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Does attention to health labels predict a healthy food choice? An eye-tracking study

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ABSTRACT

Visual attention to health labels can indicate a subsequent healthy food choice. This study looked into the relative effects of Choices logos and traffic light labels on consumers' visual attention and food choice. A field experiment using mobile eye-tracking was conducted in a Dutch university canteen. Participants (N = 48) walked to the shopping area wearing an eye-tracking device and chose one pack of yoghurt out of 12 from the refrigerated shelf. The packages varied in health label format (traffic light label, the Choices or no logo), fat content (low-fat, semi-fat and full fat), and brand. Participants were randomly assigned to one of the two conditions: with or without time constraint. The results revealed that participants fixated longer and more often on the traffic light labels compared to the Choices logos. Participants in the time constraint condition demonstrated less visual attention to health labels compared to participants without time constraint. General Health Interest (GHI) moderated the effect of time constraints. The condition without time constraints increased attention to health labels for participants with high GHI, but not for participants with low GHI. However, visual attention to health labels was a poor predictor of the subsequent healthy choice. The results suggest that attention to health labels might indicate the interest towards an unfamiliar food label, but it does not necessarily indicate a healthier food choice.

1. Introduction

Helping consumers to choose healthy food is important for public health, considering the steady growth of deceases related to overweight and obesity. The World Health Organization considers nutrition labelling an essential part of its global strategy on diet and health (World Health Organization, 2014). Recently, the focus has shifted towards the front of the food package with simplified and visible summary information on nutritional quality. During the last decade the number of products with front-of-pack labels, such as traffic light labels and Choices logos, has increased substantially and continues to grow (Bonsmann, Celemín, & Grunert, 2010; Lobstein & Davies, 2009; Van Kleef & Dagevos, 2015).

Health labels are intended to help consumers to understand the relative nutritional quality of a food product and to improve purchase decisions regarding diet and health (Lytton, 2010; Williams et al., 2010). However, while shopping for food, consumers tend to ignore health labels due to their lack of time, knowledge, and/or awareness (Grunert, Celemin, Storcksdieck, & Wills et al., 2012; Grunert & Wills, 2007; Lähteenmäki, 2013; Soederberg, Miller & Cassady, 2015). For instance, only 10% of Americans report looking for a health label on food packages (Schor, Maniscalco, Tuttle, Alligood, & Kapsak, 2010).

When walking into a grocery store, consumers are confronted with a vast amount of choices. A supermarket is a very complex multisensory environment in which consumers are tempted to make unplanned purchases (Otterbring, Wästlund, & Gustafsson, 2016). Store visitors are often too rushed to intentionally search for nutrition information in a distracting and noisy purchase environment. Due to their limited cognitive abilities, consumers pay attention to a limited amount of product characteristics that might be important for them, such as price, brand, convenience and expected taste (Szanyi, 2010; Bialkova, Sasse, & Fenko, 2016).

Visual attention can be seen as the gatekeeper for incoming visual information (Grunert & Wills, 2007). Eye tracking devices measure and analyse eye movements to characterize visual attention (Duerrschmid & Danner, 2018). The effects of visual attention on product choice are usually measured by static eye-trackers (Orquin & Mueller Loose, 2013).

The static eye-tracker can be used in laboratory experiments with mock-up product packages presented at the computer screen. This method can give useful insight into the mechanisms of visual attention, since it allows to systematically manipulate multiple visual attributes of

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a package and a label: size, position, colour, font, images, and shapes. Using a mobile eye-tracker gives valuable insights into consumer behaviour in a realistic shopping environment. Mobile eye tracking allows to investigate visual attention by identifying where and for how long a person is looking while walking freely in a real store environment. It emphasises the complexity of consumer decision-making and allows to study the influence of the factors that cannot be captured in lab experiments, such as the store design, the presence of other people in store, the distance to the shelf, and the position of a product on a shelf.

This study used a mobile eye tracker to investigate the visual attention towards two front-of-pack health labels, the Choices logos and the traffic light labels. Both labels intend to help consumers in making an informed food choice (Cowburn & Stockley, 2005). The Choices logo is an example of a directive label, while a traffic light label is an example of a semi-directive label (Hodgkins et al., 2012).

The experiment was performed at a Dutch university canteen. Visual attention towards health labels was measured in two experimental conditions: with or without time constraints. Participants were asked to make a choice between 12 products that differed in fat content, health label and brand name. The study aimed to answer the following research question:

To what extent can visual attention towards a health label predict the healthy product choice?

1.1. Health labels

Food labels can play an important role in promoting healthy food choice. Therefore, a lot of studies have looked into the effect of health labels on consumer behaviour (see Lähteenmäki, 2013 for a review). Most of these studies have found small positive effects of health labels on perceived food healthiness (Lähteenmäki, 2010; Saba, 2010; Van Trijp & Van der Lans, 2007). For instance, studies performed both in the restaurant (Roberto, Larsen, Agnew, Baik, & Brownell, 2010) and in the laboratory settings (Temple, Johnson, Recupero, & Suders, 2010), have demonstrated that calorie labels displayed on menus decreased the amount of calories consumed by participants. Relae and Flint (2016) showed that the use of colour and health logos in menus led participants to choose meals containing significantly less calories compared to when nutritional information was presented in black text alone.

However, other studies did not find any effects of health labels on healthy food choice, and in some cases, even found a negative effect (Aaron, Evans, & Mela, 1995). For instance, Fenko and Faasen (2014) did not find any effects of health labels on the choice of healthy or unhealthy menu items in a restaurant. Other experimental studies performed in a Dutch cinema (Vermeer et al., 2011) and work site cafeterias (Vyth et al., 2011) also did not find any significant effects of food labels on food intake.

Minor effect of health labels on purchase decisions may be explained by people's lack of attention towards the labels, poor understanding of health claims and/or little importance of the food health benefits compared to other benefits, such as price, convenience and taste (Grunert & Wills, 2007). Therefore, in order to help consumers in making healthier food choice, it is essential to understand the factors influencing consumer attention to health labels.

1.2. Factors influencing visual attention

Researchers differentiate between two types of attention: goal-directed attention and stimulus-driven attention (Norman & Shallice, 2000; Yantis, 2000). Goal-driven attention is influenced by top-down factors, while stimulus-driven attention is mostly determined by the bottom-up factors. Bottom-up factors refer to visual stimuli design factors (e.g., number of images, complexity of images, colour, shape, and information level of images), whereas top-down factors refer to consumers and their individual preferences, goals, mood or task instructions (Corbetta & Shulman, 2002; Gere, Kókai & Sipos, 2017; Orquin & Mueller Loose, 2013).

Research shows that bottom-up factors, such as a label format or its position on the package, influence the probability that a label attracts consumer attention (Pieters & Wedel, 2004; Van Herpen & Van Trijp, 2011). Bialkova and Van Trijp (2010) have found that consumer attention towards health labels is determined by the size of the label, its colour scheme, familiarity with the label and its location on the front of the package.

The salience of nutrition labels can be increased by increasing the size of the label (Graham, Orquin & Visschers, 2012). Combining bold texts, colour schemes and familiar words also increase the salience of nutrition labels (Ranilovic & Baric, 2011).

Compared to more traditional nutrition tables, traffic light labels are more likely to attract consumer attention (Van Herpen & Van Trijp, 2011). Antúnez et al. (2013) investigated the influence of the label design on consumers' attention with eye-tracking techniques. The results showed that the traffic light labels increased participants' attention to nutrition information and facilitated its processing. Usually, traffic light labels make use of bold familiar words ('medium', 'low' and 'high') combined with colour schemes. Although visual search studies reported faster attention capture with monochrome than color-coded labels (Bialkova & Van Trijp, 2010), consumers seem to prefer color-coded traffic light labels (Kelly et al., 2009). Besides, traffic light labels are bigger in size than the Choices logos, and thus can be more salient.

Based on the previous studies, we propose the following hypothesis:

H1. Consumers pay more attention to the traffic light labels compared to the Choices logos.

Cognitive information processing and decision making can take different routes depending on motivation, cognitive resources and time available to a person (Petty & Cacioppo, 1986). Information can be processed quickly and automatically or relatively slow and consciously using goal-directed attention and rational thinking. When people have limited time resources, their capacity for controlled, deliberate or systematic thinking decreases (Kahneman & Frederick, 2002). Recent studies suggest that consumer food choice is guided by automatic, heuristic information processing, which requires less time and cognitive resources than elaborate information processing (Fenko, Lotterman, & Galetzka, 2016; Fenko, De Vries, & Van Rompay, 2018). Time pressure decreases cognitive resources and thus negatively influences visual attention towards nutrition labels (Van Herpen & Van Trijp, 2011).

Therefore, in this study, the following hypothesis is tested:

H2. Visual attention to health labels is lower for participants in the time constraints condition compared to the condition without time constraints.

Interest in healthy eating, measured by the General Health Interest scale (GHI), appears to influence healthy food choice (Roininen, Lähteenmäki, & Tuorila, 1999; Zandstra, De Graaf & Van Staveren, 2001). People with high GHI are more likely to purchase food products based on their health benefits rather than hedonic benefits (Lähteenmäki, 2013) and are more likely to choose low fat foods (e.g., an apple) over a chocolate snack (Roininen et al., 2001). Furthermore, when shopping for food, people with high interest in health pay more attention to health labels (Vyth et al., 2011).

Research suggests that the effect of nutrition information depends on whether consumers have a preference goal or a health goal when making choices (Bialkova & Van Trijp, 2011). Consumers with health goals pay more attention to nutrition labels than consumers with preference goals (Visschers, Hess & Siegrist, 2010). Thus, General Health Interest might be an important determinant of visual attention to nutrition labels. The study suggests the following hypothesis:

H3. Consumers with high General Health Interest pay more attention to health labels compared to consumers with low General Health Interest.

Prior knowledge has been known to render cognitive processes such as attention and subsequent decision making. A review by Soederberg, Miller and Cassady (2015) showed that prior knowledge is indeed significantly associated with food label use. Christie and Klein (1995) have demonstrated that consumers pay more visual attention to a familiar item compared to an unfamiliar one. Furthermore, visual attention is drawn to the familiar item if both familiar and unfamiliar items exist in the same display at random locations.

Dutch consumers are more familiar to the Choices logos compared to the traffic light labels (Van Herpen, Seiss & Van Trijp, 2012). However, the Choices logos have recently received a lot of public criticism in the Netherlands. Consumers have become more sceptical about the Choices logos (Elving & Steenhuis, 2014), which may reduce the trust and influence visual attention in a negative way (Fenko, Kersten, & Bialkova, 2016).

In this study, the following hypothesis was tested:

H4. The higher is the familiarity with the health label, the higher will be the visual attention to this label.

1.3. Effect of visual attention on product choice

It has been demonstrated across different tasks that several gazing parameters are correlated with choice decisions (Glaholt & Reingold, 2012; Orquin & Mueller Loose, 2013). Summarizing several eye-tracking studies, it was found that participants tend to have more fixations on the alternative they choose (Schotter, Gerety, & Rayner, 2012). For instance, Pieters and Warlop (1999) examined the relationship between attention and brand choice and found that consumers were more likely to choose the brands on which they fixated their gaze longer. Samant and Seo (2016) studied the effect of label knowledge on consumers' purchase behaviour. They found that people with high label knowledge looked at label claims associated with sustainability and process more often and longer than those with low label knowledge. Furthermore, participants with high label knowledge liked and trusted the products significantly more than those with low knowledge, suggesting that visual attention to labels positively influences the expected product liking and subsequent purchase behaviour.

Recently, Duerrschmid and Danner (2018) investigated the relationship between gazing behaviour and food choice. Pictures of four product alternatives were presented on the screen of a Tobii T60 eye tracker, and the participants' task was to choose the product that appealed most to them. The results showed a strong correlation between choice probability and visual attention in the form of the number of fixations and fixation duration. If a product received more visual attention, its probability of being chosen was significantly higher.

In a choice experiment combined with eye tracking, Bialkova et al. (2014) investigated to which extent attention to various formats of nutrition labels mediates the effect of labels on product choice. Consumers were asked to choose the healthiest product or the product of their preference. Participants with a health goal looked longer and more frequently to health labels compared to participants with a preference goal. Furthermore, the product fixated on longer had the highest likelihood of being chosen. Based on these results, the authors argue that visual attention mediates the effect of health labels on product choice.

Based on the previous studies, we propose the following hypothesis:

H5. The higher is the visual attention to health labels, the healthier will be the subsequent food choice.

2. Method

2.1. Participants

Participants were randomly recruited at a university canteen and through social media and e-mail. Forty-eight participants (26 females, aged from 18 to 63 years, mean age 31) took part in the experiment. All participants had normal or corrected-to-normal vision.

Table 1
Demographics of the participants per condition.

Condition		Male	Female	Age (SD)	N
Time constraints	Low GHI	7	5	28.9 (13.5)	12
	High GHI	6	6	34.1 (15.8)	12
No time constraints	Low GHI	5	7	28.2 (8.2)	12
	High GHI	4	8	33.2 (13.8)	12
Total		22	26	31.1 (13.0)	48

Participants were randomly assigned to one of the experimental conditions (see Table 1). The demographic differences between conditions were non-significant (both p's $> .05$).

2.2. Stimulus material

Yoghurt was chosen as a product category because it can be easily categorised into healthy (low-fat), less healthy (semi-fat) and unhealthy (full-fat) subcategories. Twelve packages of yoghurt were developed by adding either a Choice logo or a traffic light label to the existing packages. The Choices logo attached to the packages was 1.95 x 1.95 cm, and the traffic light label was 1.7 × 5.5 cm.

The packages selected for modification had a similar colour scheme (predominantly green and white) and contained either no images or a simplified image of a yoghurt bowl. Eight packages contained a brand name and four packages did not contain a brand name. Four of the yoghurts were low-fat (the healthiest option), four were semi-fat (the less healthy option) and four were full-fat (the unhealthy option). Four products contained traffic light labels, four contained the Choices logos and four had no health logos.

In the low-fat and semi-fat categories, two packages had the Choices logo, one had a traffic light label and one package had no logo. In the full-fat category, two packages had traffic light labels and two packages had no logo. In order to maintain the credibility of the experimental products, the Choices logo was not attached to the full-fat yoghurt. The Choices logo cannot be attached to packages of full-fat yoghurt because this type of yoghurt does not meet the requirements to receive a Choices logo, and Dutch consumers are aware of that. However, the total amounts of products with traffic light labels, the Choices logos and without health logos were equal.

The position of the stimuli on the shelves was randomized in order to control for the influence of shelf position on consumer attention. Twelve different shelf arrangements were created; each arrangement was shown to four participants (see Fig. 1A).

2.3. Procedure

Each participant was invited to a university canteen at a specific time and date. There, they received a brief instruction and signed an informed consent form. The high time constraints condition was manipulated by the following phrase, which the experimenter said to a participant after installing and calibrating the mobile eye tracker: *"You need to hurry up a little bit, because there are other participants waiting already"*. In the low time constraints condition the experimenter installed and calibrated the mobile eye-tracker without saying anything.

The manipulation check showed that the manipulation was successful. In the time constraint condition, participants spent significantly less time on the experimental task ($M = 15.25\,s \pm 0.87\,s$,) than in the no time constraint condition ($M = 28.79\,s \pm 4.15\,s$, $t(46) = -3.19$, $p < .05$).

In order to collect accurate eye tracking data, Tobii Glasses 2 should be calibrated individually for each participant. The calibration target

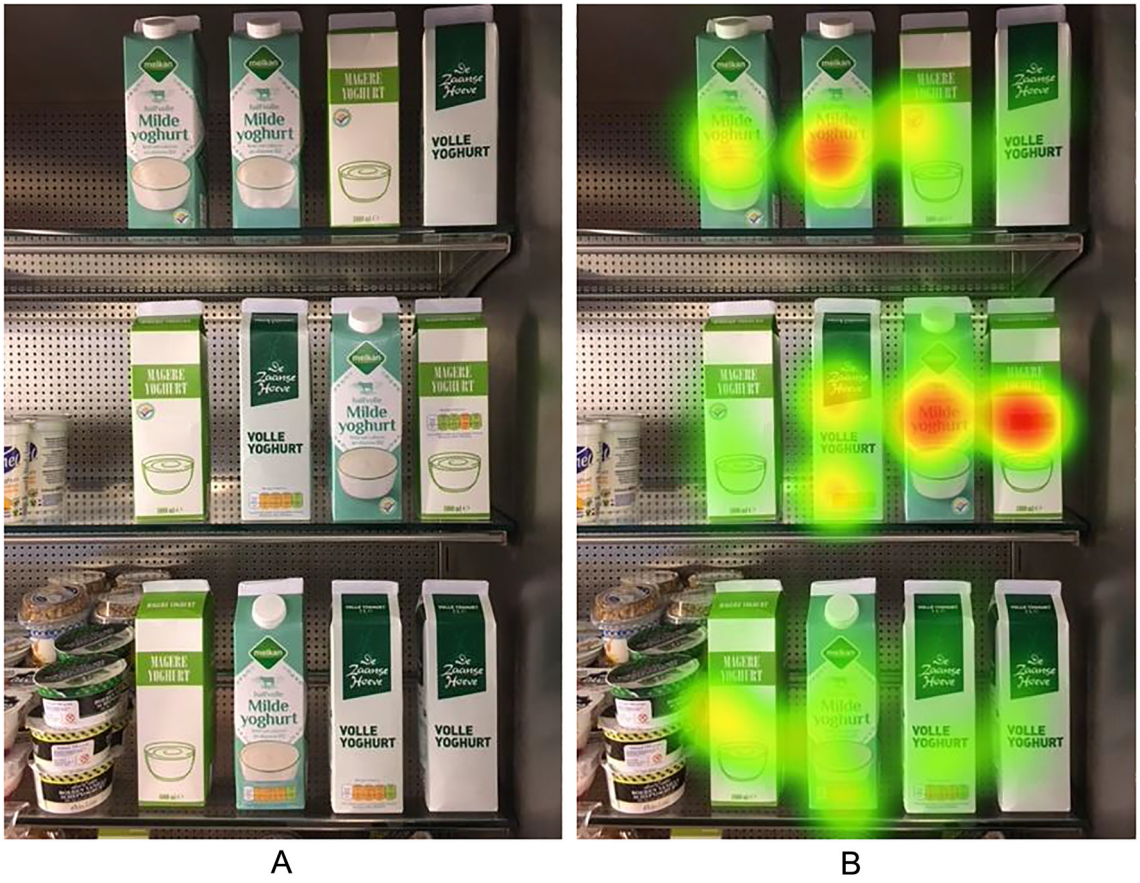

Fig. 1. An example of the shelf arrangement of the stimuli (A) and the heat map created by Tobii Pro Lab (B). The heat map demonstrates how the fixation duration was distributed for four participants that have seen the same shelf arrangement. Dark red corresponds to the long fixation duration and light green to the short fixation duration. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

was attached to the back of the iPad and shown to participants at a distance of 2 m. Participants were asked to look at the centre of the Calibration Target. The Toby Pro Glasses 2 software gave a notion when the calibration was successful.

After installing and calibrating the mobile eye tracker, participants were asked to walk to the food area of the canteen and to choose one package of yoghurt of their choice from the refrigerated shelf. After that they were instructed to return to the experimenter with the pack of yoghurt they selected. There the mobile eye-tracker was removed from their head, and they were further asked to fill in a short questionnaire.

After completing this task, participants filled out the questionnaire on the laptop, containing the questions about their General Health Interest, familiarity with the labels, and demographic characteristics. The whole procedure took approximately five minutes per participant.

2.4. Measures

Eye-tracking data are usually reported in terms of the number of fixations and fixation duration (e.g., Rayner, 1998, 2009). During the experiment participants were wearing Tobii Pro Glasses 2 (Tobii Technology AB, Sweden) that measured 1) the number of fixations on the Areas of Interest, and 2) fixation duration (in seconds) on the areas of interest (AOI).

Fixation Duration (s) measures the duration for all fixations within an AOI. The minimum fixation duration was set at 80 ms (Bialkova & van Trijp, 2011; Komogortsev et. al., 2010). All fixations shorter than the 80 ms were classified as non-fixation data points.

The number of fixations measures the number of times participants fixated on an AOI.

Areas of Interest included the traffic light labels, the Choices logos, brand names and the labels indicating fat content. Fixation duration on the areas of interest is typically illustrated by the heat map which gives an intuitive visualization of the eye-tracking data. An example of a heat map generated during the experiment is presented in Fig. 1B.

General Health Interest was measured with the balanced 8-item General Health Interest scale (Roininen et al., 1999) using a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The reliability of the scale was high (Chronbach's $\alpha = 0.81$). By using the median of 4.31, participants were grouped in either high or low GHI groups.

Familiarity with the health labels was measured on a 7-point Likert scale with the question: "Are you familiar with the label shown on the right?", repeated for both labels.

The healthiness of the participants' choice was indicated by the choice of a low-fat yoghurt (the healthiest choice), a low-fat yoghurt (a less healthy choice), or a full-fat yoghurt (an unhealthy choice).

2.5. Data analysis

Two-way ANOVAs with Time constraints (low vs high) and General Health Interest (low vs high) were performed on the number of fixations and fixation duration on traffic light labels and Choices logos. Post-hoc tests with Bonferroni correction were used for post-hoc pairwise comparisons.

The multinomial logistic regression was used to test the hypothesis about the mediating role of visual attention to health labels in healthy food choice that was reported in the previous experiment using static eye-tracker and computer images of food packages (Bialkova et al., 2014). Our goal was to find out whether similar results could be obtained in a more realistic field study using mobile eye-tracker and the

Table 2
Mean number of fixations and fixation duration (s) on the main areas of interest: health labels, fat content and brand names (± SE).

		Number of fixations	Fixation duration (s)
Label type	Traffic light	2.23 (± 0.41)	1.19 (± 0.28)
	Choices	1.08 (± 0.20)	0.49 (± 0.10)
Fat content	Low-fat	0.85 (± 0.19)	0.30 (± 0.08)
	Semi-fat	2.56 (± 0.41)	1.17 (± 0.23)
	High-fat	5.10 (± 0.76)	2.17 (± 0.38)
Brand	Melkan	0.75 (± 0.18)	0.31 (± 0.08)
	Zaanse Hoeve	1.10 (± 0.21)	0.44 (± 0.09)

actual food packages. For that reason, we used the same attention metrics (fixation duration and fixation count) reported by Bialkova et al. (2014) and the same statistical model (multinomial logistic regression).

Multinomial logistic regression was used to predict the final choice of yoghurt (low-fat, semi-fat of full-fat). The predictors included the number of fixations and fixation duration on the traffic light and the Choices logos, time constraints, and General Health Interest.

3. Results

3.1. Effect of a label format

The analysis of fixations on the areas of interests showed that participants fixated significantly more often ($t(47) = 3.02$, $p < .01$) and significantly longer ($t(47) = 2.71$, $p < .01$) on the traffic light labels compared to the Choices logos (see Table 2). This result confirms H1.

Analysis of the other areas of interest indicated that the high-fat label attracted the most visual attention in terms of both the number of fixations and fixation duration. Both brand names did not attract much attention compared to traffic light labels, and the differences between two brands on both the number of fixations ($t(47) = 1.45$, $p > .05$) and fixation duration ($t(47) = 0.91$, $p > .05$) were non-significant.

3.2. Effect of time constraints

The results of the ANOVAs with Time constraints (low vs high) and General Health Interest (low vs high) showed significant effects of time constraints on both measures of visual attention for both labels (see Table 3 for the overview of statistical tests). The number of fixations on traffic light labels without time constraints (3.04 ± 0.35) was higher than the number of fixations under time constraints (1.41 ± 0.35). The fixation duration on traffic light labels without time constraints (1.72 ± 0.37) was higher than without time constraints (0.66 ± 0.37). Similarly, the number of fixations on Choices logos without time constraints (1.54 ± 0.26) was higher than under time constraints (0.62 ± 0.26), and the fixation duration on Choices logos without time constraints was higher (0.69 ± 0.13) than under time constraints (0.27 ± 0.13). These data confirm H2.

3.3. Moderating effect of General health Interest

In the two-way ANOVAs with Time constraints (low vs high) and General Health Interest (low vs high), the main effect of *General Health Interest* on the number of fixations and fixation duration on traffic light labels and Choices logos was not significant (see Table 3). Thus, H3 was not supported.

However, the results revealed significant interaction effects of time constraints and GHI on all four variables. The effects are illustrated at Fig. 2. Post-hoc tests showed that in the low GHI condition, the differences in the number of fixations and fixation duration on traffic light labels are non-significant (both p's > .05). However, for participants with high GHI, the number of fixations without time constraints (4.41 ± 0.57) is higher than under time constraints (1.25 ± 0.57, $p < .05$). Similarly, for participants with low GHI, fixation duration without time constraints (2.67 ± 0.53) is higher than under time constraints (0.43 ± 0.53). In a similar way, in the low GHI condition, the differences in the number of fixations and fixation duration on Choices logos are non-significant (both p's > .05). However, for participants with high GHI, the number of fixations on Choices logos without time constraints (2.08 ± 0.28) is higher than under time constraints (0.33 ± 0.28, $p < .05$). Furthermore, for participants with low GHI, fixation duration on Choices logos without time constraints (0.98 ± 0.11) is higher than under time constraints (0.15 ± 0.11).

3.4. Effect of familiarity

Familiarity with the traffic light label (M = 3.56, SD = 1.11) was lower than familiarity with the Choices logo (M = 4.33, SD = 0.75, $t = -4.03$, $p < .001$). However, the attention to the traffic light label was significantly higher than to the Choices logo. Linear regression analyses showed that familiarity with the traffic light label did not significantly affect the number of fixations ($\beta = -0.22$, $t = -1.51$, $p > .05$) and fixation duration on the traffic light labels ($\beta = -0.26$, $t = -1.79$, $p > .05$). Similarly, familiarity with the Choices logo did not influence the number of fixations ($\beta = 0.13$, $t = 0.80$, $p > .05$) and the fixation duration ($\beta = 0.11$, $t = 0.79$, $p > .05$) on the Choices logos. Therefore, H4 is not confirmed.

3.5. Effect of visual attention to health labels on healthy food choice

Participants looked significantly longer and more often at the traffic light labels compared to the Choices logos. However, they have chosen approximately the same number of products with the traffic light (N = 21) and the Choices logo (N = 18, $\chi^2 = 1.7$, $p > .05$), see

Table 3
Summary of ANOVA tests.

Factor	DV	Df	F	p
Time constraints	Number of fixations on traffic light labels	1 (44)	4.61	.03*
	Fixation duration on traffic light labels	1 (44)	4.41	.04*
	Number of fixations on Choices Logos	1 (44)	5.81	.02*
	Fixation duration on Choices Logos	1 (44)	5.06	.03*
General Health Interest	Number of fixations on traffic light labels	1 (44)	2.54	.12
	Fixation duration on traffic light labels	1 (44)	1.85	.18
	Number of fixations on Choices Logos	1 (44)	0.43	.51
	Fixation duration on Choices Logos	1 (44)	0.59	.44
Time constraints x GHI	Number of fixations on traffic light labels	1 (44)	4.15	.04*
	Fixation duration on traffic light labels	1 (44)	4.82	.03*
	Number of fixations on Choices Logos	1 (44)	4.79	.03*
	Fixation duration on Choices Logos	1 (44)	5.18	.02*

Fig. 2. The number of fixations on Choices logos (A) and traffic light labels (B), and the fixation duration (s) on Choices logos (C) and traffic light labels (D) for consumers with high versus low General Health Interest in time constraints and no time constraints conditions (with SE).

Table 4).

To further examine the influence of visual attention to health labels on product choice, multinomial logistic regression was used to predict the final choice of yoghurt (low-fat, semi-fat of full-fat). The predictors included the number of fixations and fixation duration on the traffic light labels and the Choices logos, time constraints, and General Health Interest (see Table 5). The fit between the model and the data was significant ($\chi^2 = 21.34$, Nagelkerke's $R^2 = 0.405$, $p < .05$). The contributions of GHI, fixation duration on traffic light labels and the number of fixations on Choice logos were significant, while the contributions of time constraints, fixation duration on Choices logos and the number of fixations on the traffic light labels were marginally significant (see Table 5).

When predicting the final choice of a product, GHI, fixation duration on traffic light labels and the number of fixations on traffic light labels significantly affected the choice of low-fat over the full-fat yoghurt (see Table 6), while time constraints, fixation duration on traffic light labels and the number of fixations on the Choices logos significantly predicted the choice of the semi-fat yoghurt over the full-fat yoghurt (see Table 6).

However, the predictive power of the model for the healthy choice was low. Compared to the observed product choice, using the logistic model results in 50% correct prediction of the product choice. Compared to the observed product choice of low-fat, semi-fat and high-fat products, correct predictions were more frequent for the choice of a semi-fat yoghurt (65%) and full-fat yoghurt (57.1%) than for the choice of a low-fat yoghurt (21.4%).

Table 5
Contributions of visual attention, GHI and time constraints in Multinomial Logistic Regression Model.

Predictor	χ^2	DF	p-value
Fixation duration on Choices logo	4.90	2	.08
Fixation duration on traffic light Labels	6.57	2	.03*
Number of fixations on Choices logo	6.06	2	.04*
Number of fixations on traffic light labels	5.69	2	.05
GHI	6.08	2	.04*
Time constraints	5.29	2	.07

4. Discussion

This research examined the influence of the traffic light labels and the Choices logos on visual attention and consumer choice. The results confirm the hypothesis (H1) that visual attention to the traffic light labels is higher than to the Choices logos, which is in line with previous findings (Graham, et al., 2012; Pieters & Wedel, 2004).

The data also confirm the hypothesis (H2) that time constraints negatively influence visual attention to health labels. Pieters and Warlop (1999) suggested that consumers under time pressure adjust their attention process: they accelerate information acquisition by reducing the duration of fixations on the stimulus. Our findings confirm

Table 4
The number of products chosen as a function of experimental condition and GHI.

	Health labels			Time constraints		GHI		Total
	Traffic light	Choices	No logo	Yes	No	High	Low	
Low-fat yoghurt	8	6	0	7	7	10	4	14
Semi-fat yoghurt	5	12	3	12	8	10	10	20
Full-fat yoghurt	8	0	6	5	9	4	10	14

Table 6
Parameter estimates for the final product choice.

Product choice	Predictors	B	Wald	Df	p
Low-fat over full-fat	Fixation duration on Choices logo	−2.59	0.41	1	.52
	Fixation duration on traffic light Labels	11.19	4.91	1	.02*
	Number of fixations on Choices logo	2.05	0.43	1	.51
	Number of fixations on traffic light labels	−8.11	4.51	1	.03*
	GHI	1.10	4.9	1	.02*
	Time constraints	1.49	2.25	1	.13
Semi-fat over full-fat	Fixation duration on Choices logo	−7.62	3.56	1	.06
	Fixation duration on traffic light Labels	9.59	4.91	1	.04*
	Number of fixations on Choices logo	6.20	4.29	1	.03*
	Number of fixations on traffic light labels	−6.59	3.48	1	.06
	GHI	.806	2.86	1	.09
	Time constraints	2.039	4.476	1	.03*

this suggestion: consumers who did not experience time constraints fixated more often and longer on both the traffic light labels and the Choices logos compared to consumers under the time constraints.

We expected that consumers' General Health Interest would positively influence visual attention towards health labels (H3). The data did not support this hypothesis. However, we found that General Health Interest moderates the effect of time constraints on visual attention to health labels. Participants with high General Health Interest look at health labels longer and more often without time constraints than under the time constraints. However, time constraints did not influence visual attention of the participants with low GHI. These data suggest that in order to attract attention to the health labels, two conditions have to be met: participants should be motivated to process health information and they should have enough time to elaborate on this information.

Our findings are in line with the Elaboration Likelihood Model (Petty & Cacioppo, 1986), which suggest that the motivation to engage in elaboration increases when personal involvement increases, and that the ability to engage in elaboration can be influenced by the amount of time available for information processing. People who are interested in healthy eating analyse information more systematically and are more likely to respond to central cues, including health labels, than to peripheral cues, such as packaging colours, images and brand names (Fenko, et al., 2016). Visscher and colleagues (2010) also found that health motivation stimulates deeper processing of nutrition information. Our study contributes to these findings by specifying that the central information processing guided by the health motivation can be disrupted by time constraints.

In line with previous findings (Van Herpen, et al., 2012), our results showed that the Choices logos are more familiar to Dutch consumers compared to the traffic light labels. However, we did not find significant effects of label familiarity on visual attention (H4 was not supported). Our data suggest that the higher level of attention towards the traffic light labels can be explained by the interest towards a less familiar label. The experimental products presented to participants were familiar to consumers. They were the regular brands and packages of yoghurt that can be found in Dutch supermarkets. However, the traffic light label is normally not displayed at these packages. Seeing familiar products with the unfamiliar label could result in surprise and thus increase the interest and attention towards the new package element. However, the bigger size of the traffic light label and its colour could also be the reasons for capturing more visual attention (Bialkova & van Trijp, 2010; Van Herpen & Van Trijp, 2011).

We expected that the attention to health labels would positively influence the subsequent healthy product choice (H5). Although attention towards the traffic light labels was significantly higher than towards the Choices logos, the final product choice did not show consumer preferences for products with the traffic light labels. The multinomial regression model demonstrated that visual attention in terms of fixation duration on traffic light labels and the number of fixations on Choice logos, as well as General Health Interest, significantly predicts the subsequent product choice. However, the model was poor in predicting the healthy choice. Correct predictions were more frequent for the choice of a semi-fat yoghurt (65%) and full-fat yoghurt (57.1%) than for the choice of a low-fat yoghurt (21.4%).

Although several previous studies found positive effects of visual attention on product choice (e.g., Bialkova et al., 2014; Duerrschmid & Danner, 2018, Pieters & Warlop, 1999; Samant & Seo, 2016), some studies suggest that people do not necessarily look at the labels in order to make a decision about which product to choose. For instance, a recent study of Coulthard, Hooge, Smeets, and Zandstra (2017) investigated the effects of implicit visual cues on food package design on visual attention and subsequent decision-making. Participants chose between two products while their eye movements were measured with eye tracking. Target stimuli were identical soups with labels varying in shape, angularity and orientation. Results showed that packages with upward-rounded labels were chosen most often, although participants only looked at them for a very short time. This research suggests that labels can affect subsequent decision-making when perceived by peripheral vision. Although gazing behaviour and especially fixations are highly correlated with attention, information in the peripheral field of vision can still be perceived and processed to a certain degree and may potentially influence choice or other behaviour (Yokoyama, Sakai, Noguchi, & Kita, 2014).

The aim of our study was to compare the influence of the Choices logos and traffic light labels on consumer attention and food choice in a realistic shopping environment. In such environments traffic light labels can be attached to unhealthy products, while the Choices logos can only be attached to relatively healthy products within a given category. This difference can influence the relative usefulness of the labels in the decision-making process. However, it was unlikely to influence the current data, since in this study we balanced the amount of healthy (4), less healthy (4) and unhealthy products (4) and the amount of products with the Choices logo (4), traffic light label (4) and without a label (4).

4.1. Limitations of mobile eye tracking

One of the limitations of eye tracking is related to its ability to investigate only overt visual attention, which occurs when the observer's visual attention matches the fixated aspect of the stimulus. Another limitation is the relatively high price of eye tracking equipment and the need for a technical experience to set it up. In our study, this resulted in the limited time the equipment was available for the experiment, which determined a relatively low number of participants. A bigger sample could result in more reliable results.

Besides, the eye-tracking data may be biased by the participants' awareness of observation of their gazing behaviour. Participants could try to guess the goals of the experiment and move their gaze consciously and deliberately to areas of the stimuli that they consider to be the most appropriate or socially desirable.

Mobile eye-tracking might also provide less precise measurement of gazing behaviour compared to the static eye-tracker. When participants move freely around the shop, they look at objects from different distances. The glasses are only calibrated at a single distance and the scene camera is never in the exact same position as the eye. This can explain the weak predictive power of gazing behaviour in our study.

Nevertheless, using mobile eye-tracker gives valuable insights into consumer behaviour in realistic shopping environment. It highlights the complexity of consumer decision-making and allows to study the influence of the factors that cannot be captured in the lab experiments

with static eye-tracker, such as the store design, the presence of other people, the distance to the shelf, and the position of a product on a shelf. In general, eye tracking methodology gives more accurate estimates of health label use than self-report measures (Duchowski, 2007).

4.2. Further research

Our results demonstrated that both the label format and time constraints significantly influence visual attention towards health labels, and that the effects of time constraints are moderated by General Health Interest. However, visual attention towards health labels was a poor predictor of a subsequent product choice. This raises another interesting question for future research: What in the visual field of a consumer walking towards a supermarket shelf determines the actual product choice?

In our study, product choice was not significantly affected by the brand or the fat content of the experimental products. However, we only manipulated two regular brands of a low involvement product. For other product categories, such as soft drinks or beer, brand might be a significant predictor of product choice (Pieters & Warlop, 1999). Therefore, in future research using mobile eye tracking it is interesting to look at the visual attention toward the brand names of other product categories to see whether attention to brand names can mediate product choice. Other packaging elements, such as colour, shape, material and images displayed on packages, have been shown to influence product choice (see Spence, 2016; Krishna, Cian, & Aydınoglu, 2017 for the recent reviews). It is interesting to see whether the effects of sensory and informational packaging elements are mediated by visual attention to these elements.

In our study, the Choices logo was found more familiar to participants than the traffic light labels. However, the traffic light label attracted more consumer attention than the Choice logo. This result is surprising, but it could be explained by the specific combination of familiar products with unfamiliar food labels used in the study. In future eye-tracking research, it would be interesting to see how (un)familiarity with different product attributes affects visual attention and how it is related to the subsequent product choice.

5. Conclusions

This study investigated visual attention towards traffic light labels and the Choices logos in the realistic environment of a university canteen. The results demonstrated that traffic light labels attract more consumer attention in terms of the number of fixations and fixation duration than the Choices logos. Attention to both labels was significantly disrupted by time constraints. Furthermore, consumers' General Health Interest moderated the effect of time constraints on visual attention. In the situation without time constraints visual attention to health labels increased only for participants with high General Health Interest, but not for participants with low General Health Interest. This result suggests that both time resources and motivation in terms of General Health Interest and are necessary for consumers to pay attention to health labels. However, the study did not find direct evidence of the influence of visual attention towards health labels on healthy food choice. Further research is needed to find out how the health labels are processed in a real shopping situation and whether visual attention to other packaging elements may predict product choice.

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