

# Broadening the range of applications of eye-tracking in business research

*Ampliando o leque de aplicações de eye-tracking na pesquisa em Administração*

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**ABSTRACT:** Analyzing eye movements has had a long tradition in various scientific disciplines, serving different purposes. In psychology, observations of the eye movements in reading date back to the end of the 19<sup>th</sup> century. In business research, applications are a more recent phenomenon and mostly confined to studies in marketing. Tracking the eye movement is particularly well suited for investigating the consumers' attention to advertisements. Assessing the usability of websites represents another classic application. Notwithstanding occasional use of eye-tracking in brand and product management, eye movement data are scarcely used in business research. Given the successful examples of eye-tracking applications in various scientific disciplines, this is both surprising and unfortunate. Eye-tracking also has a great, but vastly underutilized, potential as a complementary tool in research in marketing. It offers, for example, objective insight into the perception of questionnaires or stimuli in experimental settings. Thus, we propose two specific areas in which eye-tracking can inform the researcher: (1) eye-tracking in the pre-testing of questionnaires, and (2) eye-tracking as a control tool for manipulations in experimental settings. These new applications are exemplars of how eye-tracking could be used more intensely in business research.

**Keywords:** Eye-tracking. Multidisciplinary. Literature review. Research agenda.

**RESUMO:** Analisar os movimentos dos olhos tem uma longa tradição em várias disciplinas científicas, com diferentes finalidades. Na psicologia, observações dos movimentos dos olhos na leitura data do final do século 19. Na pesquisa em Administração, as aplicações são um fenômeno mais recente e confinado principalmente a estudos em marketing. Rastrear o movimento dos olhos é particularmente adequado para investigar a atenção dos consumidores para anúncios publicitários. Avaliar a usabilidade de sites representa uma outra aplicação clássica. Não obstante o uso ocasional do *eye-tracking* no gerenciamento de produto e de marca, os dados de movimento dos olhos são pouco usados em pesquisas em Administração. Tendo em conta os exemplos de sucesso de aplicações de *eye-tracking* em várias disciplinas científicas, isto é ao mesmo tempo surpreendente e lamentável. *Eye-tracking* também tem um grande, mas muito pouco utilizado, potencial como ferramenta complementar na pesquisa em marketing. Ele oferece, por exemplo, uma visão objetiva sobre a percepção de questionários ou estímulos em ambientes experimentais. Assim, propomos duas áreas específicas em que o *eye-tracking* pode informar o pesquisador: (1) *eye-tracking* no pré-teste de questionários, e (2) *eye-tracking* como ferramenta de controle para manipulações em ambientes experimentais. Estas novas aplicações são exemplos de como o *eye-tracking* poderia ser usado mais intensamente na pesquisa em Administração.

**Palavras-chave:** *Eye-tracking*. Multidisciplinaridade. Revisão da literatura. Agenda de pesquisa.

**JEL Classifications:** M, M1, M3.

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## 1 Introduction

“The eyes are the windows to our soul”; “Beauty is in the eye of the beholder”. There are many well-known proverbs around the sense of vision. This might emerge from the perceived predominant role of vision among the remaining human sensory system (SCHIFFERSTEIN, 2006). The core function of the human eye is to provide information through the sense of vision. Light enters the eyes and hits the retinae, where it is translated into neural signals by photo receptor cells. Some of these cells, the central ones, are sensitive to colour providing the brain with accurate and sharp high spatial resolution images, while others, the more peripheral ones, have an excellent temporal resolution and a high absolute sensitivity. From the eyes several visual pathways project to different areas in the brain. One of them leads to the visual cortex, an area required for conscious vision. However, the human eye is not a one-way communication channel. We also express emotions through our eyes. Today, technology has advanced to the point where we can make use of recorded data associated with both functions of the eyes. For instance, in facial expressions research (YOUNG; HUGENBERG, 2010), emotions are analyzed by recording EMG (electromyography) of facial muscles (VRANA, 1993). Measuring the changes in electric muscle potentials, modulated by a human’s current emotional state, of the so called *musculus orbicularis oculi* (muscle around the eye) is another example where the area surrounding the eye is used to measure affective states (e.g., startle reflex modulation BRADLEY et al., 1993; WALLA et al., 2011). However, in the remainder of this article we focus on the core function of the eye: providing the opportunity to gather and process visual information.

Neural signals in the brain that reflect visual information are rich in details about the external world. These details lead to neural activity that represents semantic information and/or affective information that play a dominant role for any decision making. Photoreceptors receiving light from the centre of the visual field are densely packed and project to the so called parvo-cellular system (located in the thalamic visual interconnection nuclei) that processes visual information very accurately but relatively slowly. In the end, this sort of visual processing

feature is what can be mainly captured through eye-tracking techniques.

Eye movements performed during capturing objects or reading is associated with mental processes, predominantly with cognitive processing (GLAHOLT; REINGOLD, 2011). Despite the long tradition of eye movement analysis, a review of the extant literature reveals a strong unutilized potential of applications beyond the current range of research. Hence, the aim of the present paper is to review current applications of eye-tracking across disciplines and to propose two major fields of application in marketing research where advanced eye-tracking methodology can be applied and expected to provide added value to empirical experimental designs: (1) eye-tracking and pre-testing of questionnaires, and (2) eye-tracking as control tool for manipulations in experimental settings.

## 2 History of eye movement research

Peoples’ eye and gaze directions are not only assumed to communicate their emotion. They may also serve as indicators for their current focus of interest in the environment (CONTY et al., 2007). Hence, analyzing eye movements has had a long tradition in various scientific disciplines. In psychology, observations of the eye movements in reading date back to 1879. In this very early phase many basic facts about eye movements had already been discovered (RAYNER, 1998). However, tremendous technological advances occurring in the past three decades have lifted the tracking of eye movement to a new level allowing for addressing various scientific problems in different academic disciplines. Cognitive psychology benefits extensively from the analysis of eye movements. Eye-tracking contributes significantly to a more comprehensive understanding of human reading and information processing behavior (RAYNER et al., 2001; SCHNITZER; KOWLER, 2006) as well as encoding mechanisms during scene perceptions (RAYNER et al., 2009) and visual textures (JACOBS et al., 2010). In vision research, eye-tracking applications (DRIEGHE et al., 2005; KENNEDY, 2008; LEE et al., 2003) help understand differences in central and peripheral vision and their effects on cognitive processing. But not only psychology and the biological sciences have recognized the strengths of

analyzing eye movements. Eye-tracking and the modeling of gaze motions is also discussed in IS and computational research (DUCHOWSKI, 2002; DUCHOWSKI et al., 2004; VILLANUEVA et al., 2007). Moreover, it is applied in other areas like ergonomics in respect to safety perceptions in care driving (DUKIC et al., 2005), and it helps to get a more comprehensive knowledge of how we perceive the visual arts (ENGELBRECHT et al., 2009). In sports science eye-tracking is used to get a more elaborate understanding of the underpinnings of perceptual-cognitive expertise and superior performance in group sports (AFONSO et al., 2012).

The new opportunities of eye-tracking and the rise in interest are reflected in the institutionalization of the research technique. Various scholars have established specific eye-tracking laboratories (RAYNER, 2011). The online platform "Eye movement research portal" provides an up-to-date overview of research groups worldwide, conferences, recent applications in industry and so on and so forth (2011). With the Journal of Eye Movement Research, there has even been a specific outlet exclusively devoted to this area of research available for a couple of years (<http://www.jemr.org/>, 2011).

The research industry continuously brings new applications and integrations of eye-tracking technology to market. Eye-tracking is used in many industries aiming at improving performance (e.g., in automotive safety research or regarding eye control in computer interaction; tobii.com, 2011). Moreover, eye-tracking devices are used in video games to control the avatars with your eye movements ([www.eyetrackgames.com](http://www.eyetrackgames.com), 2011).

In business research, applications slowly transcend the domain of marketing. For instance, there are successful applications found in accounting (HUNTON; MCEWEN, 1997). Zülch and Stowasser (2001) discuss eye-tracking in the context of quality management in production (ZÜLCH; STOWASSER, 1999). However, the majority of eye-tracking studies in business disciplines is still confined to marketing issues. Pieters and Warlop (1999) analyzed eye movement data during brand choice and Pieters and Wedel (2004) and Pieters, Warlop and Wedel (2002) the attention to advertisements. Feiereisen, Wong and Broderick (2008) used eye-tracking to test the role of visual attention in the

context of product innovations. Another popular field of applying eye-tracking technology is usability research, testing websites and online content (see, e.g., [www.eyetrackingupdate.com](http://www.eyetrackingupdate.com), 2011). This field of application has reached extensive attention in corporate market research as well. Usability research and applications in advertising (analyzing both print and TV-spots) rank highest among eye-tracking studies in marketing. This mainly reflects the interest of commercial applications of eye-tracking in current marketing practice.

While more and more studies are published in acknowledged academic outlets, when looking at the top-tier marketing journals, applications are scarce. This illustrates that eye-tracking has not yet achieved undisputed academic status in marketing and still appears to be avant-garde.

As an alternative to actually recording eye-movements, some scholars discuss 'mouse-tracking' in usability research. This method is based on an assumed close relationship between gaze position and the position of the cursor on a computer screen during web browsing (CHEN et al., 2001). Although this method might provide an additional piece of information, further research is needed to clarify what type of information we really extract from this kind of data, how it can provide added value to traditional gaze recordings or behavioral data, and to what extent it can substitute actual eye-tracking.

The major strength of including gaze motions to analyze marketing-related questions is to have a more objective source of individual information. Although there is growing evidence for eye movements being diagnostic of underlying cognitive processes (FENG, 2003), objective eye movement parameters are usually combined with (mostly qualitative) self-report data to overcome the potential gap of drawing misleading conclusions from mere fixations to higher cognitive processing like learning or memory encoding.

Given the successful examples of applying eye-tracking in multiple scientific disciplines, it is quite surprising that in marketing research the applications eye-tracking has seen so far are limited to certain topics. Especially the application of eye-tracking to facilitate our understanding of methodological issues and to help evaluate empirical designs in marketing research is scarce. In the following, we propose

two potential areas in which eye-tracking can serve as another valuable source of information. It may be used to considerably advance knowledge in the respective fields related to methodological issues. These new areas are beyond traditional applications of eye-tracking in business research.

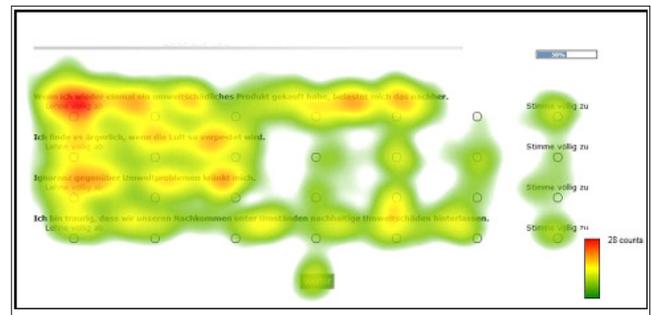
### 3 Applications in business research

#### 3.1 First field of application: pre-testing of questionnaire designs

A questionnaire represents a relatively complex pattern of visual cues, which have to be interpreted by the respondents. Respondents may take various cognitive shortcuts to reduce the effort needed to complete questionnaires (GALESIC et al., 2008; KAMOEN et al., 2011). Analyzing reading patterns of respondents and observing their gaze motions while dealing with different response formats can significantly contribute to a better designing of surveys in both scientific and applied marketing research. Optimally designed surveys in turn may positively contribute to increased response rates and may help to minimize the cognitive and behavioral burden for respondents. Unfortunately, there is only a small amount of research dealing with these issues available at the moment (GALESIC et al., 2008; KOLLER et al., 2010; MEIBNER; DECKER, 2010). Survey measurement instruments should be pre-tested using biological data in combination with traditional behavioral methods. Eye-tracking lends itself as a useful tool in scale development. Eye-movements could be recorded while reading different items of a measurement scale to be established. These reading patterns could give a hint at the necessity to examine certain items in more detail. Reading patterns (based on gaze measures) related to certain items that significantly differ from the rest of the scale items could be an indicator that the wording poses difficulties. Hence, gaze measures could be used as additional information along with traditional criteria like reliability and validity in scale development. Eye-tracking might reveal inappropriate design elements in a questionnaire that would otherwise result in a low response rate and a high drop-out rate. Diagnosing the suitability of the design and the positioning of various elements in a survey (e.g., items, answer format, back-button, progress

bar) via eye-tracking can help researchers avoid misunderstandings, ambiguity, and possibly also boredom on the part of the respondent and thus contribute to better and more user-friendly questionnaires. Facing the great potential that eye-tracking is able to offer in this regard, there is hopefully more research to come in the very near future. Figure 1 illustrates an example of how eye-tracking can be used to pre-test an online survey via recording fixation counts on particular elements of the questionnaire.

**Figure 1** – Example of eye-tracking used in the pre-testing of a questionnaire, heatmap of reading patterns (aggregated data over all participants in the pre-test, based on fixation counts)

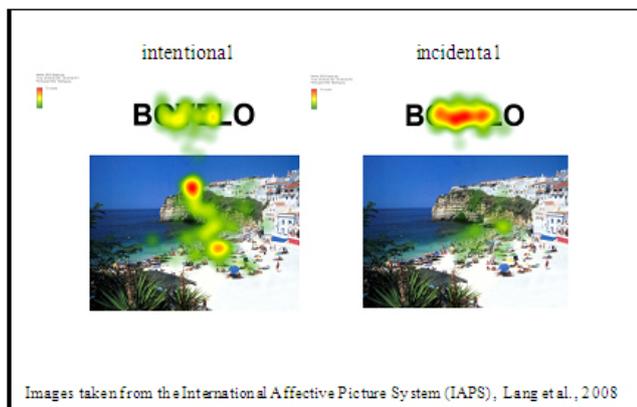


#### 3.2 Second field of application: control tool for manipulation in experimental designs

Eye-tracking might be used to control for manipulations in experimental designs. We will illustrate this suggestion using the example of incidental information processing. In today's consumption society, humans are exposed to inflationary informational cues. Hence, the role of incidental information exposure in forming attitudes towards products or brands has become increasingly relevant (McQUARRIE; MICK, 2003). From a methodological point of view, brand attitude or other similar dependent variables are often investigated in experimental settings with various informational cues manipulated. If, for instance, one is interested in the impact of incidental versus intentional processing of emotionally framed visual information on the attitude towards a given brand, the two respective conditions have to be manipulated successfully. In the condition of incidental processing of the visual elements, respondents have to be given an additional task instruction to prevent them from directly fixating the visuals. Recording eye-movements during

the experimental tasks can serve as control tool to check whether certain elements had been perceived intentionally (direct fixations on the visuals) or not. Eye-tracking can provide objective data in terms of a control check of a successful manipulation of the two experimental conditions (see figure 2 for an example).

**Figure 2** – Example of eye-tracking used as control tool for experimental manipulations, heatmaps of fixations of visuals presented (aggregated data over all participants in two experimental groups, based on fixation counts)



These are only two out of many promising areas in which eye-tracking can be a useful tool. We hope that our short multidisciplinary review of the status quo and the two examples given provide guidance to develop other innovative ideas for potential future applications.

#### 4 Discussion and further research

Almost more than a century of eye-movement research has produced multiple creative ways of how both academics in different disciplines and practitioners in various industries have used gaze information. In some cases, this has been used as a diagnostic tool to get a better understanding of certain psychological phenomena under scrutiny, in other cases as additional information for professional decision-making. The development of the methodology itself and the various different multidisciplinary applications were only possible as the underlying technology has continuously improved. Today, the methods of recording gaze motions have reached a highly sophisticated standard, making eye-tracking an interesting tool for various applications in academic research and industry. Cost-efficient eye-tracking tools have

lead to creative ways of using gaze recordings as additional pieces of information in the social sciences. Nevertheless, the literature review suggests that particularly in business research the method has not been used to its full potential yet. Hence, we propose two areas of application, how eye-tracking can additionally be used in future business research.

All methods come with limitations and eye-tracking is certainly no exception. By recording fixations of a certain object under scrutiny, it cannot necessarily be inferred that the visual information was actually subjected to mental processing. Visual selective attention is just one of the factors that can influence which areas out of the entire visual field are actually in the focus of conscious information processing. Via visual selective attention the brain can bring peripheral information, which is physiologically not in the optical focus, to the very center of cognitive and/or affective information processing. Only through simultaneous neuroimaging such as with electroencephalography (EEG) or functional Magnet Resonance Imaging (fMRI) would it be possible to reliably define, which areas of the entire visual field are actually in the focus of conscious processing at any given time. It remains to be seen how quickly and to what extent eye-tracking diffuses into business research. We hope that our short discussion paper stimulates interest and serves as an idea-generating source for scholars and practitioners alike.

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