Title: Combining discrete choice experiment, eye tracking and sensory tests to assess consumer preferences for nutritional and health claims

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Abstract

Nutritional and health claim (NHCs) requirements on food packages are among the most important and influential policy measures that help consumers make more informed and healthier food choices. This study combines a discrete choice experiment (CE) method with the eye-tracking (ET) technology to assess consumer preferences for multiple NHCs on a yogurt selection, and explores how taste affects preferences during choice decision. Results indicate that: i) health claims outperform nutritional claims leading to higher utilities, ii) preferences towards NHCs change when participants taste the products, and iii) even though not in the same exact order due to treatment effects, the utility preference ranking indicates that there is a consistency in the relation between the visual attendance (fixation count) and actual choices. This finding suggests that total fixation count can be interpreted as a proxy for actual choices.

Key words: Choice experiment; eye-tracking; visual attention; sensorial analysis; nutritional and health claims

1. Introduction

In the European food market, the most important attributes for consumers are taste and health (Nielsen et al., 1998). One way to communicate the potential health benefits of food products is the use of NHCs[1]. The European Food Safety Authority has provided a list of authorized NHCs and conditions for their use (Regulation (EC) No 1924/2006). Evidence from previous studies show that NHCs lead to healthier diets (Jurado & Gracia, 2017; Lopez-Galan & De-Magistris 2017; De-Magistris & Lopez-Galan, 2016), however, since consumers spend only few seconds when selecting products, some of the available information in the food labels might not be attended (Milosavljevic & Cerf, 2008). Therefore, identifying consumers' attention becomes a key aspect for the design of food labels. In this paper, we focused on this latter aspect by exploring consumer choice and attention of different NHCs on different types of yogurts and explore whether taste influences the final purchase decision. The study focuses on NHCs because they are a simpler way to present information compared to nutritional facts, where consumers spend more time obtaining information. Taste is important for yogurts because consumers generally perceive savory foods as less healthy than healthy foods. Hence, knowing if the taste influences in the choice decision of a food that consumers already perceive as not very tasty, would be of particular interest. In addition, taste is considered as one of the most important determinants that generate repeated purchases (Bollinger et al. 2011; Elbel et al. 2011). Therefore, we divide the sample into two groups (taste and no-taste) to measure the differences in the final decision[2].

To elicit consumer preferences for alternative NHCs, we employ a hypothetical choice experiment (CE) using a yoghurt selection and measure the visual attention with the eye-tracking (ET) technology in terms of fixation count. The ET technology is mainly used in marketing and psychology. For example, a number of marketing studies have used ET to measure the level of attention to certain brands on shelves and have found relation between attention and subsequent purchase choices (Wedel and Pieters, 2007; Aribarg et al. 2010). Recently, ET has been also used in economics to examine how visual attention relates to decision making. For example, a number of studies have combined CE and ET (Van Loo et al. 2015; Bialkova et al. 2014; Bialkova and van Trijp 2011) to assess how visual attention affects choice behavior. Results from these studies generally indicate that attention plays a pilot role in determining choice behavior for a variety of food products and their attributes. However, to the best of our knowledge, no previous research has examined how attention affects final food choices on specific NHCs and examine whether taste influences final choice decisions. The current study contributes to this research gap by identifying the visual attention paid to multiple NHCs on yogurts. We proceed as follows; in Section 2 we present the materials and methods. In Section 3 we report the results of our experiment and in Section 4 we conclude and discuss.

[1] Specifically, the EU regulation (EC) No. 1924/2006 defines a nutritional claim as "any statement that suggests or implies that a food has specific beneficial nutritional properties", and health claims as any claim that ‘‘states, suggests or implies that a relationship exists between a food category, a food or one of its constituents and health” (Regulation (EC) No 1924/2006).

[2] Results from the sensorial analysis are not included in this research paper.

2. Materials and Methods

Nutritional and health claim labeling and experimental design of choice experiment

The study was carried out in the city of Zaragoza-Spain, in 2016. A total of 218 participants were divided into two treatments: i) an eye-tracking choice experiment on NHCs with tasting, and ii) an eye-tracking CE on NHCs without tasting. Visual attention was measured in both treatments.

The selection of the NHCs attributes and levels was in accordance to the EU official definitions (Regulation (EC) No 1924/2006). To determine the presence of NHCs we created a database that collects information regarding yogurts with NHCs available in the Spanish market. We chose yogurt as a product of interest because it is considered as a healthy food product and contains a large variety of NHCs. Results indicated that out of 480 yoghurts in total, 261 of them contained one NC and 67 one HC in the package. We selected a package of 500g (125x4) because it was the quantity with the highest presence and six levels of NCs and eight levels of HCs. A plain yogurt was selected as baseline for comparison. Table 1 shows the attributes and attribute levels included in the CE.

Table 1: Levels of nutritional claims used

Nº	NC levels	Presence (%)	HC levels	Presence (%)
1º	Fat-free	42.78	1. Reducing consumption of saturated fat contributes to the maintenance of normal blood cholesterol levels (A)*	-
2º	Source of calcium	21.25	2. Calcium is necessary for maintaining bones under normal conditions	2.17
			3. Calcium contributes to normal muscle function (A)	-
3º	Plain - Full fat (Baseline)	12.26	-	-
4º	Low sugars	11.99	4. Consumption of food containing sweeteners instead of sugar induces a lower blood glucose (A)	-
5º	Source of vitamin B6	10.63	5. With vitamin B6 that helps your defenses and reduces fatigue	10.33
			6. Vitamin B6 contributes to the normal functioning of nervous system (A)	-
6º	Source of fiber	1.09	7. Fiber contributes to an acceleration of intestinal transit	3.80
			8. Fiber contributes to an increase in fecal bulk (A)	-

* Defines that a HC has not yet being introduced to the local market - absent (A).

Several studies indicate that health claims are not fully understood by the "average consumer". Hence, in addition to those present in the local market (e.g., health claims number 2, 5 and 7 as reported in table1) we have used five additional NHCs regulated by the Regulation (EC) No 1924/2006 (e.g., health claims number 1, 3, 4, 6 and 8 as reported in table 1) that are easier to understand according to a focus group of fifteen "average consumers" we carried out before the experiments. In our study we replicated Carlsson et al., (2007) by using a CE without the price attribute. Other examples of excluding the price attribute in experimental choice paradigms combined with ET are also performed by Bialkova and van Trijp, (2011) and Bialkova et al., (2014) who analyze the attention and choice of nutritional information. As in Carlsson et al., (2007), we told participants that all alternatives cost the same. We used a full

crossing of the experimental factors, which leaded to 44 choice sets of NHCs to be evaluated. To reduce this number to a more effective manageable size, we divided them into 4 blocks of 11 choice sets. Each choice set included three alternatives: two designed alternatives consisting of different products and a non-buy option (i.e., A, B or opt-out).

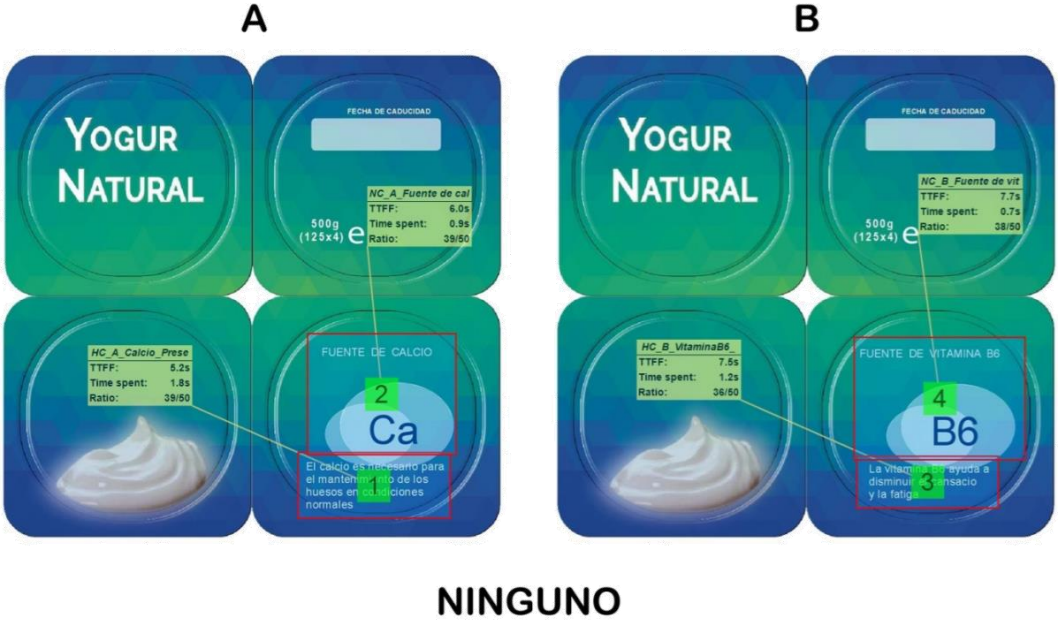
Experimental procedures of eye-tracking

The combination of the choice set images was presented in full color on a 24" computer screen with a 1920x1080 pixel resolution. Eye positions were sampled at 50 Hz, with remote ET device (Tobii X2-30 Eye tracker) integrated under the computer screen of which the stimuli were displayed. Before the CE task participants received instructions and the ET device was individually calibrated using the nine-point calibration procedure. After a successful calibration, one warm-up choice set was presented to fully familiarize participants with the experimental procedures. Participants knew that the ET technology was applied but where not aware of its purpose. Visual stimuli of yogurt packages were presented and participants had 15 seconds to observe and after were asked to choose "out-loud" the mostly preferred yoghurt as in Bialkova and van Trijp, (2011) and Bialkova et al. (2014). Then the facilitator was choosing their stated preference from a parallel screen.

Eye-tracking measures

Areas of interest (AOIs)[3] were defined on the NHCs (figure 1) corresponding to each of the fourteen attributes. Visual attention was measured for each attribute (AOI) in terms of fixation count. Fixation count is the number of times a participant fixated her/his gaze on the AOI. More fixation counts means that the area is more noticeable with respect to the rest of AOI present in that choice set (Poole et al. 2005).

Figure 1: An example of an AOI and the information provided after the experiment



[3] Area-of-interest (AOI) is the selected area within an image which will provide the eye tracking data.

Model specification: Mixed logit model accounting for preference heterogeneity

CE is consistent with the random utility theory and the Lancaster theory (Lancaster, 1966) of consumer demand. Accordingly, the utility that individual *n* derives from alternative *j* at choice occasion *t* can be represented as follows:

$$(1)\quad \mathrm{U_{njt}} = V_{\mathrm{njt}} + \ \varepsilon_{\mathrm{njt}}$$

where V_{nj} is the representative portion of the utility that depends on the attributes presented in alternative *j*, and ε_{nj} is the stochastic (unobserved and treated as random) element, which is assumed to be *iid* extreme type 1 distributed.

We estimated the data using a random parameter logit (RPL) model. Two models were specified. Model I, which account for random taste variation for the NHCs, and Model II, which adds to Model I by incorporating the visual attention measures collected using the ET technology during the experiments. For both models I and II we used a split data approach[4]. Hence, we estimated the two models separately for each treatment: taste and no-taste.

In Model I, the utility that individual *n* derives from alternative *j* at choice occasion *t* can be represented as follows:

$$\begin{aligned}\mathrm{U_{njt}} = OptOut + \ \beta_1 ncfat_{njt} + \beta_2 hcfat_{njt} + \beta_3 ncsug + \beta_4 hcsug_{njt} + \beta_5 ncfib_{njt} \\ + \beta_6 hcpfib_{njt} + \beta_7 hcafib_{njt} + \beta_8 ncvit_{njt} + \ \beta_9 hcpvit_{njt} + \beta_9 hcavit_{njt} \\ + \beta_{10} nccal_{njt} + \beta_{11} hcpcal_{njt} + \beta_{12} hcacal_{njt} + \ \varepsilon_{\mathrm{njt}}\end{aligned}$$

$OptOut$ is the alternative-specific constant representing the opt-out option. The other thirteen attributes (nutritional claim fat-free *ncfat*, fat-free health claim *hcfat*, NC low in sugar *ncsug*, sugar HC *hcsug*, NC high in fiber *ncfib*, fiber present in the market HC *hcpfib*, fiber absent in the market HC *hcafib*, NC source of vitamin B6 *ncvit*, vitamin B6 present in the market HC *hcpvit*, vitamin B6 absent in the market HC *hcavit*, NC source of calcium *nccal*, calcium present in the market HC *hcpcal*, and calcium absent in the market HC *hcacal*) enter the model as dummy variables, where *"plain"* yoghurt represents the baseline. To investigate the effects of visual attention on consumer choice behavior and preferences, we used both the CE and the ET data and estimated one additional model (Model II). Once again, the data in Model II are estimated separately according to each treatment (taste and no-taste). Unlike Model I, this model also includes interaction terms between NHCs in the CE and visual attention measures in terms of fixation count[5]. Accordingly, the utility function that an individual *n* derives from alternative *j*, at choice situation *t*, can be defined as follows:

[4] We also estimated the two models using a pooled data approach to investigate whether differences across the taste and no-taste treatments is due to difference in preferences for the NHCs, in scale, or both. The scale effect was not statistically significant all pooled models indicating there is no difference in scale across the two treatments: taste and no-taste. Results from the pooled models from both model (model I and II) are not included in the final results and are available upon request.

[5] Fixation count enters in the utility model as dummy variable. It takes the value of 1 when the individuals' fixation count is equal to or higher than the mean of each attribute and 0 otherwise (i.e., the fat-free yoghurt takes the value of 1 if the fixation count is equal to or higher than 5, or 0 otherwise and so on for the remaining variables).

(2) $$U_{njt} = OptOut + \beta_1 ncfat_{njt} + \beta_2 hcfat_{njt} + \beta_3 ncsug_{njt} + \beta_4 hcsug_{njt} + \beta_5 ncfib_{njt} + \beta_6 hcpfib_{njt} + \beta_7 hcafib_{njt} + \beta_8 ncvit_{njt} + \beta_9 hcpvit_{njt} + \beta_9 hcavit_{njt} + \beta_{10} nccal_{njt} + \beta_{11} hcpcal_{njt} + \beta_{12} hcacal_{njt} + \gamma_{Ancfat}(FCncfat * ncfat_{njt}) + \gamma_{Ahcfat}(FChcfat * hcfat_{njt}) + \gamma_{Ancsug}(FCncsug * ncsug_{njt}) + \gamma_{Ancfib}(FCncfib * ncfib_{njt}) + \gamma_{Ahcpfib}(FChcpfib * hcpfib_{njt}) + \gamma_{Ahcafib}(FChcafib * hcafib_{njt}) + \gamma_{Ancvit}(FCncVit * ncvit_{njt}) + \gamma_{Ahcpvit}(FChcpVit * hcpvit_{njt}) + \gamma_{Ahcavit}(FChcaVit * hcavit_{njt}) + \gamma_{Anccal}(FCnccal * nccal_{njt}) + \gamma_{Ahcpcal}(FChcpcal * hcpcal_{njt}) + \gamma_{Ahcacal}(FChcacal * hcacal_{njt}) + \varepsilon_{njt}$$

where γ_{Ancfat} is the coefficient of the interaction term between the free-fat attribute and the fixation count for the free-fat label (*FCncfat*) attribute and so on for the other attributes (i.e., *γAhcfat, γAncsug, γAhcsug, γAncfib, γAhcpfib, γAhcafib, γAncvit, γAhcpvit, γAhcavit, γAnccal, γAhcpcal, γAhcacal*).

3. Results

Estimates from the mixed RPL models

Table 1 report the parameter estimates from models I and II across the "taste" and "no-taste treatments". We remind the readers that Model I accounts for random taste variation, while model II adds to Model I by also accounting for visual effects[6] on consumer valuation for the NHCs label. The mixed RPL estimates were conducted in Nlogit 5. Table 2 reports the coefficients of the two models.

In both models the coefficient of the opt-out alternative is negative and statistically significant, indicating that participants maximize utility by choosing one of the proposed NHCs alternatives with respect to the non-buying (opt-out) alternative. In the model I the coefficients from most of the attributes are statistically significant indicating that the utility of participants increases when these NHCs are included on yogurts as compared with the unlabeled yogurts.

Turning to the results from Model I across the two treatments (taste and no taste), the coefficients of most attributes are positive and statistically significant at 1% and 5% significance level, indicating that consumer utility increases when these claims are reported on food products. In addition, most of the standard deviations of the random parameters are statistically significant, indicating the presence of unobserved heterogeneity in taste preferences across participants. Most notably, our results also indicate that participants´ utility changes across the two treatments (taste and no-taste). When they taste the products the highest utility is captured when the *Hc_sug* label is present followed by the *Hc_fat* and the *Hcp_cal*. On the other hand, when participants do not taste the product they receive a higher utility by yogurts that bare the *Hcp_vit* claim followed by *Hc_fat* and *Hcp_cal*. In both treatments, *Nc_fat, Hca_fib* and *Nc_cal* results in the lowest utility increase (or are even not significant).

[6]The interactions between the choice experiment and the eye-tracking data using fixation count which again enter the model first as a pool approach and then each treatment is estimated separately. We want to remind the reader that the pool approaches for both models are not included in the results of this paper, and are available upon request.

Table 2 – Parameter estimates from a RPL model with and without visual attention measures across treatments (n=218)

	Model I		**Model II**	
Attributes	Taste	No taste	Taste	No taste
	β (*z*)		β (*z*)	
Opt-out	-0.51***(-5.95)	-0.43***(-4.42)	-0.64***(-12.25)	-0.71***(-11.08)
Nc[1]_fat	**0.49***(2.78)**	**-0.09(-0.33)**	**0.15***(7.81)**	**0.43***(3.36)**
St.dev.	0.13(0.71)	1.34***(4.73)	0.00(0.01)	0.78***(2.67)
Hc[2]_fat	**1.48***(6.25)**	**2.52***(8.20)**	**0.16***(5.88)**	**0.83***(4.01)**
St.dev.	4.86***(13.18)	4.18***(12.95)	0.15***(2.63)	0.83***(2.95)
Nc_sug	**-0.99***(-4.02)**	**-0.52**(-2.12)**	**0.06***(4.28)**	**-0.00(-0.10)**
St.dev.	1.71***(5.02)	1.80***(4.86)	0.00(0.00)	0.30**(2.12)
Hc_sug	**2.07***(7.65)**	**1.02***(3.58)**	**0.05***(5.86)**	**0.25***(4.44)**
St.dev.	4.62***(13.68)	3.64***(12.00)	0.01(0.19)	0.53***(3.15)
Nc_fib	**-0.35**(-2.35)**	**0.55***(4.14)**	**0.07***(4.16)**	**0.19***(4.30)**
St.dev.	1.54***(11.88)	1.23***(11.20)	0.00(0.00)	0.57***(3.13)
Hcp[3]_fib	**1.12***(7.11)**	**2.05***(11.44)**	**0.12***(9.63)**	**0.34***(5.35)**
St.dev.	1.17***(8.43)	2.23***(11.09)	0.00(0.02)	0.28***(2.64)
Hca[4]_fib	**0.08(0.66)**	**-0.12(-0.85)**	**-1.55(-0.80)**	**-0.50(-1.01)**
St.dev.	0.00(0.02)	0.37**(1.97)	1.98(0.89)	0.77(1.43)
Nc_vit	**-0.34*(-2.40)**	**-0.31**(-2.31)**	**0.05***(4.94)**	**0.08***(4.95)**
St.dev.	1.19***(7.23)	0.22**(1.96)	0.03(0.65)	0.00(0.07)
Hcp_vit	**1.10***(5.42)**	**2.70***(12.52)**	**0.16***(7.42)**	**0.57***(5.39)**
St.dev.	2.80***(15.95)	2.45***(13.23)	0.09**(2.14)	0.62***(4.14)
Hca_vit	**1.18***(3.74)**	**1.64***(8.66)**	**0.13***(8.09)**	**0.35***(5.88)**
St.dev.	3.08***(14.27)	2.64***(13.24)	0.06(1.30)	0.34***(4.16)
Nc_cal	**0.03(0.24)**	**-0.15(-0.79)**	**0.06***(5.94)**	**0.12***(6.66)**
St.dev.	0.82***(8.10)	1.36***(6.86)	0.00(0.09)	0.00(0.02)
Hcp_cal	**1.35***(6.73)**	**2.32***(11.78)**	**0.11***(5.89)**	**0.40***(5.51)**
St.dev.	2.40***(10.53)	1.93***(9.89)	0.10**(1.99)	0.32***(3.42)
Hca_cal	**0.96***(5.95)**	**1.53***(8.52)**	**0.11***(7.65)**	**0.29***(5.52)**
St.dev.	2.22***(12.25)	2.05***(10.38)	0.07*(1.92)	0.29***(2.80)
N	5060	4529	5060	4529
Taste Scale	-	-	-	-
Log-lik.	-3359.84	-3727.54	-4504.31	-3639.93

Notes: *,** and *** indicate statistical significance at 10%, 5% and 1% levels, respectively.
[1]Nc means nutritional claim.
[2]Hc means health claim.
[3]Hcp means health claims present in the local market.
[4]Hca means health claims absent from the local market

Results from model II, where visual attention is incorporated, show that generally most of the attributes are statistically significant at 1% and 5% significant level. Most of the standard deviations are also significant indicating heterogeneity in preferences. The visual attendance utility ranking of the taste treatment corresponds to that of the no-taste with the main difference

that in the latter *Hc_fat* is ranked as first. The NHCs that received the lowest visual attention in this model (corresponding to the lowest utility increase in model I) are *Nc_sug* and *Hca_fib,* (which in most cases are not significant), and *Nc_cal.*

4. Conclusions and discussions

This study explored consumer choice and attention of different NHCs on different type of yogurts and explored whether taste influenced the final purchase decision. Results illustrated that the attention captured by the NHCs are not in the exact utility order as in the actual choice model. This is presumably due to the fact that some label formats may require more attention than others in order to process the information given (Bialkova et al. 2014; Bialkova & van Trijp, 2010) and due to treatment effect (taste and no-taste). However, even though with not the same exact order, there is a consistency in the utility ranking of the mostly valued and attended NHCs between the choice selection and the visual attention in both models and their treatments.

A very important result of this study is that health claims outperform nutritional claims leading to higher utilities. In particular, the highest premium price is received by yogurts that bare the cholesterol claim. These estimates are consistent with other studies who find that product claiming to prevent cardiovascular diseases by lowering or controlling cholesterol levels are well accepted by dairy product consumers (Ares & Gámabro, 2007). Nutritional claims were the least valued in terms of utility and in many cases not even statistically significant.

These findings suggest that NHCs can be used as a differentiation strategy. Since the presence of health claims in the local market is very low (2%) compared to NCs (28%) this "potential demand" would be informative to producers, processors and retailers to be used when developing marketing strategies. Food processors or manufacturers should take into account the growing consumer concerns on healthier food products and heterogeneous preferences. In the yogurt market, health enhancing products differentiated by functional food ingredients seems to be a promising profitable way of product differentiation. Even though, certain nutritional claims had very low utilities, a profitable strategy may be introducing them accompanied by the corresponding health claim that exactly defines the benefits of that nutrient on our health (i.e., the case of Hc_fat, Hcp-vit, Hcp_cal nutritional and health claim).

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