Visual Attribute Non-Attendance in a Food Choice Experiment:

Results From an Eye-tracking Study

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ABSTRACT

Respondents in choice experiments (CEs) may ignore some of the attributes presented to them when evaluation alternatives in a choice task, which has been referred to as attribute non-attendance (ANA). Previous studies have shown that ANA may impact both the model fit as the WTP estimates for the presented attributes. We used a new approach and accounted for the issue of ANA, by using eye-tracking measures. By accounting for visual ANA, the coefficients from the ANA model differ from the model which did not account for this issue. This clearly indicates that assuming that respondents in a CE attended to all attributes in all of the choice tasks biases your estimation results.

Key words: Eye-tracking; sustainability labeling; Attribute non-attendance, Visual attention; Consumers; Decision making

INTRODUCTION

There is a growing body of literature applying choice experiments (CE) as a valuation method. A common assumption when analyzing CE data is that respondents attend to all proposed attributes presented to them (Hensher et al., 2005). However, some studies have shown that respondents may ignore some of the described attributes while evaluating the alternatives in the choice task. In the CE literature, this decision heuristic, referred to as attribute non-attendance (ANA), has been found to affect the model performance and WTP estimates when not accounted for (Campbell et al., 2008; Carlsson et al., 2010; Hensher and Rose, 2009; Scarpa et al., 2010).

Two general methods have been used to address ANA in CEs: (1) by inferring ANA based on observed choices (inferred ANA) or (2) by asking additional questions to the respondents on which attributes they ignored (stated ANA). In this study, we propose a third method with the use of eye-tracking measures to determine visual ANA. While the use of eye-tracking has been applied widely in the field of marketing and psychology, it is a relatively new methodology in the field of economics. While some researchers such as Scarpa et al. (2013) suggested the use of improved methods such as eye-tracking technology to obtain information on ANA, no known study has really used eye-tracking in hypothetical CEs, with the exception of Balcombe et al. (2014). In our study, instead of asking respondents if they have ignored any of the attributes during the choice tasks, also referred to as stated ANA, we measure the visual attention of each CE respondent to check whether the respondent visually attended or ignored each of the attributes. Balcombe et al. (2014) defined visual ANA as visually ignoring information about attribute levels. Visual ANA is related to eye fixations which is an eye-tracking measure that can be used as an indicator of visual attention (Balcombe et al., 2014).

Our objective is to obtain better knowledge of how consumers process the information given to them by incorporating the issue of visual ANA into CEs based on eye tracking visual attention. In order to account for visual ANA, we evaluated the visual attention given to the information presented to respondents during CE with the use of eye-tracking technology. An attribute is considered visually not attended to if the fixation count is less than two. That is, since the first eye fixation is assumed to be random, at least two fixations are required to be able to consider the attribute to be attended to in a specific choice task (Balcombe et al., 2014). Following Balcombe et al. (2014), we then considered a respondent as a "non-attender" of a certain attribute in a CE if he/she ignored the attribute in more than half of the choice tasks. We refer to this approach as the serial visual ANA. We also measure ANA using two additional approaches: visual ANA at the choice task level and visual ANA at the alternative level.

MATERIALS AND METHODS

Coffee and sustainability labeling

In our study, we selected coffee as the food product of interest since coffee often carries sustainability labels, both environmental and ethical labels. In the US coffee market, these include labels referring to fair trade, rainforest alliance as well as the USDA organic which are all included in our study (Table 1). Several of these labels are often combined or presented together on the coffee packages. Coffee is the most commonly purchased fair trade product in the US (Mintel, 2009). The fair trade certification promises a fair and stable price for the farmers and prohibits child labor. Rainforest alliance is a similar certification assuring that the products have been grown and harvested using environmentally and socially responsible practices. Another type of sustainability label is the USDA organic label, which indicates that the coffee is produced according to the USDA organic standards. These three types of labels are commonly present on coffee products. A fourth label used in this study, but generally not yet evident in the US market is the carbon footprint labeling, which is an environmental label indicating that the company is reducing its carbon emissions. For example, the Carbon Trust's carbon reduction label indicates that the company displaying the label is making a commitment to reduce the carbon footprint of their product. The carbon footprint of a product or service is the total carbon dioxide (CO_2) and other greenhouse gases emitted during its life, from production to final disposal.

Experimental design of choice experiment

Participants in our CE were recruited from a consumer N=6,500) of the University of Arkansas Sensory Service Center (Fayetteville, AR, U.S.A.). In total, 81 consumers who purchased coffee in the last two months (March, April 2013) and did not have any eye diseases or eye surgery in the past participated in our CE. Each respondent was given a $20 gift card as participation fee. The demographic analysis reveals that 53% of the participants are female and 47% are male. Each age and income category is represented. The sample is slightly biased toward more highly educated respondents.

The coffee products were described using a combination of five attributes that includes four sustainability labels (USDA organic label, fair trade certified label, Rainforest alliance label and the Carbon Trust's carbon reduction label) and price. The attributes and corresponding levels are shown in Table 1. For all the sustainability labels, two levels were considered: present or not present. The levels of the price attribute were chosen based on the actual coffee prices during a store check in April 2013 in food stores in Arkansas.

-----Insert Table 1----

The CE design followed Street and Burgess (2007) and used a full factorial design with 64 (2^4x4) original combinations. The generators as described by Street and Burgess (2007) were used to obtain eight choice sets, with a D-efficiency of 97.6%. To increase the similarity with a real shopping experience, a no-buy alternative was added to each choice set. Hence, in each choice set, participants were presented with three alternatives: two types of roasted ground coffee as well as a no-buy option. Due to the hypothetical nature of our CE, a cheap talk script was presented to respondents prior to the choice tasks (Aprile et al., 2012; Silva et al., 2011; Van Loo et al., 2011).

Experimental procedure of eye-tracking

When answering the eight choice tasks, participants' visual attention to the coffee packages was recorded using a contact-free eye-tracking (Model: RED, SensoMotoric Instruments GmbH, Teltow, Germany) connected to a high-resolution computer screen (22 "). This eye-tracking device was located in a panel beneath a computer screen. The sampling rate and tracking resolution of eye-tracking device were 120 Hz and 0.03°, respectively. Visual stimuli were randomly presented using stimulus presentation software (Experiment Suite 360°™, SensoMotoric Instruments, GmbH, Teltow, Germany).

Before the choice experiment task, participants received instructions and the eye-tracking device was individually calibrated using the five-point calibration method with a low tracking error (less than 0.4°). After a successful calibration, two warm-up choice sets were presented to fully familiarize the respondents with the experimental procedures. As in Balcombe et al. (2014), participants knew that eye-tracking was applied; however, they were not aware of its purpose. As visual stimuli, pictures of coffee packages were presented. The participants were given time to look at the coffee packages and to choose the option they prefer. After the two warm-up questions, respondents were then randomly assigned to one of the ten treatments and answered all eight choice set questions, randomly presented to them. Following Balcombe et al. (2014), the participant viewed each choice set as long as they wanted before indicating their choice. On average, the respondents spend 73 seconds to answer all the eight choice questions.

Eye-tracking measures

Areas of interest (AOI) were defined on the coffee packages, corresponding with five possible information cues on the packages, including an AOI for each of the labels (fair trade, rainforest alliance, USDA organic, CO_2 reduction label), and the prices at the bottom of the pictures. Using the eye-tracking software (BeGaze™, ver. 3.0, SensoMotoric Instruments GmbH, Teltow, Germany), fixation count (number of times the participant fixated on the AOI) were calculated for the five AOIs in each of the eight choice sets.

Defining visual ANA

In order to account for visual ANA, with the use of eye-tracking, we recorded the visual processing of the presented information while the participants were making decisions in each of the eight choice tasks. As previously mentioned, an attribute is considered visually not attended to if the fixation count is less than two. In contrast to Balcombe et al (2014) who only used one measure, we use three types of visual ANA measures:

1) **<u>Serial visual ANA</u>**

When a respondent ignores a given attribute in a majority of the choice tasks considered (i. e. more than half of the choice tasks), this respondent is classified as a visual non-attender for this attribute over the whole CE. This definition was previously applied by Balcome et al. (2014). In our specific case, with eight choice sets, a participant is classified as a visual non-attender for a given attribute for the whole CE if the fixation count is less than two in more than four choice tasks. This approach, however, ignores more detailed information at the choice task level, which is incorporated in the two newly proposed methods: choice task and alternative visual ANA.

2) **Choice task visual ANA**

A second approach is what we refer to as choice task visual ANA, where for each of the eight choice tasks, the participants can be a visual attender or visual non-attender for a given attribute based on the fixation counts on the specified attributes in each choice task. When a respondent ignores (less than two fixations) a given attribute in a choice task, we assume that the attribute has not been attended to only in that particular choice task. This is a choice task level approach as compared to the serial visual ANA approach which is defined over the whole sequence of the choice tasks, and over the whole CE.

3) **Alternative visual ANA**

The third approach, alternative visual ANA, is the strictest approach since we look at the visual attendance in each of the two product alternatives within a choice task separately. When an attribute is ignored in one of these two alternatives, then the attribute is considered ignored for this choice task. If the participant did not attend to a given attribute in one of the two alternatives (fixation count less than 2), then he/she is classified as a non-attender for this attribute for that particular choice task.

Model specification: Error Component Random Parameter Logit (ECRPL)

Consistent with the random utility theory, CEs are based on the assumption that the utility of individual *n* of choosing alternative *j* in choice situation *t* can be represented as:

$$U_{njt} = \beta_n^{'} x_{njt} + \varepsilon_{njt} \quad (1)$$

where x_{njt} is a vector of observed variables relating to alternative j and individual n; β_n is a vector of structural taste parameters which characterizes choices; ε_{njt} is the unobserved error term, which is assumed to be independent of β and x.

Specifically, with our attributes, the utility that individual *i* obtains from alternative *j* at choice situation *t* takes the following form:

$U_{njt}= \beta_0$ $No\_Buy_{njt} + \beta_1 Organic_{njt} + \beta_2$ $Rainforest_{njt} + \beta_3$ $Fairtrade_{njt} + \beta_4 Carbonreduction_{njt} + \beta_5$ $Price_{njt} + \eta_{ij} + \varepsilon_{ijt}$.

where *j* pertains to option A, B and C. No_Buy_{njt} is a dummy variable taking the value equal to 1 when the no-buy option is chosen, and 0 when either product profile A or B is selected. β_0 is an alternative-specific constant representing the 'no-buy' option choice. Price is the price of a package of 12 ounces of coffee. The four variables referring to the four sustainability labels for USDA organic, Rainforest alliance, fair trade, carbon reduction labeling enter the model as dummy variables and take the value of 1 if they are present in option *j* and 0 otherwise. ε_{ijt} is the unobserved random error term. While the classical conditional logit model assumes homogeneity in consumer preferences, we assume that heterogeneity may be an issue in analyzing consumer preferences for food labelling (Bonnet and Simioni, 2001; Loureiro et al., 2001; Lusk et al., 2003). Therefore, the random parameter logit (RPL) model is employed, which allows random taste variation and accounts for the panel structure as each respondent made eight choices. This results in the estimation of mean and standard deviations for each of the random taste parameters.

Two additional modeling issues are taken into account - that of the correlation across utilities and across taste parameters to make the estimates more robust and consistent with consumer choice behavior (Barreiro-Hurle, 2010; Gracia et al., 2012, 2014). Firstly, since the design consists of two designed alternatives and one no-buy option, correlation across utilities may exist (Scarpa et al., 2005). The no-buy alternative is actually experienced by participants while the designed alternatives can only be imagined. Therefore, the utilities of the buying alternatives are likely to be more correlated between themselves than with the no-buy option. To account for this correlation pattern, we employed a RPL model with error component (RPL-EC) (Scarpa et al., 2005, 2007a). The two product alternatives share an extra error component, which is a zero-mean normally distributed random parameter. By using the RPL-EC model, correlation across utilities is tested. Secondly, correlations across taste parameters are incorporated. In the general RPL model, the random parameters are uncorrelated. However, we allowed for free correlation among the taste parameters. The significance of the elements in the Cholesky matrix can illustrate the dependence across tastes. The marginal WTP values are calculated as a negative ratio, where the nominator is the estimated mean values of the coefficients associated with a particular sustainability label and the denominator is the price coefficient. Data were analyzed using NLOGIT 5.0.

Accounting for ANA

The standard approach to account for stated ANA is restricting the coefficient in the utility function to zero for the attributes that the respondents stated they ignored, which results in the removal of the respective attribute from the choice consideration (Hensher et al., 2005). In this study, we use the same approach even though we are measuring visual ANA instead of stated ANA. So instead of using a dummy variable which indicates if the attribute was stated to be ignored or not (stated ANA), we now use a dummy variable to indicate if the attribute was visually attended to or ignored. Following the stated ANA approach by Hensher et al. (2005), when an attribute is ignored, its coefficient in the utility function is set to zero which results in the removal of the respective attribute from the choice consideration (Hensher et al., 2005). This method has been incorporated into the NLOGIT 5.0 software by coding the attribute as -888.

As a result, four RPL models were compared: assuming full attendance and treating all attributes as if they were attended to (model 1), accounting for serial visual ANA (model 2) , accounting for choice task visual ANA (model 3), and accounting for alternative visual ANA (model 4).

RESULTS AND DISCUSSION

Visual attribute non-attendance frequency

The frequency of visually ignoring the attributes differs depending on which of the three types of visual ANA measures is used (Table 2). When applying the serial visual ANA, each respondent is classified as either ignoring or attending to a certain attribute over the whole CE. Of the 81 respondents, only 14% were classified as visual non-attenders for price. There are more visual non-attenders for the sustainability labels, ranging from 27% to 31% of the total number of participants.

----Insert Table 2------

The proportions of ignored attributes are higher when using the choice task and alternative visual ANAs than when using the serial visual ANA. This is because for serial visual ANA, only those respondents who ignored the attribute for more than half of the choice tasks are identified as non-attenders. For the choice task visual ANA, each of the 648 choice tasks[1] is examined to determine whether the fixation count is less than two for a certain attribute, resulting in a choice task for which the attribute is considered ignored. For the price attribute, this results in

1. [1] 81 individuals performing eight choice tasks each

26% of the 648 choice tasks that were ignored and for the sustainability labels, it reaches percentages between 41% and 44% ignored choice tasks. As for the alternative visual ANA, the fraction of choice tasks in which price is considered ignored reaches even 79%. This is much higher than in the other visual ANA measures since the price attribute here is considered attended to in a certain choice task if in both alternatives in the choice task, the price attribute has a fixation count of at least two, as opposed to a fixation count of least two for the choice task as a whole.

Estimates from RPL-EC model

The RPL-EC estimations are based on 648 observations (81 individuals performing eight choice tasks each) and were conducted in NLOGIT 5 assuming price as a fixed coefficient and the coefficients of the four sustainability labels following a normal distribution. Table 3 presents the estimation results for the four different models based on the full attended models and the three models for visual ANA (i.e., one using each of the three visual ANA measures).

----- Insert Table 3-----

As expected, the coefficient of the no-buy option is negative and statistically significant suggesting that consumers increase their utility when choosing one of the proposed coffee product alternatives (options A and B) compared to the no-buy option C. This indicates that the attributes included in the experiment are relevant and important to consumers. Moreover, in all four models, the hypothesis of correlation across utilities is verified since the standard deviation of the error component (η_{ij}) for the purchase alternatives is statistically significant. The coefficient of price is negative and statistically significant at the 0.01 level indicating that consumer's utility decreases with increasing price. All the other coefficients are positive and if significant suggests that consumer utility increases when one of the labels are present on the coffee package. In all four model, the strongest utility increase is caused by the presence of the label “USDA organic” while the presence of the carbon reduction label results in the lowest utility increase (or is even not significant in two of the models).

Comparison across models

As reflected by the decrease in likelihood (LL) function and the increase in the AIC and BIC statistics, accounting for ANA results in a decrease fit model (Table 3). This result corroborates the findings of a great deal of the previous work in ANA, which showed decreases in model fit when accounting for ANA. This decrease in model fit may be caused by our sample of 81 respondents. As defined by the method used previously for stated ANA (Hensher et al., 2005), if an attribute was reported as ignored (in Hensher et la., 2005, this is reported by the respondents while in our case this is the attendance is defined base on the eye-tracking data), these responses were excluded for that respondent in the estimation of the parameter attached to that attribute. The coefficients in the models differ, indicating that assuming full attendance or accounting for visual ANA according to one of the three used definitions has an impact on the coefficients and the WTP values. Comparing WTP values for the four labels based on models accounting for visual ANA (model 2, 3, 4) and the full attendance model (model 1), illustrates that accounting for visual ANA results consistently to higher WTP values compared to the benchmark model (model 1) (except for Rainforest alliance in model 2, where there is a slight decrease in WTP as compared to model 1). This shows that accounting for visual ANA has important implications on WTP estimates.

CONCLUSIONS

As stated by Hensher et al. (2005), it is an important research challenge to build in processing strategies into the analysis of stated choices. One way to contribute to this challenge is by using eye-tracking measures to evaluate the visual attention to the attributes in a CE. Researchers cannot assume that respondents have attended to all attributes and processed all the information given as this may lead to different parameter estimates and resulting WTP values. By incorporating visual ANA, we can partially correct for this. However, there is still a challenge about how to best define visual ANA as different definitions may lead to different outcomes.

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Table 1. Attributes and levels for the choice experiment

Attributes	**Level**
Fair trade label	- 0 = Not present - 1 = Present
USDA Organic label	- 0 = Not present - 1 = Present
Rainforest alliance	- 0 = Not present - 1 = Present
Carbon reduction label	- 0 = Not present - 1 = Present
Price	- 0 = $4.30 - 1 = $6.30 - 2 = $8.30 - 3 = $10.30

Table 2. Frequency (%) of visual ANA on serial, choice task and alternative level

	Serial (N=81)	Choice task (N=648)	Alternative (N=648)
CO2	28.40	41.98	41.98
Organic	30.86	41.36	41.36
FairTrade	27.16	40.90	40.90
RainForest	28.40	44.29	44.29
Price	13.58	25.62	78.70

Table 3. RPL model with error component (RPL+EC) estimates (N=81)

		Assuming Full attendance (model 1)		**Accounting for serial visual non-attendance (model 2)**		**Accounting for choice task visual non-attendance (model 3)**		**Accounting for alternative visual non-attendance (model 4)**	
		Coefficients	Standard errors	Coefficients	Standard errors	Coefficients	Standard errors	Coefficients	Standard errors
No_buy (β_0)		-8.82***	0.89	-8.70***	0.88	-7.29***	0.92	-4.05***	0.89
Price		-0.85***	0.06	-0.82***	0.05	-0.61***	0.05	-0.37***	0.07
USDA organic	Means	1.05***	0.29	1.07***	0.38	0.93***	0.23	0.76***	0.18
	St.dev	1.16***	0.26	0.78	0.75	0.46	0.71	0.09	0.5
Rainforest alliance	Means	0.74***	0.23	0.62**	0.29	0.60***	0.20	0.57***	0.17
	St.dev	0.52*	0.29	0.61	0.46	0.51	0.97	0.27	0.69
Fair trade	Means	0.54**	0.26	0.74**	0.37	0.63***	0.24	0.64***	0.19
	St.dev	0.72***	0.24	0.70**	0.29	0.56	0.37	0.34	0.43
Carbon reduction	Means	0.21	0.22	0.35	0.33	0.49**	0.23	0.59***	0.20
	St.dev	0.77	0.62	0.78*	0.45	0.44	0.63	0.20	1.00
St. dev. of error component		2.70***	0.90	3.52***	1.32	3.26***	0.94	2.81***	0.97
N		648		648		648		648	
Log likelihood		-348		-357		-405		-493	
AIC		731		748		844		1020	
AIC/N		1.133		1.160		1.309		1.582	
BIC		806.5		824		920.5		1096.4	
BIC/N		1.250		1.277		1.427		1.700	

Note: ** and *** indicate WTP values statistically significant at 5% and 1% level, respectively.