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EYE-TRACKING BASED ANALYSIS OF TRAFFIC LIGHT LABELLING AND ITS IMPACT ON CONSUMERS' RISK PERCEPTION

Master Thesis

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Abstract

Food safety is the primary concern of governments, independent bodies, and industries to one purpose; to assure that the food product should be kept safe from production to table, keeping its nutrition content to the maximum level. The choice of a food product from a consumer's point of view should be made also considering the important criterion, health. However, this is not always the case, although the repeated food scares have an impact on the final decision of food product choice.

This study aims to investigate whether the use of a labelling system with green and red signs influences consumer perceptions of food safety risks. A further objective is to investigate gazing behavior and food product choice using the eye-tracking method. To this end, we conducted an eye-tracking experiment during which each of the 128 participants was shown two product variants in the same image frame and was asked to make a choice between the two products. Each product variant included different ratios of red and green signs on the label or label with plain text. At the end of the test, a questionnaire was completed by the participants to investigate risk perception and reasons for product choice.

Our findings show that in general participants did not perceive a food safety risk while their choices were mostly driven by the idea of healthy products. Overall, the individuals avoided to choose products with red signs. The type of sign was an influential factor for gazing behaviour and the thumb sign attracted more attention compared to the smile one. The demographic characteristics of the sample probably influenced the final choice and risk perception as most of the participants were young in age (18-25) years. Female participants were found to be more susceptible to risky choices than male participants.

Zusammenfassung

Lebensmittelsicherheit ist das vorranginge Anliegen von Regierungen, unabhängigen Körperschaften und Industrien; um zu garantieren, dass das Lebensmittelprodukt von der Produktion bis zum Tisch sicher aufbewahrt werden kann, zum Erhalt des Nährstoffgehalts auf dem höchsten Niveau. Die Auswahl eines Lebensmittelprodukts aus Sicht des Verbrauchers sollte auch unter Berücksichtigung des wichtigen Kriteriums Gesundheit getroffen werden. Dies ist jedoch nicht immer der Fall, obwhol die Wiederhollten Lebensmittelskandale einen Einfluss auf die endgültige Entscheidung bei der Auswahl von Lebensmitteln haben.

Ziel dieser Arbeit ist es, zu untersuchen, ob die Verwendung eines Ampelsystems mit grünen und roten Zeichen, die Wahrnehmung der Verbraucher vor Lebensmittelsicherheitsrisiken beeinflusst. Ein weiteres Ziel ist es, das Blickverhalten und die Produktauswahl mit der Eye-tracking Methode zu untersuchen. Zu diesem Zweck führten wir ein Eye-tracking Experiment, durch während dessen jedem von dem 128 Teilnehmern wurden zwei Produktvarianten im selben Bildrahmen gezeigt und sie gebeten wurden, zwischen den beiden Produkten zu wählen. Jede Produktvariante umfasste verschiedene Verhältnisse von roten und grünen Zeichen auf dem Etikett oder ein Etikett mit Klartext. Am Ende des Tests wurde von den Teilnehmern ein Fragebogen ausgefüllt, um die Risikowahrnehmung und die Gründe für die Produktauswahl zu untersuchen.

Die Ergebnisse zeigen, dass die Teilnehmer im Allgemeinen kein Risiko für die Lebensmittelsicherheit wahrgenommen haben und gleichzeitig ihre Entscheidungen hauptsächlich von der Idee für gesunde Produkte bestimmt waren. Die Menschen vermieden es insgesamt Produkte mit roten Zeichen zu wählen. Die Art des Zeichens war ein einflussreicher Faktor für das Blickverhalten und das Daumenzeichen erhielt mehr Aufmerksamkeit als das Lächeln. Die demografischen Merkmale der Stichprobe beeinflussten wahrscheinlich die endgültige Auswahl und Risikowahrnehmung, weil die meisten Teilnehmer im Alter von 18 bis 25 Jahren waren. Weibliche Teilnehmer waren anfälliger für riskante Entscheidungen als männliche Teilnehmer.

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Abbreviations

AGES	Österreichische Agentur für Gesundheit und Ernährungssicherheit
AOI	Area of interest
BSE	Bovine Spongiform Encephalopathy
EFSA	European Food Safety Authority
FC	Fixation count
FD	Fixation duration
L1	Label of the first product
L2	Label of the second product
P1	Product 1 (Packaging 1)
P2	Product 2 (Packaging 2)
RASFF	Rapid Alert System for Food and Feed
SIFC	Safety in the Food Chain
TFD	Total fixation duration
TFF	Time to first fixation
TVD	Total visit duration
VC	Visit count
VD	Visit duration

1 Introduction

Modern lifestyle with increasing number of working women, increased single-person households, and one parent families, has influenced food habits and food preparation. The aforementioned changes have also lead to a rapid development of food technology, processing, and packaging techniques in order to ensure safety in the food supply chain. Despite these advances, contamination in food supply does still exist, due to a variety of reasons such as naturally or accidentally introduced contaminants and bad manufacturing practices (EUFIC, 2017).

The repeated food scares in the last decades such as the mad cow disease (BSE) from the 90s, (Knowles et al., 2007), and until the quite recent Fipronil eggs contamination, have caused the public's concerns and attention for food safety and health issues. Many consumers are concerned about the impact of modern agriculture and new technologies in food production, including synthetic pesticides, fertilizers, GMOs, plastic packaging and food additives (EFSA, 2010). As a result, consumers' uncertainty and sensitivity to food risks are continuously increasing while the public demands protection by the governments and the regulatory authorities (Bocker and Hanf, 2000). Additionally, people require sufficient and relevant risk information in order to form their own accurate risk perception.

1.1 European Regulation

Food law ensures consumers' rights to safe food and accurate but not misleading information. Food labelling is a direct way of communication among consumers and food businesses. The European Union sets the labeling rules in order to enable the citizens to get comprehensive information about the content and composition of pre-packed food products and how to use them properly. Food labels help consumers to make informed choices during the buying process.

Food regulations are of high importance since they define the specific instructions that should be followed by companies in order to produce safe products. The European Union food safety policy encompasses the whole of the animal and human food chain. The European Regulations focus to make producers responsible for safe food and they are among the most stringent in the world (EUFIC, 2017).

Since December 2014, the Regulation No 1169/2011 on the provision of food information to consumers concerning the labelling of foodstuffs is applied. The European Union is interested in consumer's safety, health, information and avoidance of misleading information (EUR-Lex, 2011).

The mandatory particulars are the following:

(a) The name of the food

(b) The list of ingredients

(c) The quantity of certain ingredients or categories of ingredients

(d) The net quantity of the food

(e) The date of minimum durability or the 'use by' date

(f) Any special storage conditions and/or conditions of use

(g) The name or business name and address of the food business operator

(h) The country of origin or place of provenance

(i) Instructions for use in case it would be difficult to make appropriate use of the food in the absence of them

(j) Beverages containing more than 1,2 % by volume of alcohol, the actual alcoholic strength by volume

(k) Indication of ingredients causing allergies/intolerances

(l) A nutrition declaration

The obligation to provide information on ingredients causing allergies/intolernaces and nutrition declaration to consumers entered into application on 2016. The mandatory information regarding the nutritional declaration consists of the following:

(a) The energy value

(b) The list of ingredients

(c) The amounts of fat, saturates, carbohydrate, sugars, protein, and salt

Additionally, information can be added for monounsaturates, polyunsaturates, polyols, starch, fiber and some vitamins or minerals. Moreover, based on the European legislation, Member States may add additional symbols to highlight or express nutrition information. For example in United Kingdom the traffic lights system is used.

1.1.1 Background of European Regulations

The Treaty of Rome, signed in 1957 (EUR-Lex-2, 2017), did not provide any guidance for food regulation, since one of its main objectives was foodstuffs transportation freedom along the European Union. In 1970, European Commission issued directives that created standards of composition for certain foodstuffs. The standards allowed the use of some ingredients while they prohibited the use of others. The directives applied only to particular ingredients such as sugars, jams, chocolate products and preserved milk. In 1985 the European Commission decided to use labelling in order to indicate the differences in composition and production methods, allowing consumers to make an informed decision.

Food scares of the mid-1990s such as bovine spongiform encephalopathy (BSE) crisis and the dioxin contamination created a series of new determinations and recommendations regarding the need for reform. Following this period, in 1997 the European Union issued a Green Paper stating the current food legislation according to the needs of consumers, producers and manufacturers of food products.

Accordingly, the European Union developed an integrated approach to food safety, “from farm to table”. The White Paper on Food Safety was published in 2000 and it includes all sectors of production and sales chain. Specifically, the White Paper describes food safety regulations from feed production, primary production, food processing, storage, transportation and retailing.

In 2002 the European Parliament and the European Council adopted the Regulation (EC) No178/2002, laying down the general principles and requirements of food law (Eur-Lex, 2002).

The General Food Law Regulation is the foundation of feed and food law. More specifically:

- It sets out the framework for the development of feed and food legislation in European Union and European Union member states.
- It describes general principles, requirements and procedures regarding food and feed safety, covering all stages of food production and distribution.
- It established the European Food Safety Authority (EFSA), an independent agency, responsible for scientific advice and support.
- It develops the main procedures and tools for the management of emergencies and crises as well as the Rapid Alert System for food and feed (RASFF).

The General Food Law created a European food safety system where the responsibility for risk assessment (science) and risk management (policy) are separate, while the role of European Food Safety Authority (EFSA) is to conduct risk management as well as to communicate its scientific findings.

As risk assessor, the European Food Safety Authority expresses scientific opinions regarding:

- Food and feed safety
- Nutrition
- Animal health and welfare
- Plant protection
- Plant health

Since its establishment, European Food Safety Authority has delivered scientific advice on a wide range of issues such as BSE, Salmonella, food additives such as aspartame, allergenic food ingredients, GMOs and animal health issues.

1.2 Food related risks

Consumer research is regularly conducted by EFSA in order to be examined the public perception towards risk. In 2010, a second Eurobarometer was published by EFSA and the research objective was the investigation of consumer opinions regarding food risk factors. Respondents from all 27 European Member States have participated in the research and have answered questions regarding how their food risk perceptions have altered during the last five years.

The key findings of the survey suggest that 37% of consumers are worried about food safety, while they enjoy eating with friends and family by 54% and the majority associate eating with pleasure, for example, they combine fresh and tasty food products (58%). Furthermore, regarding the risks that can affect consumers' life, the respondents' state that the main factors were the economic crisis (20%), environmental pollution (18%), and food-related risks (11%). Additionally, the possibility for food-related factors to damage someone's health was increased by 3% over the last five years. In detail, the respondents that express their concern about food-related risks by 19% mention chemical, pesticides and other substances as potential risk factors while from them they consider chemical residues from pesticides as more important by 31% following by antibiotics (30%) and pollutants like mercury and dioxins (29%).

The European citizens show high levels of trust on health professionals (84%), consumer organizations (76%), scientists (73%), environmental groups (71%), EFSA (64%) and not on governments (only 47%). Additionally, there is an agreement on the high effectiveness of public authorities since the respondents believe that they act quickly and they inform people on time. Finally, the research shows that the citizens are getting informed mainly from media and the Internet, while one of the three avoids unhealthy or unsafe food mentioned in the news. Generally, the survey concludes that during last 5 years, the confidence in public authorities and the perception of food-related risks have increased. The data of Eurobarometer on food-related risks provide a good basis for further research on the relation between trust in information sources, confidence in public authorities and perception of food-related risks.

The role of AGES, the Austrian Agency for Health and Food Safety, is to minimize risk and to maintain food safety (Fuchs, 2015). More specifically, particular emphasis is placed on the control of risks through the implementation of risk analysis (risk assessment, risk management and risk communication). Due to the complexity of different subjects involved in the cycle 'soil-plant-animal-food-human', it is necessary to further analyse these issues. To

achieve this task, AGES is using risk maps for each combination of hazard carrier and risk carriers, taking into consideration threats that can occur through the chain of 'soil-plant-animal-food-human'.

The creation of risk atlas, a collection of risk maps, is a dynamic process, which is expanded through the addition of new maps while it is regularly updated through the adaptation of existing maps. It presents risk maps for the combinations of food-human, human-human as well as animal-economics. According to the risk maps, the top 5 risk groups in connection with the risk carrier of food are pathogenic microorganisms, malnutrition, mycotoxins, allergens and toxic elements. The top 5 risk groups from the perspective of naïve consumers, however, are GMOs, pesticides, radioactivity, food-additives and allergens.

1.3 Traffic Light Labelling System

Drichoutis (2011) and his colleagues (Drescher et .al, 2014) state that Traffic Light Labelling System is defined as:

"The "traffic light" label places colours next to each nutrient of a product, similar to traffic lights, which indicate low, medium, and high assessments of the nutrient. Usually foods are labelled with a panel of coloured spots relating to the amount of sugar, salt, fat and saturated fat".

Studies are increasingly being conducted on consumer understanding and acceptance of food labels as well as on their usefulness in making the diets of consumers healthier. A review of the research on consumer responses to nutritional information on food labels is provided by Grunert and Wills (2007). This review shows that consumers prefer the idea of simplified front-of-pack information while they present differences in their likings of various labelling formats. Campos et al. (2011) summarize previous studies and conclude that the use of nutritional labels is positively linked to healthier diets across studies but that their use varies strongly among different subgroups of the population. More specifically, children, adolescents and adults, who are obese, show a lower use.

Plain images have been shown to be more salient and consequently more strongly convey health risks (Severtson and Henriques, 2009). Plainness may also explain why consumers' understanding of Traffic Lights on food items is higher compared with that of other labels. Based on in-store observations in UK supermarkets as well as questionnaires, Grunert et al. (2010) showed that consumers' understanding of Traffic Lights was high, with a large proportion of respondents (80%) being able to identify the healthiest product, while the usage of these labels is mainly due to interest in healthy eating.

One reason that the food industry opposes Traffic Lights is that a product could receive a red label, if it contains a nutrient in an amount that exceeds a certain threshold. According to the presentation style, a red label is, in fact, a 'negative label'. Negatively labelled products might face competitive disadvantages.

1.3.1.1 Key points of Traffic Light Labelling System

The traffic light system has been preferred by consumers since it is easy to use and it enables people to identify healthier food choices. Especially, it has been found to be particularly useful when provided on ready prepared and processed foods such as sandwiches, ready meals, breakfast cereals and processed meat products which often contain unexpectedly high levels of fat, sugar and salt. This is particularly important for some countries such as the United Kingdom which is considered as one of the largest markets for ready meals in Europe.

The traffic light scheme consists of three key elements as shown in Figure 1:

- Traffic light colour coding for high, medium and low levels of nutrients

- Text denoting ‘high’, ‘medium, and ‘low’
- The percentage of GDAs

Figure 1: Example of Traffic light product label (Source: World Cancer Research Fund)

Some of the characteristics of traffic light system are considered as more important and allow the consumers to make the necessary comparisons and take their decisions on what they need. The traffic light labelling system should be referred on the same product proportion as the sign “per 100g”, which would allow consumers to accurately compare the nutritional profile of different products (World Cancer Research Fund). The exact amount of each nutrient should be communicated per portion along with percentage (%) of GDAs.

1.3.2 The perception of risk

Risk perception is the ability of a person to understand a potential harm or the possibility of a loss (Gellmann and Turner, 2013). It is an individual and subjective judgement about the severity of a risk and it depends on many factors such as culture, awareness, maturity, ethical principles, I.Q or E.Q. level etc.

Risk is an important factor that determines food choice (Knox, 2000). However, it is important to mention that the incidents of food poisoning are limited in comparison with other causes of morbidity and mortality. In other words, food is a very small factor as a cause of immediate death comparing to other factors. (Craven and Johnson, 2004). Following a decade of food scares, attention has moved towards the study of food risk. The mad cow disease arose out of unnatural animal husbandry practices from a consumers’ point of view. Therefore, the 'unnaturalness' of genetic modification has been shown to be a major barrier to public acceptance. It is quite possible that consumer rejection of genetically modified foods may reflect this attitude against unnatural food production practices.

Finally, in order to reveal risk perception related issues (perception, information and decision making), several models such as the psychrometric paradigm have been developed. Individuals have been found to evaluate risks mainly according to subjective perceptions, intuitive judgments, and associations made from media and limited source of information. Experts tend to base their risk perceptions on research findings and statistical evidence. (Paek, Oh and Hove, 2017).

1.4 The eye-tracking system, gazing behaviour and choice

Colours of food products have a high impact on visual preferences and gazing behavior (Jantathai et al., 2013). Food colour might influence the choice behaviour by eliciting certain expectations and feelings of appropriateness. Due to the fact that colours may also modulate the gazing behaviour, this might have also an impact on decision making. Previous studies (Armel et al,, 2008) have shown that the relative amount of time that subjects fixate an item during a decision making process increases the probability that the item will be chosen.

This is also confirmed by most recent studies. The study of Jantathai et al. (2013) with the help of the eye-tracking technology to investigate whether consumers' food choice and gazing behaviour are correlated, has shown that the longer and the more often consumers look at one food image, the more often that food image was chosen. However, it is important to investigate which factors may influence this correlation. These factors may vary according to the demographic characteristics, the attitudes of the person and product image.

To understand how perception and action are linked, mobile eye-tracking devices are used to record the eye movements in real world activities. Far beyond laboratory studies, such studies provide useful insight for relations between vision and action when consumers are acting naturally in real environments (Horsley et al., 2014). In marketing, mobile eye-tracking has been used to understand consumer responses to advertising, focusing on the impact of branding, images and text in media, product labelling, supermarket shelves and TV commercials (Janiszewski, 1998).

2 Research objectives and hypotheses

Studies have revealed that there is a misconception of risk perception between experts and consumers. Experts place high importance in the consumers' nutrition pattern whereas consumers focus intuitively more on details such as food additives. Understanding how the term food safety is perceived by individuals is therefore a challenging issue.

The current study was conducted using the eye-tracking system and aims at determining:

i) whether the use of a labelling system with green and red signs can influence consumer perceptions of food safety risks or not.

Further objectives of this study are:

ii) to examine consumers' gazing behaviour and choice as characterized by means of the Eye-tracking method and

iii) to investigate if demographics influence the final choice.

According to the objectives of the current thesis, the following research hypotheses are formulated:

H1: The Traffic Light Labelling System enhances risk perception in terms of food safety

H2: Consumers are more interested in health than food safety

H3: Red signs have a dissuasive effect on choice

H4: Demographics influence the samples decisions

3 Strategy, materials and methods

3.1 Experiment

The research sample consisted of 128 individuals and the experiment has been conducted in the sensory laboratory Muthgasse 18, Armin Szilvinyi Haus, Erdgeschoss. The research population consisted of students, stuff and externals from University of Natural Resources and Life Sciences in Vienna (BOKU).

The stimulus for the Eye-tracking analysis was a picture of a marble cake packaging from Bahlsen GmbH & Co. KG used as a basis for the investigation of the traffic light labelling system. The original cake picture was edited and three different variants of a traffic light system were implemented into the picture, namely smiles, thumbs, traffic lights and plain text (without images). On each picture there were two packagings of marble cake, which we call in this work products. In each case, one product contained always four green signs while the number of red sign variants in the second product is gradually increasing, resulting in one to four red signs. Also, a comparison of labelled and non-labelled (without any information designed on the second packaging) products took place. Consumers were asked to choose between the first and the second product in the same picture. Except from the different signs, the products differed in the content of basic ingredients that are related to healthy diet.

3.1.1 Software

For the implementation of the Eye-tracking test, the following materials were used:

- Adobe Illustrator CC (2015)
- Tobii Studio software (version 3.0.5)
- Microsoft Excel 2016
- Statgraphics Centurion
- Matlab 2016

3.1.2 Procedure

Participants received instructions before starting the test procedure. They first completed a small questionnaire regarding their demographic characteristics and their experience with eye-tracking. Afterwards, they were asked to sit in front of the eye-tracking screen and they were given instructions in order to complete the experiment correctly. In the beginning of the procedure, each individual had to follow a red cross with the eye movement as part of a 5-point calibration. After the calibration was successfully completed, the picture of the test appeared on the screen until the participants had formed an answer in their minds and clicked the computer mouse to continue the process. Then the same picture appeared on the screen, the mouse cursor occurred and individuals had to indicate their preferred product with a mouse click. After completing the choice task, participants were asked to fill in a questionnaire consisting of the three following questions:

Questionnaire

Q1: Which was the reason that you have chosen this product?

– Looks safe

– I like the appearance
– I know the brand
– Looks healthy
– Looks tasty
– No specific reason.

Q2: Did you perceive any risk in one of the products?

– Yes
– No

Q3: If you replied yes to the previous question, please indicate what was the risk related with

– Food safety
– Health
– Another reason
– I replied No

3.1.3 Implementation of the Eye-tracking test

The Tobii T60 eye tracker as well as the Tobii Studio software (version 3.0.5, Tobii Technology Ab, Sweden) were used to obtain and analyse data on consumers gazing behaviour. The pictures used for the experiment had a resolution of 72dpi and appeared on the software monitor. Only the participants that completed successfully the calibration process and had a quality of data outcome higher than 75% were included in the data analysis.

The images of choice (marble cake) are presented below in every alteration of red number signs and labelling (thumbs, smile, traffic, plain) and were edited in Adobe Illustrator CC (2015) image software.

(a) Non Labelling

(b) 4 Green Traffic Lights

(c) 4 Green Smiles

(d) 4 Green Thumbs

(e) Plain Text

(f) 3 Green 1 Red (4G-3G) Smile

(g) 2 Green 2 Red (4G-2G) Traffic Lights

(h) 4 Red (4G-0G) Thumbs

Figure 3.1: Images of product variants presented at the participants during the experiment

3.2 Data Description

3.2.1 Outcomes of the Eye-tracking Test

For each test, two areas of interest (AOI) were examined as following:

1) Label: Label of the first product (L1) and label of the second product in the same picture (L2)
2) Packaging: Product 1 (P1) and product 2 (P2) in the same picture

In each case the following parameters were automatically calculated by the Tobii software:

- Time to first fixation (TFF): Time from starting the test until the start of the first fixation in AOI (sec)

- Fixation duration (FD): Time of the first fixation (sec)
- Total fixation duration (TFD): Sum of all fixation durations of one participant within an AOI (sec)
- Fixation count (FC): Number of fixations within one AOI
- Visit duration (VD): Duration of each individual visit with an AOI (sec)
- Total visit duration (TVD): Sum of all visit durations for one person within an AOI
- Visit count (VC): Number of times that a participant enters an AOI

The results of the statistical analysis are presented in the chapters 3.2 and 3.3.

3.2.2 Demographics

As far as the demographic characteristics of the sample are concerned, the sample is almost equally partitioned between men and women. The number of men who participated in the research is 68 (Table 3.1) forming a percentage of nearly 53% of the sample (Figure 3.2), while the equivalent percentage of women is 47% (N=60).

Table 3.1: Gender of the sample

Gender	Number	Percentage (%)
Male	68	53
Female	60	47

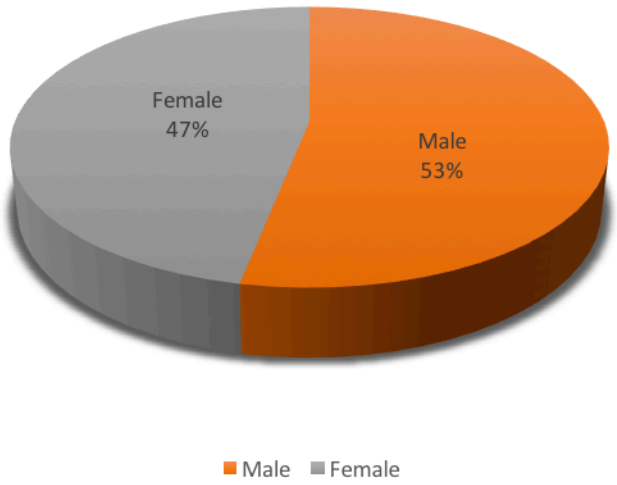

Figure 3.2: Gender of the Sample

Age of test participants varied between 18 and 40 years old. As presented in Table 3.2, age variable is prevailed by ages less than 25 (N=93) and the equivalent percentage of this category is 73% (Figure 3.3). More specifically, the sample majority was in the youngest group (18-25), while the rest (25%) was in the 26-33 age category.

Table 3.2: Age composition of the sample

Age	Number	Percentage (%)
18-25	93	73
26-33	32	25
33+	3	2

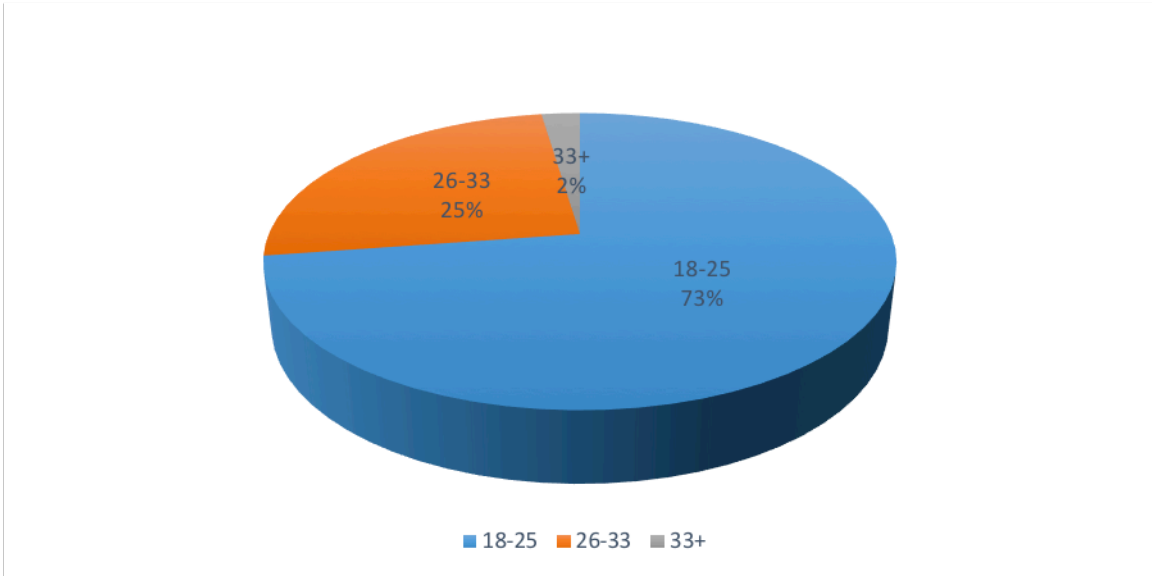

Figure 3.3: Age composition of the sample

The participants of the survey originated from 24 different countries in total. The majority of them came from European and the minority from Non-European countries. Most of the individuals were Austrian (N=85) (Table 3.3) forming the 66% of the sample (Figure 3.4). A small percentage of participants came from other European countries such as Italy (7%) and Greece (5%).

Table 3.3: Country of origin of the sample

Country	Number	Percentage (%)
Austria	85	66
Italy	9	7
Greece	6	5
Other	28	22

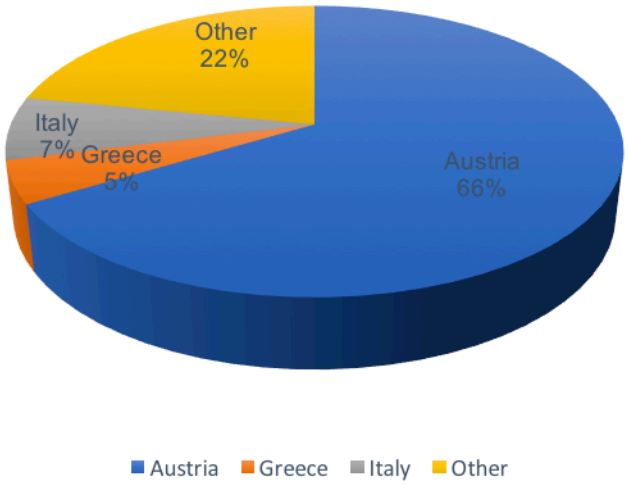

Figure 3.4: Country of origin of the sample

Students from the Food Science and Biotechnology study programme had most participants in this research (N=81) (Table 3.4) which corresponds to the 63% of the sample (Figure 3.5). The rest of the participants were studying Environmental Management (13%), Organic Chemistry (7%), Safety in the Food Chain (5%) and other programmes (13%).

Table 3.4: Study Programme of the sample

Study programme	Number	Percentage (%)
Food Science and Biotechnology	81	63
Environmental Management	17	13
Organic Chemistry	7	6
Safety in the Food Chain (SIFC)	6	5
Other	17	13

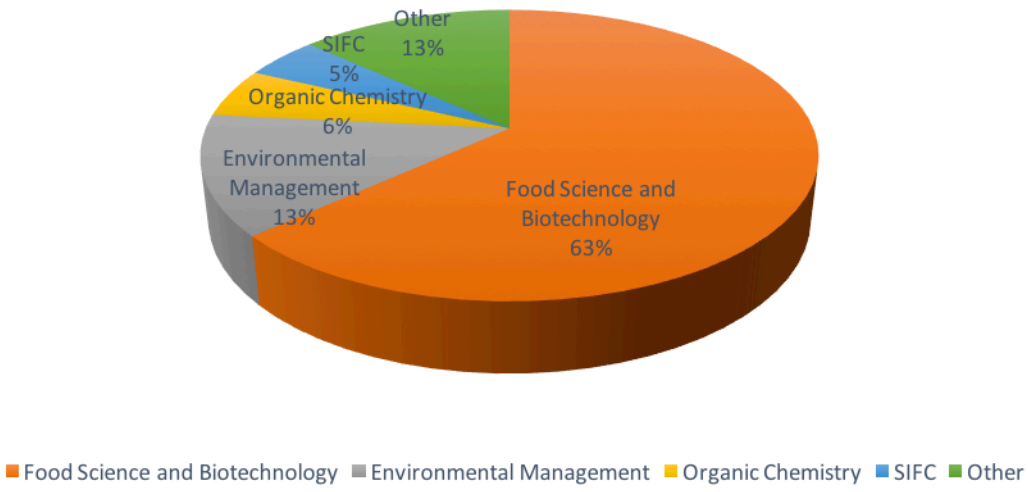

Figure 3.5: Study programme of the sample

To reveal how participants of this research were familiar with the eye-tracking experience, they were asked, if they had participated in a similar experiment before. The majority of them (N=97, 76%) did not have any previous eye-tracking experience according to Table 3.5 and Figure 3.6.

Table 3.5: Previous Eye-tracking experience of the sample

Eye-tracking Experience	Number	Percentage (%)
Yes	31	24
No	97	76

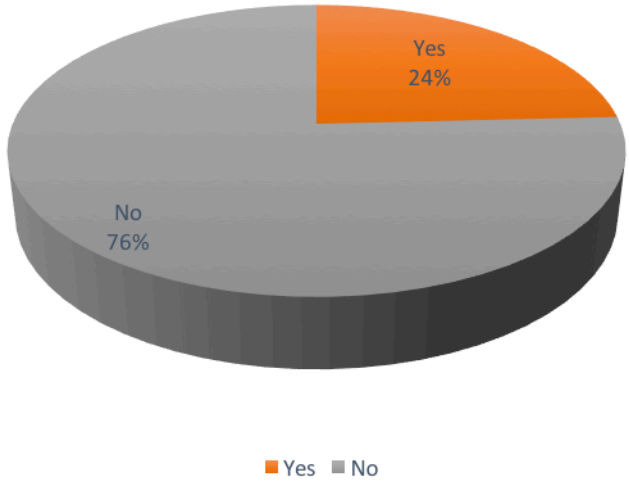

Figure 3.6: Previous Eye-tracking experience of the sample

Overall, the demographic results describe an sample which consists mainly of Austrians, that is almost equally divided by men and women of young age, studying in the department of Food Science which had never had previous Eye-tracking experience.

3.3 Methods of Analysis

The methods of data analysis in this research are quite straightforward and involve descriptive as well as inferential statistics. Descriptive statistics examines data behaviour both arithmetical and graphical with the help of frequency tables and graphical representations. The numerical and graphical representation of the data as well as the conclusive arithmetical results of the tests are presented in the research pat of this study. The data analysis in this project was implemented with the help of Microsoft Excel 2016 software and t-Test results were performed with the help of Statgraphics Centurion and Matlab 2016.

To focus on significant results, all the mean levels of eye-tracking outcomes were compared under the null hypothesis that they are even (H_0: $\mu_1 = \mu_2$) at the significance level 10%, while rejecting this would mean that there is a difference at the 10% significance level. (Alternate hypothesis H1). This is known as p-value and is the only criterion for selecting the significant cases. All comparisons were between two independent Samples and statistics were calculated according to the equation 2.3 for the estimation of t-value:

$$t = \frac{\overline{x_1} - \overline{x_2}}{\sqrt{\frac{{S_1}^2}{N_1} + \frac{{S_2}^2}{N_2}}}$$ *Eq. 2.3*

were x_1 and x_2 are the two variables examined each time. The above statistic follows the t distribution under the null hypothesis and was the basis for the comparisons that have taken place. Each time the null hypothesis was rejected or not along with a probability of an error (p value).

4 Results and discussion

4.1 Main research questions

This chapter presents the results of the questionnaire that participants completed in the end of the test, as well as the results regarding product choices. The questionnaire is presented in subsection 3.1.2 of this work.

4.1.1 Self-reported reasons for product choice

Table 4.1 and Figure 4.1 present the participants' answers regarding their product choice. More specifically, the majority of the respondents (27%) made their choice based on the healthy look of the product, following by how tasty it seems (21%), how safe it looks (20%) and if they like its appearance (17%).

Table 4.1: Self-reported reasons for product choice

Reasons for product choice	Number	Percentage (%)
I like the appearance	22	17
No specific reason	17	13
Looks tasty	27	21
Looks healthy	34	27
Looks safe	25	20
I know the brand	3	2

Figure 4.1: Self-reported reasons for product choice

4.1.2 Risk perception

The last two questions of the questionnaire aimed to understand if participants of this research perceived any risks regarding the presented two products in the same picture, and if so, to point out the risk factor. More specifically, the risk that was perceived by the sample was positive for the 57% of the sample according to Table 4.2 and Figure 4.2.

Table 4.2: Risk perception of the sample

Risk perception	Number	Percentage (%)
Yes	73	57.03
No	55	42.97

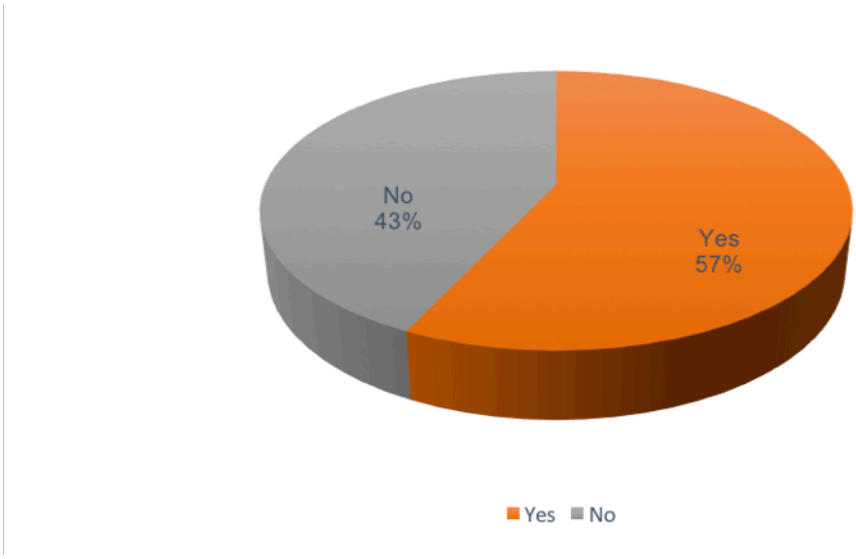

Figure 4.2: Risk perception of the sample

4.1.3 Type of perceived risk by the sample

Concerning the kind of risk factor, that participants perceived, from the 63 persons, who answered positively in the previous question, 49 (38% in total) answered, that they have perceived a risk related to health, as it is presented in Table 4.3 and Figure 4.3. Only 6% of the participants perceived a food safety risk, while 5% of them perceived a risk related to another reason.

Table 4.3: Type of perceived risk by the sample

Type of risk perceived	Number	Percentage (%)
I replied No	65	51
Food Safety	8	6
Health	49	38
Another Reason	6	5

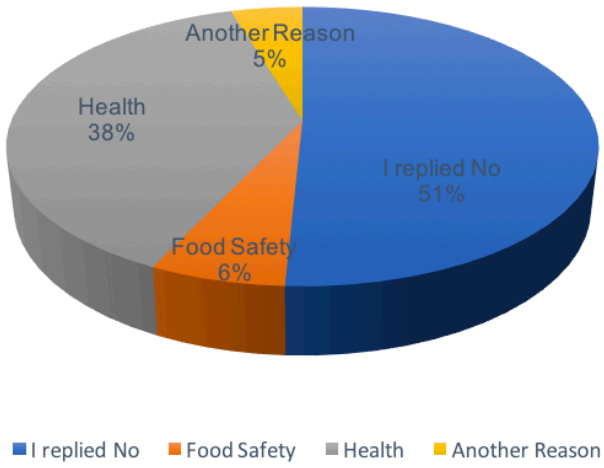

Figure 4.3: Type of perceived risk by the sample

It is important to consider that this question aimed at revealing one of the main goals of this research, namely participants' risk perception in terms of food safety. More specifically, Table 4.4 presents in detail the participants that have perceived a food safety risk, as well as the related test. Taking into account the fact, that almost half of the individuals, that participated in the experiment, studied Food Science and Biotechnology, it can be assumed, that in general participants were aware of the traffic light system scheme. Analysing the answers of the type of risk perceived, we conclude that 8 from 128 participants (6% as mentioned before) perceived a food safety risk for the three signs namely smile, traffic and thumbs. It is plausible as result, that no risk was perceived for the plain test since there was no red sign.

Table 4.4: Tests in which a food safety risk was perceived

Type of risk perceived	Test	Product Choice
Food safety	Smile 4G-2G	Product 1
Food safety	Smile 4G-2G	Product 1
Food safety	Traffic Lights 4G-3G	Product 1

Food safety	Traffic Lights 4G-3G	Product 1
Food safety	Thumbs 4G	Product 1
Food safety	Thumbs 4G	Product 1
Food safety	Thumbs 4G-1G	Product 1
Food safety	Thumbs 4G-1G	Product 1

4.1.4 Choice between labelled and non-labelled product

Table 4.5 and Figure 4.4 show that nearly half of the respondents prefer labelled products (54.17%) while the other half (45.83%) prefer non-labelled products.

Table 4.5: Choice between labelled and non-labelled product

Choice between labelled and non labelled product	Number	Percentage (%)
Non Labelled	11/24	45.83
Labelled	13/24	54.17

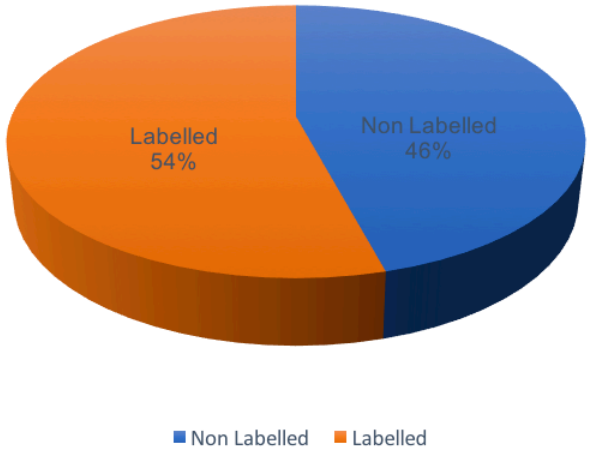

Figure 4.4: Choice between labelled and non-labelled product

According to the sample's answers, it is clear that health is the primary concern from the consumers' point of view since this factor was answered more frequently both in product choice and as a risk factor. From this analysis, we conclude that the stronger concern is the health which is synonym to fitness as it is clear that food safety is a stronger and a more immediate factor of health i.e. unsafe food, that might have immediate effects in health as in pathology. Moreover, the percentage of choice regarding safety and tasty is almost equally partitioned between participants (nearly 20%).

4.1.5 Choices of products with red sign

Table 4.6 presents participants' choices by the number of red signs. The number of red signs seems to have no clear effect on the choice since there is no clear correlation between the number of reds and the choice for only green. The red sign itself can be generally perceived as a negative sign and the quantity (1 or more signs) does not play a role. Moreover, adding

all the above values we can state that with the presence of at least one red, only 20, 8 % of the participants have chosen a product with a red sign. It is observed that for more than 3 reds, the percentage of choice is extremely low (12.5%). The red sign has, in general, a dissuasive effect on the choice of our participants.

Table 4.6: Table of choices by number of red signs

Number of Reds	Choice for only Green	Percentage (%)	Choice for only Red	Percentage (%)
1	19/24	79.2	5/24	20.8
2	17/24	70.8	7/24	29.2
3	21/24	87.5	3/24	12.5
4	21/24	87.5	3/24	12.5

4.1.6 Risk affine individuals

Risk affine individuals is a subgroup of the sample and represent participants that have chosen a product with at least one red sign. More specifically, the sample of risk affine consists of 96 individuals, of which 51 are males and 45 females. This subgroup is consisted of 61 Austrians (35 males, 26 females) and 35 non-Austrians (16 males, 19 females). The data of this sample are presented in the appendix and this category involves nearly the 19% of the sample (Table 4.7, Figure 4.5).

Table 4.7: Risk affine individuals of the sample

	Number	Percentage (%)
Risk affine individuals	18/96	18.75
Non-risk affine individuals	78/96	81.25

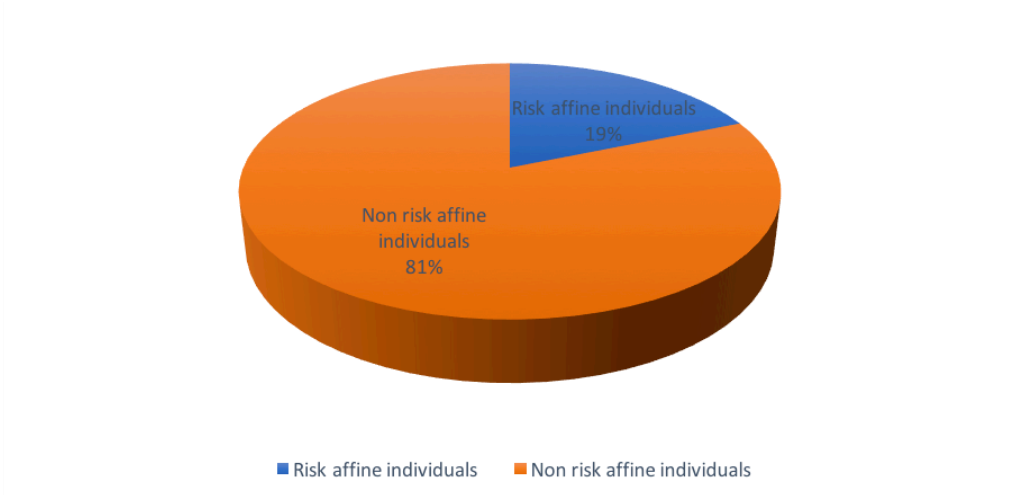

Figure 4.5: Risk affine individuals of the sample

Table 4.8 informs about the risk affine individuals by gender. The percentage of male risk affine individuals (21.56%) is higher than the female risk affine ones (15.55%), as it is presented in Figure 4.6. This is plausible as women are generally more sensitive towards risks.

Table 4.8: Risk affine individuals of the sample by gender

	Number	Percentage (%)
Male risk affine	11/51	21.56
Male non-risk affine	40/51	78.44
Female risk affine	7/45	15.55
Female non-risk affine	38/45	84.45

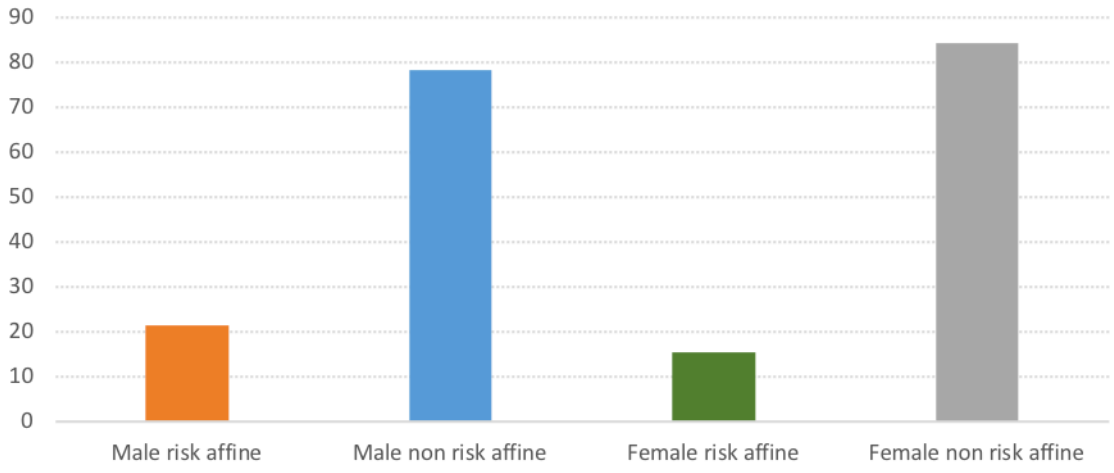

Figure 4.6: Risk affine individuals of the sample by gender

The percentage of male Austrian risk affine individuals (14.28%) is higher compared to the female ones (7.69%) as presented in Table 4.9 and Figure 4.7.

Table 4.9: Austrians risk affine vs non-risk affine by gender

	Number	Percentage (%)
Male Austrian risk affine	5/35	14.28
Male Austrian non-risk affine	30/35	85.72
Female Austrian risk affine	2/26	7.69
Female Austrian non-risk affine	24/26	92.31

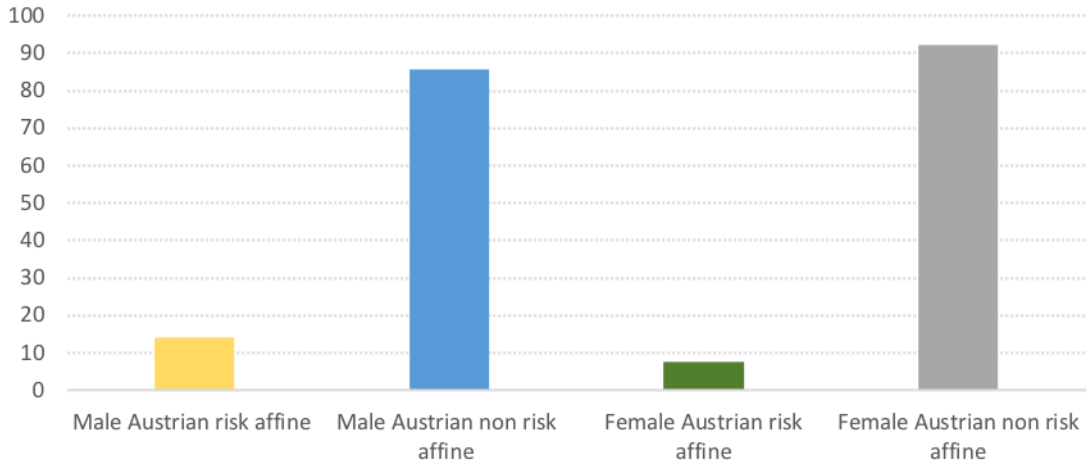

Figure 4.7: Austrians risk affine individuals of the sample by gender

The results of Table 4.10 and Figure 4.8 reveal that non-Austrian males (37.50%) are more risk affine compared to the non-Austrian females (26.31%).

Table 4.10: Non-Austrians risk affine by gender

	Number	Percentage (%)
Non-Austrian male risk affine	6/16	37.50
Non-Austrian male non-risk affine	10/16	62.50
Non-Austrian female risk affine	5/19	26.31
Non-Austrian female non-risk affine	14/19	73.69

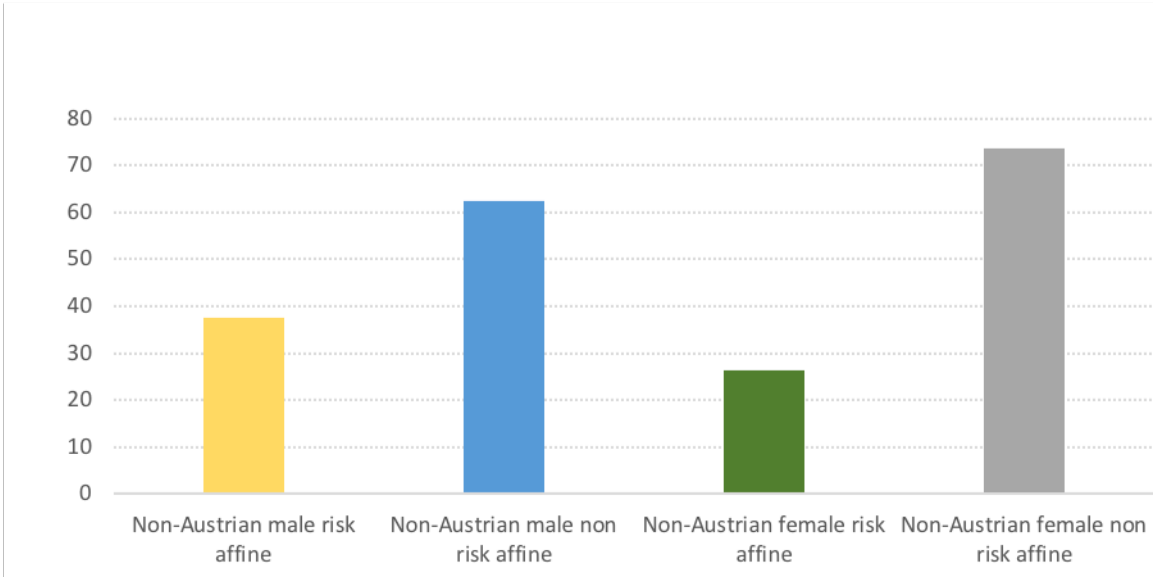

Figure 4.8: Non-Austrians risk affine by gender

The results of this analysis reveal that males more than females and non-Austrians more than Austrians are susceptible to risky choices. These differences imply, that women make

more healthy choices. The second result needs to further be investigated and a more realistic approach shall be examined considering other factors such as economic criteria and willingness to explore new products.

4.2 Outcomes of the eye-tracking experiment

In this chapter, we present the results of the eye-tracking experiment calculated using the Tobii software for specific areas of interest as discussed in the subsection 3.1.1. More specifically, for each pair of products placed in the same image frame, we present the statistics, i.e. average and standard deviation, of the eye-tracking parameters. Furthermore, the same statistics are studied by the number of red smiles, thumbs and traffics on the product and label as well as for each variable. Finally, we investigate whether there is a significant difference between the mean values for all the above cases.

4.2.1.1 Time to first fixation

The average time to first fixation of product 1 and product 2 for each of the 16 tests are shown in Table 4.11. It is clear from this figure that nearly in all tests, the average time of first fixation for the second product was larger than the equivalent time for the first product. This inequality (TFF-P2 > TFF-P1) suggests that the participants need more time to focus on the second product than on the first one. The typical eye movement of the participants was to look at the first product and then at the second one, probably because of the four green signs on the label of the first product or because the first product was placed in the upper part of the image frame. The results in Table 4.11 show that there is a significant difference between P2 and P1 in the mean value of all the tests (M1=0.56, M2=1.33). Moreover, significant differences were found between P1 and P2 mean values for tests 3, 4, 8, 10, 13, 16 at level 0.05.

Table 4.11: Average time to first fixation in seconds between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Count Product 2	Product 1 Mean	Product 2 Mean	Product 1 STDEV	Product 2 STDEV
1	8	8	0.37^{ns}	0.99^{ns}	0.25	1.18
2	8	8	0.72^{ns}	1.32^{ns}	0.55	0.96
3	8	8	0.57	1.54*	0.25	1.15
4	8	8	0.38	1.74*	0.12	1.01
5	8	8	0.56^{ns}	0.76^{ns}	0.36	0.57
6	8	8	0.48^{ns}	1.04^{ns}	0.27	0.78
7	8	8	0.55^{ns}	0.92^{ns}	0.38	0.54
8	8	7	0.29	1.36*	0.19	0.58
9	8	8	0.67^{ns}	1.39^{ns}	0.49	1.06
10	8	8	0.47	1.55*	0.29	1.34
11	8	8	0.38^{ns}	1.79^{ns}	0.07	2.02
12	8	8	0.6^{ns}	10.4^{ns}	0.37	0.47
13	8	8	0.52	2.17*	0.31	1.78

14	8	8	0.81^{ns}	2.21^{ns}	1.10	1.98
15	8	8	0.89^{ns}	0.59^{ns}	0.43	0.58
16	8	8	0.62	0.92*	0.56	0.68
Test Avg.	16	16	0.56	1.33*	0.16	0.48

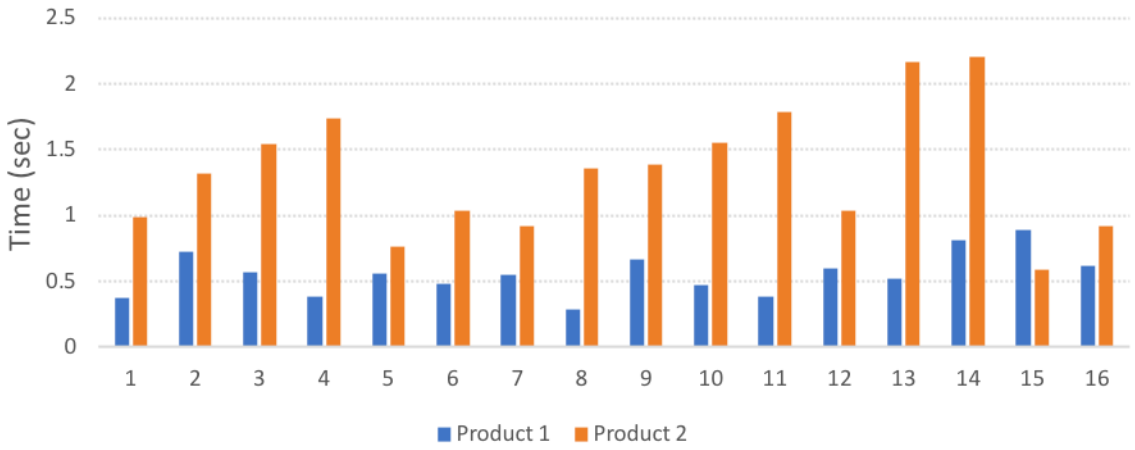

Figure 4.9: Average time to first fixation between product 1 (P1) and product 2 (P2) in the same picture

A more detailed examination of the average time to first fixation by the number of the red signs on the second product (P2) and the sign of the label shows that the 3 reds present the larger average time in almost all cases and thus, the largest overall average time (Table 4.12). The results that are also presented in Figure 4.10 show that the more the red signs, the longest the time to first fixation with the exception of four red smiles and four red thumbs, where in the last case the time to first fixation is shortest. Significant differences were found between 3 red and 4 red smiles. Moreover, in the case of thumbs, significant differences were noted between 2 and 4 red as well as 3 and 4 red signs. No significant differences were found between the smile, traffic and thumb mean values.

Table 4.12: Average time to first fixation in seconds by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean Dif.	Count	Traffic	Mean Dif.	Count	Thumb	Mean Dif.	Avg.	STDEV
1	8	1.32	xx	8	0.92	xx	8	1.04	xx	1.10	0.21
2	8	1.54	xx	7	1.36	xx	8	2.17	x.	1.69	0.42
3	8	1.74	x.	8	1.39	xx	8	2.21	x.	1.78	0.41
4	8	0.76	.x	8	1.55	xx	8	0.59	.x	0.96	0.51
Test Avg.	4	1.34^{ns}		4	1.31^{ns}		4	1.50^{ns}			

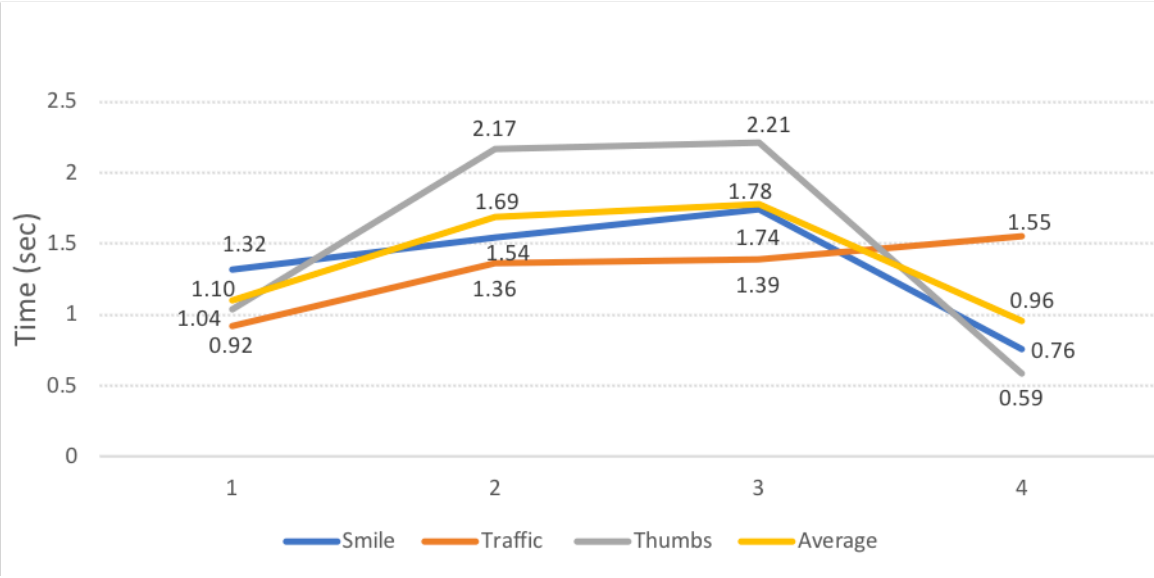

Figure 4.10: Line plot of the average time to first fixation by the number of red signs present on product 2 (P2)

Table 4.13 shows that the label of the second product (L2) presents the larger total average time on traffic sign for 1 red. Figure 4.11 also informs that the average time of the three signs presents a declining trend when the number of red signs is increasing. No significant differences were found between smile, traffic and thumbs mean values as well as for each one of the 3 signs separately.

Table 4.13: Average time to first fixation in seconds by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean Dif.	Count	Traffic	Mean Dif.	Count	Thumb	Mean Dif.	Avg.	STDEV
1	8	1.87	xx	8	3.61	xx	7	1.89	xx	2.46	1.00
2	7	2.45	xx	5	1.96	xx	8	2.79	xx	2.40	0.42
3	8	2.75	xx	8	1.81	xx	8	2.41	xx	2.32	0.48
4	7	2.05	xx	4	1.23	xx	8	1.48	xx	1.59	0.42
Test Avg.	4	2.28^{ns}		4	2.15^{ns}		4	2.14^{ns}			

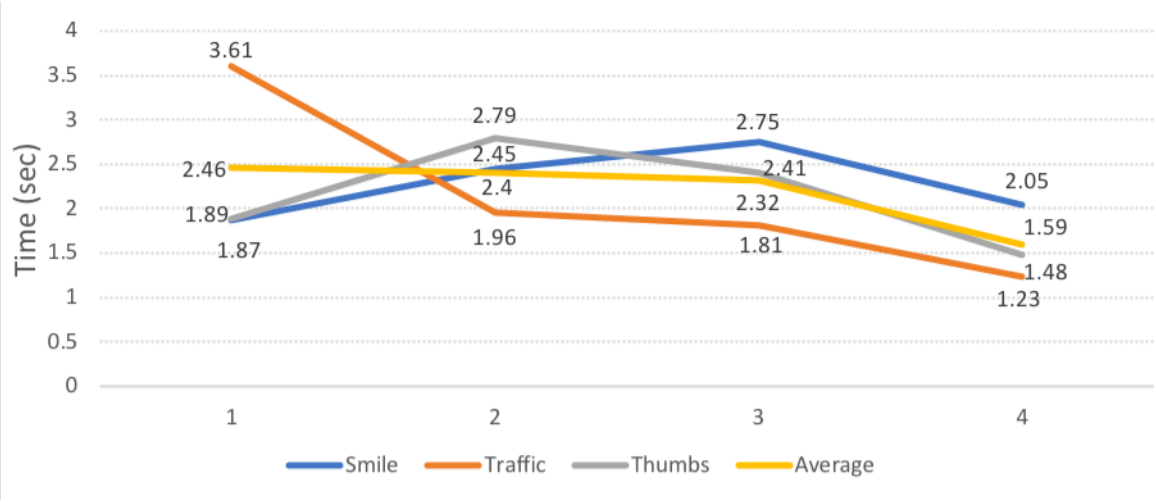

Figure 4.11: Line plot of the average time to first fixation by the number of red signs present on label 2 (L2)

The average time to first fixation is higher for the second label of the smile sign than for the whole product regardless the number of red signs (Table 4.14, Figure 4.12). Significant differences were found between product 2 and label 2 for the case of 4 red smiles.

Table 4.14: Average time to first fixation between product 2 (P2) and label (L2) by the number of red smiles [ns=not significant, *=significant, level=0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	1.32^{ns}	8	1.87^{ns}	1.60	0.38
2	7	1.54^{ns}	5	2.45^{ns}	1.99	0.65
3	8	1.74^{ns}	8	2.75^{ns}	2.24	0.71
4	8	0.76	4	2.05^{*}	1.40	0.91

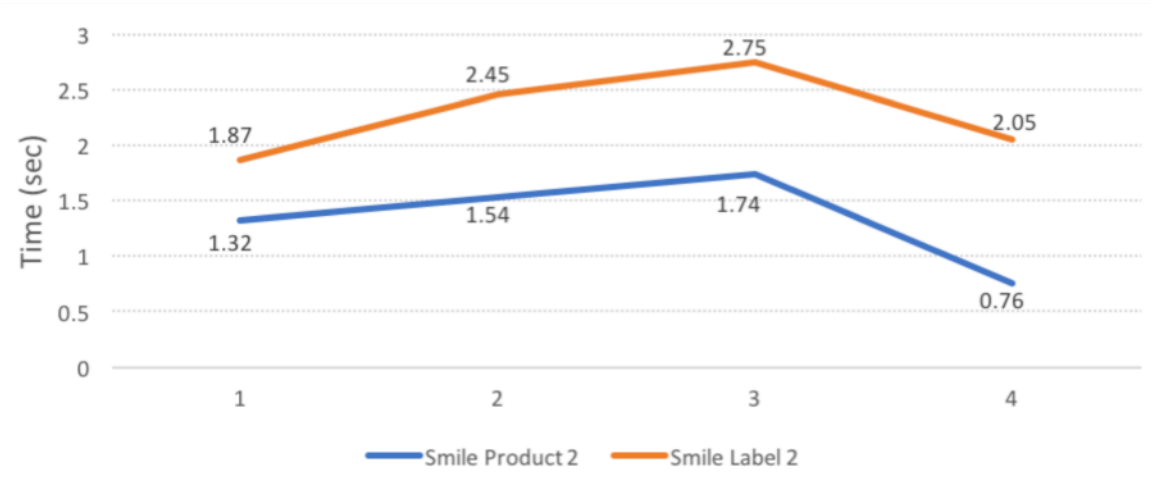

Figure 4.12: Line plot of the average time to first fixation in seconds between product 2 (P2) and label 2 (L2) by the number of red smiles

In the case of the traffic sign, the time to first fixation is lower for the second product when the label includes up to 3 red signs, and higher when it includes 4 red signs. It is also noted

that the time for label 2 (L2) with one red sign is higher than all the other times (Table 4.15, Figure 4.13). The traffic label with one red sign attracts gaze much slower than the label with more than 1 red signs and time to first fixation drops with the number of red signs, whereas time to first fixation of product 2 increases with the number of red signs. A significant difference was found for one red traffic between product 2 and label 2 mean values.

Table 4.15: Average time to first fixation in seconds between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level=0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Label 2	Avg.	STDEV
1	8	0.92	8	3.61*	2.27	1.90
2	7	1.36^{ns}	5	1.96^{ns}	1.66	0.42
3	8	1.39^{ns}	8	1.81^{ns}	1.60	0.30
4	8	1.55^{ns}	4	1.23^{ns}	1.39	0.22

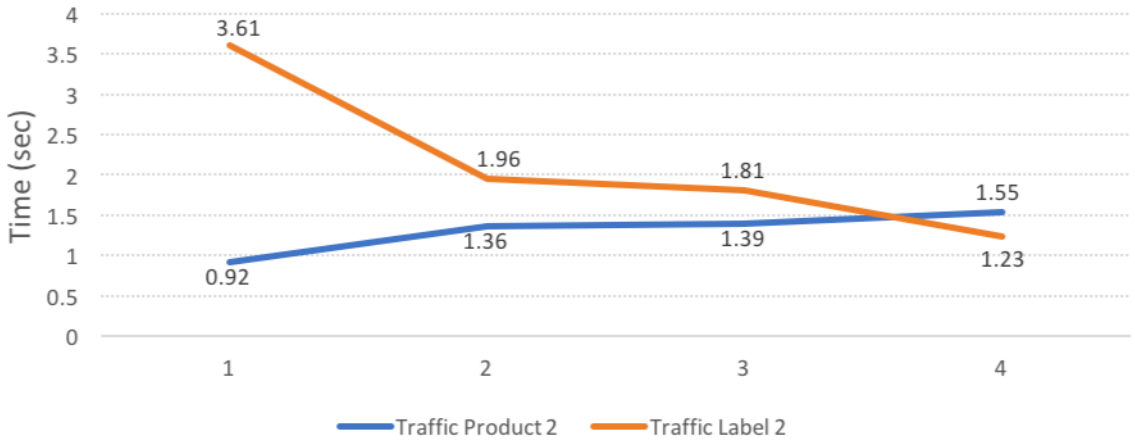

Figure 4.13: Line plot of the average time to first fixation between product 2 (P2) and label 2 (L2) by the number of red traffics

The average time to first fixation for the thumb sign presents results which are coherent to the smile test presented in Table 3.13. However, the peak is now observed for 2 red signs instead of 3 (Table 4.16, Figure 4.14). Finally, a significant difference was found in the case of 4 red thumbs between product 2 and label 2.

Table 4.16: Average time to first fixation in seconds between product 2 (P2) and label 2 (L2) by the number of red thumbs [ns=not significant, *=significant, level=0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	1.04^{ns}	7	1.89^{ns}	1.47	0.60
2	8	2.17^{ns}	8	2.79^{ns}	2.48	0.44
3	8	2.21^{ns}	8	2.41^{ns}	2.31	0.14
4	8	0.59	8	1.48^{*}	1.03	0.63

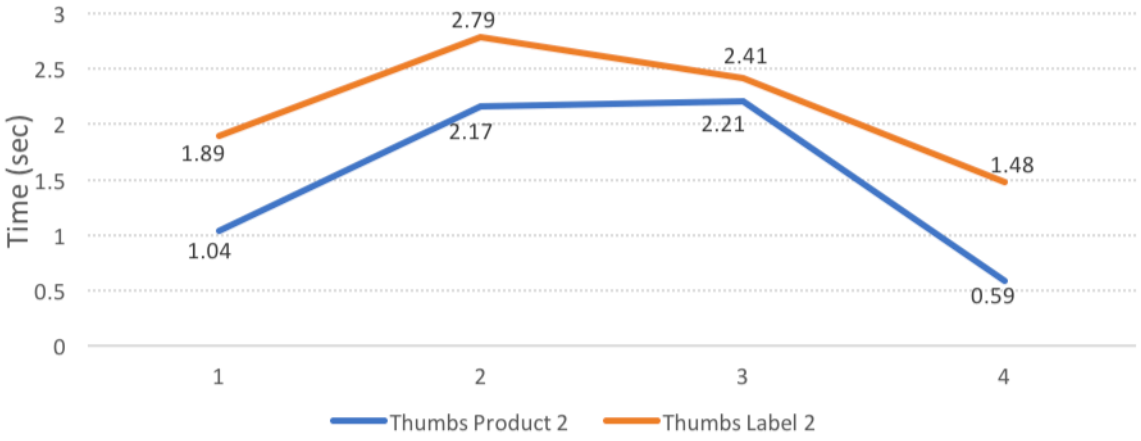

Figure 4.14: Line plot of the average time to first fixation between product 2 (P2) and label 2 (L2) by the number of red thumbs

4.2.1.2 Fixation Duration

The average time of fixation duration between product 1 and product 2 for each of the 16 tests are presented in Figure 4.15. It is observed that the average time of fixation duration for the first product was higher than the average time for the second product (except tests 1, 3 and 4) although the mean values were close to each other in nearly all cases, as Table 4.17 and Figure 4.15 reveal. Moreover, no significant differences were found between product 1 and product 2 mean values or for all tests mean (M1=0.30, M2=0.28).

Table 4.17: Average time of fixation duration in seconds between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Count Product 2	Product 1 Mean	Product 2 Mean	Product 1 STDEV	Product 2 STDEV
1	8	8	0.27^{ns}	0.28^{ns}	0.05	0.06
2	8	8	0.28^{ns}	0.25^{ns}	0.06	0.05
3	8	8	0.25^{ns}	0.28^{ns}	0.03	0.06
4	8	8	0.26^{ns}	0.28^{ns}	0.04	0.05
5	8	8	0.30^{ns}	0.26^{ns}	0.07	0.08
6	8	8	0.30^{ns}	0.28^{ns}	0.09	0.09
7	8	8	0.31^{ns}	0.27^{ns}	0.05	0.04
8	8	7	0.28^{ns}	0.28^{ns}	0.06	0.06
9	8	8	0.27^{ns}	0.24^{ns}	0.07	0.06
10	8	8	0.42^{ns}	0.37^{ns}	0.20	0.31
11	8	8	0.30^{ns}	0.25^{ns}	0.10	0.03
12	8	8	0.30^{ns}	0.26^{ns}	0.09	0.06
13	8	8	0.30^{ns}	0.27^{ns}	0.07	0.06
14	8	8	0.39^{ns}	0.29^{ns}	0.28	0.12

15	8	8	0.31^{ns}	0.30^{ns}	0.04	0.08
16	8	8	0.27^{ns}	0.27^{ns}	0.09	0.06
Test Avg.	16	16	0.30^{ns}	0.28^{ns}	0.09	0.08

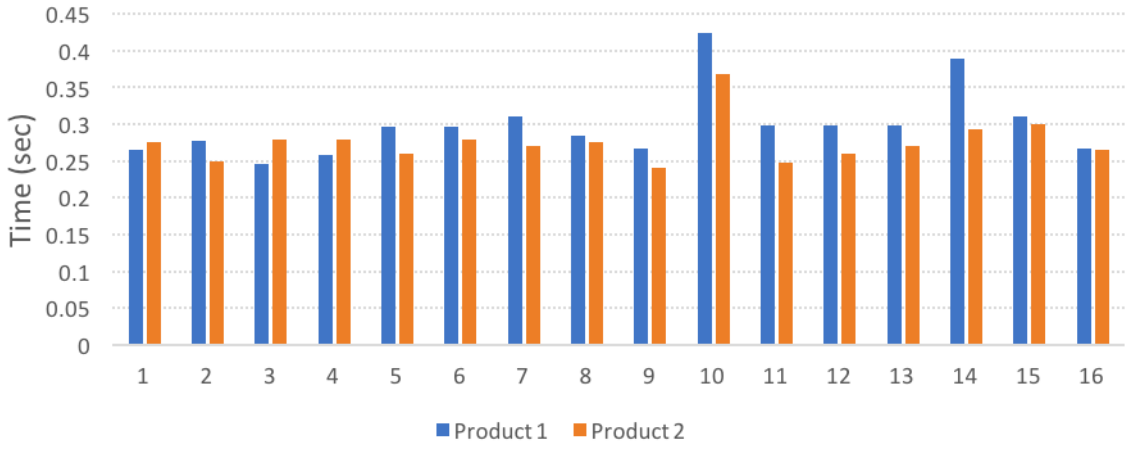

Figure 4.15: Average time of fixation duration between product 1 (P1) and product 2 (P2) in the same picture

A more detailed examination of the average time of fixation duration in seconds by the number of red signs present in product 2 (P2) and the label sign show coherent values in all categories (Table 4.18). Traffic sign deviates from all other signs after the number of 2 reds as it is presented in Figure 4.16. No significant differences were found between the smile, traffic and thumb mean values as well as separately for each of the 3 signs.

Table 4.18: Average time of fixation duration in seconds by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean Dif.	Traffic	Count	Mean Dif.	Thumb	Count	Mean Dif.	Avg.	STDEV
1	8	0.25	xx	0.27	8	xx	0.26	8	xx	0.26	0.28
2	8	0.28	xx	0.28	7	xx	0.27	8	xx	0.27	0.00
3	8	0.28	xx	0.24	8	xx	0.29	8	xx	0.27	0.03
4	8	0.26	xx	0.37	8	xx	0.30	8	xx	0.31	0.31
Test Avg.	4	0.27^{ns}		0.29^{ns}	4		0.28^{ns}	4			

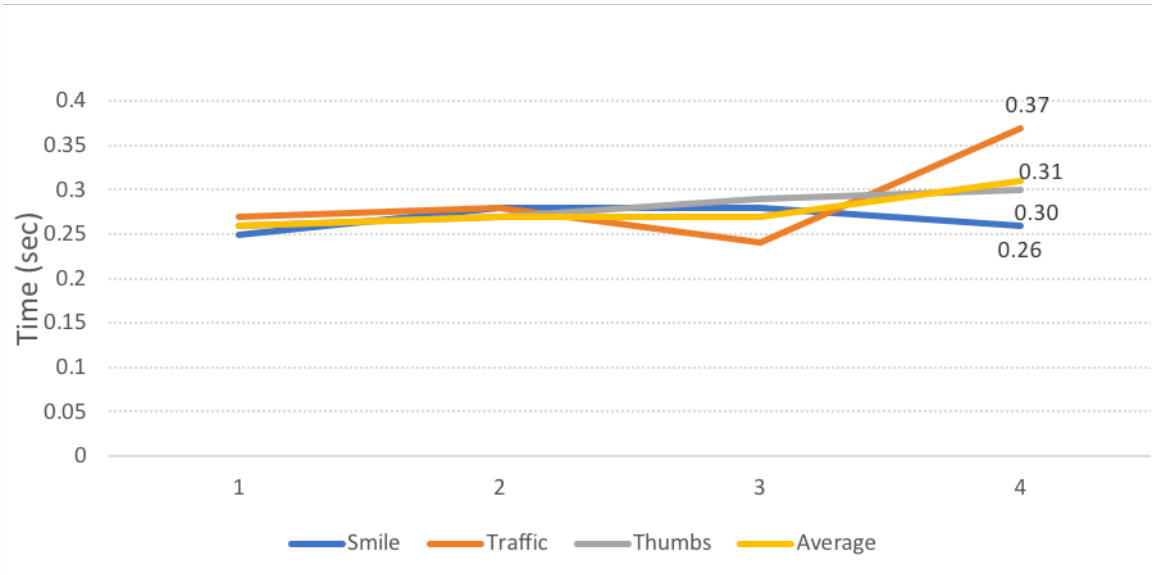

Figure 4.16: Line plot of average time of fixation duration by the number of red signs present on product 2 (P2)

Table 4.19 shows that for the label of the second product (P2) the average time of fixation duration values were generally coherent except from the case with 4 reds (Figure 4.17). Significant differences were found between 2 and 4 as well as between 3 and 4 red smiles. Moreover, in the case of the traffic sign, significant differences were noted between 3 and 4 red signs.

Table 4.19: Average time of fixation duration in seconds by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean Dif.	Traffic	Count	Mean Dif.	Count	Thumb	Mean Dif.	Avg.	STDEV
1	8	0.26	xx	0.31	8	xx	7	0.27	xx	0.28	0.01
2	7	0.32	x.	0.31	5	xx	8	0.30	xx	0.31	0.00
3	8	0.30	x.	0.28	8	x.	8	0.32	xx	0.30	0.03
4	7	0.23	.x	0.40	4	.x	8	0.37	xx	0.33	0.06
Test Avg.	4	0.28^{ns}		0.31^{ns}	4		4	0.32^{ns}			

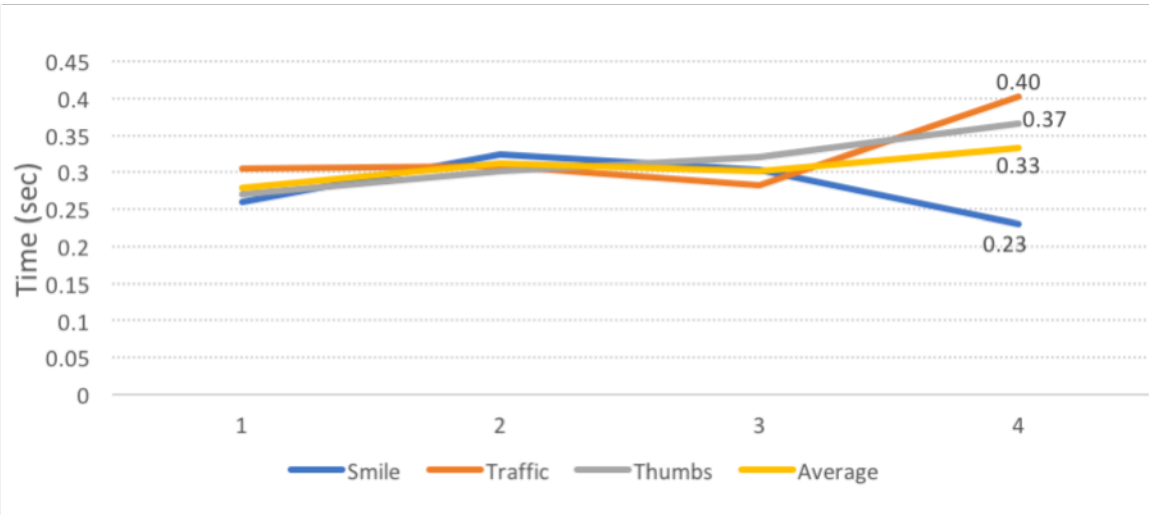

Figure 4.17: Line plot of the average time fixation duration by the number of red signs present on label 2 (L2)

The results of Table 4.20 and Figure 4.18 show that the average time values of fixation duration are close with a small deviation on the 4th red sign. No significant differences were found between product 2 and label 2 mean values.

Table 4.20: Average time of fixation duration in seconds between product 2 (P2) and label 2 (L2) by the number of red smiles [ns=not significant, *=significant, level=0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	0.25^{ns}	8	0.26^{ns}	0.26	0.01
2	8	0.28^{ns}	7	0.32^{ns}	0.30	0.03
3	8	0.28^{ns}	8	0.30^{ns}	0.29	0.02
4	8	0.26^{ns}	7	0.23^{ns}	0.24	0.02

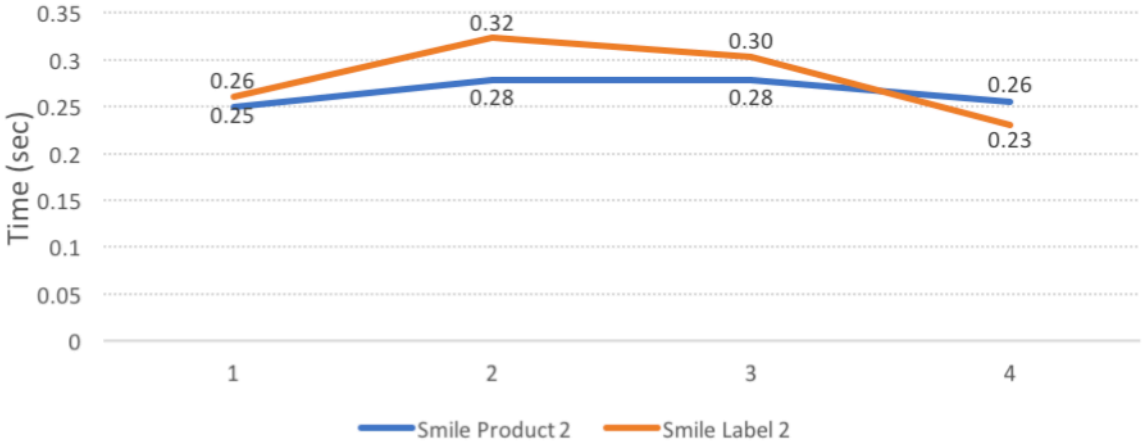

Figure 4.18: Line plot of the average time of fixation duration between product 2 (P2) and label 2 (L2) by the number of red signs

The average time values of fixation duration are close in both cases of product 2 and label 2 as it is revealed in Table 4.21 and Figure 4.19. No significant differences were found between product 2 and label 2 mean values.

Table 4.21: Average time of fixation duration in seconds between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level=0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Product 2	Avg.	STDEV
1	8	0.27^{ns}	8	0.31^{ns}	0.29	0.02
2	7	0.28^{ns}	5	0.31^{ns}	0.29	0.02
3	8	0.24^{ns}	8	0.28^{ns}	0.26	0.03
4	8	0.37^{ns}	4	0.40^{ns}	0.39	0.02

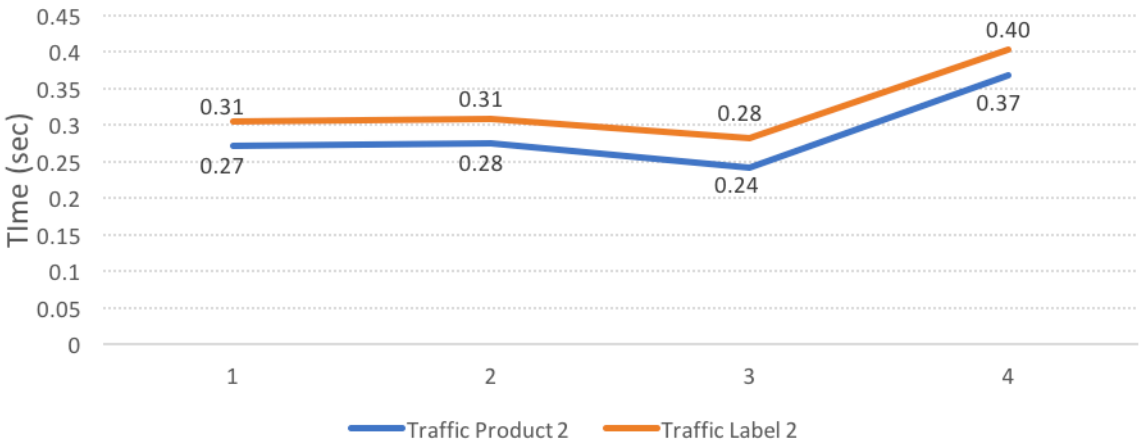

Figure 4.19: Line plot of the average time of fixation duration between product 2 (P2) and label 2 (L2) by the number of red traffics

The results of Table 4.22 and Figure 4.20 show that the average time of fixation duration of the thumb sign present on product 2 and label 2 behaves almost in the same way in both cases. Moreover, no significant differences were found between product 2 and label 2 mean values.

Table 4.22: Average time of fixation duration in seconds between product 2 (P2) and label 2 (L2) by the number of red thumbs [ns=not significant, *=significant, level=0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	0.26^{ns}	7	0.27^{ns}	0.27	0.01
2	8	0.27^{ns}	8	0.30^{ns}	0.29	0.02
3	8	0.29^{ns}	8	0.32^{ns}	0.31	0.02
4	8	0.30^{ns}	8	0.37^{ns}	0.33	0.05

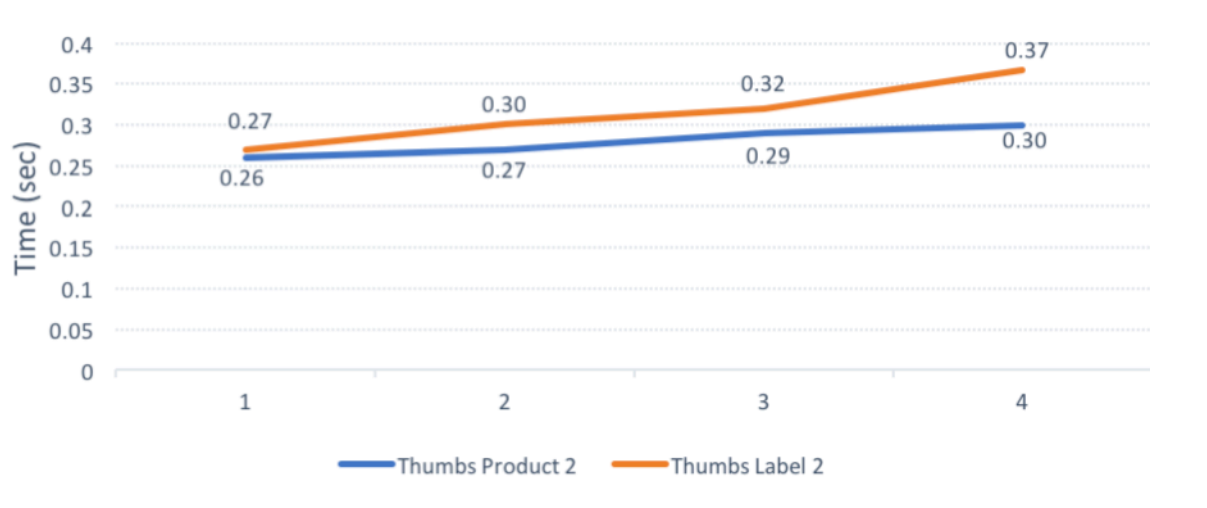

Figure 4.20: Line plot of the average time of fixation duration between product 2 (P2) and label 2 (L2) by the number of red thumbs

4.2.1.3 Total Fixation Duration

The data of the total fixation duration indicate that the average time of total fixation duration was higher for the first than for the second product, as presented in Table 4.23 and Figure 4.21. Significant differences were found for the mean values of all tests (M1=14.29, M2=10.12) and between product 1 and product 2 mean values of Test 11.

Table 4.23: Average time of total fixation duration in seconds between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Mean Product 1	Count Product 2	Mean Product 2	STDEV Product 1	STDEV Product 2
1	8	8.52^{ns}	8	6.32^{ns}	5.51	4.09
2	8	9.35^{ns}	8	5.97^{ns}	6.52	4.81
3	8	7.73^{ns}	8	5.41^{ns}	6.86	4.85
4	8	6.65^{ns}	8	4.30^{ns}	4.33	2.35
5	8	5.96^{ns}	8	3.98^{ns}	3.89	5.89
6	8	9.29^{ns}	8	4.49^{ns}	6.52	3.71
7	8	21.75^{ns}	7	14.99^{ns}	15.26	15.07
8	8	8.00^{ns}	8	4.45^{ns}	6.43	3.21
9	8	8.31^{ns}	8	4.73^{ns}	6.27	1.91
10	8	14.61^{ns}	8	7.49^{ns}	12.91	8.39
11	8	12.02*	8	6.58*	6.02	3.54
12	8	8.34^{ns}	8	7.35^{ns}	6.73	5.46
13	8	24.66^{ns}	8	15.25^{ns}	26.89	10.70
14	8	11.91^{ns}	8	10.09^{ns}	7.01	7.07
15	8	19.41^{ns}	8	12.53^{ns}	24.21	9.09
16	8	14.29^{*}	8	10.12^{*}	11.10	6.50

Test Avg.	16	11.92^{ns}	16	7.75^{ns}	9.77	6.04

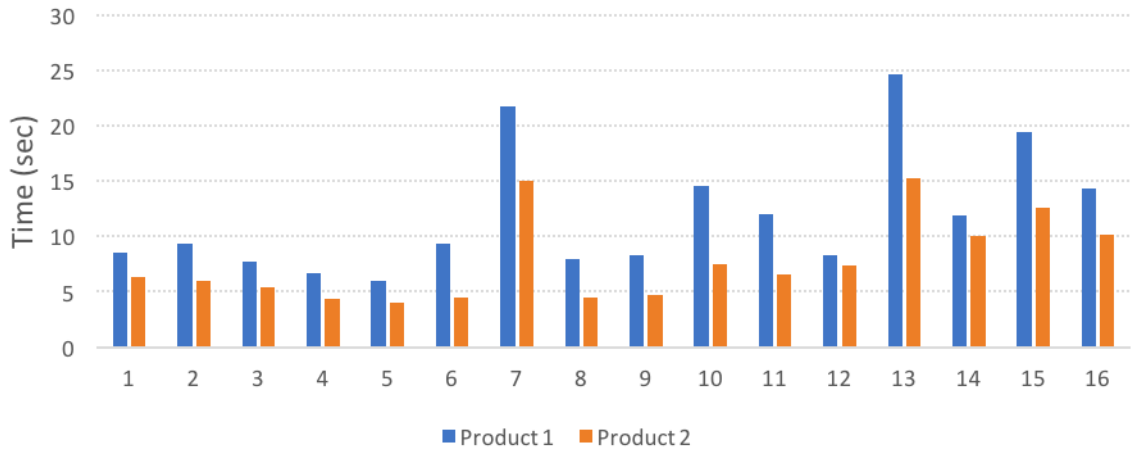

Figure 4.21: Average time of total fixation duration between product 1 (P1) and product 2 (P2) in the same picture

The investigation of the average time of total fixation duration by the number of red signs present on the second product (P2) indicate that the higher average value was found for 1 red sign (smile and traffic) or 2 red signs (thumbs) (Table 4.24). The results in Figure 4.22 also illustrate that all signs except from smile do not have a specific trend and they present lower values for 3 reds. More specifically, the smile sign presents a declining trend. Significant differences were found between 1 and 2 red as well as 1 and 3 red traffics. Moreover, significant differences were found between smile and thumb mean values.

Table 4.24: Average time of total fixation duration in seconds by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean Dif.	Count	Traffic	Mean Dif.	Count	Thumb	Mean Dif.	Avg.	STDEV
1	8	5.97	xx	8	14.99	x.	8	7.35	xx	9.44	4.86
2	8	5.41	xx	7	4.45	.x	8	15.25	xx	8.37	5.98
3	8	4.30	xx	8	4.73	.x	8	10.09	xx	6.37	3.23
4	8	3.98	xx	8	7.49	xx	8	12.53	xx	8.00	4.30
Test Avg.	4	4.91*		4	7.91^{ns}		4	11.30*			

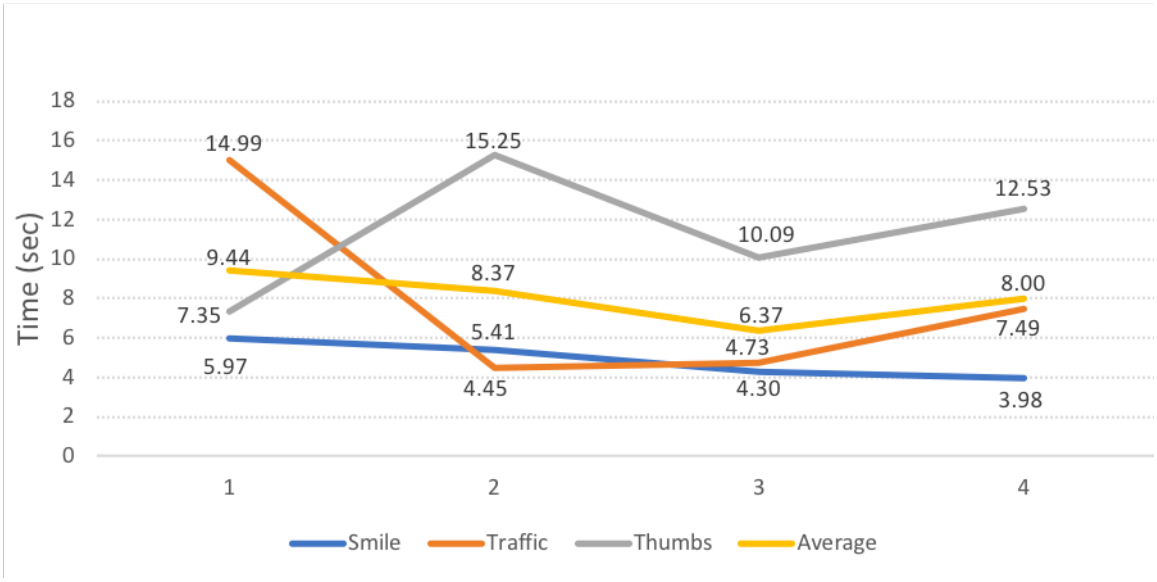

Figure 4.22: Line plot of average time of total fixation duration by the number of red signs present on product 2 (P2)

The results of Table 4.25 show that the average time of total fixation duration by the number of red signs on label 2, presents coherent values in all categories. Figure 4.23 also presents the deviations for all signs on the 4th red. Significant differences were found between smile and thumb mean values.

Table 4.25: Average time of total fixation duration in seconds by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	3.41	xx	8	5.79	xx	8	3.77	xx	4.32	1.28
2	8	3.74	xx	7	3.62	xx	8	8.28	xx	5.22	2.66
3	8	2.53	xx	8	2.19	xx	8	7.25	xx	3.99	2.83
4	8	1.31	xx	8	6.96	xx	8	7.65	xx	5.31	3.48
Test Avg.	4	2.75		4	4.64		4	6.74*			

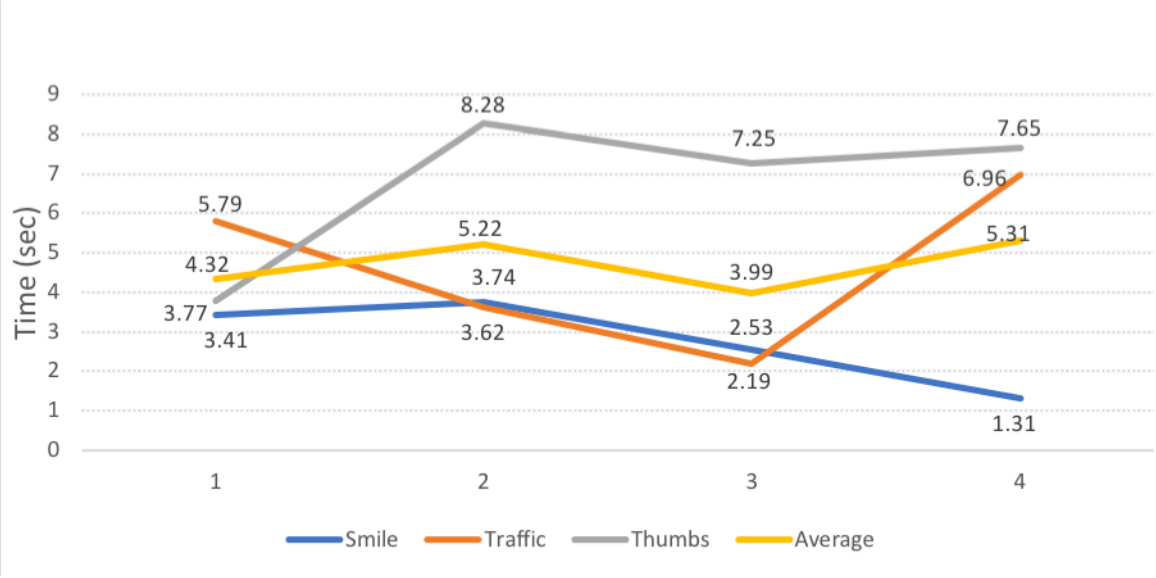

Figure 4.23: Line plot of the average time fixation duration by the number of red signs present on label 2 (L2)

The results of Table 4.26 and Figure 4.24 show that the average time of total fixation duration for smile sign presents a negative trend both for product 2 and label 2. No significant differences were found between product 2 and label 2 mean values.

Table 4.26: Average time of total fixation duration in seconds between product 2 (P2) and label 2 (L2) by the number of red smiles [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	5.97^{ns}	8	3.41^{ns}	4.69	1.81
2	8	5.41^{ns}	8	3.74^{ns}	4.57	1.18
3	8	4.30^{ns}	8	2.53^{ns}	3.42	1.25
4	8	3.98^{ns}	7	1.31^{ns}	2.64	1.89

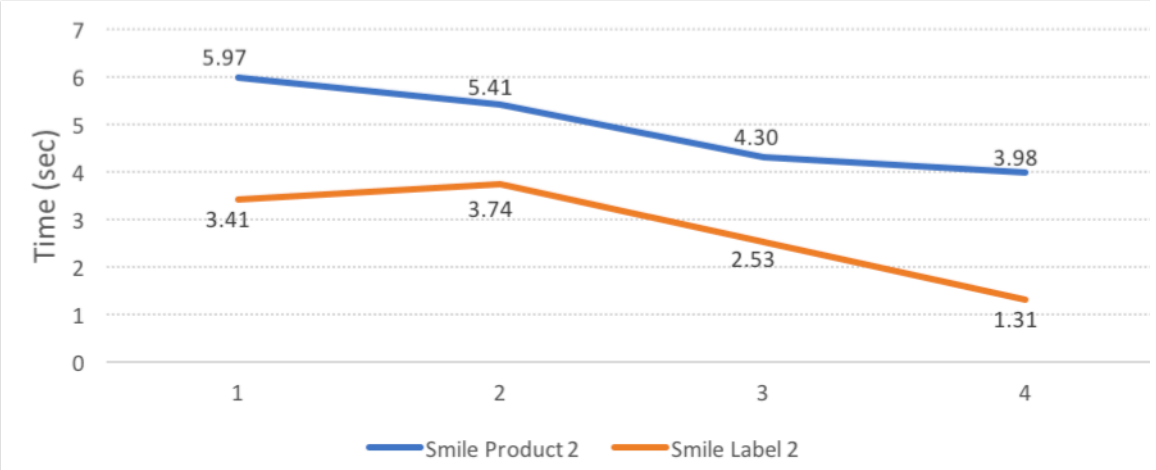

Figure 4.24: Line plot of the average time of fixation duration between product 2 (P2) and label 2 (L2) by the number of red smiles

The results of Table 4.27 and Figure 4.25 show that the average time of total fixation duration behaves in an elliptic curve for the traffic sign, reaching the top for 1 red on the second

product and 4 reds for the second label. Significant differences were found for 3 reds between product 2 and label 2.

Table 4.27: Average time of total fixation duration in seconds between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Label 2	Avg.	STDEV
1	8	14.99^{ns}	8	5.79^{ns}	10.39	6.50
2	7	4.45^{ns}	5	3.62^{ns}	4.04	0.59
3	8	4.73	8	2.19*	3.46	1.80
4	8	7.49^{ns}	4	6.96^{ns}	7.22	0.37

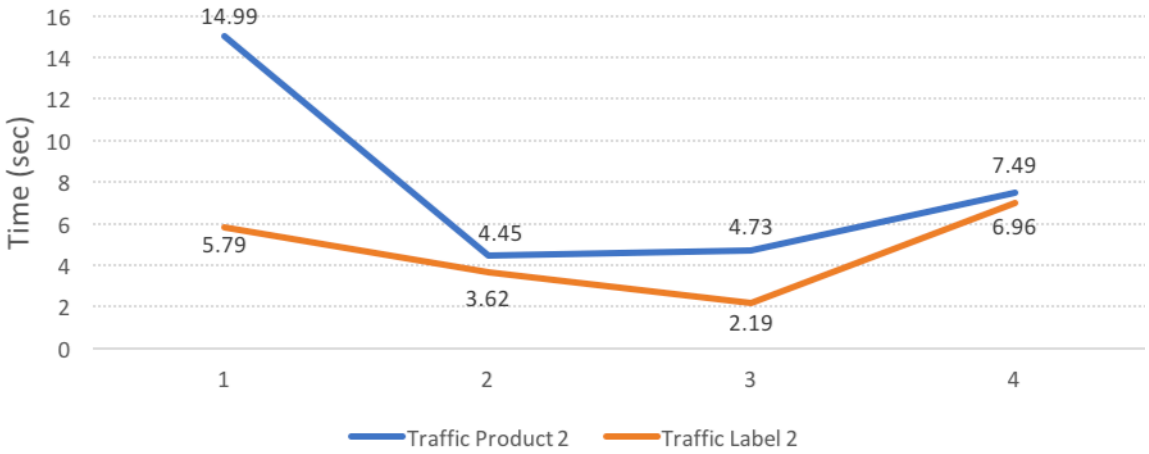

Figure 4.25: Line plot of the average time of total fixation duration between product 2 (P2) and label 2 (L2) by the number of red traffics

The results of Table 4.28 and Figure 4.26 show that the average time of total fixation duration of thumb sign has a coherent behaviour in both cases of product 2 and label 2. No significant differences were found between product 2 and label 2.

Table 4.28: Average time of total fixation duration in seconds between product 2 (P2) and label 2 (L2) by the number of red thumbs [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	7.35^{ns}	7	3.77^{ns}	5.56	2.53
2	8	15.25^{ns}	8	8.28^{ns}	11.77	4.93
3	8	10.09^{ns}	8	7.25^{ns}	8.67	2.01
4	8	12.53^{ns}	8	7.65^{ns}	10.09	3.44

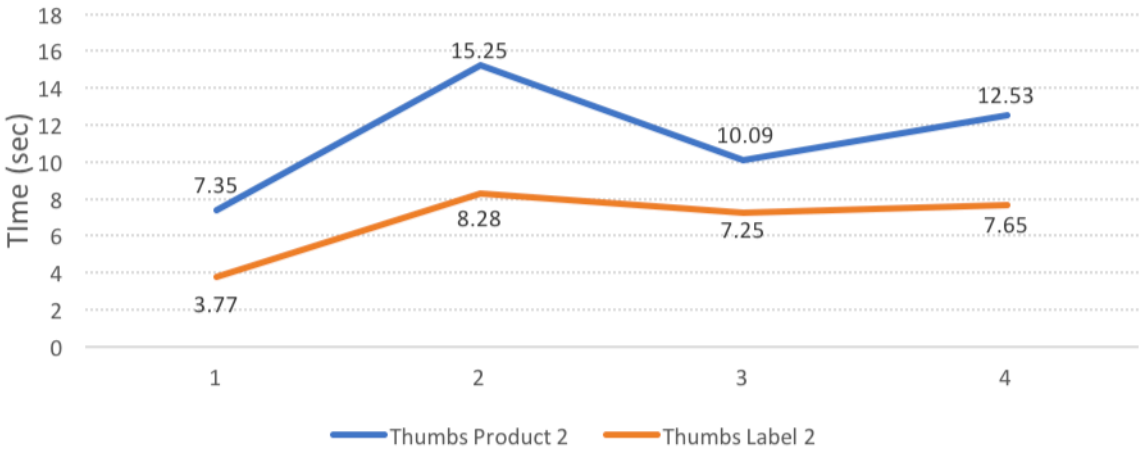

Figure 4.26: Line plot of the average time of total fixation duration between product 2 (P2) and label 2 (L2) by the number of red thumbs

4.2.1.4 Fixation Count

The results of fixation count show that in all tests the average count for the first product was greater than the corresponding time for the second product (Table 4.29, Figure 4.27). No significant differences were found between product 1 and product 2 mean values. However, there is a significant difference between the mean values of all tests for product 1 and product 2 (M1=39.83, M2=27.66).

Table 4.29: Average fixation count between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Count Product 2	Product 1 Mean	Product 2 Mean	STDEV Product 1	STDEV Product 2
1	8	8	31.13^{ns}	21.88^{ns}	18.23	11.85
2	8	8	33.50^{ns}	23.25^{ns}	23.46	19.09
3	8	8	32.75^{ns}	17.88^{ns}	30.54	13.42
4	8	8	24.75^{ns}	15.50^{ns}	14.32	8.19
5	8	8	20.13^{ns}	13.75^{ns}	12.15	16.03
6	8	8	31.63^{ns}	14.88^{ns}	21.41	6.40
7	8	8	67.25^{ns}	52.00^{ns}	45.12	43.68
8	8	7	30.25^{ns}	16.86^{ns}	26.93	12.02
9	8	8	30.00^{ns}	20.00^{ns}	18.62	6.19
10	8	8	43.75^{ns}	24.50^{ns}	43.09	25.86
11	8	8	40.63^{ns}	26.13^{ns}	18.85	13.80
12	8	8	25.88^{ns}	26.88^{ns}	19.49	17.69
13	8	8	73.75^{ns}	54.00^{ns}	74.80	39.43
14	8	8	36.75^{ns}	36.25^{ns}	22.22	20.84

15	8	8	66.25^{ns}	40.88^{ns}	88.19	23.04
16	8	8	48.88^{ns}	38.00^{ns}	36.92	2.76
Test Avg.	16	16	39.83*	27.66*	32.15	17.52

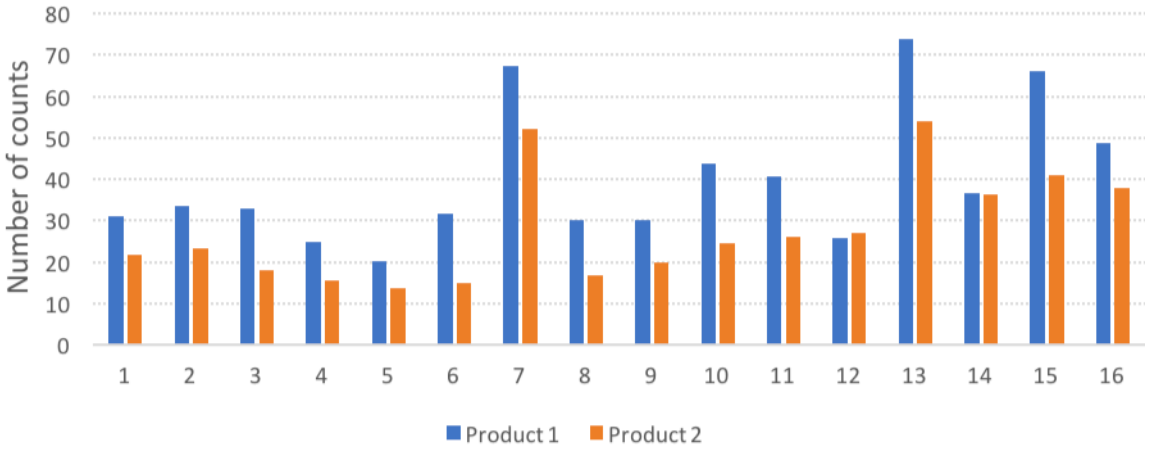

Figure 4.27: Average fixation count between product 1 (P1) and product 2 (P2) in the same picture

Table 4.30 and Figure 4.28 show that the higher average value for the three signs was observed in the case of one red sign. The smile sign is following a declining trend while the other signs do not present a specific trend. Significant differences were found between 1 and 2, 1 and 3, as well as 1 and 4 red traffics and between smile and thumb mean values.

Table 4.30: Average fixation count by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	23.25	xx	8	52.00	x.	8	26.88	xx	34.04	15.66
2	8	17.88	xx	7	16.86	.x	8	54.00	xx	29.58	21.16
3	8	15.50	xx	8	20.00	.x	8	36.25	xx	23.92	10.92
4	8	13.75	xx	8	24.50	.x	8	40.88	xx	26.38	13.66
Test Avg.	4	17.60*		4	28.34		4	39.50*			

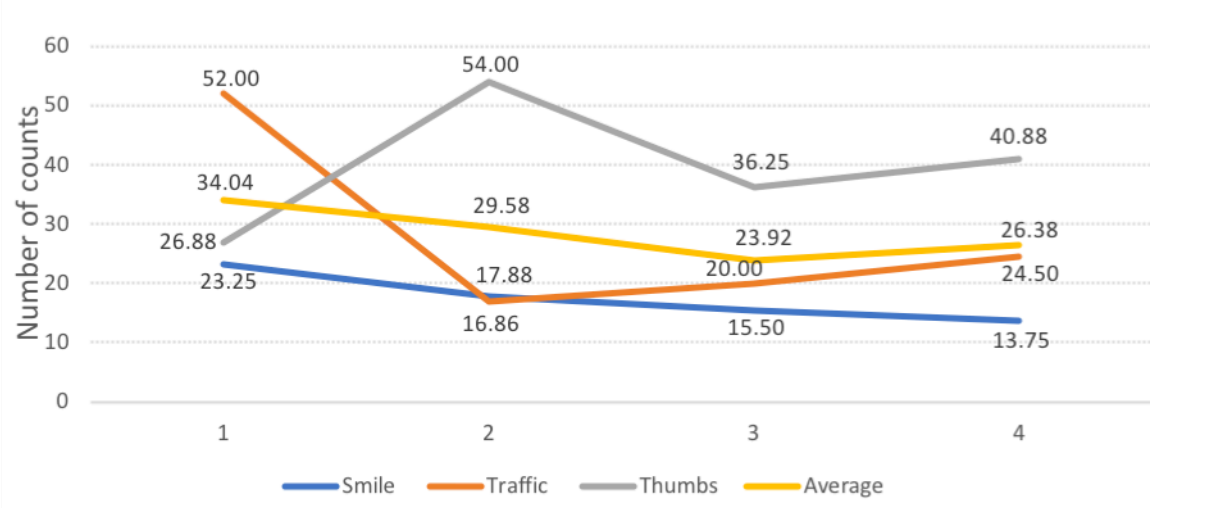

Figure 4.28: Line plot of average fixation count by the number of red signs present on product 2 (P2)

The results of Table 4.31 show that the higher average value was found in the case of 2 red signs as well as all categories except smile do not follow a specific trend (Figure 4.29). The smile sign is following a declining trend. Significant differences were found between smile and thumb mean values but not between each sign separately.

Table 4.31: Average fixation count by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	12.13	xx	8	17.25	xx	7	13.00	xx	14.13	2.74
2	7	10.57	xx	5	11.80	xx	8	25.00	xx	15.79	8.00
3	8	8.25	xx	8	9.13	xx	8	23.63	xx	13.67	8.64
4	8	5.29	xx	4	18.25	xx	8	19.25	xx	14.26	7.79
Test Avg.	4	9.06*		4	14.10		4	20.22*			

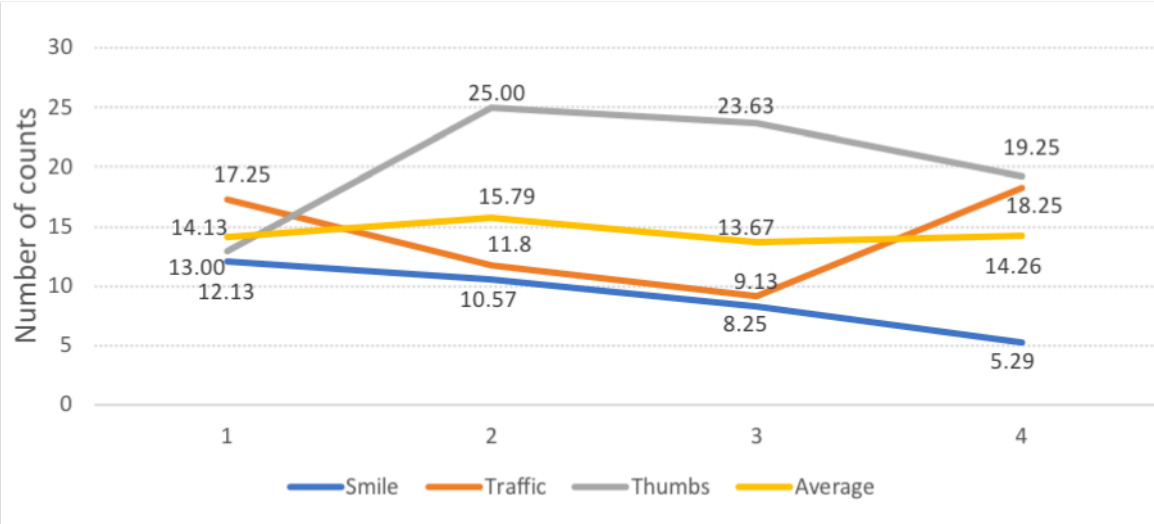

Figure 4.29: Line plot of the average fixation count by the number of red signs present on label 2 (L2)

The average fixation count results show a declining trend between product 2 (P2) and label 2 (L2) by the number of red smiles, as it is presented in Table 4.32 and Figure 4.30. No significant differences were found between product 2 and label 2 mean values.

Table 4.32: Average fixation count between product 2 (P2) and label 2 (L2) by the number of red smiles [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	23.25^{ns}	8	12.13^{ns}	17.69	7.87
2	8	17.88^{ns}	7	10.57^{ns}	14.22	5.16
3	8	15.50^{ns}	8	8.25^{ns}	11.88	5.13
4	8	13.75^{ns}	8	5.29^{ns}	9.52	5.99

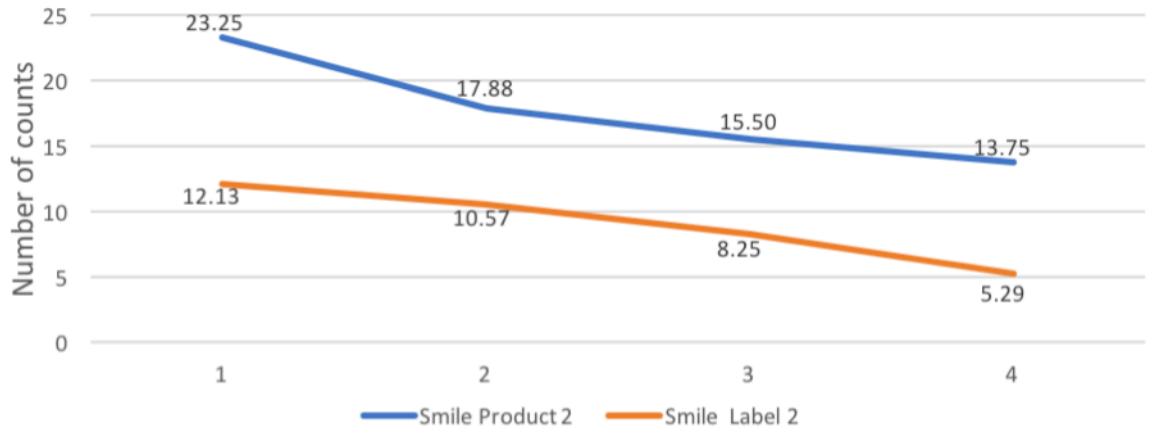

Figure 4.30: Line plot of the average fixation count between product 2 (P2) and label 2 (L2) by the number of red smiles

The results of Table 4.33 and Figure 4.31 show that the highest average fixation count of traffic sign was found for product 2 (P2) with 1 red sign, presenting a deviation from all the

other values. Significant differences were found for 3 red traffics between product 2 and label 2 mean values.

Table 4.33: Average fixation count between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Label 2	Avg.	STDEV
1	8	52.00^{ns}	8	17.25^{ns}	35	25
2	7	16.86^{ns}	5	11.80^{ns}	14	4
3	8	20.00*	8	9.13*	15	8
4	8	24.50^{ns}	4	18.25^{ns}	21	4

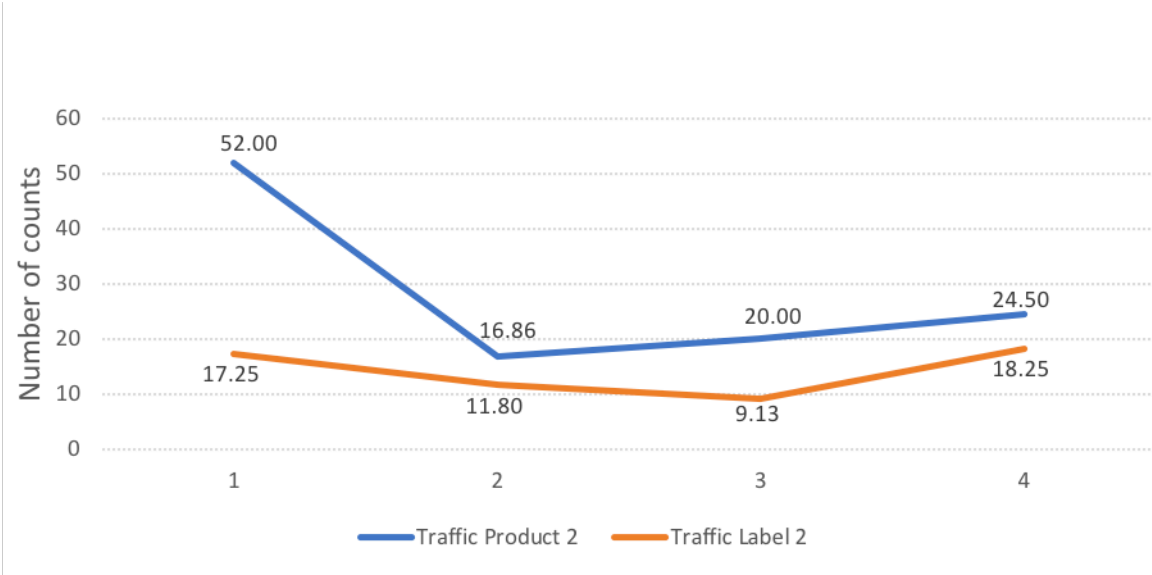

Figure 4.31: Line plot of the average fixation count between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level 0.05]

The results of Table 4.34 and Figure 4.32 show that the average fixation count of thumb sign behaves almost the same in both cases of product 2 and label 2, except from the case of 4 red signs. Significant differences were found in the aforementioned case between product 2 and label 2 mean values.

Table 4.34: Average fixation count between product 2 (P2) and label 2 (L2) by the number of red thumbs [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	26.88^{ns}	7	13.00^{ns}	19.94	9.81
2	8	54.00^{ns}	8	25.00^{ns}	39.50	20.51
3	8	36.25^{ns}	8	23.63^{ns}	29.94	8.93
4	8	40.88*	8	19.25*	30.96	15.29

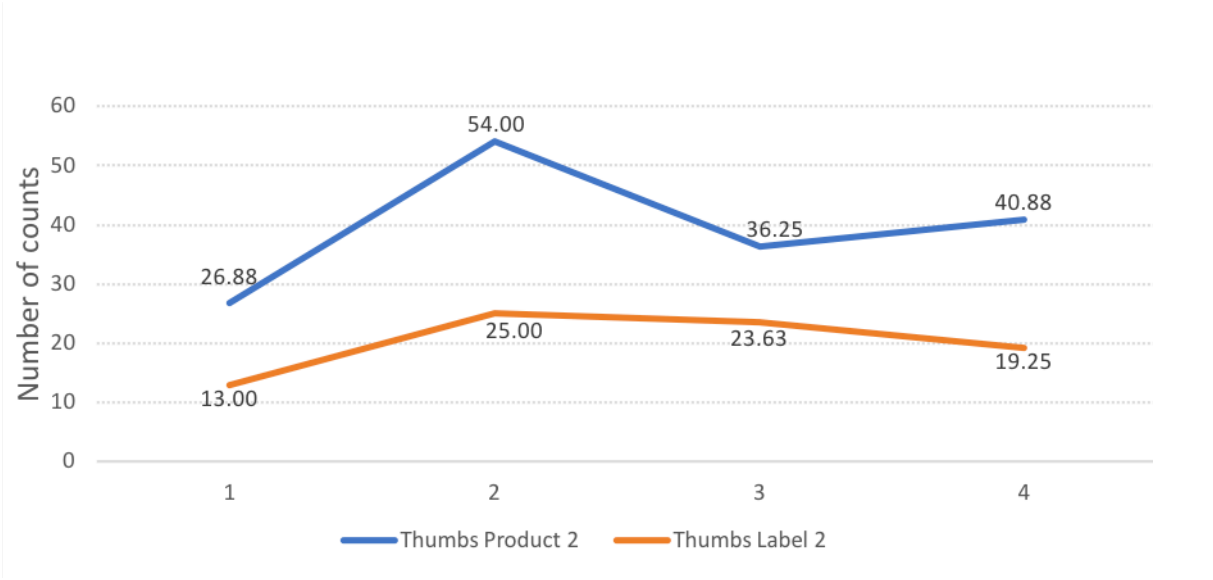

Figure 4.32: Line plot of the average fixation count between product 2 (P2) and label 2 (L2) by the number of red thumbs

4.2.1.5 Visit Duration

The data of visit duration indicate that in most of the tests, the average time of this parameter Fiwas higher for the first than for the second product (P1>P2), as presented in Table 4.35 and Figure 4.33. The results in Table 4.35 show that there is a significant difference between product 1 and product 2 mean value of all the tests (M1=1.52, M2=1.11). Moreover, significant differences were found between P1 and P2 mean values for tests 2 and 10 at level 0.05.

Table 4.35: Average time of visit duration in seconds between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Count Product 2	Product 1 Mean	Product 2 Mean	STDEV Product 1	STDEV Product 2
1	8	8	1.24^{ns}	0.95^{ns}	0.64	0.30
2	8	8	1.31*	0.85*	0.44	0.42
3	8	8	1.41^{ns}	1.15^{ns}	0.49	0.87
4	8	8	1.28^{ns}	1.23^{ns}	0.46	0.45
5	8	8	2.11^{ns}	0.82^{ns}	2.47	0.34
6	8	8	1.60^{ns}	0.87^{ns}	1.02	0.29
7	8	8	1.45^{ns}	0.99^{ns}	0.64	0.41
8	8	7	1.30^{ns}	0.89^{ns}	0.45	0.43
9	8	8	1.39^{ns}	1.09^{ns}	0.71	0.47
10	8	8	1.95*	1.05*	0.79	0.80
11	8	8	1.92^{ns}	1.07^{ns}	1.81	0.59
12	8	8	1.04^{ns}	1.06^{ns}	0.41	0.38
13	8	8	1.61^{ns}	1.26^{ns}	0.80	0.66
14	8	8	1.80^{ns}	1.71^{ns}	0.80	0.74

15	8	8	1.69^{ns}	1.56^{ns}	1.07	1.13
16	8	8	1.24^{ns}	1.27^{ns}	0.42	0.87
Test Avg.	16	16	1.52*	1.11*	0.83	0.57

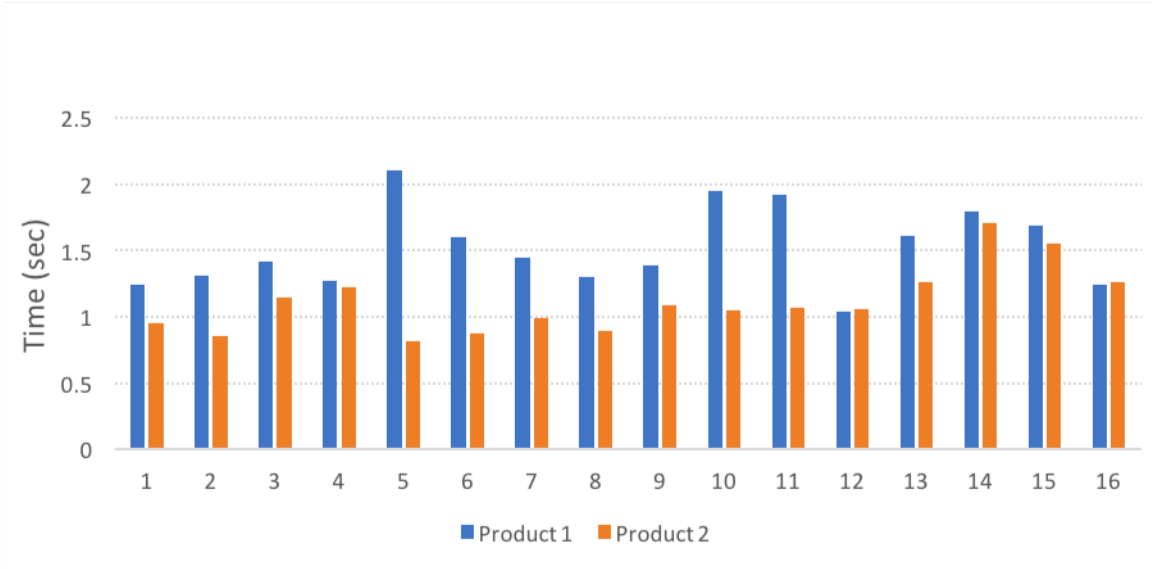

Figure 4.33: Average time of visit duration between product 1 (P1) and product 2 (P2) in the same picture

The average time of visit duration by the number of red signs present on product 2 presents coherent behaviour in all cases as indicated in Table 4.36 and Figure 4.34. More specifically, visit duration increases from 1 to 3 red signs and drops on the 4th sign. Significant differences were found between smile-thumb and traffic-thumb mean values.

Table 4.36: Average time of visit duration in seconds by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	0.85	xx	8	0.99	xx	8	1.06	xx	0.97	0.11
2	8	1.15	xx	7	0.89	xx	8	1.26	xx	1.10	0.19
3	8	1.23	xx	8	1.09	xx	8	1.71	xx	1.34	0.38
4	8	0.82	xx	8	1.05	xx	8	1.56	xx	1.14	0.38
Test Avg.	4	1.01*		4	1.01*		4	1.40*			

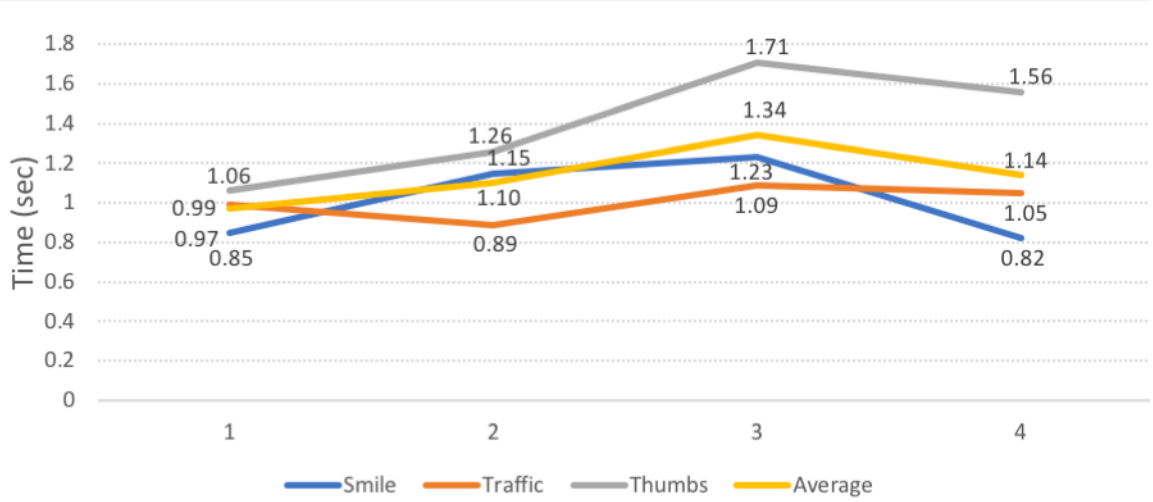

Figure 4.34: Line plot of average time of visit duration by the number of red signs present on product 2 (P2)

The results of visit duration by the number of red signs present on label 2 show that there is an increase on values from 1 to 3 red signs and a decrease on fourth red in the case of smile and thumb sign. (Table 4.37, Figure 4.35). Significant differences were found between 1 and 3 red thumbs. No significant differences were found between smile, thumb and traffic mean values or for the average values between the 3 signs.

Table 4.37: Average time of visit duration by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Count	Mean dif.	Traffic	Count	Mean dif.	Thumb	Mean dif.	Avg.	STDEV
1	8	0.60	8	xx	0.62	7	xx	0.66	x.	0.63	0.18
2	7	1.00	5	xx	0.87	8	xx	0.94	xx	0.94	0.17
3	8	1.10	8	xx	0.76	8	xx	1.25	.x	1.03	0.25
4	7	0.56	4	xx	0.89	7	xx	1.10	xx	0.85	0.19
Test Avg.	4	0.81^{ns}	4		0.79^{ns}	4		0.99^{ns}			

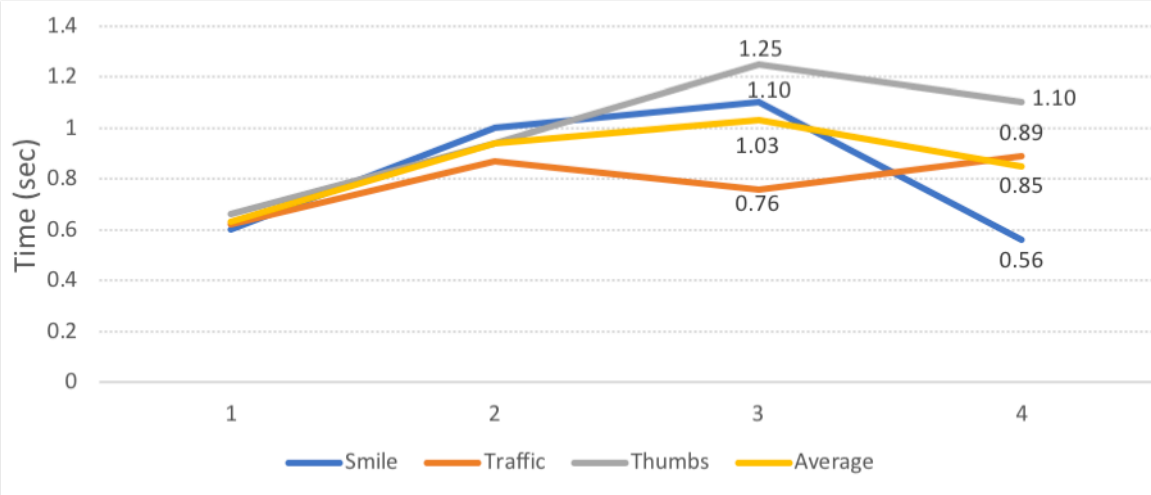

Figure 4.35: Line plot of the average time of visit duration by the number of red signs present on label 2 (L2)

The results of Table 4.38 and Figure 4.36 show that the average time of visit duration have coherent behaviour between product 2 (P2) and label 2 (L2). More specifically, the values are increasing from 1 to 3 red signs and decreasing on the 4th red sign in both cases. No significant differences were found between product 2 and label 2 mean values.

Table 4.38: Average time of visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red smiles [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	0.85^{ns}	8	0.60^{ns}	0.72	0.18
2	8	1.15^{ns}	7	1.00^{ns}	1.07	0.11
3	8	1.23^{ns}	8	1.10^{ns}	1.16	0.09
4	8	0.82^{ns}	7	0.56^{ns}	0.69	0.18

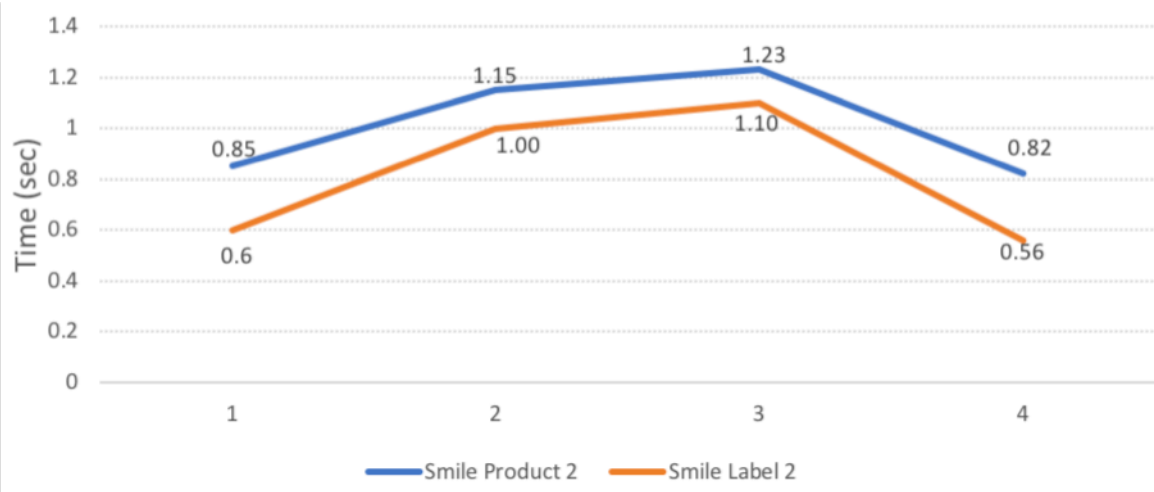

Figure 4.36: Line plot of the average time of visit duration between product 2 (P2) and label 2 (L2) by the number of red smiles

Table 4.39 and Figure 4.37 show that the average visit duration between product 2 and label 2 traffic sign shows a reverse behaviour in both cases. This means that the visit duration of

product 2 decreases from 1 to 2 red signs, increases from 2 to 3 red signs and decreases on the 4th sign. The visit duration of label 2 increases from 1 to 2 red signs, decreases from 2 to 3 red signs and increases on the 4th sign. No significant differences were found between product 2 and label 2 mean values.

Table 4.39: Average time of visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Label 2	Avg.	STDEV
1	8	0.99^{ns}	8	0.62^{ns}	0.81	0.26
2	8	0.89^{ns}	5	0.87^{ns}	0.88	0.02
3	8	1.09^{ns}	8	0.76^{ns}	0.93	0.24
4	8	1.05^{ns}	4	0.89^{ns}	0.97	0.11

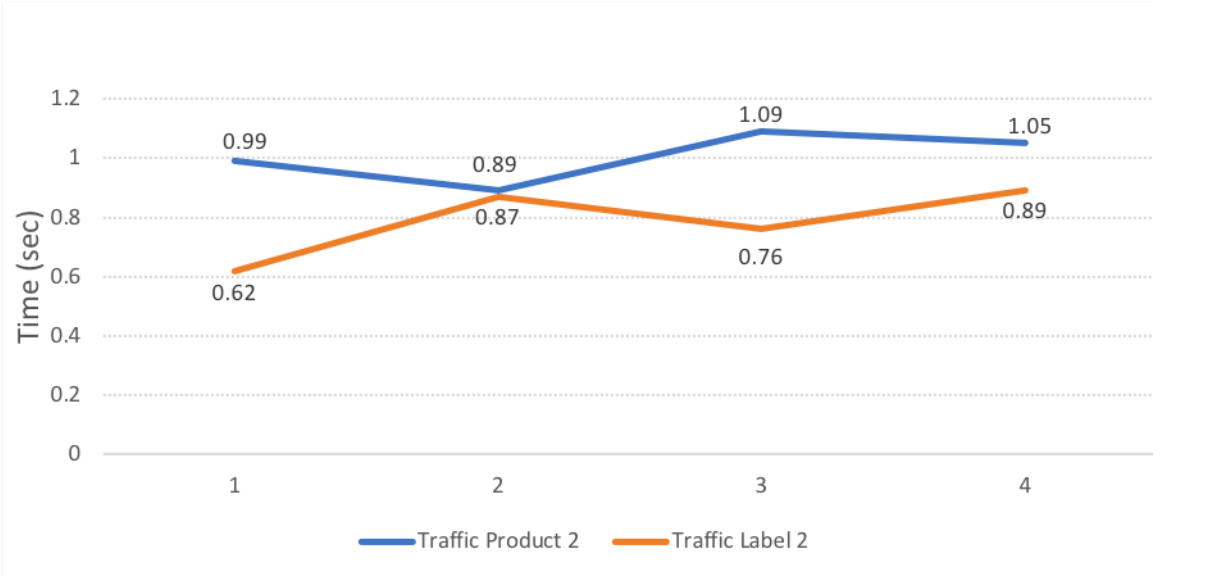

Figure 4.37: Line plot of the average time of visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red traffics

Additionally, Table 4.40 and Figure 4.38 show that the average time of visit duration behaves identically in both cases (P2 and L2) of thumb sign following a small positive trend. More specifically, the values of product 2 and label 2 are increasing from 1 to 3 red signs and decreasing on the 4th sign. No significant differences were found between product 2 and label 2 mean values.

Table 4.40: Average time of visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red thumbs [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	1.06^{ns}	7	0.66^{ns}	0.86	0.28
2	8	1.26^{ns}	8	0.94^{ns}	1.10	0.22
3	8	1.71^{ns}	8	1.25^{ns}	1.48	0.33
4	8	1.56^{ns}	7	1.10^{ns}	1.33	0.32

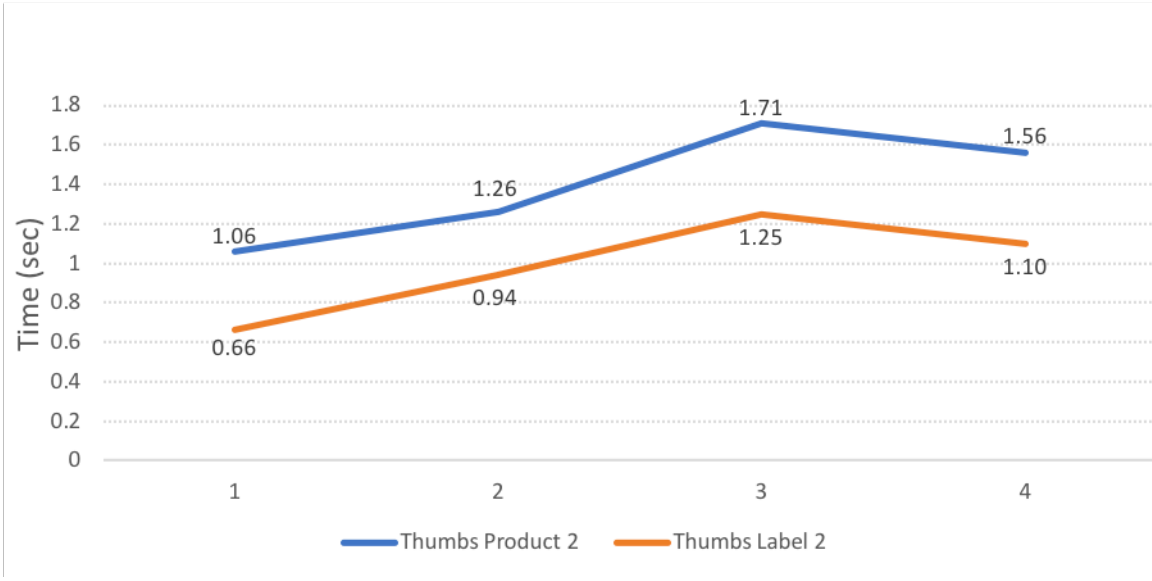

Figure 4.38: Line plot of the average time of visit duration between product 2 (P2) and label 2 (L2) by the number of red thumbs

4.2.1.6 Total Visit Duration

The data of the average total visit duration presented in Table 4.41 and Figure 4.39, show that in all tests the values for the first product were greater than the corresponding ones for the second product. No significant differences were found between product 1 and product 2 mean values of the 16 tests. However, significant differences were found between the mean values for product 1 and product 2 of all tests (M1=13.62, M2=8.62).

Table 4.41: Average time of total visit duration in seconds between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Count Product 2	Mean Product 1	Mean Product 2	STDEV Product 1	STDEV Product 2
1	8	8	9.54^{ns}	6.86^{ns}	6.03	4.31
2	8	8	10.49^{ns}	6.72^{ns}	7.06	5.58
3	8	8	9.21^{ns}	6.10^{ns}	8.85	5.55
4	8	8	7.48^{ns}	4.74^{ns}	4.87	2.48
5	8	8	6.99^{ns}	4.57^{ns}	4.72	6.90
6	8	8	10.26^{ns}	4.96^{ns}	7.13	4.11
7	8	8	24.29^{ns}	16.41^{ns}	17.44	16.41
8	8	7	10.30^{ns}	5.05^{ns}	8.74	3.46
9	8	8	9.31^{ns}	5.75^{ns}	6.65	2.00
10	8	8	16.34^{ns}	8.17^{ns}	14.61	9.23
11	8	8	13.82^{ns}	8.55^{ns}	6.85	5.63
12	8	8	9.16^{ns}	8.39^{ns}	7.49	6.30
13	8	8	27.93^{ns}	17.29^{ns}	31.32	12.55
14	8	8	13.39^{ns}	12.17^{ns}	7.81	7.78

15	8	8	23.41^{ns}	14.18^{ns}	31.86	9.77
16	8	8	16.15^{ns}	11.28^{ns}	12.46	6.92
Test Avg.	16	16	13.62*	8.62*	11.49	6.81

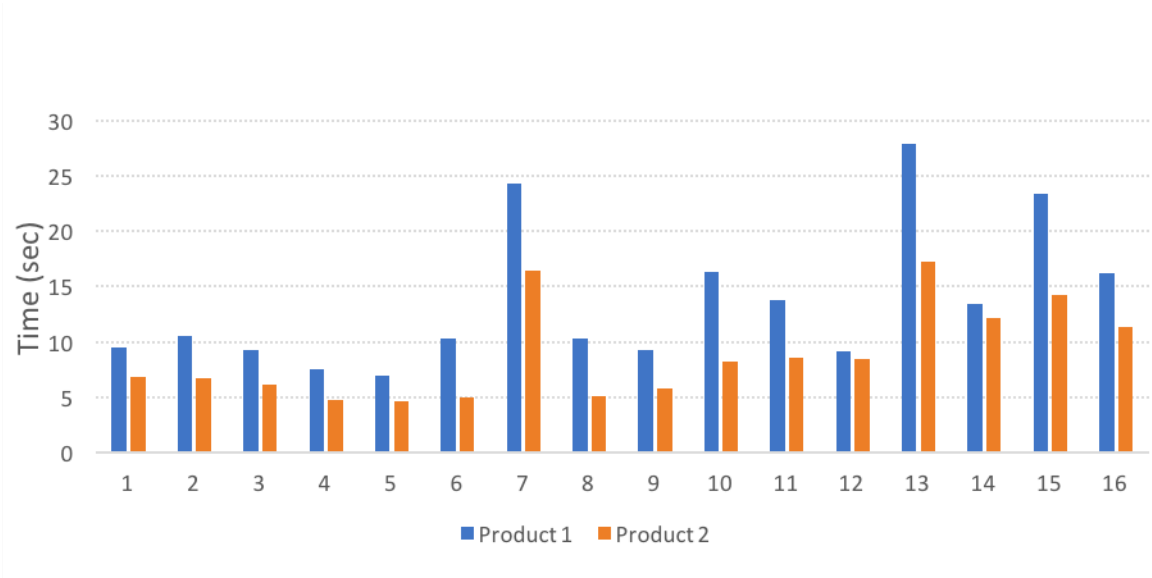

Figure 4.39: Average time of total visit duration between product 1 (P1) and product 2 (P2) in the same picture

The investigation of the average time of total visit duration by the number of red signs present on the second product (P2) indicates that the higher average value was found for one red sign (Table 4.42). The results presented in Figure 4.40 also show that all signs except from the smile do not illustrate a specific trend. The smile sign is following a declining trend. Significant differences were found between 1 and 4 red traffics and between smile and thumb mean values.

Table 4.42: Average time of total visit duration in seconds by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	6.72	xx	8	16.41	x.	8	8.39	xx	10.51	5.18
2	8	6.10	xx	7	5.05	.x	8	17.29	xx	9.48	6.78
3	8	4.74	xx	8	5.75	.x	8	12.17	xx	7.55	4.03
4	8	4.57	xx	8	8.17	xx	8	14.18	xx	8.97	4.86
Test Avg.	4	5.53*		4	8.85		4	13.01*			

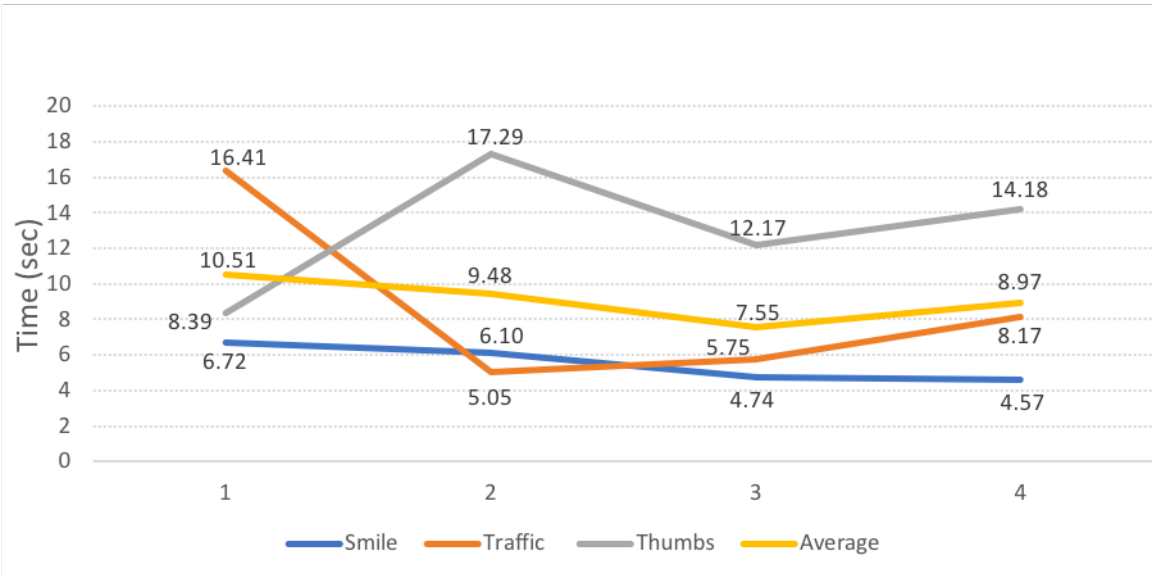

Figure 4.40: Line plot of average time of total visit duration by the number of red signs present on product 2 (P2)

The results of the average time of visit duration by the number of red signs present on label 2, do not reveal any specific trend, as indicated in Table 4.43 and Figure 4.41. Significant differences were found between smile and thumb mean values.

Table 4.43: Average time of total visit duration in seconds by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Traffic	Count	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	3.64	xx	6.02	8	xx	8	4.10	xx	4.59	1.26
2	8	4.13	xx	3.91	7	xx	8	8.82	xx	5.62	2.77
3	8	2.73	xx	2.62	8	xx	8	8.37	xx	4.57	3.29
4	8	1.4	xx	7.39	8	xx	8	8.05	xx	5.61	3.66
Test Avg.	4	2.98*		4.99	4		4	7.34*			

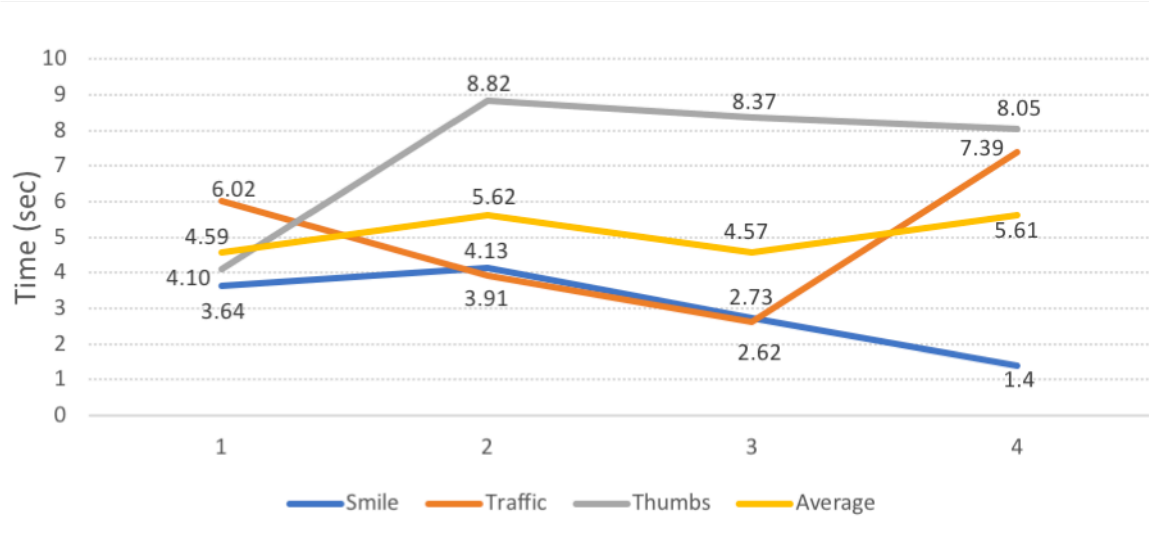

Figure 4.41: Line plot of the average time of total visit duration by the number of red signs present on label 2 (L2)

The average time of total visit duration of smile sign for product 2 and label 2 presents a negative trend, as illustrated in Table 4.44 and Figure 4.42. No significant differences were found between product 2 and label 2 mean values.

Table 4.44: Average time of total visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red smiles [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	6.72^{ns}	8	3.64^{ns}	5.18	2.18
2	8	6.1^{ns}	7	4.13^{ns}	5.12	1.39
3	8	4.74^{ns}	8	2.73^{ns}	3.74	1.42
4	8	4.57^{ns}	7	1.40^{ns}	2.98	2.24

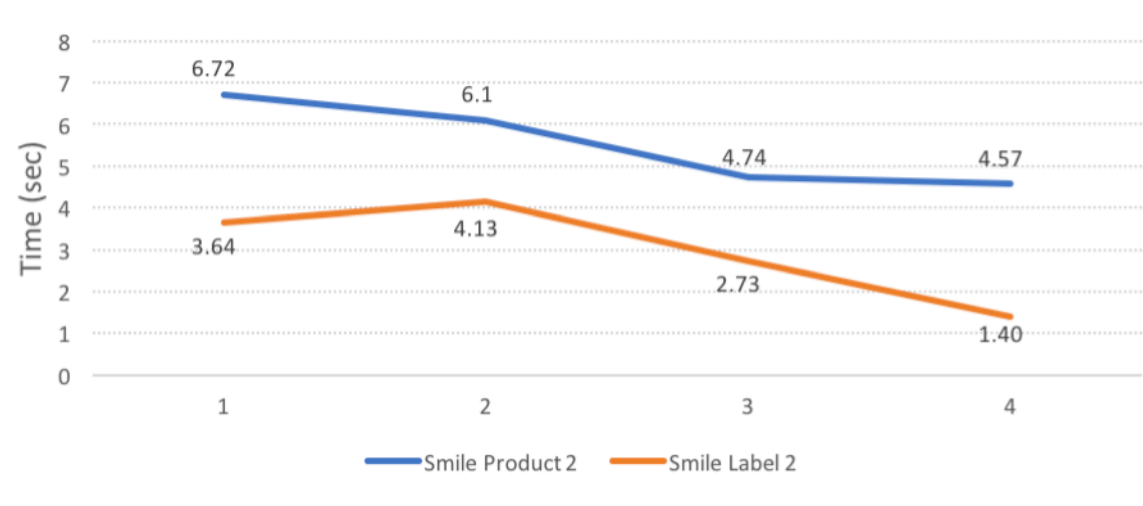

Figure 4.42: Line plot of the average time of total visit duration between product 2 (P2) and label 2 (L2) by the number of red smiles

Additionally, Table 4.45 and Figure 4.43 show that show that the average time of total visit duration of the traffic sign on product 2 and label 2 presents an elliptic curve. Significant differences were found between product 2 and label 2 mean values for 3 red signs.

Table 4.45: Average time of total visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Label 2	Avg.	STDEV
1	8	16.41^{ns}	8	6.02^{ns}	11.22	7.35
2	7	5.05^{ns}	5	3.91^{ns}	4.48	0.81
3	8	5.75*	8	2.62*	4.19	2.21
4	8	8.17^{ns}	4	7.39^{ns}	7.78	0.55

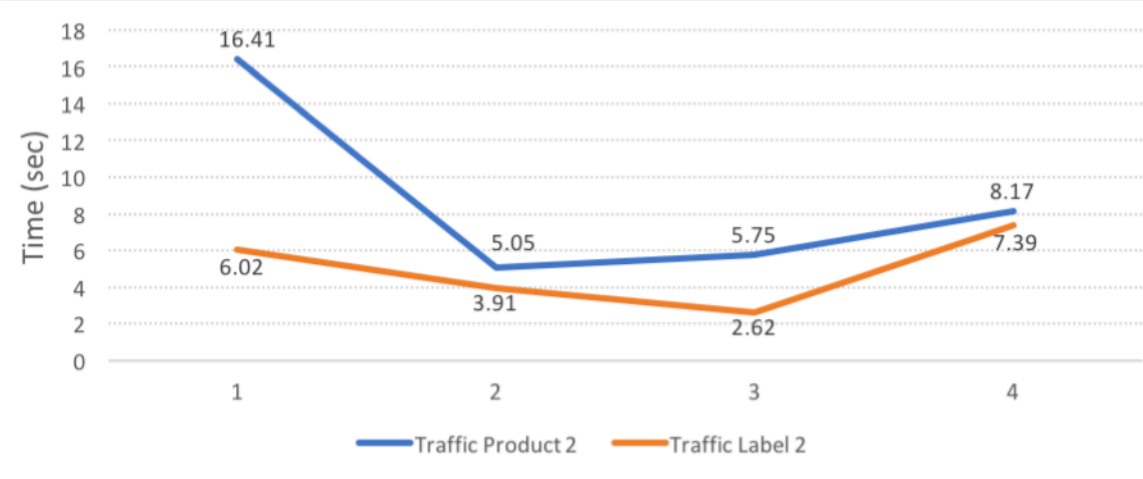

Figure 4.43: Line plot of the average time of total visit duration between product (P2) and label 2 (L2) by the number of red traffics

Table 4.46 and Figure 4.44 indicate that two red thumbs on product 2 and label 2 present the higher average time of total visit duration. No significant differences were found between product 2 and label 2 mean values.

Table 4.46: Average time of total visit duration in seconds between product 2 (P2) and label 2 (L2) by the number of red thumbs [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	8.39^{ns}	7	4.10^{ns}	6.25	3.03
2	8	17.29^{ns}	8	8.82^{ns}	13.06	5.99
3	8	12.17^{ns}	8	8.37^{ns}	10.27	2.69
4	8	14.18^{ns}	8	8.05^{ns}	11.12	4.33

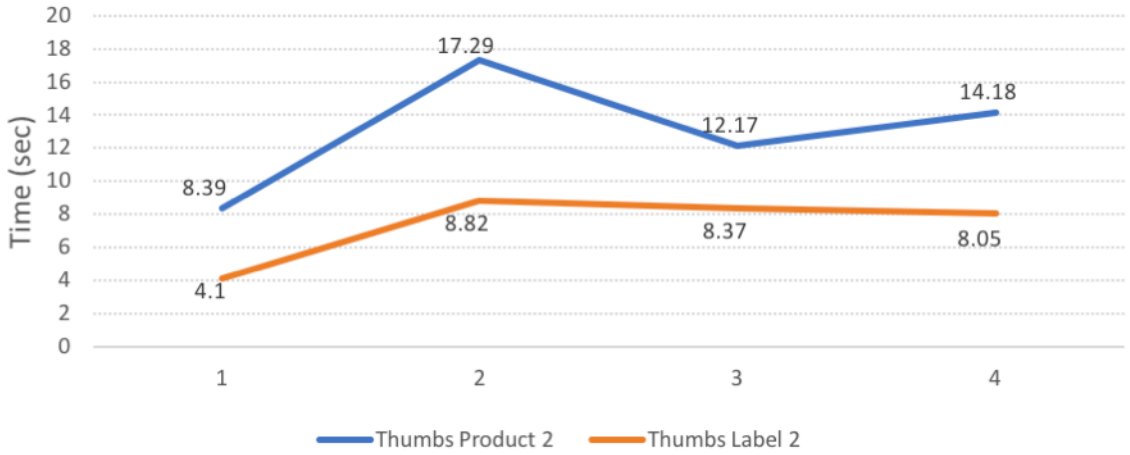

Figure 4.44: Line plot of the average time of total visit duration between product 2 (P2) and label 2 (L2) by the number of red thumbs

4.2.1.7 Visit Count

Table 4.47 and Figure 4.45 indicate that there are small differences between the two products regarding visit count, in favour of the first product (P1>P2). No significant differences were found between the mean values of all tests or between the mean values of product 1 and product 2 for each one of the 16 tests.

Table 4.47: Average visit count between product 1 (P1) and product 2 (P2) in the same picture [ns=not significant, *=significant, level 0.05]

Test No	Count Product 1	Count Product 2	Mean Product 1	Mean Product 2	STDEV Product 1	STDEV Product 2
1	8	8	8.25^{ns}	7.25^{ns}	4.17	4.53
2	8	8	7.63^{ns}	6.75^{ns}	3.42	3.20
3	8	8	6.25^{ns}	4.88^{ns}	5.57	2.85
4	8	8	6.50^{ns}	4.63^{ns}	4.66	3.42
5	8	8	4.75^{ns}	4.50^{ns}	3.85	4.54
6	8	8	6.50^{ns}	5.13^{ns}	2.83	2.64
7	8	8	16.00^{ns}	14.25^{ns}	9.72	9.39
8	8	7	7.25^{ns}	5.57^{ns}	5.01	4.16

9	8	8	6.88^{ns}	5.75^{ns}	3.44	2.60
10	8	8	9.38^{ns}	7.88^{ns}	8.73	7.94
11	8	8	9.38^{ns}	8.63^{ns}	6.09	5.63
12	8	8	8.13^{ns}	7.63^{ns}	6.06	5.78
13	8	8	14.50^{ns}	12.38^{ns}	9.96	8.11
14	8	8	8.13^{ns}	7.50^{ns}	4.49	5.21
15	8	8	11.00^{ns}	9.75^{ns}	6.61	5.75
16	8	8	13.00^{ns}	10.75^{ns}	10.14	6.63
Test Avg.	16	16	8.97^{ns}	7.70^{ns}	5.92	5.15

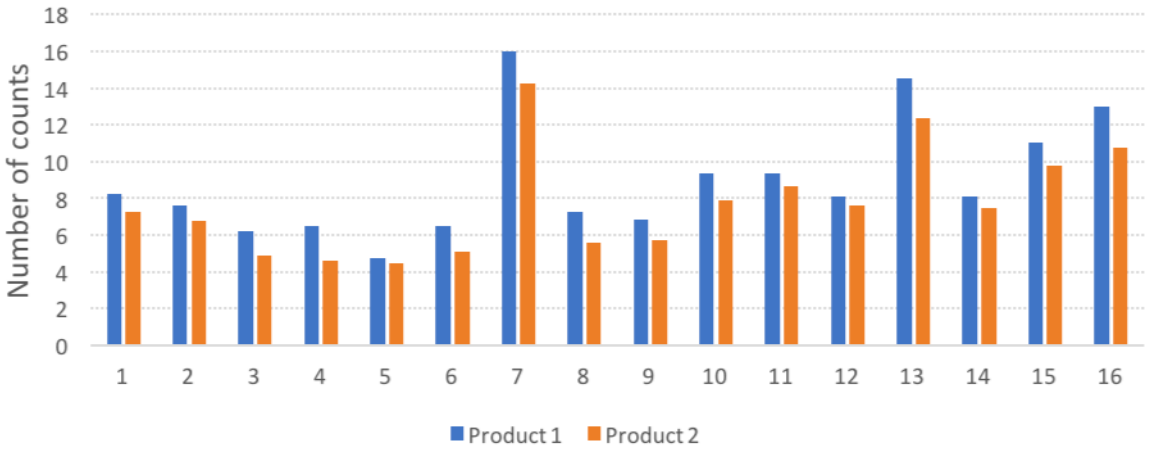

Figure 4.45: Average visit count between product 1 (P1) and product 2 (P2) in the same picture

There is a declining trend on average visit count for smile sign and not a specific behaviour for the other signs, as illustrated in Table 4.48 and Figure 4.46. Significant differences were found between 1 and 2 as well as 1 and 3 red traffics. No significant differences were found between the smile, traffic and thumb mean values.

Table 4.48: Average visit count by the number of red signs present on product 2 (P2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Mean dif.	Avg.	STDEV
1	8	6.75	xx	8	14.25	x.	8	7.63	xx	9.54	4.10
2	8	4.88	xx	7	5.57	.x	8	12.38	xx	7.61	4.14
3	8	4.63	xx	8	5.75	.x	8	7.50	xx	5.96	1.45
4	8	4.50	xx	8	7.88	x.	8	9.75	xx	7.38	2.66
Test Avg.	4	5.19^{ns}		4	8.36^{ns}		4	9.31^{ns}			

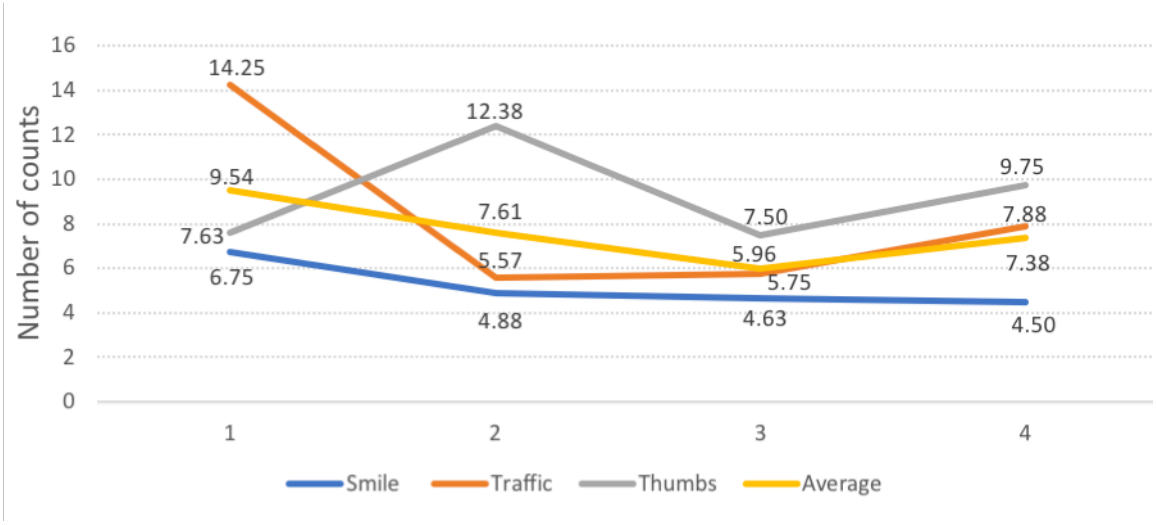

Figure 4.46: Line plot of average visit count by the number of red signs present on product 2 (P2)

Moreover, the average visit count by the number of red signs present on label 2 shows a reduction of values for smile sign as the red signs are increasing. (Table 4.49, Figure 4.47). The other two signs present an irregular behaviour. Significant differences were found between 2 and 4 red signs as well as between smile and thumb mean values.

Table 4.49: Average visit count by the number of red signs present on label 2 (L2) [ns=not significant, xx=not significant, x. .x=significant, level=0.05]

No of red signs	Count	Smile	Mean dif.	Count	Traffic	Mean dif.	Count	Thumb	Count	Avg.	STDEV
1	8	5.88	xx	8	8.63	xx	7	6	xx	6.83	1.55
2	7	4.29	x.	5	5.60	xx	8	8.75	xx	6.21	2.29
3	8	3.13	xx	8	3.75	xx	8	7.75	xx	4.88	2.51
4	7	2.57	.x	4	9.00	xx	8	7.75	xx	6.44	3.41
Test Avg.	4	3.96*		4	6.74		4	7.56*			

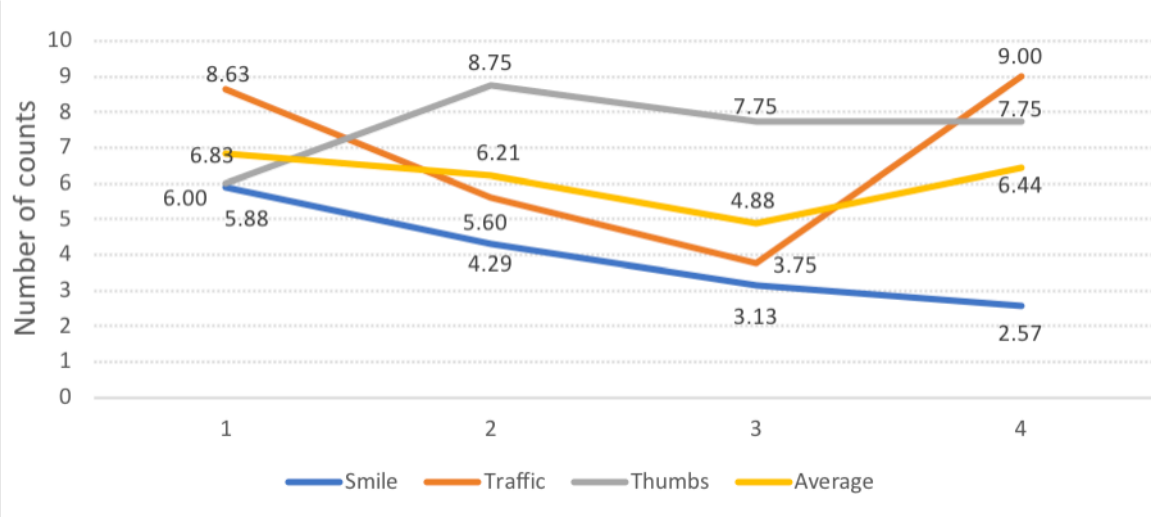

Figure 4.47: Line plot of the average visit count by the number of red signs present on label 2 (L2)

Table 4.50 and Figure 4.48 show a declining trend in the average time of visit count between product 2 (P2) and label 2 (L2) in all cases. No significant differences were found between product 2 and label 2 mean values.

Table 4.50: Average visit count between product 2 (P2) and label 2 (L2) by the number of red smiles [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Smile Product 2	Count	Smile Label 2	Avg.	STDEV
1	8	6.75^{ns}	8	5.88^{ns}	6.31	0.62
2	8	4.88^{ns}	7	4.29^{ns}	4.58	0.42
3	8	4.63^{ns}	8	3.13^{ns}	3.88	1.06
4	8	4.50^{ns}	7	2.57^{ns}	3.54	1.36

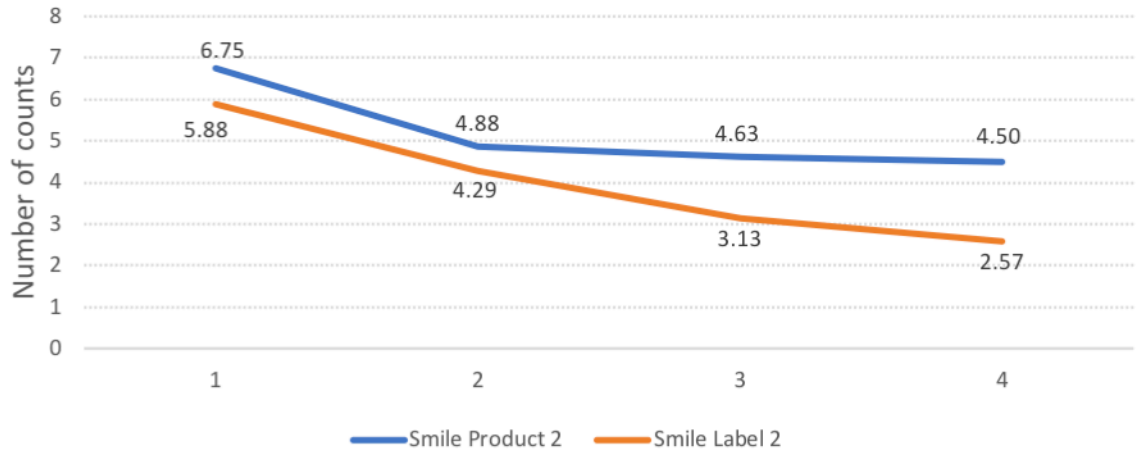

Figure 4.48: Line plot of the average visit count between product 2 (P2) and label 2 (L2) by the number of red smiles

Additionally, Table 4.51 and Figure 4.49 illustrate that the visit count of the traffic sign behaves in an elliptic curve in both cases of product 2 and label 2. No significant differences were found between product 2 and label 2 mean values.

Table 4.51: Average visit count between product 2 (P2) and label 2 (L2) by the number of red traffics [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Traffic Product 2	Count	Traffic Label 2	Avg.	STDEV
1	8	14.25^{ns}	8	8.63^{ns}	11.44	3.98
2	7	5.57^{ns}	5	5.60^{ns}	5.59	0.02
3	8	5.75^{ns}	8	3.75^{ns}	4.75	1.41
4	8	7.88^{ns}	4	9.00^{ns}	8.44	0.80

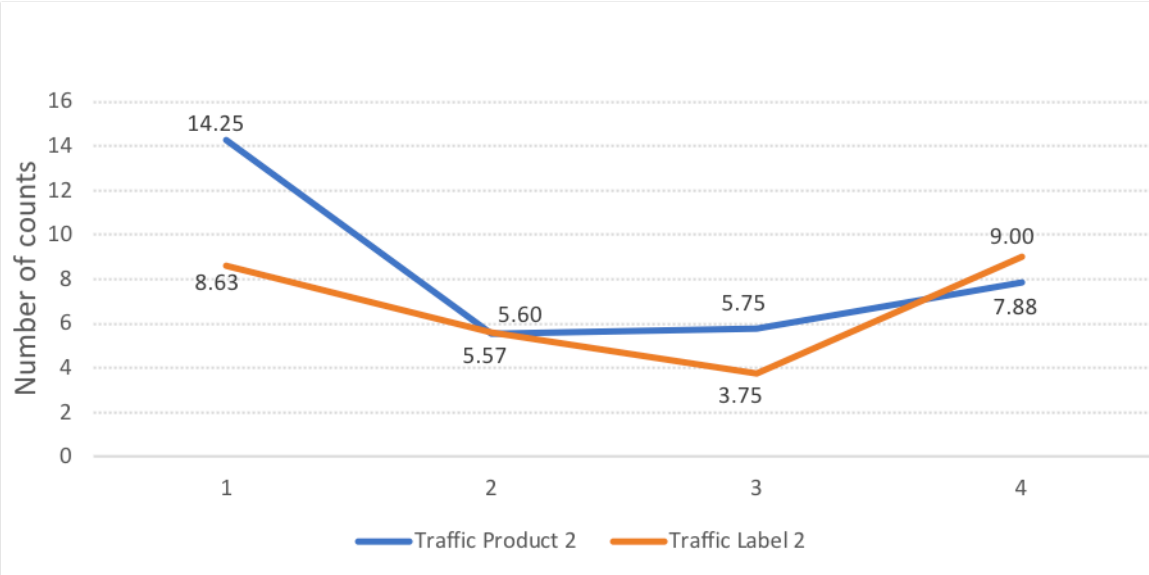

Figure 4.49: Line plot of the average visit count between product 2 (P2) and label 2 (L2) by the number of red traffics

Table 4.52 and Figure 4.50 show that the average visit count of thumb sign has a coherent behaviour in both cases (P2 and L2) until three red signs. This means that visit count of both product 2 and label 2, increases from 1 to 2 red signs and decreases from 2 to 3 red signs. No significant differences were found between product 2 and label 2 mean values.

Table 4.52: Average visit count between product 2 and label 2 by the number of red thumbs [ns=not significant, *=significant, level 0.05]

No of red signs	Count	Thumb Product 2	Count	Thumb Label 2	Avg.	STDEV
1	8	7.63^{ns}	7	6.00^{ns}	6.81	1.15
2	8	12.38^{ns}	8	8.75^{ns}	10.56	2.56
3	8	7.50^{ns}	8	7.75^{ns}	7.63	0.18
4	8	9.75^{ns}	8	7.75^{ns}	8.75	1.41

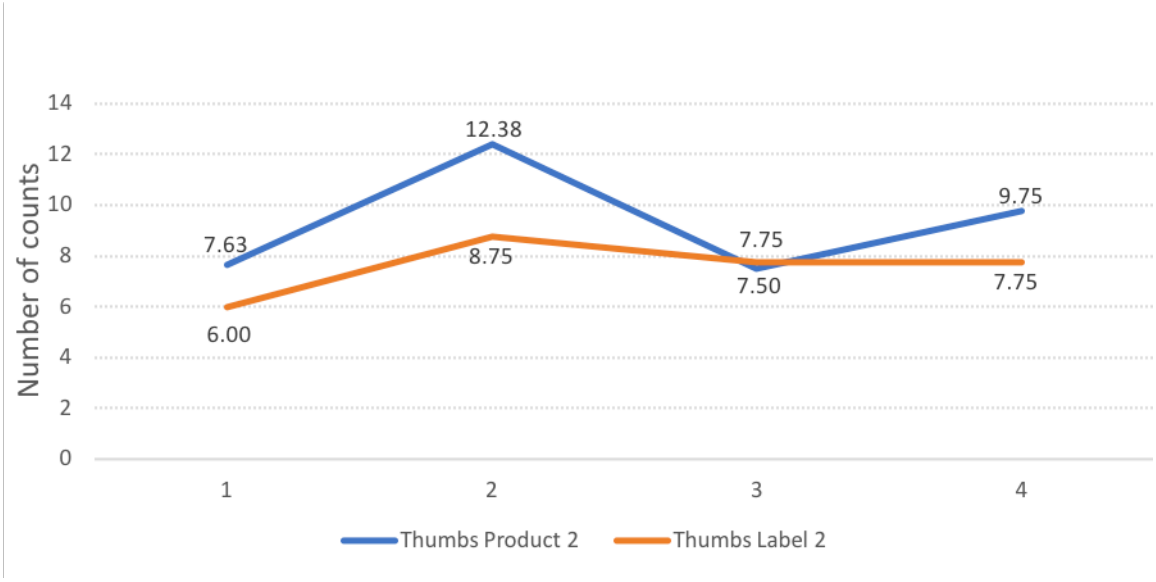

Figure 4.50: Line plot of the average visit count between product 2 (P2) and label 2 (L2) by the number of red thumbs

5 Discussion

According to the experiments' results, only a few participants perceived a food safety risk (6%) while viewing the three signs, namely smile, traffic lights and thumb which leads to the rejection of the first hypothesis. More specifically, the participants that perceived a food safety risk during the small talk after the end of the experiment claimed that "The product looked a bit dangerous", this is "Bad food" and "Red means that the product to be consumed is not good". However, a significant percentage of the respondents (38%) perceived a health risk rather than a food safety risk. Many of these respondents linked the increased amount of fat or sugar content to health risk as the small talk also revealed.

The second hypothesis of this research was that consumers are more interested in health than food safety and it could not be disproved by our experiment. According to the results summarized in Table 4.1, the participants seem to link well-being primarily to health state and secondarily to food safety. Their choices are attributed to healthy appearance (27% of the participants) and safety (20%). Comparing these results to the first hypothesis, we can conclude that for some participants the safety term is interpreted as a subset of the health term.

The third research hypothesis that red signs have a dissuasive effect on choice was also not disproved. More specifically, the results of choices in subsection 4.1.6. reveal that only 18% of the participants selected a product labelled with at least one red sign. This percentage drops further below 13% in the case of products with 3 and 4 red signs.

The demographic characteristics of the sample in the experiment showed influence on gazing behaviour, the choice of product and the perception of health and safety issues. Specifically, 73% of the sample belonged to the youngest age group namely, 18-25 years. Males more than females and non-Austrians more than Austrians were susceptible to risky choices, as the results of risk affine subsection revealed. Therefore, the fourth research hypothesis that demographics determine the participants' choices and risk perception was not disproved as well.

Further analyses of the experiment results reveals that the number of red signs has an effect on gazing behaviour. More in detail, the lower the number of red signs present in a label with smile traffic or thumb, the higher the time the participants spent gazing at a certain product (Table 4.12, 4.19, 4.30, 4.37, 4.42, 4.48, 4.49). This might be explained by the fact that in the case of few red signs, the participants tried to determine which nutrients are related to these signs.

The type of sign used on the label had also an impact on the gazing behaviour. The thumb sign attracted more attention compared to the smile sign, as participants spent more time looking at products with thumb signs. (Table 4.24, 4.30, 4.36, 4.42, 4.25, 4.31, 4.43, 4.49). This might be attributed to the familiarity of the participants, the majority of whom belongs to the youngest age group, with symbols used in social media platforms.

During the experiment, participants were gazing longer time at the whole product than on its label (Table 4.14, 4.15, 4.16, 4.19, 4.27, 4.33, 4.34, 4.45). This result is plausible because the area of interest defined for the whole product included the label area. Further, time to first fixation results show that the participants initially gazed first at the whole product and then at the label.

Overall, the placement of the product on the image frame influenced the gazing behaviour. In the majority of the cases, participants were initially looking at the first product and also spent more time gazing at the first than at the second product. Since the product placed on top contained always four green signs, it is not possible to differentiate between the placement effect and the green sign effect in this experiment.

6 Conclusions, summary and outlook

The perception of risk depends on the sample's demographic characteristics and further on their cultural background. Male participants in the experiment were found to be more risk affine than females. Moreover, non-Austrians were more risk affine than Austrian participants. Only a few of the participants perceived a food safety risk when seeing traffic light labelling signs. Therefore, risk perception in terms of food safety was found to be low in our experiment. According to the responses, health was the first priority ranking first above food safety.

The presence of red signs on the label seems to have a dissuasive effect on the choice. Generally, participants avoid the selection of a product that contains one or more red signs. However, they seem to spend more time gazing at labels with few red signs. In the presence of few red signs, individuals might try to further clarify the nutrient related to a red sign. This could imply that too many red signs function in a negative way for further information processing whereas less red signs increase the difficulty of the participant's decision.

Participants spent more time looking at the product placed at the top of the image frame than at the second product at the bottom, a result which can be either attributed to the placement of the products presented to the participants or to the fact that the labels of the products on the top included always only green signs. This impact should be examined in a further study.

The label signs used in this experiment present differences with regard to the attention capture. Thumb sign resulted in longer gazing behaviour and more frequent visits compared to the smile one. Consumers' higher attention on thumb signs was probably due to the fact that this sign is well known from social media.

The traffic light labeling system is a technique intended to inform the consumers about the nutrient content of products and guide them towards choices beneficial to their health. This experiment conducted in a young age group revealed that such a labeling method can have an impact on product choices, with participants generally avoiding products with red signs driven mainly by health considerations while being less sensitive to food safety issues. A future study should include information on the pricing of the product, it should investigate participants' intention to buy the product as well as it should consider age category expansion. Another factor that needs to be further investigated in the future is the visability of the presented choices and more specifically, the experiment has to be conducted with the pictures placed in a reversed order to be able to differentiate between the placement and sign effect.

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8 Appendix

8.1 Data of Risk Affine Individuals

Test Description	Part. Number	Reasons of choice	Risk perception	If yes, which was the risk?	Choice (1st or 2nd product)	Gender	Age	Country of Origin	Previous eye-tracking experience	Study Programme
Smile 4G_2G	P18	Looks tasty	Yes	Health	2	F	26	Austria	Yes	Food Science & Biotechnology
Smile 4G_2G	P20	Looks tasty	Yes	Health	2	M	23	Turkey	No	Electrical Engineer
Smile 4G_2G	P21	Looks tasty	Yes	Health	2	F	27	Austria	No	Enirionmental Management
Smile 4G_4G	P34	Looks tasty	No	I replied No	2	F	23	Germany	No	Organic Chemistry
Smile 4G_4G	P38	Looks tasty	No	I replied No	2	M	29	Syria	No	Biology
Traffic Lights 4G_3G	P51	I like the appearance	Yes	Health	2	M	21	Austria	Yes	Food Science & Biotechnology
Traffic Lights 4G_3G	P56	I like the appearance	No	I replied No	2	F	35	India	No	Agriculture
Traffic Lights 4G_2G	P58	No specific reason	No	I replied No	2	M	26	Serbia	No	Food Science & Biotechnology
Traffic Lights 4G_2G	P59	I like the appearance	No	I replied No	2	M	21	Austria	No	Food Science & Biotechnology
Traffic Lights 4G_2G	P62	I like the appearance	No	I replied No	2	M	21	Austria	Yes	Food Science & Biotechnology
Traffic Lights 4G_2G	P61	Looks healthy	Yes	Health	2	F	26	Greece	No	Pharmacy
Trafficl Lights 4G_1G	P69	No specific reason	No	I replied No	2	F	25	Slovakia	No	Agriculture
Trafficl Lights 4G_1G	P71	Looks tasty	Yes	Health	2	F	24	France	No	Organic Chemistry
Thumbs 4G_3G	P91	Looks tasty	No	I replied No	2	M	24	Albania	No	Sport Science
Thumbs 4G_3G	P93	Looks tasty	No	Another reason	2	M	20	Austria	No	Enirionmental Management
Thumbs 4G_3G	P96	Looks healthy	Yes	Another reason	2	M	24	Czech Republic	Yes	Food Science & Biotechnology
Thumbs 4G_1G	P105	Looks healthy	No	I replied No	2	M	26	Italy	No	Enirionmental Management
Thumbs 4G_0G	P115	Looks healthy	No	I replied No	2	M	25	Austria	No	Genetics