaching the highest values for the wine Vinanza, representing 5.85%. The emotion disgust for the wines Vindevie and Peter Podola reached zero average value, so the average line is interrupted. The maximum value (max) of this negative emotion was reached by the Vinanza wine, which represents 62.9%. The mean of the wine Château Topolčianky was 0.89% and the maximum value (max) represents 14.2%.

The emotion surprise (Figure 6) is reaching the highest values for the wines Movino, representing 3% and Vinanza, representing 3.9%. For the wines Zaječí CZ and Vinitory Premium, we recorded an

average value of zero, therefore, the average line of the emotion (surprise) is interrupted. The maximum value (max) was reached by the Movino wine, which represents 61.4%. The mean of the wine Château Topolčianky reached a relative value of 1.3% and the maximum value (max) represents 5.2%.

Neutral emotions (Figure 7) are reaching the highest value for the wines Vino Nitra, which represents 59.5%, the Vindevie, representing 59%, the Château Topolčianky, which represents 58.9% and the Vinitory Premium, representing 58, 7%. The maximum values (max) of neutral emotions were reached by the wines Vino Nitra, which represents 87.4%, and Vinanza, representing 89.1%. The mean of the wine Château Topolčianky was around 58.9% and the maximum value (max) represents 80.8%. In this case, therefore, the unpleasant and neutral emotions prevailed, what is contrary to the research where the pleasant emotions were reported more often than unpleasant (De Smet a Schiffertein 2008).

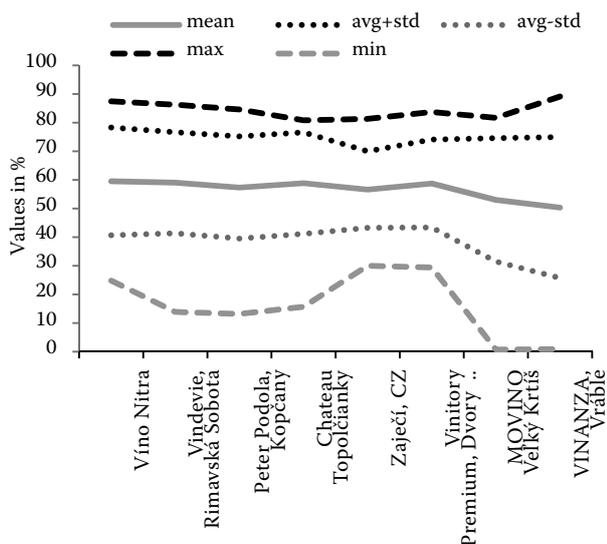


Figure 7. Neutral emotions

Source: own processing

### Recognition of emotions in the brain using the EEG

For illustration, we would like to use an example of recognizing the emotional state of the respondents during testing of the blank samples of white wines, also using the electroencephalograph (EEG). A course of individual emotions is recorded in the graph immediately after tasting the wine samples. In this case, the graph shows the course of an emotion during

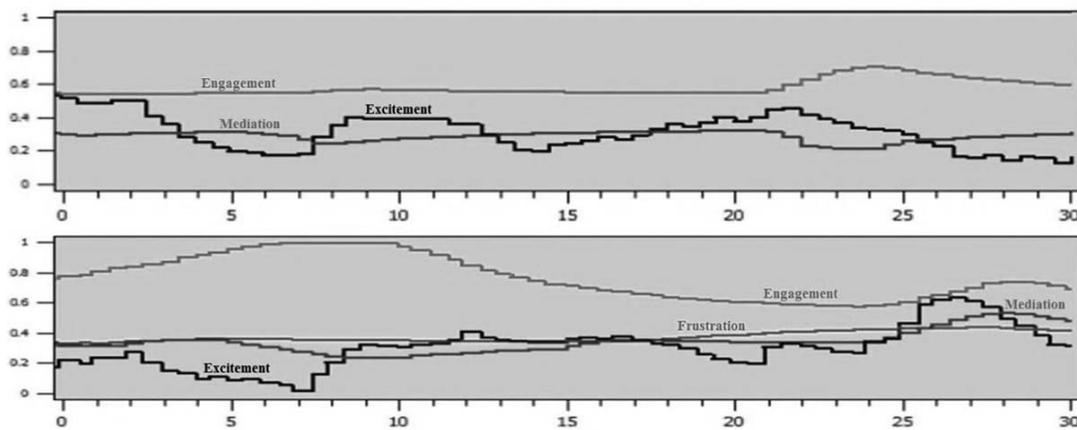


Figure 8. The brain reaction – Man aged 22 years (figure above) vs. Man aged 48 years (figure below)

Source: own processing

testing of the wine sample 4 Château Topoľčianky. As an example, the results of two men (younger and older) and two women (younger and older) were used.

From the Figure 8, we can see that the test wine Château Topoľčianky led to a higher emotional engagement, as well as the relaxation (meditation) in the case of a younger male respondent. Frustration was at level 1 throughout the testing, which could be due to the concerns of the respondent from the neuro-testing itself. Also, immediately after the tasting, a decrease of the excitement of the respondent was recorded.

In the case of the older male respondent, we can see that from the moment of drinking the wine there was an increase of the emotional engagement and emotion meditation. The frustration recorded the value below 0.4, which was slowly increasing. Throughout

the period, the excitement had a fluctuating tendency, but immediately after the wine tasting, this emotion increased reaching the value 0.6. We can say that this man was positively impressed by the wine and it would influence his consumption behaviour.

From the Figure 9, we can see that the wine did not cause any emotional engagement, similarly the relaxation (meditation) and the frustration were nearly at the same level throughout the period, even though after the 25<sup>th</sup> second some minor changes occurred. It can be said that the level of the frustration and meditation had a relatively small value, i.e. the wine affects a woman positively and it could influence her purchase behaviour, as we can see that immediately after the tasting, an increase in the excitement was recorded in the case of this younger female respondent.

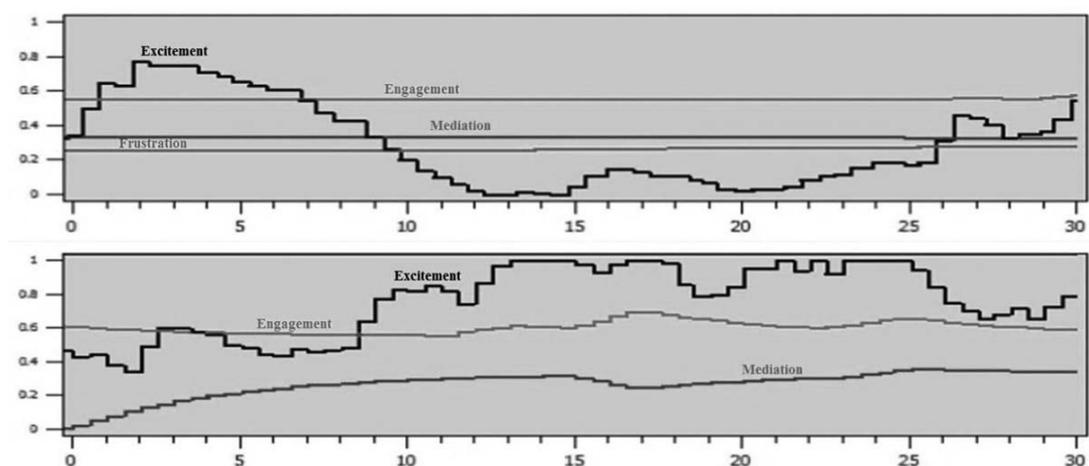


Figure 9. The brain reaction – Woman aged 33 years (figure above) vs. Woman aged 51 years (figure below)

Source: own processing

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We know that the female brain reacts more emotionally, our research confirmed it as we can see in Figure 9 (similar results as in Collignon et al. 2009). With this woman, we noticed that the wine has caused a higher emotional excitement than in the case of men, although the emotional engagement was gradually decreased. The frustration was at the level 1 throughout the testing, which could also be due to the concerns from the neuro-testing. Meditation had an upward trend, leading to a positive change. As we can see, immediately after the tasting, a decrease of the excitement was recorded in the case of the older female respondent.

## CONCLUSION

Many articles and publications describe neuro-marketing as a key to the understanding of the consumer's brain and as a way through which companies can find a "buy" button in the consumer's brain. The aim of this paper was to determine to what extent neuro-marketing is important to a better understanding of the consumer behaviour and if it is not just a concept highlighted by the desire for sensation by means of publications.

In the first part of the neuro-marketing research, we evaluated the overall impression of the tested blank samples of wine by tasting, because the taste is a crucial sense when making the final judgment about the evaluated wine. We found that among all the samples, the best overall impression was made by the sample B2 Vindevie, but at the same time, it was most differentially evaluated by the respondents. The highest assigned value for the Vindevie wine was 9 and the lowest one 3. During the sensory evaluation of the sample B4 Château Topolčianky, the respondents rated this wine to a maximum value of 6 and a minimum 1. In contrast, the sample B3 Peter Podola was the most similarly evaluated.

In the second part of the neuro-marketing research, we recognized the micro expressions immediately after tasting each type of the test wines. The emotion happiness was reaching the highest values for the wines Vinanza, representing 14.68% and Vindevie, representing 12.92%. The lowest mean positive emotion happiness was recorded with the wine Château Topolčianky, representing 8.46%. The Château Topolčianky wine did not arouse a positive change with the respondents. The emotion sadness was reaching the highest values for the wine Zaječí

CZ, representing 21.6%, and for the wine Movino, representing 21.8%. The mean of the emotion sadness of the wine Château Topolčianky reached the relative level of 19.5%. The emotion anger was reaching the highest values for the wines Peter Podola, representing 8.22%, and Château Topolčianky, which represents 8.01%. The micro-emotion disgust was reaching the highest values for the wine Vinanza, representing 5.85%. The mean of the micro-expression disgust of the wine Château Topolčianky was 0.89%. The emotion surprise was reaching the highest values for the wines Movino, representing 3%, and Vinanza, representing 3.9%. The mean of the micro-expression surprise of the wine Château Topolčianky was around 1.3%.

The third part of the neuro-marketing research dealt with the recognition reactions in the brain of a subject based on the emotions. We found that women reacted more emotionally than men. They are also more empathic and responsive, their emotional engagement was increased to the maximum value of 1 immediately after the wine tasting. Therefore, we recommend the companies to focus on a female target group, because this wine can affect their consumer behaviour positively. The proof is the success abroad, in Taiwan, where the target group is women, however, this success on the Taiwanese market is not demonstrated by the research, only by the internal materials of the Château Topolčianky based on the export data. Therefore, in the future, we suggest demonstrating this achievement by a research and if it proves to be reasonable, we propose to continue with this strategy.

An application of neuro-marketing methods increases the sales effectiveness by activating the shopping trigger in customers. Continuously, we can expect the implementation of the neuro-marketing tools not only in the evaluation of the organoleptic characteristics of wines directly in the production process, but also in the evaluation of marketing and merchandising activities across the food vertical. As a result, effective marketing strategies are created, thereby increasing the business opportunities. Finally, it shortens the sales cycle of the product, increasing sales and profits of enterprises.

In the future, we plan to carry out a similar research but instead blank samples, we plan to use the original packaging, labels and also an indication of the price of the particular wines to reveal the impact of the brand and the price on the final emotional state of respondents. The result will reveal the actual impact

on the final preferences of consumers in the wine market.

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