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THE ROLE OF VISUAL ATTENTION AND EYE MOVEMENTS IN PRODUCT PURCHASES ON WEBSITES

Master Thesis

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Abstract

In this study we investigated the role of eye movement behavior when making a purchase online by choosing between four products. Two groups were created: one that saw a stimulus in which one of the products was labeled as the most sold, and the other group who saw the same stimulus without the label. Eye movements were measured with a Tobii X3-120 eye tracker. The objectives were (1) to see if the product more fixated would be in the end the chosen one, (2) to understand if, due to the added label, there was a difference in the looking behavior between the two groups, (3) to see if by manipulating the visual scene there could be an influence in the final product choice, and (4) to understand through a questionnaire differences and trends in the participants' purchasing behavior on e-commerce websites. The results partially confirm the initial hypotheses. Although an influence in the final choice wasn't found by adding the label, the findings align with previous researches (Pieters, R., & Warlop, L., 1999; Van der Laan et al., 2015) in the possibility to infer someone's preference by looking at the eye movements. The results explain and show the importance of this type of study to further investigate online consumer behavior, especially for marketing purposes, by using eye tracking technology.

Keywords: Eye movements ; Fixation Duration ; Product choice.

Contents

Introduction

In everyone's life, almost every day there is a moment where it is necessary to choose between several options. Imagine yourself having to choose between two car models, three different cell phones or which direction to take while going to work. While from the outside it may seem just a simple choice based on someone's preference, the internal decision process is far more complex. There can be goal, attribute or context influences when making a choice. When we find ourselves, for example, on a website where several products are displayed, our perception and the characteristics of the scene are analyzed by the interaction between two mechanisms that influence eye movements (Orquin & Loose, 2013). These are called bottom-up and top-down. The former, also called stimulus-driven, shifts attention to salient visual features of relevant importance (Orquin & Loose, 2013). An example can be a sudden movement or a bright light coming from one extreme of the visual scene. Bottom-up mechanism is usually explained in relation to visual saliency, which guides our attention thanks to low level features such as color, form and edges (Itti & Koch, 2001). The top down mechanism, also called goal-driven attention, moves the visual attention on parts of the scene more relevant for the specific goal. This was discovered by Yarbus (1967), in his experiment he showed the same photography to different participants, but gave them different visual tasks. He was then able to see how eye movements differed between the participants based on the visual task they were given.

It is in this field that decision theory works, trying to understand how we pursue our goals in front of different options (Hagen et al. 2012). To make decisions it's necessary to acquire information from the environment. If you have to choose between two cell phones you need to know their attributes in order to make the choice with the highest utility for yourself. This doesn't apply only when buying products. In every moment of the day we are continually targeted by stimuli and information. In selecting and analyzing information from the environment, attention has a primary role (Orquin & Loose, 2013). Most of the decisions we make every day are shaped by attention, which helps us to acquire information according to the behavioral goals and inhibit it when it's irrelevant (Yang, C.T., 2017). Already decades ago, Bettman (1979) explained how attention is one of the most important factors in influencing information processing when making choices. He believed that consumers have several goals which are all analyzed when trying to make a decision. There are different types of attention, in this study we will focus on visual attention, which has a fundamental role in our life. It is defined as a set of cognitive

mechanisms that through head and eye movements selects relevant information and filters out irrelevant information from visual scenes (McMains S.A., Kastner S., 2009).

The aim of this research is to investigate with an eye tracker how visual attention, measured through eye movements, is related to the final product choice on websites. When making a decision, in order to choose a specific product, attention is distributed on the web page in different ways, depending on goals and visual saliency. The eye tracker provides a reliable way to measure eye movements. Perception regarding a product is in fact affected mostly by its appearance since the vision is the first mechanism involved in the collection of information (Moshagen, M., & Thielsch, M. T., 2010). Earlier eye tracking studies have shown that several eye movements parameters are correlated with decision making. Pieters and Warlop (1999) showed that the elements on a display that were fixated for a longer amount of time, eventually became their final choice. The study showed the importance of the fixation duration as a visual attention measure with a positive effect on brand choice. Another similar study by van der Laan et al (2015) showed how the fixation duration was determined by 2 factors: decision goal and already existing preferences. Participants were asked to select the product they preferred or the product they least preferred between the ones shown. In both conditions, participants fixated longer on the product they chose in end. The study showed how the total fixation duration is indicative of the final product choice. These studies findings should grow interest in studying even more visual attention and decision making, especially when making purchases on online websites. This research builds on these previous mentioned studies for what concerns the focus on fixation duration as a visual attention measure to indicate product preference but also different viewing behaviors. To be able to investigate the role of visual attention in the context of decision making is important to explain how eye movements, in connection with attention, help us to acquire information from the scene.

Eye movements are indicative on how the participant inspects the scene depending on if his search is more goal or attribute oriented. This can be seen through what was fixated, in what order and for how long. Being able to analyze where the participant's gaze is allocating his/her attention in a scene in which several products are displayed is crucial to understand his preferences and how particular elements of the scene can attract more or less someone's attention. Nowadays with the increase of e-commerce the replication of an online shopping website is the perfect environment to study visual attention and eye movements when making decisions.

The development of internet technology has affected the way certain human activities, such as shopping, are made (Sari, J. N., Nugroho, L. E., Santosa, P. I., & Ferdiana, R., 2018). Nowadays people are using online platforms much more to buy products (Clement, J., 2018). In 2018 1.8 billion people around the world purchased products online (Clement, J., 2018). Around 63% of shopping journeys start online rather than going to find products in local shops (Thinkwithgoogle, 2018). This shows the importance for brands to have a strong presence online. Even if people eventually end up buying a product in a store their product choice starts online, in Google or Amazon for example, where they're doing their research. When a potential buyer is viewing an e-commerce website page, he makes distinguished eye movements that reflect the redirection of his attention. These are called fixations and saccades. A fixation is the condition where the eyes remains relatively still approximately for 200-500 milliseconds and the fixated area is projected to the fovea (Chandon, Hutchinson, Bradlow, & Young, 2009). Saccades are mainly used for orienting gaze towards an object of interest, and they may be done in all directions. They can be voluntary movements, but also occur reflexively whenever the eyes are open, even when fixated on a target (Chandon, Hutchinson, Bradlow, & Young, 2009).

During our eyes' fixations on the visual scene not all information is processed, there is actually a selection process. Herbert Simon explains this by giving the notion of bounded rationality, which elaborates on the fact that the environment we live inside is very complex and full of information (Selten, R., 1990). For this reason, our attention can't elaborate every single stimulus we encounter, but it elaborates only the relevant ones (Selten, R., 1990). If on a website there are too many different products to choose between, analyzing all the scene would take too much time. Placing on a website too many options to choose between would just confuse the user and increase the time before he actually buys the product. Eye movements are optimized so that the demand to the working memory decreases and, sometimes, to reduce fixations and saccades (Hutton, S. B., 2008). This is why it's very important that marketers select the information they want people to see when inspecting their website. Therefore, the website has a role itself in influencing product choices and on how a person interacts with it. With the growth of the internet a lot of companies started using e-commerce to bring their products to the market, and for the same reason products and websites are designed in order to engage more customers (Sari, J. N., Ferdiana, R., Santosa, P. I., & Nugroho, L. E., 2015). When someone selects a

product, online shopping websites like Amazon usually show at the end of the web page a horizontal comparison matrix where several products of the same category and their attributes are displayed. The horizontal chart is not a casualty. The research conducted by Shi, Wedel & Pieters (2013) demonstrated how people tend to make horizontal eye movements when observing the web page. This gives the opportunity to managers to strategically place information regarding product and attributes, so that comparison is facilitated and the probability of buying a dominant product decreases (Shi, S. W., Wedel, M., & Pieters, F. G. M., 2013). Marketers' goal is to be able to attract consumer's attention in order to arouse desire of buying products, but also to understand purchasing behaviors and how to exploit attention. In this study the web page was designed with the goal of reaching specific results in the final choices and in the viewing behavior. A horizontal comparison matrix was placed below the products so that all the attributes could be compared by the participants, and one of the two stimuli shown was manipulated with a label to attract the participant's attention and eventually lead him to a specific choice.

Methods

Stimulus

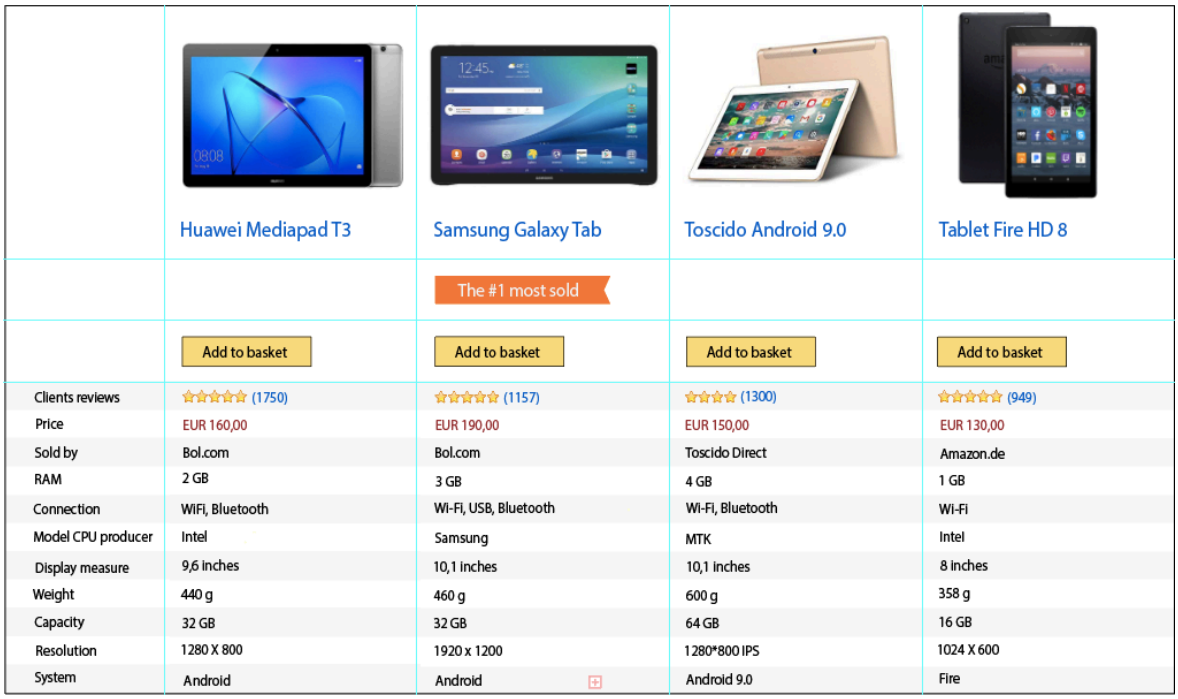
For this experiment the stimulus was designed using the software Adobe Illustrator so that it resembled a web page that contained a four-product-comparison matrix (See *Figure 1*). The products shown were four different tablets, each one with the description of 11 attributes including client reviews. Two versions were created: one that included an orange label stating "The 1# most sold" under the second of the four products, and one without the label but the same products, in the same order and with the same attributes. The stimulus was made in order to see if the manipulation of visual saliency could attract more the participant's attention and lead to a major choice of the product that displayed the orange label by the group who saw it. Consumers when purchasing products online are not able to physically touch and analyze them. Therefore the intent of omitting the label from one of the two stimulus was to see if the participants of the experiment, without a clear hint on which was the most sold item, would have eventually taken more time to reach a decision and to spend more time fixating the product's attributes, compared to the group that saw the labeled stimulus.

To be able to analyze the data it was necessary for each stimulus to aggregate the fixation coordinates to the coordinates of relevant areas of the stimuli. These areas called the areas of interest (AOIs), more specifically spatial regions on the stimuli (product's attributes,

labels, images) that are used to link the eye-movements to them (van der Lans, R., & Wedel, M., 2017). The stimuli were divided in 20 different AOIs segments (See *Figure 1*). In this way once the fixations coordinates were known it was possible to see in which AOI they were included.

Figure 1

Stimulus 2



Note. An example of the stimulus that represents a web page with the "The 1# most sold" label that was shown to one group of the study. To this image, in addition, there is also the division in the different AOIs used to track the fixation coordinates.

Participants

In this study 42 participants were included. They were all students from the International Business Administration and Business administration courses of the Erasmus University of Rotterdam. An announcement where you could sign up to participate to the study was posted on the University website. Each participant received study credits for their studies. To be able to test the effect of "The 1# most sold" label, we used a between-subject design. The two stimuli were designed to differ only on that particular element and each participant was exposed to only one stimulus. The exposure to one stimulus or the other was random. Forty-two participants were tested and two groups were created: one group formed by 20 participants was assigned to the stimuli that had the "The 1# most sold

item" label, while the other group formed by 22 participants was assigned to the stimuli without the respective label.

Measurement Tool

The task was performed in a lab room of the University of Rotterdam equipped with computer screens and eye tracker, more specifically the Tobii X3-120 remote eye tracker. Before starting the experiment, the eye tracker was calibrated to make sure it would make correct measurements. To do so the participant had to follow a point that moved across the screen, while the eye tracker measured the characteristics of the eye, such as shape, light refraction and reflection. To calibrate in the most precise way we had to make sure the positioning of the participant was correct. Each participant had to find a comfortable position so that they could keep their eyes in the center of the track box for the entire task, and also face the eye tracker and the screen at an optimal distance of 60 to 65 cm. After the participant successfully completed the calibration task the study could begin by showing the instructions to understand the task. When all the participants completed the task and the Tobii software saved all the eye measurements, the Tobii algorithm was used to process the eye movements so that all data of the metrics could be exported in Excel files (Anneli Olsen, 2012).

Choice task

The instructions informed the participants about the products they would have to choose between. In this way the initial idea of a specific object a consumer has in mind when going on a website was replicated. When viewing the different pages of the study, the Tobii software allows you to click anywhere on the screen in order to turn page. Consequently, it was necessary to instruct participants that they had to press over the label "Add to Basket" to finalize the purchase. To make them more familiar with the stimulus they would see and to make sure they would press the correct button when ready to purchase the product they were given a stimulus example in which four laptops were shown. The instructions also informed them about the absence of time pressure, so that they would know they would have all the time they needed to choose the best product for them, as they were at home. The highest price between the products was € 190, for this reason they were given a budget of € 200 so that they wouldn't have the idea of spending their entire money. Once they confirmed that they understood the instructions the four different products with the respective attributes were shown on the computer screen. When

they reached a decision, they had to select the product by clicking on the "Add to basket" button. After they chose the product they were thanked and asked to fill in a questionnaire.

Questionnaire

The questionnaire was built with the objective to further understand how and why people use e-commerce websites. We first asked questions regarding their sight, if they are color blinded or if they wore glasses or contact lenses during the task. After, we focused more on the personal aspect of shopping. We were interested in knowing their focus on specific product attributes, such as the customer reviews, but also on their relationship with online shopping: how often they purchase online, what they purchase or if they prefer online shopping or going directly to the shop. We built a questionnaire that contained multiple choice questions, open answer questions and Likert scale (see Appendix). After they completed the questionnaire they were free to leave the room.

Data validation

First, a threshold was determined in order to validate the eye tracking data, in terms of data loss, for each participant. The threshold used was of 75%, so participants' that had at least 75% of valid data were included in the study. To calculate this, the number of samples where a gaze signal was detected by the eye-tracker was divided by the total number of samples the eye tracking took when the stimulus was on the screen. In this way it was possible to identify the participants with low eye trackability and exclude them from the analysis. Of the 42 initial participants 20 of them had low eye trackability and were excluded, resulting in a total population of 22 participants. Twelve of them saw the stimulus with the orange label and ten of them saw the stimulus without it.

Participant's data

One of the research objectives of the study was to see if the product chosen was eventually also the most fixated between the 4 shown. By knowing the fixations coordinates alongside with the AOIs coordinates it was possible to see in which AOI each fixation was included. The AOIs included each product's attributes alongside with the image and the description of it. For this reason, it was also possible to know which specific AOI of the stimuli was fixated and to divide the fixations made for each product and attribute. To know how long it took for each participant to reach a decision the total duration of the eye tracking measurement was divided by the number of samples and later

multiplied by the number of samples taken only when viewing the stimulus. In the end, the data for each participant included the fixations coordinates, the product and the attributes fixated, and the amount of time they took to choose one product.

Results

The first hypothesis was that the participants would eventually choose the product they fixated the most. This happened for 68% of them (15 participants), while for the rest of them the product chosen was the second more fixated. The fixations were mostly distributed on the central products (number 2 and 3), which were the best products in terms of attribute qualities, but also the central ones which might have also influenced the choice (Valenzuela, A., & Raghubir, P., 2009). Product 4 was the least fixated by all participants, while product 1 was fixated the most by only 9% of the participants (2 participants). Regarding the choice frequency the same results were found: product 2 and 3 were by far the most chosen (respectively 63,6% and 27,3%) compared to product 1 and product 4 (respectively 9,1 % and 0 %).

The second hypothesis was that the group who viewed the stimulus without the orange label (Group 1), would have taken more time to make the final choice and also would have fixated for a longer amount of time the attributes of the displayed products, compared to the group who saw the stimulus with the orange label (Group 2). By using a t-test it was possible to see a significant difference in the time spent making a choice, and so to reject the null hypothesis. Group 1 who didn't see the orange label ($M = 48.5$, $SD = 19.5$), compared to Group 2 who viewed it ($M = 31.1$, $SD = 9$), took longer time to reach a decision, $t\ (11) = 2.6$, $p = .001$.

To see if Group 1 also fixated for a longer period of time the products' attributes compared to Group 2 another t test was done. Before using this statistical test it was necessary to calculate the relative looking time of each participant to see which group spent more time looking at the attributes. Each participant's fixation duration on the attributes was divided by the total looking time. This was done to remove the effect from the total looking time, because indeed if someone took more time to reach a decision, he also consequently looked more time to the attributes. Later, with a t-test the relative looking time of Group 1 ($M= 0.66$, $SD= 0.13$) was compared with the relative looking time of Group 2 ($M = 0.59$, $SD = 0.16$). Results show how there wasn't significance difference between the two groups for the relative looking time on the attributes, $t(19) = 0.9$, $p = 0.2$.

The third hypothesis was that the group that viewed the stimulus with the orange label would have chosen more frequently the product with the orange label. However, by looking at the number of times the product was chosen, Group 2 ended up choosing the product with the orange label less frequently (58% = 7/12 participants) compared to the Group 1 (70% = 7/10 participants). Also in this case the alternative hypothesis was rejected.

Questionnaire

Thanks to the questionnaire it was possible to collect more useful information regarding consumer behavior on online websites. The results show how online shopping is an activity that is more or less pursued by each participant regardless their opinion about if they prefer buying products online or in shops. Each participant had bought something online between one month and 5 days prior to the testing, and 75% of the participants affirmed that they usually make one or more purchases online every month.
There was a clear preference between the participants for online shopping, around 64% of the participants stated it. They motivated this choice by underlying how on the internet there is a wider range of products, there is the possibility to see comparisons, read product reviews and also there is a minor waste of time. On the other hand, in favor of buying inside shops there were motivations such as: the possibility to actually touch and see the product, no transportation time and more transparency. Yet most of the participants, either preferred buying online or inside a shop, said that the choice also depended on the specific product they are willing to buy. For accessories or tech products the preferred choice was online shopping, while for clothing they stated that local shops were better. However, in the end more than one third of the same participants that preferred to buy clothes in shops, when naming the last product they bought online, stated that it was clothing related, while the rest was for the majority books or tech accessories.

Discussion

The uprising utilization of the online platform to discover, compare and buy products is every year putting companies in the position to deeply explore how customers buy their products and how to get to know their likings. From inviting people to take surveys, to studying analytics or interviewing customers, many companies in more recent years have been using eye tracking technology. The study of eye movements can reveal insights that can benefit every business field, especially for what concerns marketing.

Marketers have the goal to direct the customers on what is essential in the product or service they provide, and try to indirectly assist potential clients while making purchases decisions. Eye tracking can be used to collect objective data that could give insight on the customer's satisfaction, engagement and final product choices. Therefore, studying how people explore web pages when making purchases is important to potentially create marketing strategies and understand how to attract people to buy your product or to catch your message.

Following this initial introduction, it was necessary to dive deeper in how attention moves around the scene depending on the goals of a person and the visual saliency of certain elements. While attracting the attention is the final goal, being able to reach that conclusion implies studying what attracts more someone's attention and testing ways to do so. These actions are based on existing evidence of how eye movements are correlated with decision making (Pieters, R., & Warlop, L., 1999; Van der Laan et al., 2015). This study also bases some research questions on these cited researches.

First of all, the analysis confirms the initial hypothesis that the product fixated for a longer amount of time would eventually end up being the chosen one. The results show how the majority of participant (68%) chose the more fixated product. The majority of participants divided their attention between the two central products, excluding the fourth one and partially fixating, sometimes in large part, the first one. This result was somehow expected due the fact that for half of the participants one of the central products was labeled as the most sold, but also because of previous researches that investigated the phenomenon of fixations on central products. In fact, an horizontal central effect was demonstrated in shelf displays for different type of products (Shaw et al. 2000). Consumers often believe that the central products are more popular compared to the more external ones (Valenzuela, A., & Raghubir, P., 2009). This result aligns with previous researches (Pieters, R., & Warlop, L., 1999; Van der Laan et al., 2015) in demonstrating how the fixation duration on a specific product is a relevant visual attention measure to show product preference.

The second hypothesis was that people from the group that didn't saw the stimulus with the orange label would reach a decision in more time and would consequently fixate for more time the attributes. Results show that Group 1 took more time to reach a decision, which also implicated a higher amount of time spent fixating the attributes. However, from the results, it's not possible to affirm that the amount of time spent fixating the attributes was significantly higher compared to Group 2. The reasons that led to a longer time in

reaching a decision are therefore not specifically related to the absence of the orange label. The initial hypothesis was in fact that without the label giving a hint on which was the most sold product, Group 1 should have taken more time collecting information and making a choice. One other reason that might have caused the longer decision process could be connected to a lower knowledge of tablets. People from Group 1 could have had a lower familiarity with tablets that brought them to take more time to reach a decision. One improvement that could be done in this case was to ask in the questionnaire the level of knowledge about technology and electronic devices. However, by simply having a larger population the results might have been different.

The third hypothesis, which stated that the group who saw the orange label would have chosen more frequently the advertised product, wasn't confirmed. In fact from the analysis the results show that Group 1 chose the labeled product more frequently (70% compared to 58%) and consequently the null hypothesis wasn't rejected. This result can be explained by 3 reasons: the sample was very small, in fact a larger sample size could have given a different results thanks to a higher amount of data. However, due to the data validation that brought to the cancellation of more than half participant this was not possible; another reason could be that the product that was advertised with the orange label, but also the respective one that was showed to the other group, had high quality attributes compared to the other products. One alternative that could have dived deeper in studying the effect of the label could have been labeling a product with lower attribute qualities. In this way the results could have been much more connected to the label effect rather than the attributes itself; the third reason could be that there was only one location with the label. If the label was positioned in another place it could have had a major effect. Eventual follow up researches could test several label positions to see if there could be major effects linked to the actual position of the label rather than only to the label itself.

The questionnaire gave useful insights on how e-commerce has a relevant place in purchasing product between people. Data online shows how the number of purchases online is increasing every year, and from the questionnaire's answers we collected from the participants it was possible to confirm that people frequently use the online platform to buy goods. Most of the people make purchases every month, even multiple times, and the range of products they buy goes from electronic products, to more basic ones such as books and clothes. This study chose a website as stimulus because, thanks to the great amount of people's presence on the online platform, it represents a perfect environment to

study purchasing behaviors and also how by manipulating the visual scene there can be changes in amount of activity.

Investigating the manipulation of web pages is worth to continue studying to see if there are effects in influencing choices. This study through the results shows the important role that e-commerce has nowadays for people regarding purchases, but also how the eye tracking technology can be a reliable source to investigate preferences and influence effects on product choices online. Big research companies that have the opportunity to work with a very wide population of participants and the latest technologies have the chance to further investigate to a higher level several ways to attract consumers' attention and nudge them to specific decisions.

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Appendix

Questions asked in the questionnaire.

Q1 Please state your gender.

- ○ Male
- ○ Female
- ○ Prefer not to say

Q2 Did you encounter any difficulties in completing the task? If yes specify.

- ○ Yes _____
- ○ No

Q3 Did you wear any type of glasses or contact lenses during the study?

- ○ Yes
- ○ No

Q4 Are you color blind?

- ○ No
- ○ Yes, blue
- ○ Yes, red
- ○ Yes, green

Q5 After you inspected the web page, were you undecided about which product to choose?

- ○ Yes
- ○ No

Q6 Please indicate from 1(completely disagree) to 5 (completely agree) how much you agree with this statement: When I choose what product to buy online I focus on its reviews and popularity between the buyers.

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

Q7 How often do you buy products online?

- ○ Once every 2 weeks
- ○ Once a month
- ○ Once every couple of months
- ○ Once a year
- ○ Never
- ○ Other _____

Q8 Do you prefer to buy products online or to shop them physically? Motivate your answer.

- ○ Online _____
- ○ Shop _____

Q9 When was the last time you bought something online?

_____

Q10 What was the last product you bought online?

_____