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Visual Attention to Eco-Labels Predicts Consumer Preferences for Pollinator Friendly Plants

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Abstract: Recent declines in pollinator populations have led to widespread concern due to their impact on food/crop production and the environment. Contrary to growing interest in the use of insecticides in urban landscapes, the relationship between pollinator-related eco-labels, visual attention, and preferences for plants is less understood. The present study combines eye tracking and stated preference experiments to examine the effects of pollinator-related labels on consumers' preferences and willingness to pay. Results show that the pollinator-friendly attribute positively correlates with consumers' purchasing decisions and visual attention supports that relationship. Implications of mandatory labeling of pesticide content for the horticultural industry are discussed.

Keywords: conjoint analysis; eye tracking; ordered logit model; ornamental plants; willingness to pay

1. Introduction

Eco-labels are voluntary credence attributes defined by a third party that differentiate products based on their environmental impact [1]. Credence attributes are not directly observable from viewing (i.e., search attributes) or interacting with a product (i.e., experience attributes), and therefore must be communicated at the point of sale to customers. Labeling credence attributes (i.e., eco-labels) allows consumers to carefully weigh all of the products' traits and select the product that best meets their needs [2]. Currently, 465 eco-labels exist worldwide with 203 in the U.S. alone [3]. Eco-labels increase consumers' trust, preferences and willingness to pay (WTP) [4–6]. However, the extent to which eco-labels impact purchase intent is less understood [4]. Previous literature shows that excessive information in retail settings reduces the effectiveness of point-of-sale signage because customers selectively attend to visual information [7,8].

To account for consumers' visual behavior, previous studies have used eye tracking technology to address in-store signage [9] and sustainability labels [8]. Visual attention is a key component in consumers' decision-making processes since information must be visually noticed to influence choice [7,10]. For instance, Reutskaja et al. [7] note consumers often choose the best-seen alternative. Factors that influence consumers' visual attention during the decision making process can be framed as top-down (i.e., "goal-driven") and bottom-up (i.e., "stimulus-driven") [10]. Top-down stimuli are the focus of this study because they dominate when consumers are making choices [11] or are presented with unfamiliar labels (such as pollinator-related eco-labels [12]).

Eye tracking metrics are becoming more prevalent in consumer behavior research addressing eco-labels and sustainability [5,8,13]. For example, Van Loo et al. [8] reported that consumers who value sustainably produced coffee fixate more on sustainability labels (i.e., United States Department of Agriculture (USDA) organic, Rainforest Alliance, carbon footprint, Free Trade) and pay premiums for coffee with those labels. In the ornamental plant industry, Behe et al. [9] found that consumers interested in production methods (sustainable, energy-saving, water-saving) had increased visual attention to the production methods. Rihn et al. [5] determined consumers' visual attention to sustainable production methods on plants varied by product end use. To date, eye tracking metrics have not been utilized to address consumer behavior toward pollinator-related eco-labels.

2. Background

Recently, pollinator insects have received considerable attention due to declining populations. This is concerning because of their role in crop/food production, the environment, and the economy [13,14]. Pollinator insects pollinate 70% of the world's food crops [14], resulting in increased food quantity and quality [15]. Gallai et al. [13] determined that, in 2005, pollinator insects contribute 153 billion euros per year (about 195 billion USD) to global food crop production with insect-pollinated crops being valued at 761 euros per ton (about 970 USD per ton). Global food crop supply would not meet current or projected world consumption levels without insect pollination [13]; an issue that will become more critical over time, given expected world population growth. Pollinators also benefit the environment through increased biodiversity, wildlife food availability, and landscape aesthetics and contributed to the prevention of soil erosion and water runoff [15,16].

Despite the importance of pollinator insects, very few studies investigate consumer preferences for pollinator-friendly products but instead focus on the value of pollinator services and/or conservation efforts [17–21]. In 2008, UK households were willing to pay 1.37 pounds sterling per week (cumulatively 1.77 billion pounds sterling per year or roughly 3.5 billion USD) to protect bees [19]. Another study demonstrated that UK consumers would pay 13.4 pounds sterling/year per taxpayer (roughly 21.6 USD/year) to protect pollinator insects and their habitat [17]. U.S. consumers were willing to pay 4.78–6.64 billion USD to conserve monarch butterflies and their habitat [18]. Consumers value conservation measures to aid pollinator insects; however, research at the retail level assessing the impact of pollinator-related eco-labels on consumer behavior are scarce [20,21].

Currently, the U.S. does not have a pollinator-related eco-label. Instead, the promotion of pollinator-friendly products is the responsibility of individual green industry stakeholders (e.g., retailers), resulting in a plethora of pollinator-related labels (e.g., pollinator friendly, neonics-free, bee friendly, and so forth [20]), which may reduce the effectiveness of pollinator eco-labels. Despite this issue, Wollaeger, Getter, and Behe [21] determined pollinator-related labels positively impact consumers' WTP for ornamental plants. Similarly, Rihn and Khachatryan [20] found that the presence of a pollinator-related label had a positive impact on U.S. consumers' purchase likelihood for plants regardless of wording. However, the impact of actually viewing the pollinator-related label cannot be determined from these studies. Nor was the presence of additional eco-labels (i.e., production method, origin) factored into the experiments. More information may improve product value by increasing consumer understanding [22], or it may reduce label effectiveness by increasing cognitive load [23]. The current study builds on the assumption that consumers want to aid pollinators [17–21] by incorporating visual attention measures and alternative eco-labels.

To examine consumers' purchase likelihood and WTP for pollinator-friendly plants, we used a rating-based conjoint analysis (CA) in combination with eye tracking technology. Ordered logit models estimated purchase likelihood while controlling for visual attention and socio-demographic variables. Recently, visual attention metrics have been incorporated into CA. A review article of CA literature by Agarwal et al. [24] recommends using eye tracking technology in CA to explore decision-making strategies. A key assumption of CA is that participants evaluate all available attributes and choose the product that provides them the most utility. Yet several studies have shown consumers selectively attend to relevant attributes to reduce their cognitive load, which influences WTP and utility [12,17,25,26]. For instance, Meißner, Musalem and Huber [11] found consumers focus on positive attributes of the chosen product and negative attributes of rejected products. Previous studies have addressed this selectivity using self-reported attendance measures [27] or latent class models [28]. However, participants often overstate their attendance [27] while latent class models can be problematic in that as the number of attributes increase, the number of latent classes increase exponentially [28]. Eye tracking analysis overcomes the difficulties by accurately recording what attributes participants view, which improves model accuracy, reduces bias, and accounts for attribute non-attendance [8,23,26,29]. Bundesen, Habekost, and Kyllingsæk's [30] neural theory of visual attention states that consumers are very selective about what information is viewed/used in decision making due to limited cognitive capacity. As a result, the stimulus that are visually attended to are subject to filtering and sorting prior to processing so that only a fraction (approximately 2%) of the visual field is used when making a decision [29,30]. Neural theory of visual attention indicates that more processing (i.e., visual attention) is devoted to important stimuli while reduced processing occurs for less important stimuli [8,12,30]. Here, eye tracking technology is utilized to assist in capturing what attributes consumers visually attend to while making purchasing decisions.

3. Objectives and Hypotheses

Following the conceptual framework that links eco-labels with consumer preferences and WTP price premiums, the overall objective of this study was to assess consumers' preferences, specifically for the pollinator-friendly attribute on ornamental plants. First, since consumers are willing to pay taxes to fund pollinator insect conservation programs [17–19] and are willing to pay premiums for plants with bee-friendly production labels [21], we hypothesize that a pollinator-friendly eco-label will be positively correlated with participants' purchase likelihood (H1).

Building off hypothesis 1, we hypothesize that if consumers are interested in aiding pollinators through purchasing ornamental plants that are pollinator friendly, one would expect that their visual attention to that attribute would increase. For instance, Van Loo et al. [8] found sustainability-minded individuals fixated on sustainable labels more than those who are not interested in sustainability. Other studies found similar results with consumers selectively viewing important, relevant attributes [11,12,17,25,26]. Thus, hypothesis 2 is that consumers' visual attendance to the pollinator-friendly eco-label will positively impact consumers' purchase likelihood (H2).

The rest of the manuscript is organized as follows. The following section provides an overview of the research methodology, followed by the empirical results, and a discussion of implications and limitations of the study.

4. Methods

4.1. Product Selection

Ornamental plants were chosen as the experimental product for several reasons. First, environmental groups have recently targeted the horticulture industry for their use of controversial insect control measures (i.e., neonicotinoid pesticides) that may negatively impact pollinator insects [1,31]. Due to inconclusive research about the risks of neonicotinoid pesticides on pollinator insects [32], the United States Environmental Protection Agency [31] currently does not require labeling of neonicotinoid-based pesticides on plants sold in the U.S. With this in mind, our results may have implications for the commercial horticulture industry in terms of the impact of mandatory labeling of neonicotinoid pesticides on consumer preferences. Secondly, ornamental plants directly impact pollinator insects' health due to providing nutrients and habitat [17,32]. Therefore, encouraging the sales of plants that aid pollinators could improve pollinator insect health [33]. Lastly, ornamental plants are sold with minimal packaging and branding, which reduces preconceived preferences at the onset of the experiment [34].

4.2. Visual Attendance Metrics

Previously, stated attribute non-attendance has been used to account for consumers' attribute selectivity; however, discrepancies exist between stated and actual attribute attendance [27]. Eye tracking metrics can be used to remove this discrepancy by accurately recording what consumers view [23,24]. Fixation counts (when the eye is still/focused for 200–500 ms) are one means of measuring visual attendance since fixations are positively correlated with information acquisition and processing [34], attribute importance/relevance to task [9,12], and decision-making [10]. According to Balcombe et al. [29], more than one fixation is needed to constitute visual attendance since the first fixation is random. In this study, two fixations were deemed an acceptable point for the visual attendance metrics. Similar to Balcombe et al. [29], one visual attendance variable was generated per attribute, where 1 equals greater than two fixations and 0 otherwise.

4.3. Experimental Design

A rating-based CA experiment and eye tracking technology were used to assess the impact of the pollinator-friendly attribute on consumers' purchase likelihood. A rating-based CA was chosen for several reasons. First, a rating-based CA experiment minimized additional visual clutter and isolated the effects of visual attendance to attributes on participants' purchasing behavior. Secondly, rating-based CA experiments are comparable to the choice-based approach in terms of reliability, validity, and predictive power [35–37]. Lastly, rating-based CA and gaze data have been successfully used to investigate consumer purchasing behavior toward ornamental plants [9]. Thus, the rating-based CA approach aligned well with the research goals. The University of Florida's Institutional Review Board approved all experimental procedures (2014-U-0539).

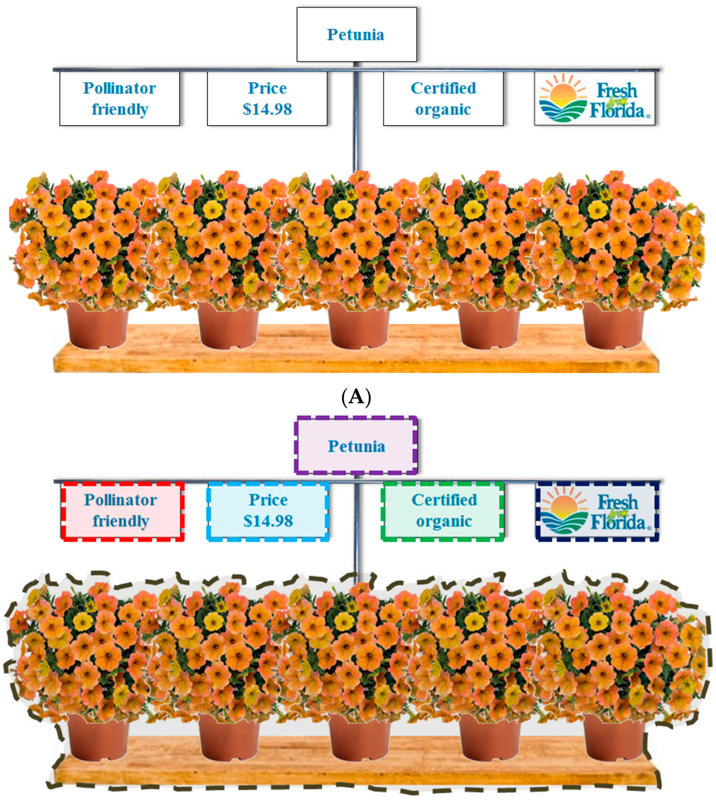
The CA experiment scenarios were comprised of five product attributes: plant type; price; pollinator friendly; production method, and; origin (Table 1). Plant types (petunia—*Petunia* × *hybrid* Juss., pentas—*Pentas lanceolata* Forssk., and hibiscus—*Hibiscus rosa-sinensis* L.) were selected after consulting with retail experts to identify the most common landscape plants sold in the research area (Florida). The three price points reflect the low-end prices present in big box stores and high-end prices found in niche/specialty stores (i.e., independent garden centers). Regarding the pollinator-related attribute, in-store labels, and signage varies greatly. To encompass all of the options (i.e., attracts bees, butterflies, etc.), pollinator friendly was selected to represent this attribute. Plants were labeled as pollinator friendly or not rated. Production method options included certified organic, organic production (i.e., produced using organic methods but not certified), and conventional. Following previous studies that incorporate organic and conventional production methods, we added organic production to assess production methods that are between the two extremes (i.e., certified organic and conventional). Regarding origin of production, in-state represented the closest area, followed by domestic, and then imported.

A full factorial design would result in 162 possible product options (Table 1). To reduce participant fatigue, Statistical Package for the Social Sciences (SPSS) software was used to generate a fractional factorial design with 16 product scenarios. Each scenario was displayed on a 24-inch computer screen with 1920 × 1080 pixel resolution. Each scenario consisted of five identical plants with the attributes presented on above-plant signs with consistent font style, size, and color (Figure 1A). Attribute sign location was randomized between the scenarios to eliminate order effect. For each image, fixation counts (FC) were collected for the attributes. In order to collect FC data, areas of interest (AOI) were generated. An AOI is a geometrical outline used to define a specific region within the image (i.e., each attribute) where researchers want to collect the visual metric recordings (Figure 1B).

Table 1. Conjoint analysis experimental attributes and attribute levels to measure consumer preferences for eco-labels on plants.

Attribute	Definition	Attribute levels
Plant type	Type of plant shown in the scenario image	Petunia (*Petunia x hybrid* Juss.) Pentas (*Pentas lanceolata* Forssk.) Hibiscus (*Hibiscus rosa-sinensis* L.)
Price [a]	Price per plant	$10.98 $12.98 $14.98
Pollinator	Describes if the plant benefits pollinators	Pollinator friendly No label—not rated
Production method	How the plants were produced	Certified organic [b] Organic production [c] Conventional
Origin	Where the plants were produced	In-state ("Fresh from Florida") Domestic ("Grown in U.S") [d] Import ("Grown outside U.S.")

[a] Price points were determined based on retail observations in central Florida (i.e., big box stores and independent garden centers). [b] Certified organic was described as "the plants are certified as organically produced". [c] Organic production was described as "the plants are produced in an organic manner but are not certified organic". [d] Grown in U.S. was described as "plants are produced in another U.S. state other than Florida" to differentiate the in-state and domestic attributes.



(**A**)

(**B**)

Figure 1. Example scenario image and areas of interest (AOI). *Note:* Dashed lines designate areas of interest (AOI), which correspond to the pollinator-friendly, price, production method, origin, plant sign, and plant image attributes. (**A**) Original Scenario Image; (**B**) Areas of Interest.

As participants viewed the scenario images, a Tobii X1 Light Eye Tracker (Tobii Technology, Stockholm, Sweden) recorded their eye movements. The eye tracking camera was stationary and located at the bottom of the monitor. After each scenario, participants indicated their purchase likelihood on a seven-point Likert scale (1 = very unlikely; 7 = very likely). A fixation cross was shown for 3 s between scenarios so all participants fixated on the same location prior to each image. Lastly, the questionnaire questions included sociodemographic questions.

4.4. Sample Demographics

Local newspaper advertisements, Craigslist posts, and printed fliers were used to recruit participants. Fliers were distributed through independent garden centers, public gardens, and community boards. Participants were screened to insure they had purchased plants within the past year. A total of 108 people participated in the experiment, of which, 104 (96% of the sample) successfully had their eye movements recorded. A sample size of 104 was deemed acceptable since comparable studies have used substantially fewer participants [7,12,26]. Participants averaged 53 years of age and had a household income between $51,000 and $60,000 (Table 2). The average household size was two people and 38.5% of participants were male. Most participants were in a relationship/married and indicated that pollinator-friendly promotions would improve their plant purchasing preferences. Florida Census statistics are also provided for comparison purposes [38]; however, statistical inferences cannot be determined due to lack of standard deviation data. But, compared to Florida as a state, the study appeared to overrepresent females, smaller households, and higher incomes, which is consistent with core plant consumers [39]. Specifically, gardeners tend to be female, over 45 years old, college educated, married, in a two-person household, and have a household income of over $50,000 [39].

Table 2. Sociodemographic summary statistics of Floridian participants from a 2014 study.

Variable	Description of Variables	Mean (Std. Err.)	Florida [a] Mean
Age	Average age (in years) of participant	52.782 (1.633)	40.7
Gender	Gender of participant 1 = male 0 = female	0.385 (0.048)	0.499
Income	2013 gross household income of participants 1 ≤ $20 K 2 = $21–$30 K 3 = $31–$40 K 4 = $41–$50 K 5 = $51–$60 K 6 = $61–$70 K 7 = $71–$80 K 8 = $81–$90 K 9 = $91–$100 K 10 ≥ $100 K	5.010 (0.298)	$47,309
Education	Highest level of education completed	3.880 (1.649) 32.2% Bachelor's degree or higher	26.2% Bachelor's degree or higher
Household	Number of people in household	1.870 (0.135)	2.58
Pollinator purchase	Likelihood that a pollinator-friendly plant label would change the consumers' purchasing decision. 1 = very unlikely 2 = unlikely 3 = undecided 4 = likely 5 = very likely	3.913 (0.893) 6.6%—very unlikely or unlikely 18.5%—undecided 75.0%—very likely or likely	Not available

[a] Source: U.S. Census Bureau [23].

4.5. Experimental Procedure

At the beginning of the experiment, the Tobii X1 Light Eye Tracker was calibrated to each participant using the Tobii Studio five-point calibration method. Next, instruction slides explained the experimental procedure and defined the attribute levels for participants. Then, to control attributes not included in the study, participants were told all plants were the same size and had the same care requirements. Fixing the unobserved attributes improves confidence that the observed responses are due to differences in the provided attributes [40]. Participants then evaluated an example product to become familiar with the experimental process. The experiment was not timed, and the participants proceeded to the subsequent slides at their own pace in order to eliminate the effects of time pressure on choice and eye movements [7,10]. The experiment lasted approximately 30 min (with 10–12 min spent on the CA experiment) and participants were compensated $30.

4.6. Ordered Logit Model

Purchase likelihood scale was used as the dependent variable. Since the dependent variable was ordinal, an ordered logit model was estimated. Following Long and Freese [41], the model was derived from a measurement model by mapping a latent variable y^* ranging from $-\infty$ to ∞ to an observed variable y. Considering the J number of categories in the ordinal measure, the relationship between observed and latent variable can be shown as:

$$y_i = m \text{ if } \kappa_{m-1} \leq y_i^* < \kappa_m \text{ for } m = 1 \text{ to } J \tag{1}$$

where κs are thresholds (or cutpoint boundaries for each m category) in the distribution of y^* that once crossed result in a category change. The extreme categories 1 and J can be represented by the following open-ended intervals $\kappa_0 = -\infty$ and $\kappa_J = \infty$, which translated into our purchase likelihood rating with seven categories can be shown as:

$$y_i = \begin{cases} 1 & if \quad \kappa_0 = -\infty \leq y_i^* < \kappa_1 \\ 2 & if \quad \kappa_1 \leq y_i^* < \kappa_2 \\ \vdots & \vdots \quad \vdots \\ 7 & if \quad \kappa_6 \leq y_i^* < \kappa_7 = \infty \end{cases} \tag{2}$$

Based on the measurement model above, the structural model then can be defined as [41]:

$$y_i^* = \mathbf{x}_i \boldsymbol{\beta} + \varepsilon_i \tag{3}$$

where $\mathbf{x}_i$ is a row vector of values for the ith observation, $\boldsymbol{\beta}$ is a column vector of structural parameters, and ε is the random error term. To estimate the model using maximum likelihood (ML) method, a specific form of the error distribution must be assumed. Although other distributions were considered in previous research (for example, McCullagh [42]) for the ordered logit model, the ε is conventionally assumed to have a logistic distribution with a mean of 0 and variance $\pi^2/3$, with the following probability distribution $\lambda(\varepsilon) = \exp(\varepsilon)/[1 + \exp(\varepsilon)]^2$, and cumulative distribution $\Lambda(\varepsilon) = \exp(\varepsilon)/1 + \exp(\varepsilon)$ functions.

The assumption of the distribution of the error term allows relating probabilities of outcomes (y) given values of $\mathbf{x}$, as shown in the following equation [40]:

$$\text{Prob}(y_i = m|\mathbf{x}_i) = \text{Prob}(\kappa_{m-1} \leq y_i^* > \kappa_m|\mathbf{x}_i) \tag{4}$$

Substituting $\mathbf{x}_i\boldsymbol{\beta} + \varepsilon_i$ for y_i^* in Equation (4) leads to the probability of any observed outcome $y_i = m$ given $\mathbf{x}_i$ to be generalized as the difference between cumulative distribution functions evaluated at any given m values:

$$\text{Prob}(y_i = m|\mathbf{x}_i) = F(\kappa_m - \mathbf{x}_i\boldsymbol{\beta}) - F(\kappa_{m-1} - \mathbf{x}_i\boldsymbol{\beta}) \tag{5}$$

where F indicates the cumulative distribution function. Given the formulation in Equation (5), the probability of observed value of y_i (i.e., purchase likelihood rating) for the ith observation can be represented as:

$$p_i = \begin{cases} \text{Prob}(y_i = 1|\mathbf{x}_i, \boldsymbol{\beta},\ \boldsymbol{\kappa}\ ) \text{ if } y = 1 \\ \vdots \\ \text{Prob}(y_i = m|\mathbf{x}_i, \boldsymbol{\beta},\ \boldsymbol{\kappa}\ ) \text{ if } y =\ m \\ \vdots \\ \text{Prob}(y_i = 7|\mathbf{x}_i, \boldsymbol{\beta},\ \boldsymbol{\kappa}\ ) \text{ if } y =\ 7 \end{cases} \tag{6}$$

The likelihood equation can be represented as:

$$L(\boldsymbol{\beta},\ \boldsymbol{\kappa}\ |\mathbf{y},\ \mathbf{X}) = \prod_{i=1}^{N} p_i \tag{7}$$

After multiplying over cases where y is observed to equal j, and taking logs, the log likelihood function becomes [41]:

$$ln\ L(\boldsymbol{\beta},\ \boldsymbol{\kappa}\ |\mathbf{y},\ \mathbf{X}) = \sum_{j=1}^{J} \sum_{y_i=J} ln[F(\kappa_m - \mathbf{x}_i\boldsymbol{\beta}) - F(\kappa_{m-1} - \mathbf{x}_i\boldsymbol{\beta})] \tag{8}$$

Upon estimation of the ordered logit model, the coefficient estimates were used to calculate WTP for attributes using the following equation [42,43]:

$$\text{WTP} =\ -(\beta_{attribute}\ /\beta_{price}\ ) \tag{9}$$

5. Empirical Results

5.1. Visual Attendance and Ordered Logit Model Coefficient Estimates

Table 3 summarizes the total fixation counts and visual attendance metrics. The highest mean fixation and percent attendance was for plant (7.892; 76.3%) and the lowest was for the plant sign (1.752; 28.0%). Other attributes that received more visual attention included import, organic, conventional, and domestic. The medium and low prices and in-state production received less visual attention. The pollinator-friendly and high-price attributes received an intermediate amount of visual attention at 2.832 (47.7% attendance) and 2.911 (attendance 49.2%), respectively.

Table 3. Participants' fixation count means and visual attendance to specific plant attributes, by attribute.

	Fixation Count	Attendance
Attribute	**Mean (Std. Dev.)**	**Mean (Std. Dev.)**
Pollinator	2.832 (1.691)	0.467 (0.288)
Low price	2.572 (1.808)	0.417 (0.301)
Medium price	2.517 (1.851)	0.410 (0.332)
High price	2.911 (1.649)	0.492 (0.277)
Certified organic	2.968 (1.831)	0.390 (0.262)
Organic	3.445 (2.245)	0.530 (0.356)
Conventional	3.252 (2.176)	0.544 (0.330)
In-state	2.688 (1.592)	0.454 (0.296)
Domestic	3.006 (2.016)	0.483 (0.314)
Import	4.490 (2.741)	0.627 (0.341)
Plant	7.892 (5.294)	0.763 (0.274)
Plant sign	1.752 (1.656)	0.280 (0.290)

Model 1 included the bivariate product attribute and sociodemographic variables while Model 2 built on Model 1 by adding the visual attendance variables (Table 4). The lower Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) values and higher Adjusted Pseudo/McFadden R^2 value for Model 2 indicates improved fit to Model 1. Across Models 1 and 2 the estimated attribute coefficients are similar in terms of sign and significance. As expected, price was negatively correlated with participants' purchase likelihood ratings. The positive coefficients for hibiscus and pentas imply that the participants preferred these plants over the base alternative (petunia). The pollinator-friendly attribute increased participants' purchase likelihood when compared to plants without the pollinator-friendly attribute, supporting the first hypothesis that the pollinator-friendly eco-label will be positively correlated with participants' purchase likelihood. This finding is consistent with the literature that reported public support for protecting pollinator insects [17,21]. Compared to conventional production methods, participants were more likely to purchase certified organic or organically produced plants, similar to the findings in previous studies [21,44,45]. Regarding origin, in-state and domestic origins improved participants' purchase likelihood when compared to imported plants. The origin results are substantiated by literature showing consumers value products from closer origins [44], even if they are uncertain about economic or environmental ramifications. Overall, the estimated attribute coefficients suggest the data is robust since the results align with the previous literature.

Table 4. Ordered logit regression coefficient estimates of Florida consumers' purchase likelihood for ornamental landscape plants with different eco-labels.

	Model 1 (*n* = 108)	**Model 2 (*n* = 104) [a]**
Variable	**Coef. (Std. Err.)**	**Coef. (Std. Err.)**
Price	−0.176 (0.028) ***	−0.186 (0.029) ***
Hibiscus	0.690 (0.114) ***	0.759 (0.116) ***
Pentas	0.420 (0.113) ***	0.463 (0.114) ***
Petunia	Base	Base
Pollinator friendly	0.318 (0.094) ***	0.343 (0.095) ***
Certified organic	0.537 (0.113) ***	0.555 (0.114) ***
Organic production	0.723 (0.128) ***	0.751 (0.129) ***
Conventional	Base	Base
In-state	1.056 (0.118) ***	1.104 (0.120) ***
Domestic	0.813 (0.123) ***	0.863 (0.124) ***
Import	Base	Base
Sociodemographic variables		
Age	0.011 (0.003) ***	0.009 (0.003) **
Gender	0.181 (0.095)	0.298 (0.106) **
Household	−0.122 (0.038) ***	−0.055 (0.043)
Income	0.049 (0.017) **	0.003 (0.018)
Education	−0.175 (0.030) ***	−0.158 (0.033) ***
Eye tracking variables		
Pollinator attendance	—	0.923 (0.329) **
Low price attendance	—	0.487 (0.215) *
Medium price attendance	—	−1.418 (0.218) ***
High price attendance	—	−0.993 (0.300) ***
Certified organic attendance	—	1.054 (0.339) **
Organic attendance	—	−1.015 (0.203) ***
Conventional attendance	—	0.416 (0.236)
In-state attendance	—	−0.225 (0.261)
Domestic attendance	—	1.476 (0.312) ***
Import attendance	—	0.211 (0.243)
Plant attendance	—	0.780 (0.212) ***
Plant sign attendance	—	−0.023 (0.200)
Threshold parameters		
1	−3.757 (0.476)	−3.072 (0.509)
2	−2.559 (0.468)	−1.826 (0.501)

Table 4. *Cont.*

	Model 1 (n = 108)	Model 2 (n = 104) [a]
Variable	Coef. (Std. Err.)	Coef. (Std. Err.)
3	−1.808 (0.466)	−1.034 (0.499)
4	−1.434 (0.466)	−0.638 (0.499)
5	−0.412 (0.464)	0.456 (0.499)
6	0.723 (0.464)	1.666 (0.501)
Number of obs.	1728	1664
Log likelihood	−2691.334	−2612.1372
Prob > χ^2	<0.001	<0.001
McFadden/Pseudo R^2	0.0476	0.0756
Akaike Information Criterion (AIC)	5420.667	5286.274
Bayesian Information Criterion (BIC)	5522.019	5451.639

***, **, * Indicate p-values of ≤0.001, ≤0.010, and ≤0.050 when compared to the base variables. [a] Four participants were unable to have their eye movements recorded reducing the sample size to 104 for Model 2. Note: Marginal effect estimates were calculated based on the ordered logit model results and are available upon request.

Several individual sociodemographic variables also impacted participants' purchase likelihoods (Table 4). In both models, older participants were more likely to purchase the plants than younger individuals. Additionally, participants who had completed a higher level of education were less likely to purchase the plants. The significance of gender, household size and income varied between the models. In Model 1, participants with higher incomes were more likely to purchase the plants. Additionally, as participants' household size increased, they were less likely to purchase the plants. The coefficient for gender was not significant. In Model 2, men were more likely to purchase plants, while household size and income were not significant.

Unlike Model 1, Model 2 also included visual attendance metrics. All visual attendance results are in comparison to participants who did not visually attend to the attribute. Participants who visually attended to the plant images (Plant attendance) were more likely to purchase the plants than those who did not view the plant images; however, visual attendance to the plant identification sign (Plant sign attendance) was not significant (Table 4). Visual attendance to the low price point (Low price attendance) improved participants' purchase likelihood, while visual attendance to the medium and high price points decreased purchase likelihood. This result aligns with the attribute coefficient results, which indicate that price and purchase likelihood are inversely correlated. Participants who visually attended to the pollinator-friendly attribute (Pollinator attendance) were more likely to purchase the plant than those who did not, supporting the second hypothesis that consumers' visual attendance to the pollinator-friendly eco-label positively impacts purchase likelihood. Visual attendance to the certified organic production (Certified organic attendance) attribute was also positively correlated with increased purchase likelihood, while visual attendance to organic production (Organic attendance) decreased purchase likelihood. Visual attendance to conventional production (Conventional attendance) was insignificant. Regarding origin, only the domestic origin (Domestic attendance) was significant and positive.

5.2. Willingness-to-Pay Estimates

Model 1 and 2 estimates were used to generate premiums participants were willing to pay for the different attributes (Table 5). Specifically, participants were willing to pay the highest premium for plants with in-state ($5.96–$6.01) or domestic origins ($4.63–$4.67) when compared to imported plants. Participants were also willing to pay premiums for plants produced using organic production ($4.02–$4.12) or certified organic ($2.98–$3.06) when compared to conventional production methods. The origin and production method WTP results are consistent with previous WTP estimates for origin [44] and organically grown ornamental plants [46], suggesting the reliability of the findings. Desirable plant types also generated premiums at $3.93–$4.05 and $2.39–$2.45 for hibiscus and pentas, respectively. Lastly, participants were willing to pay $1.81 to $1.84 more for pollinator-friendly plants.

Table 5. Floridian consumers' willingness-to-pay premiums (in U.S. dollars) for plants with different eco-labels.

	Model 1	Model 2
Attribute	*Premium* (*Std. Err.*)	*Premium* (*Std. Err.*)
Hibiscus	$3.926 (0.882)	$4.072 (0.855)
Pentas	$2.389 (0.731)	$2.486 (0.704)
Pollinator friendly	$1.808 (0.632)	$1.838 (0.602)
Certified organic	$3.056 (0.819)	$2.976 (0.773)
Organic production	$4.117 (0.981)	$4.028 (0.925)
In-state	$6.011 (1.197)	$5.922 (1.129)
Domestic	$4.629 (0.979)	$4.629 (0.932)

6. Discussion, Implications and Limitations

Previous research efforts showed that consumers value pollinator-related conservation measures [17–19], but the extent to which pollinator-related promotions attract consumers' visual attention and influence their behavior remains unknown. The present study contributes to the literature by combining a CA and eye tracking technology to investigate the effect of pollinator-friendly attributes on consumers' purchase likelihood for ornamental plants. Eye tracking technology was used as an explicit data generation mechanism to analyze participants' visual attendance to attributes. Previous studies have demonstrated that incorporating visual attendance measures reduces bias results [27,28]. Here, we found statistically significant relationships between attendance and purchase likelihood. Overall, our results indicate pollinator-related promotions improve consumers' purchase likelihood and generate $1.81–$1.84 price premiums. This suggests there is demand for pollinator-friendly products and that in-store pollinator-related promotions could benefit the green industry supply chain members (growers, intermediaries, retailers). However, it should be noted that other eco-labels also generated positive part-worth utilities (i.e., production method, origin) and further research is needed to better understand the relationships between different types of eco-labels.

An additional contribution of our research is the combination of eye tracking analysis with CA as a means to explicitly measure attribute attendance. Previously, Agarwal et al. [24] suggested pairing the two methods. Similar to Balcombe et al. [29] and Van Loo et al. [8], who used eye tracking in choice experiments, we outlined an approach of combining the two methods and using the data in regression analysis. Results indicate visual attendance positively influences consumers' purchase likelihood for pollinator-friendly plants, which supports Bundesen, Habekost, and Kyllingsæk's [30] neural theory of visual attention. Specifically, that more visual processing is devoted to important stimuli (i.e., pollinator friendly), which in turn impacts consumers' purchasing decisions. This implies visual attention to in-store signage affects consumers' purchasing behavior and demand [2], and pollinator-related promotions can be used to attract more consumers.

Although the results provide interesting implications, there are several limitations that need to be acknowledged. First, the data was collected using stated preference measures; consequently, it was subject to hypothetical commitment bias. However, the positive and statistically significant estimates for the pollinator-friendly attribute appear realistic given the increased attention to pollinator health [17–19,21]. Additionally, while participants control their choices, eye movements are much more difficult to regulate and accurately reflect what participants view [10]. The alignment of the eye tracking measures and the CA estimates suggest reliability. A second limitation was that to facilitate using eye tracking technology, on-site individual participation was required. Therefore, the sample was localized and data was collected in the lab setting using one plant type per image. In the retail setting, multiple products would be in the same visual field at one time as well as additional visual stimuli. The adding of additional visual clutter would likely influence visual attendance measures. In-store trials and retail observations could be used to overcome this limitation.

Overall, our results could assist policymakers, horticultural firms, retailers, and researchers. In the horticulture industry, stakeholders (e.g., growers, retailers, wholesalers, etc.) could utilize the findings as feedback to align their production methods and product offerings with consumer preferences, provided that pollinator-friendly product options are economically feasible. Additionally, since public opinion influences demand and subsequently affects producer welfare, results could benefit policymakers as they determine legislation pertaining to pollinator-related labels (i.e., neonicotinoid-free labeling). Results could also aid future research by providing an additional means (i.e., eye tracking recordings) of handling attribute attendance in CA and choice experiments with more explicit data.

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