http://dx.doi.org/10.15414/isd2016.s13.06

The use of HRV analysis in the marketing research

Jana Rybanská[1], Ľudmila Nagyová[2], Ingrida Košičiarová[3]
University of Agriculure in Nitra[1, 2, 3]
Department of Marketing and Trade
Tr. Andreja Hlinku 2
Nitra, Slovak Republic
e-mail[1, 2, 3]: jane.rybanska@gmail.com, ludmila.nagyova@uniag.sk, ingrida.kosiciarova@uniag.sk

Abstract
The autonomic nervous system (ANS) is the portion of the nervous system that controls the body´s visceral functions, including the action of the heart. It is well known that mental and emotional states directly affects the heart rhythms. The analysis of the heart rate variability can be very useful also in marketing, because study of the heart rate variability is an objective and non-invasive tool to explore the dynamic interactions between physiological and emotional processes. The heart rate variability patterns are responsive to emotions and heart rhythms tend to become more ordered during positive emotional states. The present paper is the pilot study and it shows consumer reactions on selected alcohol commercials and compares changes in heart rhythms with conscious statements of respondents about that, how they felt about the selected commercials. It was found out that consumers with high neuroticism react more emotionally than respondents with low level of neuroticism. There are also differences between males and females.

Key words: *heart rate variability, autonomic nervous system, emotions, neuroticism, consumer*

JEL code: *M31*

1. Introduction

The autonomic nervous system (ANS) is the portion of the nervous system that controls the body´s visceral functions, including the action of the heart. We know that mental and emotional states directly affects the heart rhythms. While the rhythmic beating of the healthy heart at rest was once believed to be monotonous and regular, now we know that the rhythm of the heart at rest is actually irregular (McCraty et al., 2001). These beat-to-beat variations in heart rate are in fact very informative. Heart rate variability is a very good indicator, primarily of health problems and risks. But the analysis of the heart rate and heart rate variability can be very useful also in marketing research. By the functioning of the heart we can observe how consumers react on various tools of the marketing communication. The study of the heart rate variability is an objective and non-invasive tool to explore the dynamic interactions between physiological and emotional processes. This paper is the pilot study and our main aim is to show how the HRV biofeedback (primarily psychological tool) can be also used in marketing. In neuromarketing research the functioning of the brain is on the first place but with the knowledge of functioning of the autonomic nervous system we can tell that the heart is as much important as the brain. The theoretical base of this paper we consider as very important for understanding how the heart works and how the heart and brain are connected.

1.1 The autonomic nervous system and the functioning of the heart

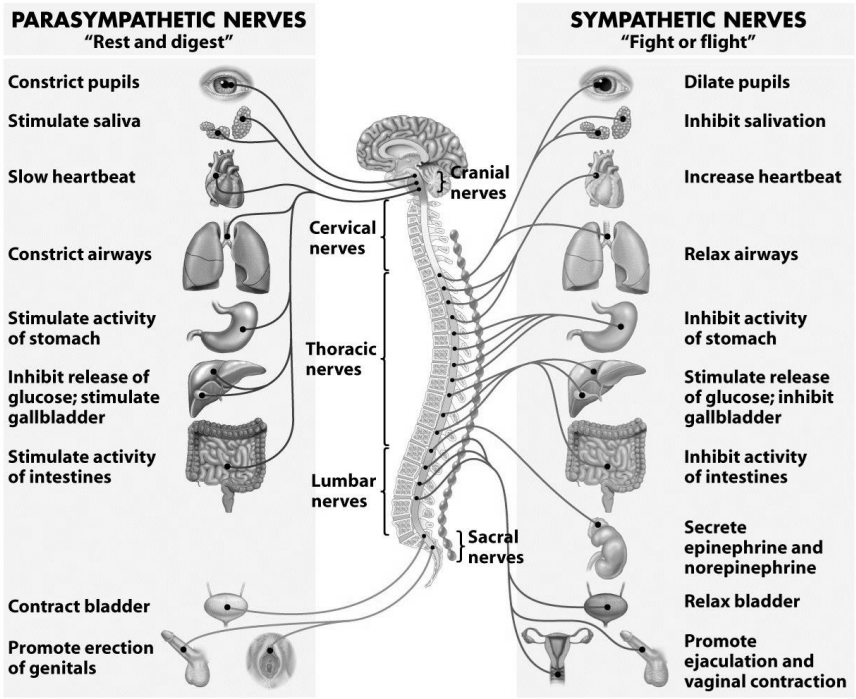
The heart plays a central role in the generation of emotional experience, and therefore, in the establishment of psychophysiological coherence. The heart is the most powerful generator of rhythmic information patterns in the human body (McCraty et al., 2001). The functioning of the heart is joined not only with the central nervous system but also with the activity of the autonomous nervous system.

http://dx.doi.org/10.15414/isd2016.s13.06

The autonomic nervous system (ANS) is a division of the peripheral nervous system that influences the function of internal organs (Figure 1). The autonomic nervous system is a control system that acts particularly unconsciously and regulates the bodily functions such as the heart rate, respiratory rate, pupillary response, urination, and sexual arousal. This system is the primary mechanism in control of the fight-or-flight response and the freeze-and-dissociate response (Schmidt &Thews, 1989). The main function of ANS is to keep the homeostasis and to assign the adaptation of individual organs to changing conditions of the environment. The functioning of ANS is regulated on the level of the brain stem and the spinal cord which are subordinated to the hypothalamus as the most crucial control element. The centres for the basic vegetative functions and reflexes are located in the reticular formation. On the level of the hypothalamus, these reflexes are connected to the more complex patterns which are modulated particularly by the limbic system (Čihák, 2004).

The autonomic nervous system has two branches: the sympathetic nervous system and the parasympathetic nervous system.The sympathetic nervous system is often considered to be the "fight or flight" system, while the parasympathetic nervous system is often considered to be the "rest and digest" or "feed and breed" system (Pocock, 2006). Both systems work antagonistically, where one system activates a physiological response and the other inhibits it. The sympathetic nervous system innervates all parts of the heart. The stimulation of the sympathetic nervous system releases the noradrenalin from the nerves terminations. The functioning of the sympathetic increases the heart rate (Perrson, 1996). The functioning of the parasympathetic nervous system decreases the heart rate. The changes in the activity of the parasympathetic fades away very quickly, so they mediate the quick changes of the heart rate from the beat to beat. The activities of both systems are joined and dependent and their effect on the heart is the result of the simultaneous changes (Javorka, 2001). Most autonomous functions are involuntary but they can often work in conjunction with the somatic nervous system which provides voluntary control.

Figure 1:The autonomic nervous system



Source: http://www.uic.edu/classes/bios/bios100/lectures/ANS.jpg

http://dx.doi.org/10.15414/isd2016.s13.06

1.1 The heart rate, the heart rate variability, personality and emotions

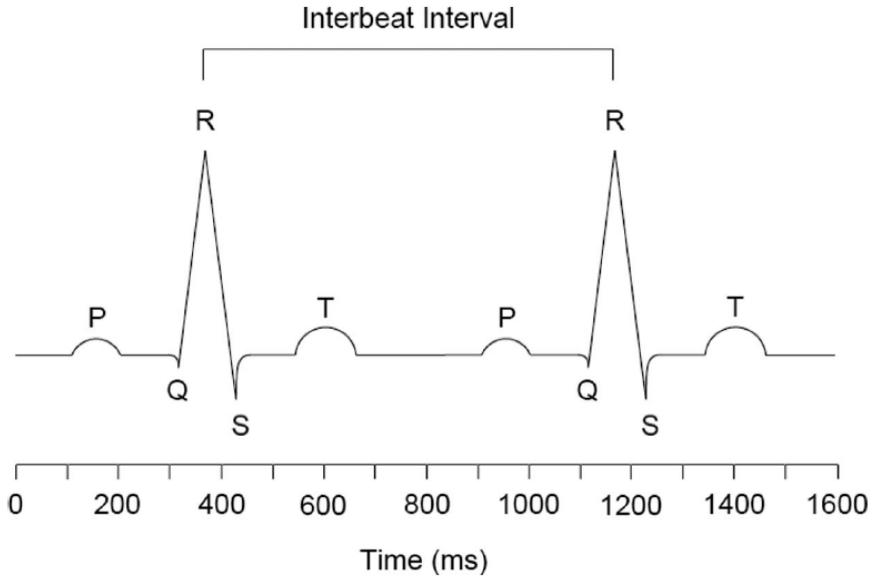
The heart rate is the speed of the heartbeat measured by the number of contractions (beats) of the heart per minute. The heart rate can vary according to the body's physical needs. It is usually equal or close to the pulse measured at any peripheral point. The normal resting adult human heart rate ranges from 60-100 beats per minute (bpm). A fast heart rate, defined as above 100 bpm at rest is called tachycardia. Bradycardia is a slow heart rate, defined as below 60 bpm at rest. During sleep a slow heartbeat with rates around 40-50 bpm is common and is considered as normal. Systolic blood pressure should be around 90-120 and diastolic blood pressure should be around 60-80 mm Hg. These values are well known because they were derived from a sample of the population in past epidemiological research (Altini, 2015). When activity in the sympathetic branch increases, heart rate goes up. When this activity decreases, heart rate goes down. Conversely, when parasympathetic activity decreases, heart rate goes up and vice versa. The parasympathetic branch acts faster than the sympathetic branch and it can therefore increase and decrease the heart rate with the greater precision. (Aldo, 2014). The heartbeat increases in the state of arousal and decreases with the upcoming calming (Nakonečný, 2000).

The heart rate variability (HRV) is a measure of the continuous interplay between sympathetic and parasympathetic influences on heart rate that yields information about autonomic flexibility and thereby represents the capacity for regulated emotional responding (Appelhans&Luecken, 2006). Heart rate variability (HRV) is a physiological marker of how we experience and regulate our emotions. The heart rate variability is relatively easy to measure. The heart rate means the number of beats per minute, the heart rate variability means the number of seconds that elapse between one heart beat and the next one (Figure 2). This is called the interbeat interval (RR interval). When we calculate HRV, we don't care about the average RR, but rather about its variability. We are interested in how much the RR fluctuates from each heart beat to the next. The parasympathetic branch is very fast, so sudden changes in RR can only be mediated by this branch. Thus, greater HRV equals more parasympathetic influences on the heart, and thus, more flexible emotional responding (Aldo, 2014).

The heart rate variability is defined as changes in the duration of consecutive cardiac cycles (heartbeats). Cardiac cycles may be measured by electrocardiography or electrocardiogram (ECG or EKG). On the ECG, the pattern of a cardiac cycle has four major parts: a P wave (which represents the electrical vector spreading from the right atrium to the left atrium during atrial depolarization), a QRS complex (which represents depolarization of the right and left ventricles), a T wave (which represents repolarization of the ventricles), and a U wave (which represents repolarization of the papillary muscles). HRV is measured as the variation in duration between the R peaks on the QRS complexes between consecutive cardiac cycles (Helschein, 2015).

http://dx.doi.org/10.15414/isd2016.s13.06

Figure 2: Interbeat interval (represents two heartbeats)



Source: Appelhans, B. M., &Luecken, L. J. (2006). Heart Rate Variability as an Index of Regulated Emotional Responding. p. 232.

HRV reflects the degree to which cardiac activity can be modulated to meet changing situational demands. Although HRV is influenced by numerous physiological and environmental factors, two are particularly prominent and of psychophysiological importance: the influence of the ANS on cardiac activity and ANS regulation by the central autonomic network (Appelhans&Luecken, 2006). In HRV it is important to look at our own baseline and monitor deviations from this baseline. It is not possible to compare heart rate variability of several people because it has no significance. Our baseline HRV is affected by some factors that we cannot easily measure (for example inborn factors), other factors that we cannot change (age, gender, etc.), and factors that can be influenced (health, lifestyle, BMI, weight, etc.) (Altini, 2015).

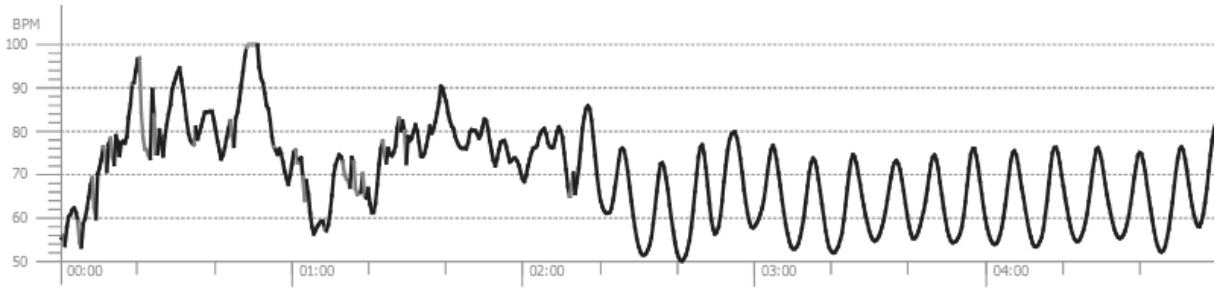
The two autonomic branches (sympathetic and parasympathetic) regulate the lengths of time between consecutive heartbeats, or the interbeat intervals (RR), with faster heart rates corresponding to shorter interbeat intervals and slower heart rates corresponding to longer interbeat intervals (Appelhans&Luecken, 2006). The heart rate variability reflects the moment-to-moment output of the central autonomic network and an individual's capacity to generate regulated physiological responses in the context of emotional expression (Thayer & Lane, 2000; Thayer &Siegle, 2002).

Many factors affect the activity of the autonomic nervous system, and therefore influence the heart rate variability. The research has shown that one of the most significant factors that affect changes in the heart rhythm are feelings and emotions. When our varying heart rate is plotted over time, the overall shape of the waveform produced is called the heart rhythm pattern. The research has found that the emotions we experience directly affect our heart rhythm pattern. In general, emotional stress – including emotions such as anger, frustration, and anxiety (negative emotions) – gives rise to heart rhythm patterns that appear irregular and erratic. The HRV waveform looks like a series of uneven, jagged peaks (an example is shown in the Figure 3). It is known as the incoherent heart rhythm pattern. In contrast, positive emotions send a very different signal throughout our body. When we experience positive emotions such as appreciation, joy, care, and love, our heart rhythm pattern becomes highly ordered, looking like a smooth, harmonious wave (an example is shown in the Figure 3). This is called a coherent

http://dx.doi.org/10.15414/isd2016.s13.06

heart rhythm pattern. When we are generating a coherent heart rhythm, the activity in the two branches of the ANS is synchronized and the body's systems operate with increased efficiency and harmony. Positive emotions actually help our body's systems synchronize and work better (McCraty et al., 2001).

Figure 3:Incoherent and coherent heart rhythm pattern



Source: own elaboration according to McCraty, R., Atkinson, M., &Tomasino, D. (2001). *Science of the Heart. Exploring the Role of the Heart in Human Performance*. p. 18.

As we described above, the emotional response involves almost all physiological systems of the body – the central and the autonomic nervous system, internal organs, endocrine glands, etc. The most common classification of emotions separates emotions to positive and negative emotions. Many studies have shown that in humans emotions are closely connected with consciousness, they have both a physiological and psychological nature, and together they form the emotional personality traits. Emotional traits are the most stable personality characteristics and they are closely connected with the temperament (Prokopenko, 2012).

Some studies investigated whether introverts and extroverts differ in cardiovascular activity. The results are mixed and inconclusive (Hogan et al., 1997). Many authors found no comparable differences in heart rate or heart rate variability. However, some of them observed higher heart rate in introverts than in extroverts in all conditions of an experiment on visual vigilance (Hogan et al., 1997). Prokopenko (2012) found out that the level of introversion-extroversion has the most prominent influence on the functional reserve of the body. In introverts, the activity of cardiovascular and respiratory systems declines.

2. Data and Methods

The main aim of this paper is to examine changes in heart rhythms of chosen consumers during watching two selected alcohol TV commercials and to find out if changes in heart rhythms correspond with conscious statements of consumers about selected commercials.

The sample consists of 20 volunteers. All probands were carefully selected from 100 participants. We chose 5 males with high neuroticism, 5 males with low neuroticism, 5 females with high neuroticism and 5 females with low neuroticism (based on Eysenck personality questionnaire EPQR-S). All probands gained similar score in intelligence (based on Cattell personality questionnaire 16 PF) and have higher, abstract intelligence. They are all students on the same university, they are similar age (20-21 years old), and they are healthy, non-smokers, medium physically active. All probands are from Slovakia and live in Slovak Republic.

The two TV commercials for alcohol were selected. First takes 2:02 min and second takes 1:01 min. The main aim of the first commercial is to evoke touching emotion and of the second is to evoke amusement.

http://dx.doi.org/10.15414/isd2016.s13.06

We compared changes in heart rate and heart rate variability with conscious statement of probands about the commercials. For recording the heart rate and heart rate variability the emWave Desktop HRV biofeedback was used.

Table 1: Conscious statement of probands about first commercial

		Commercial 1		
		Not touching	Touching	Total
Neuroticism	Low	4	6	10
	High	3	7	10
Total		7	13	20

Source: author's calculations

Table 2: Conscious statement of probands about second commercial

		Commercial 2		
		Not funny	Funny	Total
Neuroticism	Low	5	5	10
	High	3	7	10
Total		8	12	20

Source: author's calculations

In first commercial it was found out that 7 probands consider it as not touching (4 probands with low neuroticism and 3 probands with high neuroticism), 13 probands consider it as touching (6 probands with low neuroticism and 7 probands with high neuroticism).

In second commercial it was found out that 8 probands consider it as not funny (5 probands with low neuroticism and 3 probands with high neuroticism), 12 probands consider it as funny (5 probands with low neuroticism and 7 probands with high neuroticism).

We also observed changes in heart rate and heart rate variability of probands during watching the TV commercials. It was recorded a mild increase of the heart rate in 9 probands that considered the first commercial as touching (2 probands with low neuroticism and 7 probands with high neuroticism) and also an increase of the heart rate in all 12 probands that considered the second commercial as funny (3 probands with low neuroticism and 9 probands with high neuroticism).

We can conclude that respondents with high level of neuroticism (emotional lability) react more emotionally than respondents with low level of neuroticism (emotional stability).

We detected changes in heart rate also in probands who did not consider commercials as funny or touching. The coherent heart rhythm pattern was observed in all probands. We suppose it is because both commercials evoked positive emotions, so it could be the evidence that positive emotions smooth the heart patterns.

With the use of Student´s t-test we tested differences between males and females. It was found out that females react more emotionally than males. Much research shows that women are more emotional and that their emotions work a little bit different than those in men. Women are more emotional in every sphere of life, so we can assume that female customers are more emotional, as well.

3. Results and Discussion

During our research it was observed an increase of the heart rate in 9 probands that considered the first commercial as touching, and also an increase of the heart rate in all 12 probands that

considered the second commercial as funny. More emotionally reacted probands with high level of neuroticism. These results copy the general knowledge about personality and temperament characteristics of individuals. These findings could be used as the supplement of the research of Prokopenko (2012) who found out that the level of introversion-extroversion has the most prominent influence on the functional reserve of the body. In introverts, the activity of cardiovascular and respiratory systems declines. Introversion-extroversion is one of the three Eysenck´s dimensions of personality, neuroticism is the second. We can conclude that respondents with high level of neuroticism (emotional lability) react more emotionally than respondents with low level of neuroticism (emotional stability). The personality and temperament traits influence also buying decisions because it is known that more emotional consumers are more sensitive to the marketing stimuli.

We detected changes in heart rate also in probands who did not consider commercials as funny or touching. It could be the evidence that there is a difference between conscious and unconscious processes or that what people feel is not always what they say. Some marketing stimuli may work on the unconscious level. The coherent heart rhythm pattern was observed in all probands. We suppose it is because both commercials evoked positive emotions, so it could be the evidence that positive emotions smooth the heart patterns.

It was also found out that females react more emotionally than males. Many researches show that women are more emotional in every sphere of life, so we can assume that female consumers are more emotional, as well.

4. Conclusion

This paper shows how we can use the heart rate and the heart rate variability measurement on the purpose of marketing research. In this study, the emWave Desktop HRV biofeedback was used. We know that mental and emotional states directly affects the heart rhythms. During the projection of two different alcohol TV commercials we observed changes in heart rate and heart rate variability in 20 probands with similar characteristics. We could see several changes but there are a lot of factors that ought to be taken into consideration. This study is just a pilot and several improvement are necessary. Firstly we need bigger sample of respondents and we also need to know more personality differences. It is hoped that only a fraction of the utility of HRV in marketing for understanding emotional responding of consumers has far been realized, which is a truly an exciting prospect for marketers and consumer psychologists.

Acknowledgements

This paper was created within the project FOODCOST *Food Quality and Consumer Studies*. Project registration number 2014-1-SK01-KA2013-000464.

References

[1] Aldo, A. (2014, Jun 22). *What is Heart Rate Variability? And Why Does It Matter?* Retrieved February 21, 2016, from https://www.psychologytoday.com/blog/sweet-emotion/201406/what-is-heart-rate-variability-and-why-does-it-matter.

[2] Altini, M. (2015, August 28). *Heart rate variability normal values*. Retrieved February 20, 2016, from http://www.hrv4training.com/blog/heart-rate-variability-normal-values.

[3] Appelhans, B. M., &Luecken, L. J. (2006). Heart Rate Variability as an Index of Regulated Emotional Responding. *Review of General Psychology*, 10(3), 229-240. doi: 10.1037/1089-2680.10.3.229

[4] Čihák, R. (2004). *Anatomie 3*. Praha: Grada Publishing.

[5] Helschein, S. M. (2015). *Heart Rate Variability (HRV)*. Retrieved February 20, 2016, from http://level1diagnostics.com/testing/heart-rate-variability/.

[6] Hogan, R., Johnson, J., & Briggs, S. (1997). *Handbook of Personality Psychology*. California: Academic Press.

[7] Javorka, K. (2001). Autonómnynervovýsystém a hypertenzia. *Fyziol*ogia. 50(1), 71-80.

[8] McCraty, R., Atkinson, M., &Tomasino, D. (2001). *Science of the Heart. Exploring the Role of the Heart in Human Performance*. California: HeartMath Research Center, Institute of HeartMath.

[9] Nakonečný, M. (2000). *Lidskéemoce*. Praha: Academia.

[10] Persson, P. B. (1996). Modulation of Cardiovascular Control Mechanism and Their Interaction. *Physical Review A*. 20(1), 193-244.

[11] Pocock, G. (2006). *HumanPhysiology*. Oxford: Oxford University Press.

[12] Prokopenko, N. A. (2012). TheInfluence of IndividualPersonalityTraits on Heart Rate Variability in Women of Different Age underEmotionalStress. *Advances in Gerontology*, 2(2), 166-170.

[13] Schmidt, A. &Thews, G. (1989). Autonomic Nervous System. In Janig, W. (Ed.), *Human Physiology* (pp. 333-370). New York, NY: Springer-Verlag.

[14] Thayer, J. F., & Lane, R. D. (2000). A model of neurovisceralintegration in emotionregulation and dysregulation. *Journal of AffectiveDisorders,61*, 201-216.

[15] Thayer, J. F., &Siegle, G. J. (2002). Neurovisceralintegration in cardiac and emotionalregulation. *IEEE Engineering in Medicine and Biology*, *21*, 24-29.

* Online full-text paper availability: doi:http://dx.doi.org/10.15414/isd2016.s13.06