

Chapter 6

Eye-tracking in Marketing Research

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Abstract: Understanding the cognitive processes of consumers, such as attention or perception, can help orient marketing activities in such a way that the information provided to recipients is delivered in the most effective way possible. Neuromarketing methods – in contrast to conventional methods – enable scientists to measure the subconscious reactions in response to stimuli, thereby giving insight into decision-making processes, consumer preferences or motivations. One of the most commonly used methods of this type is eye-tracking. In recent years, there has been a noticeable increase in the popularity of using this technique as it provides valuable information regarding the visual processing of stimuli. The purpose of this publication is to present the possibilities of using eye-tracking in marketing research, including identifying the main research areas and insights from previous research. In the beginning, necessary information about the method will be presented, providing context for further considerations, such as eye movement characteristics and fundamental measurement indicators. Then a review of the studies conducted using eye-tracking will be carried out. A broad spectrum of the use of eye-tracking provides the opportunity for future studies to combine this method with other neuromarketing techniques (including the electroencephalography or magnetic resonance imaging).

Keywords: eye-tracking, measurement, eye movements, marketing research, psychophysiological methods, consumer behaviour

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Eye-tracking – what is it?

Eye-tracking is a set of research techniques and methods intended for measuring, analyzing and interpreting data on the position and movement of eyeballs (Rojna, 2003). Thanks to this method, it is possible to check where the subject's eyesight falls at a given moment, how long the eyesight focuses on a specific point and what path it follows (Schall, Bergstrom, 2014). In addition to observing eye movement, the technique also allows measuring its characteristics, including pupil size (Bojko, 2013). The need to track eye movements arose as a result of the desire to learn about the relationship between the brain and visual system (Schall, Bergstrom, 2014). One of the first studies in this area dates back to the 19th century, when Louis E. Javal registered eye movements using an apparatus placed on the patient's eye surface (Wawer, Pakuła, 2012). Tracking eye movements is used in various fields of science, among others in psychology, medicine or ergonomics (Wąsikowska, 2016). This technique has also been applied to marketing research.

As part of the visual activity, two types of eye movement can be distinguished – fixations and saccades. Fixations are relative pauses in the movement of the eye during which the retina stabilizes at a specific point in the visual field. Saccades, in turn, are quick eye movements occurring between fixations that rely on sight moving from place to place. In other words, these eye movements are responsible for the rapid transfer of the line of sight to those points of the visual environment in which the information needed for the current cognitive task is available (Garczarek-Bąk, Disterheft, 2018; Ober, Dylak, Gryncewicz, Przedpelska-Ober, 2009; Schall, Bergstrom, 2014). The fixations are from 150 ms to 600 ms long and constitute 90% of the looking time as they include the smallest eye movements, such as tremor, drift or microsaccades. Saccades last from 10 ms to 100 ms and are seen as a manifestation of the desire for voluntary changes of attention. From research on visual attention, a relevant category of movements are also smooth pursuits, which enable to track moving objects. In the context of the analysis of eyeball movement, it is, therefore, crucial to isolate fixations, saccades and smooth pursuits as they are an expression of voluntary visual attention (Duchowski, 2007).

The eye-tracking method based on tracking the motion of eyeballs allows for detailed follow-up of the subject's vision path, and in fact – the path of the attention. Thanks to this, it is possible to isolate the focus areas of the participant's vision, which gives an image of the content that the subject considers interesting or that has attracted the attention. Such information is a starting point for reflection on how a person perceived the viewed material (Duchowski, 2007). Researchers have always been interested in brain function in response to stimuli exposure, and thanks to eye-tracking, it is possible to understand how a human visual system works, as well as how the mind processes visual stimuli (Schall, Bergstrom, 2014). The studies conducted so far indicate a link between visual attention and eye movement. There are hypotheses according to which the same neural circuits mediate both attention and eye movements – changes in attention depend on the activation of brain structures that are closely involved in moving the eyes. In the study of Hoffman and Subramaniam (1995), it was proved that it is impossible to direct attention to one place and simultaneously perform a saccade

in another place. This, in turn, may mean that focusing attention can be an essential element in the preparation or execution of saccades. One explanation for the relationship between sight and recognition is that eye movements require the involvement of the attention system to choose which stimuli in the visual field are to take control of the oculomotor system.

The measurements of eye movement

An eye-tracker is a tool that enables to get an accurate representation and understanding of the eye motion. Most modern eye-trackers follow the position and movements of the eye using the corneal reflection method. The technique is based on the use of light sources (infrared) directed into the eye, followed by a reflection of the camera with high resolution. The image captured by the camera is used to identify the source of light reflection on the cornea, which allows determining the location of the subject's sight (Garczarek-Bąk, 2017; Schall, Bergstrom, 2014). In the analysis of the visual activity while using the eye-tracker, three main attributes can be distinguished, i.e. the location, duration and movement. The basic measure of location is the fixation, which reflects the position of the eyes captured in a given time. When interpreting this parameter, it should be remembered that the mere fact of recording the fixation does not mean that the subject actually saw or cognitively processed the recorded image (Schall, Bergstrom, 2014). Fixation measurement indicators include the number and distribution of fixations, which may be a reflection of the subject's engagement with the object. Another parameter is the total fixation time in a given area and the fixation time per unit area of the visual element being viewed (Bylinskii, Borkin, 2015). Measurement of visual activity using an eye tracker also enables to estimate the first fixation duration as well as the time to first fixation, which helps determine how much time it takes the user to notice a particular element. Additionally, the average fixation duration can be obtained by dividing the total time by the number of fixation. It is also possible to identify revisits defining all cases in which the eyesight again returns to the area in which the fixation had previously occurred (Garczarek-Bąk, Disterheft, 2018; Tullis, Albert, 2008). The analysis can be augmented with such parameters as the diversity of fixations (the number of unique points for which the fixation occurred) and inter-element fixations, which represents the number of cases in which fixation are attributable to different sets of elements (Bylinskii, Borkin, 2015). Using the eye-tracking apparatus, you can also extract parameters that take into account other types of eye movements, including dwell time – the total time of all fixations and saccades (Garczarek-Bąk, Disterheft, 2018).

As for the indicators related to saccades – they are particularly related to the sequence of searching different areas of interest by the observer. Since – unlike fixations – visual information is not processed during saccades, the measurement indicators associated with this type of eye movement are not crucial for examining visual attention. However, it is possible to obtain such indicators as the number of saccades or the saccade duration. Besides, it should also be noted that there are indicators affecting both fixation and saccades measurement as any combination of these movements is

called a scanpath. Frequently used measurement parameters based on the scanpath include scanpath length, spatial density, transition matrix, scanpath regularity and scanpath direction, which indicates the searching strategies of the participants (Borys, Plechawska-Wójcik, 2017). Information obtained during the test, therefore, can be present in the form of scanning path, reflecting the order of directing sight for each space. At the same time, it helps identify areas of withdrawing the attention from the essential content of the message during the testing procedure. Specific points that the subject looks at are represented in the form of circles, together with numbers indicating the order of observation and lines demonstrating the movement of sight from place to place. The data can also be visualized as a heat map, which allows to identify areas that received the most attention and those that have been overlooked by the participants. Places of longer concentration are marked with warm colours, while areas of shorter focus – using cool colours. On the other hand, the elements that the subject did not look at are not marked in any colour. The heat map can also be presented in an inverted form, showing the places of the presented content to which the subject directed the eyesight. Another way to present the results of measuring eye movements are areas of interest, which contain information about the extent to which a given picture attracted the attention of the subject. This information is presented in the form of a number, which allows for calculating the statistics (Garczarek-Bak, 2016; Wąsikowska, 2016).

The use of eye-tracking in marketing research

One of the reasons for using the eye-tracking in marketing research is the intention to understand the actions of consumers. The goal of marketing activities is to provide consumers with product information in an efficient enough way to increase awareness among potential buyers and to identify the needs that can be met through it. Consequently, awareness of product availability increases the likelihood of buying it. Eye-tracking can provide insight into at least one aspect of the internal model of the consumer attention: how the consumer distracts visual attention to various forms of advertising (Duchowski, 2007). Visual attention is essential in examining the consumer behavior and understanding its role in the decision-making process can provide valuable knowledge that enables to effectively design marketing activities using visual messages (Jerzyk, 2017).

Having looked at the results for queries such as “eye tracking” or “eye tracker” or “eye movement measurements” in the EBSCO database, an increase in the popularity of this method in the research is observed. Figure 1 shows the number of publications that concerned this technique. In recent years (2014–2018) more than twice as many papers related to eye-tracking have been created as in the years 2009–2013. The number of all works on this method created before 2009 (3262) is smaller by approx. 25% than the number of works from 2009 to 2013 and by almost 65% than the number of publications from 2014 to 2018.

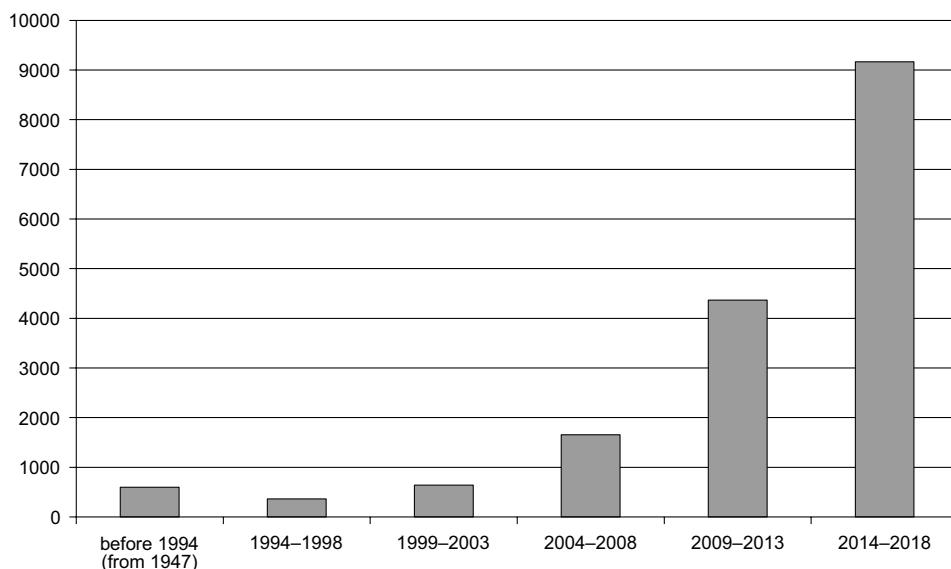


Figure 1. Number of searches for the phrase *eye tracking or eye tracker or eye movement measurements* in the EBSCO database

To examine the use of eye-tracking in marketing publications, an analysis of the number of searches in the EBSCO database for the phrases “eye tracking” or “eye tracker” or “eye movement measurements” and “marketing” was performed. The number of publications in this area is smaller (687); however, the growth trend is similar. In recent years (2014–2018) more than twice as many publications have been created as in previous years – a rapid increase in their number is observed, especially after 2000.

Experiments depending on recording the eye movements can help comprehend the processing of visual information during the purchasing decision at the point of sale and reveal phases of the decision-making process, which is affected by packaging design (Clement, 2007). The eye movement tracking method was used to test packaging effectiveness – including study by Cholewa-Wojcik and Kawecka (2015), in which the reactions for the package of energy drinks from the viewpoint of purchasing preferences were checked. When it comes to packaging design, aspects that were studied using the eye-tracking technique include shape, size, color of packaging and uses of different font (Clement, Kristensen, Grønhaug, 2013), location and characteristics of nutrition labels (Bialkova, van Trijp, 2011; Graham, Jeffery, 2011) or the presence of potentially misleading elements that may cause clients false expectations (Clement, Smith, Zlatev, Gidlöf, van de Weijer, 2017). In the Disterheft (2017) study, the relationship between the effectiveness and perception of advertising and the attractiveness of the model was analyzed using the analysis of eye movement. The participants were presented with three types of face wash gel ads – with the face of an attractive model, with the face of an average attractive model and without the face of the model. It turned out that the subjects looked at the average attractive model for longer. In the case of advertising with an attractive model, the study participants focused on the advertised product for

a long time, which, however, did not affect its better remembering (Disterheft, 2017). Other studies using eye-tracking regarding packaging design include, among others, the study of Husic-Mehmedovic, Omeragić, Batagelj and Kolar (2017).

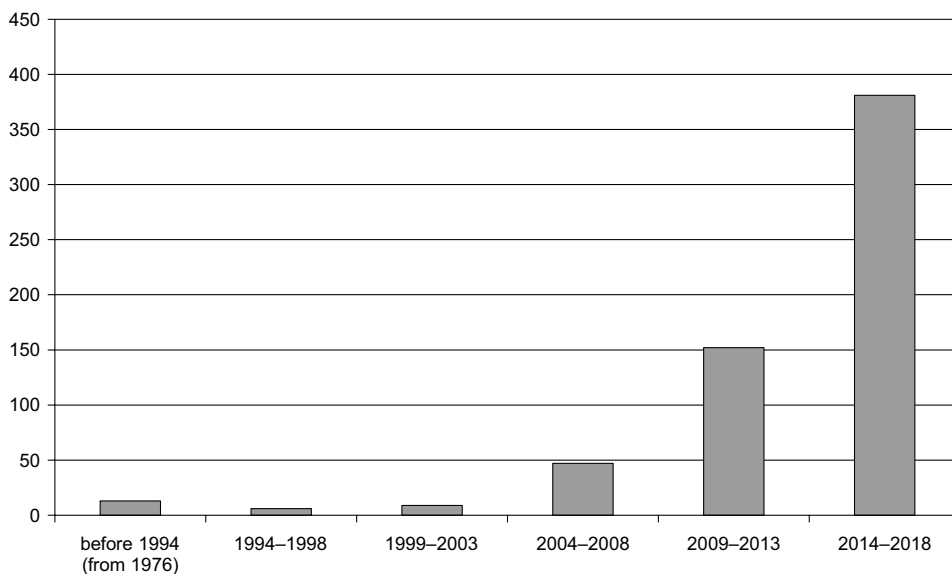


Figure 2. Number of searches for the phrase *eye tracking* or *eye tracker* or *eye movement* measurements and phrase marketing in the EBSCO database

Eye tracking was used in merchandising research as well. In this area, among others, the impact of visual ways of drawing the client's attention to the product, information about it and its price on the purchase intention was examined (Huddleston, Behe, Minahan, Fernandez, 2015). Another study using the technique of tracking the eye movements aimed to verify the impact of the location on the visual search as well as buyers' decision-making processes and their importance for the selection of the products. According to the study, the location-driven patterns of choosing the products by the consumers are crucial for retail shelf management and point-of-purchase decisions (Atalay, Bodur, Rasolofoarison, 2012). In the context of the display of goods on retail store shelves, the method was also used, among others, in the study of Chandon, Hutchinson, Bradlow and Young (2009) or in the study of Wästlund, Shams and Otterbring (2018) regarding peripheral vision.

Given the problems of the relationship between attention and customer preferences to products, purchasing decisions and the real choices, the analysis of eye movement was used in the context of emotion. In the study by Gaczek and Disterheft (2018), the impact of incidental emotions on the application of the satisfaction or maximization rule when selecting food products was examined. Using the eye-tracker, variables related to the decision rule i.e. total fixation time, number of fixations and total scanpath

length were measured. Eye movements were also recorded when the participants of the study made decisions when choosing jams. The study observed that feeling emotions when making decisions does not affect the application of satisfaction or maximization rule. The analysis showed that the products were slower and more carefully explored by the subjects in a good mood (Disterheft, Gaczek, 2018). When it comes to testing consumer behaviour, the eye-tracker was used as a method to study the impact of shopping goals (and the heuristics used) on visual attention when making purchasing decisions (Wästlund, Otterbring, Gustafsson, Shams, 2015).

The eye-tracking method can also be used to examine the marketing activity of exhibitors concerning trade fair booths. An example of such an application of the technique was presented in the study by Gębarowski (2018), focusing on the overall appearance of the booths and their exhibition part. Eye-tracking can also help determine to what extent the trade fair booth catches the eye of people moving around the market hall and how it stands out from other objects. Besides, it enables to isolate the elements that attract the attention the most and check the response to the presented products (Gębarowski, 2018).

The eye-tracking technique has also been used for television commercials. An example of such an application is the study of Smink, van Reijmersdal and Boerman (2017), which concerned brand placement disclosures. Eye-tracking was used to measure visual activity relative to the brand placement and report on its use. Besides, it was checked whether brand familiarity plays a moderating role in receiving the messages. To this end, areas of interest were analyzed. The study also used self-description methods to measure the recall of the disclosures, brand recall, perceived purchase decision, brand familiarity and brand attitude. Another study using eye-tracking in the context of television advertising was conducted, among others, by Teixeira, Wedel, and Pieters (2010).

Another area of application of eye-tracking is research on printed advertising. The study performed by Puškarević, Nedeljković, Dimovski and Možina (2016) analyzed the impact of the typeface figuration (i.e. regular and irregular forms of styling) on attention and attitude of the audience. The subject of the analysis was also the effect of changing the typeface figuration depending on the type of advertised product (hedonistic or functional). The eye-tracker study has been supplemented with measurement of attitude toward the brand, attitude toward the advertisement and purchase intentions using the Likert scale. An example of the use of eye-tracking in research on print advertising is presented in the study by Hutton and Nolte (2011), in which it was examined how gaze cues provided by models in advertisements affect the focus of attention on a specific area of advertising.

Several studies used eye-tracking for online advertising. For example, Porta, Ravarelli and Spaghi (2013) checked the impact of the congruity between the ad banner subject and webpage content on the perception and remembering of banners in online newspapers. Eye-tracker was also used to measure the number of fixations in the banner area, the total duration of the fixation, the average duration of fixation and the time of the first fixation (Porta, Ravarelli, Spaghi, 2013). In the studies in the area of online advertising, the tracking of eye movements may be helpful to measure the

phenomenon of banner blindness. The eye-tracker was used, among others, to verify whether Facebook users pay attention to the banners presented in comparison with the recommendations posted by friends (Barreto, 2013). The phenomenon of banner blindness was also investigated using an eye-tracker by Resnick and Albert (2014) who focused on banners that appear when browsing e-commerce websites. The study was completed by measuring the users' familiarity with the page and its visual appeal using the Likert scale. Owens, Chaparro and Palmer (2011), in turn, developed this area of research, exploring the topic of text advertising blindness. To this end, the authors used the eye-tracking method to check the attention of users when it comes to searching for text ads on websites. A similar use of eye-tracking also appeared in the studies of Hervet, Gue and Tremblay (2010) and Lapa (2007). The effectiveness of online advertising banners was the subject of Lee and Ahn study (2012), where it was checked what influence the visual effects of the stimulus (animation) have on attention and whether such cognitive requirements can play a moderating role. Another research has reviewed the relationship between various indicators of attention measured with eye-tracker (i.e. total fixation duration, average fixation duration and fixation frequency) with memory and a change of attitude. Examples of studies using eye-tracking also apply to content on websites and their impact on the observer's attention. In the study of Cao, Qu, Duffy and Ding (2019), the importance of the location of the ad and the colour of the web directories in relation to the users attention was examined.

In conclusion, it should be emphasized that the method of tracking eye movements in market research can be used for various purposes, such as product packaging design tests, website and e-mail communication tests, marketing communication tests (advertising, leaflets, sponsorship and product placement). It is usually combined with quantitative (questionnaires) or qualitative techniques (focus groups, in-depth interviews) (Cosic, 2016). The eye-tracking method is also often combined with other neuromarketing techniques.

Visual activity testing rules

Eye-tracking is widely used in marketing research since it is a low-invasive testing technique (Cosic, 2016). Before proceeding with the study, participants should be warned that the study will take place using technology that tracks eye movements – but be careful not to reveal too much detail about the procedure, as this may have a negative effect on the results obtained (Kara, Nielsen, 2009).

When carrying out a test using an eye-tracker, it is worth remembering a few fundamental principles that will ensure the reliability of the results obtained. Remember to control the exposure time for each participant – it should be made equal for the subjects. Besides, when the control of exposure time is not possible, the solution may be to express the dwell time in percent instead of absolute values – depending on its duration, other eye movements and other amounts of time spent on watching each element are observed. Time control should only take place when the participant is involved in the study – the time that the respondent spends reporting his experience

should not be recorded. During the test, eye movements of the subjects should be monitored in real-time, and they should be observed for correct posture. Consider the use of trigger, the point at which the participants focus their attention at the beginning of the experiment. This allows you to control the place from which all subjects begin the experiment (Tullis, Albert, 2008).

It is worth remembering that the results obtained through registering eye movements depend on the environment in which the test is performed. When planning an experiment related to tracking the subject's eyesight, it is worth considering the context in which it is carried out. For example, instead of using an eye-tracker in the store space, for reasons of cost and flexibility, researchers decide to use projectors to create a virtual environment. It should be borne in mind that the most realistic environment is a real physical store – the results of the test may be different depending on whether the eye movement is measured in a natural or artificial environment. The study of Tonkin, Ouzts and Duchowski (2011) proves that visual search is faster in the physical environment compared to the virtual image – although the perceived difference may not be significant. In turn, if the test is carried out in laboratory conditions, it should be remembered that the room in which it takes place has proper lighting. It is not recommended to conduct the test in very bright rooms – too much light may affect the device for recording eye movements (Kara, Nielsen, 2009).

The use of eye-tracking with other neuromarketing methods

There are examples in the literature of research using eye-tracking with electroencephalography (EEG). Eye-tracking enables to determine where and how long the eyesight is concentrated on some area. However, a longer time of focus on particular place does not necessarily reflect more attention or better remembering of the content (this may also mean that the material presented is too complicated). For this reason, more information can be obtained by supplementing the analysis with measuring the brain's electrical activity, which can be a representation of visual perception, mental activation, concentration, stimulation, memory or tension resulting from previous experiments (Dimpfel, Morys, 2014). The combination of eye movements tracking and EEG can be used in advertising studies as it provides essential information on individual as well as group cognitive and emotional responses leading to the objective assessment of the ads. In relation to TV commercials, both methods were used by Dimpfel (2015). Furthermore, Guixeres et al. (2017) investigated the effectiveness of advertising (recall, liking and viewing rates) available on digital channels (YouTube) using neurophysiological measures such as eye-tracking and brain electrical activity as measured by EEG and heart rate variability. The combination of both methods can be used in consumer decision research as well. Eye-tracking technology can be used to process the EEG recordings in real-time, allowing significant insight into the decision-making process recorded with it (Winslow et al., 2010). The study by Khushaba et al. (2013) aimed to provide information on the design and presentation of products so that they match the preferences of buyers. Authors have investigated the physiological reactions

of customers when making decisions regarding the products e.g. electrical activity of the brain and eye movements. The eye-tracker system was used to link EEG data with specific product selection options (i.e. to show the transition between selection sets and the actual selection of the object). A combination of methods was used in the Adhami (2013) study on mobile applications – thanks to which it was possible to verify the emotional response of the brain and concentration of attention while browsing, choosing and buying products on a mobile phone.

The challenge in advertising research is to evaluate websites in terms of the content presented on them. In the study of Dimpfel and Morys (2014) eye-tracking was used to indicate in which areas of the website and how long the users' eyesight is focused. In turn, the EEG measurement allowed to conclude about the cognitive reaction, focus of attention, memory processing or tension level. Considering the number of results of a simultaneous search in the EBSCO database, the phrase eye tracking or eye tracker or eye movement measurements and the phrase EEG or electroencephalogram or electroencephalography, 489 publications were published between 2009 and 2018.

As for the other psychophysiological measures, eye-tracking was used also with functional magnetic resonance imaging (fMRI). This combination of methods can help illustrate how brain activity corresponds to eye movement (as well as the gaze direction, pupil dilatation, or blinking frequency). In other words, the combination of these two techniques allows indicating what area of the image presented to the subject (visual stimulus) is observed when a specific part of the brain is activated simultaneously (Begdjani, Steen, 2013). In the study of Garrison, O'Malley, Gueorguieva and Krishnan-Sarin (2018), the brain response (the activity of the nucleus accumbens) was checked for advertisements for various flavours of e-cigarettes and tested whether they interfere with the reception of warning messages contained on labels. The procedure was supplemented with measuring eye concentration to verify how long the attention was focused on advertisements of individual flavours and whether the presented content drew the respondents' eyes from warning labels. Simultaneous searching in the EBSCO database of the phrase eye-tracking or eye tracker or eye movement measurements along with the phrase fMRI or functional magnetic resonance imaging or brain imaging indicates the existence of 413 publications.

Other methods combined many times with eye-tracking include analysis of electrodermal activity (Guerreiro, Rita, Trigueiros, 2015) and heart rate variability (Christoforou, Christou-Champi, Constantinidou, Theodorou, 2015). Based on the number of searches in the EBSCO database of the phrases electrodermal activity or EDA or GSR or galvanic skin response and heart rate variability or hrv along with the phrase eye tracking or eye tracker or eye movement measurements fewer publications can be observed which may indicate less frequent using both methods simultaneously. Taking into account the mentioned criteria, from 2009 to 2018, 75 papers were published regarding the use of eye-tracking with the measurement of electrodermal activity and 39 – with the measure of heart rate variability.

Combining eye-tracking with other methods – especially with neuroscience techniques – shows the vast possibilities of their use in marketing and consumer research. Tracking eye movement is essentially an indicator of the focus of attention. However, the

combination of this technique with other methods of measurement enables to obtain more detailed information on the consumer's affective states, beliefs, decision-making processes, preferences or motivations. The use of triangulation of eye-tracking and other neuromarketing methods can also give insight into how the brain works while receiving external stimuli.

Conclusions

Consumers are regularly exposed to visual stimuli, including watching ads or choosing products arranged on retail store shelves. Thus, tracking eye movements of recipients of such communication seems to be essential for the companies planning their marketing activities. Basically, eye movement is an expression of the consumer's focus on specific content. The popularity of eye-tracking in marketing research is demonstrated by the multitude of areas of application of this technique, ranging from packaging designs, through merchandising, traditional and television advertising, to fair trade stands or websites designs. Tracking eye movements can also be a perfect complement to traditional research methods, such as questionnaires and in-depth interviews. Due to the limited number of studies in this area, the prospects for future research using eye-tracking and other neuromarketing methods are broad.

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