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Design factors influence consumers' gazing behaviour and decision time in an eye-tracking test: A study on food images

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ABSTRACT

The eye-tracking method has been increasingly used for studying consumer behaviour over the last few years. Understanding factors influencing consumers' gazing behaviour in an eye-tracking test will contribute to a better organisation and a more valid application of the method. The aim of this work is to study how test design influences gazing behaviour and decision time of food consumers in an eye-tracking test. Three factors of the test design were investigated: (1) *Number of images* in one testing picture (two, three, four, five, and six images/picture); (2) *content of question* (tastiness, healthiness, price, convenience, and familiarity); and (3) *type of evaluation* (maximum choice, minimum choice, ranking, rating, and grouping). Two experiments were conducted. In the first experiment, performed with 100 participants, the influence of individual factors was studied. In the second experiment, performed with 64 participants, the joint effects (interactions) of the tested factors were investigated. The results showed that gazing behaviour and decision time are strongly influenced by the *type of evaluation* and the *number of images*, but not by the *content of question*. No joint effect of influencing factors (*number of images* and *type of evaluation*) was found. Findings are discussed in considering the relationship between eye-movements, cognitive goals, and tasks. This study highlights the importance of understanding factors influencing gazing behaviour and decision time in an eye-tracking test.

1. Introduction

1.1. Eye tracking applications in sensory and consumer science

The eye-tracking technique permits observation and measurement of the movement of eyes when consumers receive a visual stimulus or view a product. The information regarding their gazing behaviour is collected in an objective, rapid, and non-invasive way (Graham, Orquin, & Visschers, 2012). An attached device or sensor will record the eyes' movements, mark the observed region, and mark the time that the eyes stopped in each region, reflecting the observer's attention and interest levels for each zone of the visual stimulus (Russo, 1978). A number of different measures such as *time to first fixation*, *fixations before*, *fixation duration*, and *fixation count*, can be used to characterise the gazing behaviour. By analysing those measures, the gazing behaviour of consumers and influencing factors can be described, and then relationships to other important behavioural aspects such as choice behaviour can be determined. Therefore, the eye-tracking technique has great potential for objective observational studies in sensory and consumer science.

In the food sector, eye-tracking technique has mainly been applied in packaging research. By recording the dwell times and the areas that consumers pay attention to, an eye-tracker can determine how packaging attracts consumer attention. Some studies conducted a free-viewing task but varied stimulus-driven attention to study how packaging attributes (layout, nutrition label, etc.) affect consumer gazing behaviour and then suggest how to develop an appropriate packaging design (Piqueras-Fiszman, Velasco, Salgado-Montejo, & Spence, 2013; Rebollar, Lidón, Martín, & Puebla, 2015; Siegrist, Leins-Hess, & Keller, 2015). Others conducted a specific task, such as evaluating the healthiness of a product and the willingness to purchase or to try the product, to study the goal-oriented attention (Ares et al., 2013; Bialkova & van Trijp, 2011; Graham & Jeffery, 2012; van Herpen & Trijp, 2011). The eye-tracking technique is also applied to access visual stimuli of food products in order to evaluate the consumer perception of sensory properties such as colour,

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expected tastiness intensities (Jantathai, Danner, Joechl, & Dürrschmid, 2013) or consumer perception of quality factors such as healthiness (Mitterer-Daltoé, Queiroz, Fiszman, & Varela, 2014). Moreover, eye-tracking strongly contributed to the study of factors which might influence choice and consumer behaviour such as eating motivation (ex: negative mood, attentional avoidance) (Hepworth, Mogg, Brignell, & Bradley, 2010; Werthmann, Roefs, Nederkoorn, & Jansen, 2013), decision goal, and thinking style (Ares, Mawad, Giménez, & Maiche, 2014; Milosavljevic, Navalpakkam, Koch, & Rangel, 2012). Furthermore, several studies used eye-tracking to understand how psychological illnesses and food-related health status, such as anorexia nervosa, eating disorder, or BMI status, influence consumers' choice and food habits (Giel et al., 2011; Graham, Hoover, Ceballos, & Komogortsev, 2011; Horndasch et al., 2012). Hence, eye tracking is proving to be a useful tool for studying consumer perception and behaviour by gaining information in an objective way.

1.2. Design in an eye-tracking test

To achieve more valid data from eye-tracking, the question of how to design a test becomes exigent. However, only a few publications focused on this issue (Duchowski, 2007). As a result, large variations in test design were observed in the above-mentioned studies. The variations in the eye-tracking tests include: *number of images* per picture (varying from 1 to 10); *content of question* (preference, perception of healthiness, willing to try, willing to purchase, or expected intensities of sensory properties of food products); and *type of evaluation* (free viewing-task, forced choice, rating, ranking, or projective mapping).

Depending on the research purpose, each author designed his or her tasks differently. It might be that some authors did not consider the influence of the chosen design factors. In our opinion, the outcomes of above studies sometimes could not only be the result of the mechanisms under the study but also be biased by the chosen design parameters. Are there any influences of test design on consumer gazing behaviour? If yes, which design factors are influencing the gazing behaviour, and how? Finally, how should tasks in an eye-tracking test be designed?

1.3. Relationship between eye movement mechanisms, cognitive goals and task

It has been demonstrated that eye movement is coextensive with cognition, and oculomotoric processing is coextensive with cognitive processing (chap. 30, Liversedge, Gilchrist, and Everling (2011)). Eye movements are reported as highly task dependent and linked to cognitive goals (Castelhano, Mack, & Henderson, 2009).

Firstly, eye movements depend on the question including the content and the type of evaluation. Yarbus (1967) found that the task might influence patterns of eye movements. In his experiments, the same picture was presented to participants but with different questions. Consequently, different eye movement patterns were obtained. Recent studies also found similar results (Glaholt, Wu, & Reingold, 2010; Glöckner, Fiedler, Hochman, Ayal, & Hilbig, 2012; Kim, Seligman, & Kable, 2012).

Secondly, eye movements depend on the difficulty of the task. Hess and Polt (1964) were the first to observe that a person's pupils dilate when a difficult task is resolved. As the multiplication problems in their test became more difficult, pupil dilations increased steadily. More recently, Knoblich, Ohlsson, and Raney (2001) and Jones (2003) found that, in a difficult task, mean fixation duration increased significantly. They explained that participants need impasse stages (long gazes without making any moves) for cognitive processes searching for solutions; therefore, the more difficult a task is, the longer the fixation time has to be.

In conclusion, there is in general a relationship between task, cognitive processes, and eye movement mechanisms: depending on tasks, cognitive processes will change, and eye movements will follow and reveal the change of cognitive processes. These findings suggest that test design may considerably influence the results of an eye-tracking test, in the fields of both consumer science and psychology.

2. Research questions

Understanding the way to design a test will contribute to a better organisation and a more valid application of the test (Fig. 1). Hence, the objective of our study is to understand which factors of the test design influence consumer gazing behaviour, and how they influence them.

2.1. Tested design factors

In consumer behaviour studies, the task in an eye-tracking test is often to make a choice; therefore, eye movements are controlled both by top-down and bottom-up processes (Orquin & Mueller Loose, 2013). Top-down control of attention is usually defined as goal-driven attention and bottom-up control is commonly defined as stimulus-driven attention (Corbetta & Shulman, 2002). Thus, in our study, we tested three factors of the test design: *number of images* per picture, *content of question*, and *type of evaluation*. The *number of images* per picture was a factor of stimulus-driven attention. The two others were factors of goal-driven attention. The effect of *content of question* was attributable to individual differences, whereas the *type of evaluation* was caused by experimental manipulations.

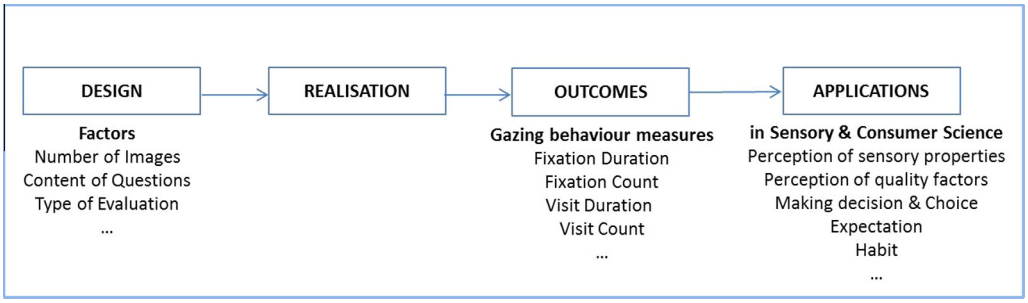

Fig. 1. Eye-tracking test: from design to applications.