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To Scan or Not to Scan: The Question of Consumer Behavior and QR Codes on Food Packages

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We conducted a field experiment involving the purchase of oysters to offer market-based evidence on whether consumers will scan quick response (QR) codes on food packages, a new labeling technology proposed by the SmartLabel™ initiative. In an artefactual marketplace selling oysters, only 1.2% participants scanned the QR code labels with their own devices. However, providing free access to a QR-scanning smartphone induced 52.6% of participants to access labeling information—a large improvement even compared to when this information was provided directly on the package. Furthermore, consumers' responses to the additional information were similar regardless of how the information was delivered.

Key words: consumer preferences, distance from information, field experiments, oysters, food labeling, QR code reading

Introduction

Food labeling has a large influence on consumers' preferences for a product and a significant impact on the market (Golan et al., 2001; McCluskey and Loureiro, 2003; Kiesel and Villas-Boas, 2013).[1] Of particular interest to researchers in recent years is consumers' responses to the presence and content of various product labels. Examples include studies of labeling that delivers information about food processing (Lusk et al., 2005; Costanigro and Lusk, 2014; Liaukonyte, Streletskaya, and Kaiser, 2015), food quality (Caswell and Mojduszka, 1996; Bialkova, Grunert, and van Trijp, 2013), health attributes (Hu, Adamowicz, and Veeman, 2006; Liaukonyte et al., 2013), health risks (Fox, Hayes, and Shogren, 2002; Hayes, Fox, and Shogren, 2002; Dillaway et al., 2011), whether a food grown locally (Wu et al., 2015), and externalities such as a product's environmental impacts (Messer, Kotchen, and Moore, 2000; Loureiro, McCluskey, and Mittelhammer, 2002). For a review of food process labeling, see the 2015 report for the Council for Agricultural Science and Technology by Messer et al. (2015) and Messer, Costanigro, and Kaiser (2017). A common finding in this literature is that providing positive information about a product can increase consumers' willingness to pay (WTP) for it (see, e.g. Loureiro, McCluskey, and Mittelhammer, 2002).

In the aforementioned studies, food labels and associated information were shown directly to consumers, reflecting the reality that labeling information is usually presented on packages.

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[1] Food labeling also largely influences firms' strategies (see, e.g., Moorman, Ferraro, and Huber, 2012).

However, recent innovations in labeling technologies are likely to change how label information is provided to consumers. In December 2015, the Grocery Manufacturers Association (GMA) predicted that “within five years, more than 80% of the food, beverage, pet care, personal care, and household products that consumers buy will be using SmartLabel™” (Grocery Manufacturer Association, 2015, p. 2), the printed quick response (QR) codes that shoppers can scan with their electronic devices to obtain additional information about products. In addition, the National Sea Grant College Act 114th Congress of the United States (2016) has also implemented regulations on genetically modified organism (GMO) disclosure. The bill states that

> USDA must also ensure that an electronic or digital link disclosure: provides access to the disclosure located in a consistent and conspicuous manner on the first product information page that appears, excluding marketing and promotional information. . . and is of sufficient size to be easily and effectively scanned or read by a digital device.

As a result, major food companies—such as Coca-Cola, Land O’Lakes, Tyson Foods—have signed on to the initiative and are moving toward using SmartLabels for a wide variety of products.

This revolution in labeling technology will undoubtedly influence the food industry (Stigler, 1961). Until recently, consumers obtained most of their direct information from food packages. If SmartLabel becomes popular in grocery stores, shoppers will be able to obtain that information in different ways, raising several important questions. When such QR information is readily available, how likely are most consumers to read it? If information previously provided on the package is delivered through a QR code, will consumers’ responses to the information change?

SmartLabel also expands the amount of information that can be provided since package size is no longer a limitation. The SmartLabel can provide consumers with information on what makes a food product “local,” “environmentally friendly,” “genetically modified,” or whatever else they may find important. This technology could be particularly helpful when the label is vague or confusing to consumers (Steenkamp, 1990), such as “certified humane” and “fair trade” (Schuldt, Muller, and Schwarz, 2012). It could also compare definitions of “organic” and “all natural,” details that usually cannot be provided on a package.

Some labels with credence characteristics can also raise safety or health concerns among uninformed consumers. For example, certain food labels can stigmatize their unlabeled counterparts. Kanter, Messer, and Kaiser (2009) found in an experimental setting that simply introducing a “rbST-free” label lowered consumer WTP for conventional milk by 33%. Misperceptions about some technology can decrease consumer WTP. For instance, Liaukonyte, Streletskaya, and Kaiser (2015) show that consumers could be reluctant to purchase products labeled as containing genetically engineered (GE) ingredients simply because they perceive the label to be a warning signal. Another example is food radiation. Although the scientific community shows no significant negative health effects (Diehl, 1999), consumers generally respond negatively to the technology (Fox, Hayes, and Shogren, 2002).

The SmartLabel technology can correct misperceptions about package labels on foods. For instance, some consumers avoid “triploid” oysters, which are engineered to have an extra set of chromosomes and are therefore larger than diploid oysters and available year-round. Consumers have tended to view them as genetically modified (North Carolina Division of Marine Fisheries, 2018), which is not the case; they were developed by interrupting part of the reproductive process (National Oceanic and Atmospheric Administration, 2016). QR codes provide the ability to convey this kind of detailed information. Nevertheless, previous studies also suggest that it is beneficial to reduce consumers’ search costs (De los Santos and Koulayev, 2017). Therefore, the question is whether consumers will take the time to access such information and how they will respond to it.

In this study, we conducted a field experiment by creating an artefactual market offering various oysters, including the aforementioned triploid oysters. Our experiment enabled us to answer four primary research questions:

1. Do consumers read information about food that is not presented to them directly?

2. Are some labeling technologies and/or settings better than others in encouraging consumers to access the additional information?

3. Will consumers respond to the detailed information and change their preferences accordingly?

4. Do various methods of labeling produce similar responses?

In total, 417 adults participated in the study at the Cape May–Lewes Ferry terminal on the Atlantic coast in 2016. The results show that consumers' likelihood of reading additional information about oyster labels depends on the search cost. In general, we find that consumers are most likely to access additional labeling information when it is convenient to do so. When we provided a direct computer link to the information, 20.2% of respondents accessed it; when we provided a QR code, only 1.2% did so. Interestingly, when we provided respondents with a smartphone that had QR-scanning software preinstalled, the information access rate not only bounced back but more than doubled compared to the computer link. These results suggest that the new labeling technology, if made convenient to use, will likely increase the number of consumers accessing additional labeling information. Moreover, we find that the additional information influences consumer preferences and that the QR information resulted in similar behavioral changes as package information. Specifically, consumers are more willing to pay for triploid oysters when information is delivered using either of the methods.

Experimental Design

To answer the four primary research questions, we designed a field experiment that involved offering consumers the opportunity to purchase oysters with and without labels that provided additional information directly on the package, indirectly through a computer link, and indirectly through a QR code. The participants considered eight types of oysters that differed by their harvest location or cultivation process. Oysters are a suitable product for this experiment because most common food products are associated with well-established labels such as GMOs, organic, and all natural. Participants may not have an incentive to look for further information because they believe themselves to be knowledgeable without searching. However, the average consumer is not familiar with triploid oysters, thus creating an incentive for nearly all participants to do some information searching.

The experiment was conducted at the Cape May–Lewes Ferry terminal on the Atlantic coast. We created an artefactual oyster market and hired professional shuckers to set up a tent at the experimental location to process oysters bought by participants. The varieties and price range of oysters were determined after consulting with the local oyster industry and stakeholders. Experiment administrators used a consistent script to recruit participants randomly from the crowd. Once an individual agreed to participate in the study, she signed a consent form that had been approved by the Institutional Review Board (IRB).

The participant then proceeded to making purchase decisions, followed by completing a demographic survey. All decisions were made on iPad Pros using Willow, a Python-based software library for experimental economics. Appendix A provides an overview of the experiment processes and protocols.

Treatments

The experiment applied eight within-subject treatments that differed by the oysters' harvest location or cultivation process and five between-subject treatments that differed in how the labeling information was conveyed. This combination allowed us to investigate consumer preferences for each of the oyster products in response to different labeling methods.

Table 1. Within-Subject Treatments by Product and Associated Information

Label on Oyster	Definition / Explanation	Sources
No label (baseline)	—	—
All natural	Food labeled "all natural," according to the Food and Drug Administration (FDA) definition, does not contain artificial ingredients or preservatives and the ingredients are only minimally processed. The definition for natural tends to be much looser than that of organic, especially the phrase "minimally processed," and generally does not require certification.	FDA[a]
Environmentally friendly	Research from the National Oceanic and Atmospheric Administration (NOAA) supports using shellfish aquaculture for nutrient removal. Oysters are filter feeders - They consume free-swimming algae and improve water quality.	NOAA[b]
Triploid (spawnless)	According to the National Oceanic and Atmospheric Administration (NOAA), triploid oysters are favored over the wild type. Researchers show that the creation of triploid oysters is done by the simple process of crossing one oyster with another in the hatchery. There are no processes, chemicals, additives, genes that do not belong, drugs, or hormones.	NOAA[b,c]
Local	There is no universal definition for "local" food. It usually means that the total distance that the product is transported is less than 400 miles from the origin of the product, or within the state in which it is produced.	110th Congress[d]
Nonlocal	Non-local food usually means that the total distance that the product is transported is more than 400 miles from the origin of the product, and not within the state in which it is produced.	110th Congress[d]
West Coast	—	—
East Coast	—	—

Notes: The order of within-subject treatments is randomized.
Sources: [a] http://www.livescience.com/52863-natural-organic-definition.html
[b] http://chesapeakebay.noaa.gov/fish-facts/oysters
[c] http://darc.cms.udel.edu/ibsa/VIMS%20Triploid%20oyster%20flyer.pdf
[d] https://www.govinfo.gov/content/pkg/BILLS-110hr2419enr/pdf/BILLS-110hr2419enr.pdf

The oyster options varied by either origin or cultivation process: all natural, environmentally friendly, triploid spawnless, local, nonlocal, West Coast, and East Coast. The baseline option was simply listed as "an oyster" with no additional information or label (see Table 1). We gathered the definition for each cultivation process from various sources. Every participant made purchase decisions based on the oyster options, while the definitions were presented to participants in treatment groups as additional labeling information. The accessibility of this additional information varied by between-subject treatments, discussed in the next paragraph. We used the all natural, environmentally friendly, and triploid spawnless labeled oysters to test the labeling methods since additional information contained in labels for those products would be informative and could change consumers' perceptions of them. The triploid spawnless oysters were of special interest. Many consumers inaccurately believe that triploid oysters are genetically modified and are likely to have negative perceptions of them if no additional explanation is provided. We expected that additional scientific information from the National Oceanic and Atmospheric Administration (NOAA) would mitigate potential stigma associated with this product.

Table 2. Treatment Design Overview

Within-Subject Treatments	Between-Subject Treatments Treatment 1: Basic Label (control)	Treatment 2: Package	Treatment 3: Computer Link	Treatment 4: QR Code	Treatment 5: QR + Smartphone
Baseline		—	—	—	—
All natural	Basic label with no additional information	Additional information in print next to the basic label	Additional information contained in a clickable link next to the basic label	Additional information contained in a QR code next to the basic label	Additional information contained in a QR code accompanied by a smart phone
Environmentally friendly					
Triploid (spawnless)					
Local					
Nonlocal					
West Coast		—	—	—	—
East Coast		—	—	—	—

Notes: "Additional information" refers to the product-specific information provided in Table 1.

Table 2 summarizes the between-subject treatments used in the study: (i) no additional information or explanation (baseline control treatment); (ii) additional information in print located next to the basic label (package); (iii) additional information provided by an iPad displaying a clickable link (computer link); (iv) additional information provided by the presence of a QR code on an iPad (QR code); and (v) additional information provided by the presence of a QR code on an iPad and an accompanying electronic device (smartphone) on which the QR scanner software was already installed (QR + smartphone). All participants made their choices privately on an iPad away from the experiment tent and the point of purchase. Those in Treatment 5 were told that they could use their smartphones to scan QR codes, if desired, at the beginning of the experiment; there were no further interaction between the administrators and participants. Figure 1 shows how the labels were presented to the participants.

Treatments 1, 2, 4, and 5 represent labeling technologies currently used for food products. Treatment 3 represents a less commonly used form of information provision (typically used with a limited number of products as part of a promotion). It allows us to measure consumer responses to additional information that is as easy to access as a package label since we could not measure whether participants read a printed label.

Tracking the number of participants who accessed information under each treatment was a challenge. Under Treatment 3 (computer link), individuals clicked a link built into the Python Willow platform and the program recorded whether each participant accessed the information. Under Treatments 4 and 5, however, participants scanned the QR code and the program could not record the number of times the code was scanned. In addition, the experimental design had to guarantee participants' anonymity in accordance to IRB approval. Participants' privacy was also important when they made their choices, so the administrators did not have access to their screens during the experiment. To overcome these obstacles, we created a Google site that offered individual webpages that provided the information for each type of oyster in Treatments 4 and 5. When participants scanned the QR code, they were led to these webpages, which allowed us to trace the number of participant scans under each treatment using Google Analytics.

Implementation

The field experiment was conducted in Lewes, DE, at the Cape May–Lewes Ferry terminal on the Atlantic coast in in 2016. The experiment took approximately 15 minutes to complete and each subject received a $10 participation fee. Student interviewers recruited adult subjects at busy locations at the terminal.

The oysters offered to participants were shucked onsite outside the terminal in a tent by two professional shuckers who accompanied the researchers and presented and prepared the oysters, Consider these **triploid (spawn-less)** oysters.

(a) Treatment 1: Basic Label

Consider these **triploid (spawn-less)** oysters.

Did you Know:According to the National Oceanic and Atmospheric Administration (NOAA), triploid oysters are favored over the wild type. Researchers show that the creation of triploid oysters is done by the simple process of crossing one oyster with another in the hatchery. There are no processes, chemicals, additives, genes that do not belong, drugs, or hormones.

(b) Treatment 2: Package

Consider these **triploid (spawn-less)** oysters.

Did you Know:Click Here for More Info on Triploid Oysters

(c) Treatment 3: Computer Link

Consider these **triploid (spawn-less)** oysters.

Did you Know:

For More Information on Triploid Oysters Scan This QR Code

(d) Treatment 4: QR Code

Consider these **triploid (spawn-less)** oysters.

Did you Know:

For More Information on Triploid Oysters Scan This QR Code

(e) Treatment 5: QR + Smartphone (Appears the Same as QR Code)

Figure 1. Treatment Appearance to Participants

ensuring both high-quality presentation and strict adherence to food safety requirements. These oysters were always stored on ice and were available for viewing by the participants but were not labeled, and the participants made their decisions in a physically separate indoor area. The participants were not encouraged or prevented from approaching the shucking table or the oyster products. The spatial configuration of the experiment ensured that all participants made their decisions away from the shucking table. These participants were not able to identify, smell, or taste the exact oysters that they were considering purchasing. This design controlled for potential noise from individuals' tastes for oysters with specific characteristics that were not related to our research.

The experiment involved a single-bounded dichotomous-choice format in which the participants chose whether to purchase various oysters at different prices. Each participant was randomly assigned by the computer to one of the five between-treatment groups, representing the information treatments. They then chose the number of oysters they wanted to purchase (three, six, nine, or twelve) and the method of preparation of the oysters (raw on the half shell, fried, or taken home in a bag on ice). We worked closely with aquaculture and restaurant industry experts when developing these options to give participants some flexibility in their choices.

Next, each participant made eight purchasing decisions for eight different oyster options (see Table 1; hereafter called "options") in response to a randomly generated price for each decision. These posted prices were obtained through random draws from a normal distribution based on a set of typical market prices for oysters with mean \$1.50 and standard deviation \$0.50, and the dominant strategy was to answer "yes" and purchase oysters only if the listed price was lower than the participant's true WTP.

The order of the questions presented to participants was randomized to avoid potential order effects. Participants clicked "yes" or "no" to indicate their choices, and the program randomly selected one of the eight decisions for implementation at the end of the experiment. Participants who had clicked "yes" in that round purchased the oysters at the posted price. Those who clicked "no" for the selected, binding option did not receive any oysters and retained the entirety of the \$10 participation fee. We offered examples on how different choices can influence participants' monetary payoffs as well as purchase outcomes (see Appendix B for more information).[2] All participants then completed a survey that collected information on their demographic characteristics and shopping behaviors. Those who purchased oysters paid the posted price, and the oysters were then prepared by professional shuckers according to their request.

Econometric Model

In a model of the single-bounded dichotomous choices (Venkatachalam, 2004) made in our experiment, responses to the dichotomous choice questions are either positive (purchases the oyster) or negative (does not purchase the oyster) in response to the posted price. This model allows us to place a respondent's WTP for a product in one of two intervals: $(-\infty, p)$ or $[p, +\infty)$, where p is the posted price. The bidding mechanism results in the following discrete outcomes:

$$D = \begin{cases} 0 & WTP < p \quad \text{(No)} \\ 1 & p \leq WTP \quad \text{(Yes)} \end{cases} \tag{1}$$

The individual WTP outcome is based on a random utility model in which the respondent maximizes utility by choosing to purchase a product at the associated price if and only if the utility derived from the product at that price is higher than forgoing the product. The probability of each outcome can be expressed as

$$\Pr(Y = D) = \begin{Bmatrix} F(v(p,\boldsymbol{Z})) \\ 1 - F(v(p,Z)) \end{Bmatrix} \text{ for } D = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix}, \tag{2}$$

where $F(\cdot)$ is a cumulative distribution function characterizing the components of utility, $v(p,\boldsymbol{Z})$ is the difference in indirect utility between purchasing a product at price p and declining the price, and $\boldsymbol{Z}$ is a vector of characteristics that influence indirect utility. The function $v(p,\boldsymbol{Z})$ for individual i can be written as

$$V(p_{ij}, Z_{ij}) = \alpha + \rho' p_{ij} + \chi' \boldsymbol{O}_j + \lambda' \boldsymbol{X}_i + \xi' \boldsymbol{T}_i + \zeta' \boldsymbol{O}_j \times \boldsymbol{T}_i,\ i = 1,2,\ldots,n,\ j = 1,2,\ldots,8, \tag{3}$$

where p_{ij} is the price of oyster j offered to respondent i, $\boldsymbol{O}_j$ is a vector of specifications for oyster option j, and $\boldsymbol{X}_i$ is a vector of observable characteristics of respondent i. $\boldsymbol{X}_i$ consists of a participant's gender, age, education, and income. $\boldsymbol{O}_j$ consists of local, nonlocal, East Coast, West

[2] Note that similar experimental procedures are used in consumer studies of various topics, including Kecinski, Messer, and Peo (2018), Li, Kecinski, and Messer (2017), and Li, Kecinski, and Messer (2018).

Table 3. Summary Statistics for Demographic Variables

Variables	Sample Statistics	Variables	Census Statistics (Delaware)	Census Statistics (New Jersey)
Number of respondents	417	Number of residents	961,939	9,005,644
Median age (years)	51	Median age (years)	40	39
		Median age of adult population (years)	45-49	45-49
Female	55.90%	Female	51.60%	51.80%
Education (highest level)		Education		
Some school	1.20%			
High school diploma	16.30%	High school or higher	88.80%	88.90%
Some college	28.10%			
Bachelor's degree	25.40%	Bachelor's degree or higher	30.50%	37.50%
Advanced or graduate degree	27.80%			
Household income (in 2015)		Household income (in 2016)		
< $10,000	3.13%			
$10,000–$34,999	17.30%			
$35,000–$74,999	32.60%	Median income	$61,017	$73,702
$75,000–$99,999	14.40%			
$100,000 $149,999	18.20%			
≥ $150,000	11.00%			
Political affiliation		Political affiliation		
Conservative	29.50%			
Moderate	32.10%		Not Available	Not Available
Liberal	28.50%			
Other	7.20%			

Notes: State data are from the U.S. Census Bureau (2017).

Coast, all natural, environmentally friendly, and triploid oysters along with a baseline oyster with no specification. $\boldsymbol{T}_i$ is a vector of dummy variables that represent each treatment $T = \{$T1 (control), T2 (package), T3 (computer link), T4 (QR code), T5 (QR plus smartphone)$\}$. α, ρ, λ, χ, ξ, and ζ are unknown parameters to be estimated. The log-likelihood function can be expressed as

$$(4) \qquad \ln L = \sum_{i=1}^{n} \left\{ \begin{array}{l} [l] I_{D=0} \ln F(\alpha + \rho' p_{ij} + \chi' \boldsymbol{O}_j + \lambda' \boldsymbol{X}_i + \xi' \boldsymbol{T}_i + \zeta' \boldsymbol{O}_j \times \boldsymbol{T}) + \\ I_{D=1} \ln [1 - F(\alpha + \rho' p_{ij} + \chi' \boldsymbol{O}_j + \lambda' \boldsymbol{X}_i + \xi' \boldsymbol{T}_i + \zeta' \boldsymbol{O}_j \times \boldsymbol{T}_i)] \end{array} \right\},$$

where $I_{D=0,1}$ represents the indicators for each D outcome for individual i. We define $F(\cdot)$ as the standard logistic distribution with mean 0, a between-subject error term $\varepsilon_i \sim N(0, \sigma^2)$, and an individual error term $\varepsilon_{ij} \sim N(0, \sigma^2)$, where $\sigma^2 = (\pi/\sqrt{3})^2$.

Results

In total, 417 adults participated in the study. Table 3 provides summary statistics for the demographic variables. We further compare our sample with the populations of Delaware and New Jersey, the two states that the Cape May–Lewes Ferry connects. The median age was 51 in our sample. In both

Table 4. Correlation among Demographic Characteristics and Attitudes toward Food Labeling (N = 417)

	Female	Age	Income	Education	Politically Liberal	Reads Labels	Looks for Information	Needs Federal Definition
Female	1.00							
Age	−0.02	1.00						
Income	−0.03	0.11***	1.00					
Education	0.04	0.05***	0.31***	1.00				
Politically liberal	0.14***	−0.05***	0.08***	0.16***	1.00			
Reads labels[a]	0.13***	0.09***	−0.02	0.14***	0.08***	1.00		
Looks for information[b]	0.08***	0.09***	0.02	0.10***	0.02	0.78***	1.00	
Needs federal definition[c]	0.09***	−0.03	0.00	0.09***	0.11***	0.67***	0.69***	1.00

Notes: Triple asterisks (***) indicate significance at the 1% level.
[a] Question: "I read food labels"; categorical: 1 (never) – 5 (always).
[b] Question: "I look for food information"; categorical: 1 (never) – 5 (always).
[c] Question: "We need federal definitions for food labels"; categorical: 1 (strongly disagree) – 5 (strongly agree).

Table 5. Click-In Rate by Treatment

Treatment	Total Number of Participants	Click-in Rate (%)
Treatment 3 (Computer Link)	89	20.20
Treatment 4 (QR Code)	82	1.20
Treatment 5 (QR + Smartphone)	76	52.60

Table 6. Clicked-In Rate by Products in Treatment 3 (Computer Link) (*N* = 89)

Product	Number of Click-Ins	Percentage (%)
Triploid	13	14.60
Environmentally friendly	12	13.50
All natural	11	12.40
Local	8	9.00
Nonlocal	4	4.50

Notes: Ordered by click-in rate in a descending order. Click-in decisions for different products are not mutually exclusive.

Delaware and New Jersey, the median age of the adult population was between 45 and 49 years. In both states, there were slightly more female than male residents, as in our sample (56%). Our participants were politically diverse: 32% identified as moderate, 30% as conservative, and 29% as liberal. The education and household income levels of participants ranged widely. Approximately 90% residents in both states had completed at least high school, while the percentage was 98.8% among participants in our experiment. The median household income was $61,017 in Delaware and $73,702 in New Jersey. In our sample, it fell between $35,000 and $74,999.

Table 4 presents correlations between their demographic characteristics and attitudes toward labeling. In general, individuals who look for more food information are more supportive of federal definitions of food labels. As age goes up, people are more likely to look for product information and read food labels. However, they are less supportive of federal food label definitions, although the correlation is not statistically significant at the 1% level. Participants who reported themselves to be politically liberal are more supportive of federal food label definitions. Higher-educated participants and female participants are more likely to seek labeling information, consistent with previous findings (Christoph et al., 2018), while income levels do not affect such behavior.

Table 5 presents the percentage of participants who accessed the additional information under the link and QR code treatments. When the relatively convenient computer link was provided next to the basic product label, 20.2% of participants clicked at least one link to obtain additional information. When the same information was provided as a QR code, only 1.2% of the participants scanned the code. However, when the participants were provided with a smartphone on which the QR scanning software had been preinstalled, 52.6% scanned the QR code for at least one product.

These results clearly indicate that most consumers are currently unlikely to scan QR code labels using their own devices, even when free Internet access is available; simply providing a scanning device can significantly increase the likelihood they will scan the QR code and access the additional information. Our results show that the percentage of people who accessed the QR code when provided with a scanner was more than twice the percentage who used the direct computer link. This behavior can be explained by a couple of factors. First, using QR codes for labeling can create a barrier to obtaining information, but providing consumers with easy access to a scanning device decreases the marginal cost of information searching. Second, it is possible that participants may be responding to the experimenter's demand. However, because participants in this experiment made choices on a private screen with no interaction with the experiment administrators, we believe this was not a dominant driver of the observed behavior. The third possible factor is that consumers may have seen using the device as a novelty, which might be more consistent with the type of consumer

Table 7. Coefficient Estimates of the Explanatory Variables on Saying "Yes" to an Option

	Model 1		Model 2	
Parameter	**Coefficient Estimate**	**Std. Err.**	**Coefficient Estimate**	**Std. Err.**
Price	−1.68***	0.16	−1.69***	0.16
Local	0.44*	0.25	0.42*	0.25
Nonlocal	−1.53***	0.29	−1.48***	0.29
West Coast	−1.17***	0.28	−1.17***	0.27
East Coast	−0.06	0.25	−0.01	0.25
All natural	−0.19	0.25	−0.19	0.25
Environmentally friendly	0.45*	0.25	0.44*	0.25
Triploid	−1.24***	0.28	−1.24***	0.28
Female			−0.98***	0.38
Age			−0.01	0.01
Income			0.03	0.07
College			1.48***	0.38
Frequent oyster consumer			0.37***	0.15
Constant	−2.22	0.53	1.29	0.15
	$N = 3{,}336$; Wald = 176.34		$N = 3{,}256$; Wald = 191.90	

Notes: Coefficients are estimated using a random effects logit model. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

response that may be observed if supermarkets began offering in-store devices for their customers to help them read QR codes.

We further investigated how different oyster types affect consumers' interest in accessing additional information using the computer link treatment (89 participants), which mimicked the status quo labeling methods and allowed us to record their behavior. As shown in Table 6, the triploid oysters most often prompted participants to seek additional information (13 of 89), followed by environmentally friendly (12) and all natural (11) oysters. Local and nonlocal oysters prompted only eight and four participants, respectively.[3] These results coincide with our expectations since triploid oysters are a relatively new product and local products already have an established market.

To draw conclusions about the participants' general preferences for the different oyster options presented, we first used a random effects logit model to estimate the marginal effects of price, oyster characteristics, and the participants' demographic characteristics on the likelihood of a respondent choosing to purchase a specific oyster option using pooled data from all between-subject treatments (Table 7). Model 1 includes price and oyster characteristics as explanatory variables, and Model 2 further includes demographic variables. The estimation results are robust with and without demographic variables. We found that participants were less likely to purchase oysters when the price was relatively high, consistent with economic theory. The participants generally showed a preference for local and environmentally friendly products, a common finding in the literature for a variety of products (Li and McCluskey, 2017). Compared to the baseline oysters with no process labels, the participants were significantly less likely to purchase nonlocal, West Coast, and triploid oysters, all at the 1% level. Model 2 provides insight into how demographic characteristics influence

[3] The software that we developed for this study did not provide any insight into whether this behavior pattern holds when information is delivered by QR code rather than by computer links. It is reasonable to assume that participants also paid significant attention to triploid oysters under Treatment 5 because, as shown in Table 8, participants' WTPs responded to labeling information in the same direction under Treatments 3 and 5.

Table 8. Effect of Between-Subject Treatments on Coefficient Estimates of the Explanatory Variables on Saying "Yes" to an Option (N = 3,336)

Parameter	Coefficient Estimate	Std. Err.	Marginal Effect	Std. Err.
Price	−1.75***	0.16	−0.11***	0.01
Local	0.43*	0.25	0.03*	0.02
Nonlocal	−1.52***	0.29	−0.1***	0.02
West Coast	−1.19***	0.28	−0.08***	0.02
East Coast	−0.01	0.25	0	0.02
All natural	0.02	0.44	0	0.03
Environmentally friendly	0.23	0.44	0.01	0.03
Triploid	−2.96***	0.72	−0.19***	0.05
Treatment 2 ×				
All natural	0.55	0.6	0.04	0.04
Environmentally friendly	0.39	0.6	0.03	0.04
Triploid	2.88***	0.84	0.19***	0.05
Treatment 3 ×				
All natural	−0.73	0.64	−0.05	0.04
Environmentally friendly	0.83	0.59	0.05	0.04
Triploid	2.8***	0.84	0.18***	0.06
Treatment 4 ×				
All natural	−0.71	0.61	−0.05	0.04
Environmentally friendly	0.08	0.59	0	0.04
Triploid	−0.01	0.97	0	0.06
Treatment 5 ×				
All natural	−0.26	0.64	−0.02	0.04
Environmentally friendly	−0.22	0.62	−0.01	0.04
Triploid	1.9**	0.88	0.12**	0.06
Treatment 2 (Package)	−0.68	0.57	−0.04	0.04
Treatment 3 (Computer Link)	−0.51	0.57	−0.03	0.04
Treatment 4 (QR Code)	−0.01	0.57	0	0.04
Treatment 5 (QR+ Smartphone)	−0.35	0.59	−0.02	0.04
Constant	−0.24	0.48	—	—

Notes: Wald = 188.28. Coefficients are estimated using a random effects logit model. Marginal effects are estimated using Delta method. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level, respectively.

consumer preferences for oysters. On average, female respondents were less likely to purchase oysters in general, while individuals who had gone to college and who consumed oysters frequently had greater WTP.

We then investigated how consumer preferences for the oyster products changed in response to additional labeling information delivered in various between-subject treatments. Those results are presented in Table 8. The different labeling methods did not change participants' overall preferences for oysters, as indicated by insignificant coefficients for the dummy variables that represented the information treatments. Additional information delivered directly to the participants on the package (Treatment 2) did not significantly change their preferences for all natural and environmentally friendly oysters but increased their preferences for the triploid oyster by 19.0% at the 1% significance level. As previously noted, the information about the triploid oysters stated that they were preferable to wild types of oysters and involved no processes, chemicals, additives, foreign genes, drugs, or hormones. This result is consistent with intuition.

Package labels are common in today's market, and our experiment supports the results of previous studies indicating that consumers are willing to pay more for a product when positive information is delivered. In addition, we find that additional information provided in a direct computer link, compared to package labels, had a similar effect for triploid oysters ($\chi^2 = 0.01$, Prob $> \chi^2 = 0.90$), increasing the likelihood that the participant would purchase those oysters by 18%. As expected, providing a QR code label did not significantly change participants' behavior (the marginal effect is 0.00) since only 1.2% of the participants accessed the information under that treatment. When we provided the QR code and a smartphone with a code scanner preinstalled, many more participants accessed the information (52.6%), and their preferences changed accordingly; the likelihood of purchasing the triploid oyster increased by 12%, statistically indifferent from package labels ($\chi^2 = 1.95$, Prob $> \chi^2 = 0.16$).

Conclusion

In this study, we conducted a field experiment to understand consumers' responses to new labeling technologies and, in particular, how providing a device capable of scanning QR codes affected the rate at which consumers pursued additional information about a product. We further analyzed whether the labeling method affected their response to the information provided.

The experimental design in this study examines the impacts of a potentially novel change in the market in response to the Grocery Manufacturers Association's SmartLabel initiative promoting QR codes for most products to provide consumers with more detailed information than can be provided on packaging. Whether consumers will actually access such information is an open question. This study provides timely, market-based evidence regarding factors that affect consumers' willingness to use QR codes, benefiting those involved with designing and implementing the new labeling technology.

Our results show that consumers will access the information as long as doing so is quick and convenient. When provided solely with a QR code, just 1.2% of the participants accessed the information. When they could either click a direct link on a screen or immediately pick up a provided device that could scan the code, the share of participants who accessed the information rose significantly, to 20.2% and 52.6%, respectively.

These findings suggest that new labeling technologies that require shoppers to scan a QR code are unlikely to motivate consumers to access the information without additional interventions. Providing consumers with quick, convenient access can greatly increase the likelihood they will access it. Furthermore, settings can be designed to invite consumers to learn more, thus further increasing how often they access the information in QR codes rather than relying solely on direct package labels.

Our results also suggest that consumer preferences for a product are influenced by the amount of information provided and accessed and that additional information can alleviate consumers' misconceptions about a product. We find that this is true regardless of how the information is delivered.

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Appendix A: Experiment Roadmap

Step 1. Experimental questions design. This step included input from stakeholders, such as industry experts, restaurant owners and policy makers.

Step 2. Location scouting: We coordinated with the Cape May–Lewes Ferry terminal to set up an indoor recruitment booth, an outdoor tent for oyster handling, and designated research areas. The experiment took multiple days at the ferry terminal, with the same setup every day. We arranged for professional oyster shucking services, which accompanied us to the experiment each day.

Step 3. Design implementation using dichotomous choice experiments. 417 participants responded either "yes" or "no" to 8 dichotomous choice questions.

1. Participants were set up with $10.
2. Participants preselected the number of oysters they would want to purchase (3, 6, 9, or 12) and how they would like the oysters prepared (raw, fried, or in a bag of ice to take home).
3. Participants made 8 dichotomous choice decisions.
4. Participants filled out a demographic survey.
5. Random selection of one of the participant's choice decision. A roll of the dice determined which one of the eight decisions would be implemented (ensuring incentive compatibility).
6. If random draw selected a "yes" decision, the participants paid for the oysters and would receive the oysters as indicated in their preselection; if the random draw resulted in a "no" decision, the participant would receive the $10 and no oysters.

Step 4. Researchers combined data from Python Willow program and Google Analytics records.

Appendix B: Experiment Instructions

Please read these instructions carefully and do not communicate with any other participants while you are making your decisions.

- **We will give you $10 that you may use to purchase oysters in this study or you may keep.**
- Depending on the choices you make, you may receive a combination of cash and oysters. There is the possibility of you owing us money if the cost of your oysters is greater than $10. In such case, you can pay with cash, check or credit card for the oysters.
- Your decisions are just like the ones you make in a store, you either buy at the listed price or you don't.

Guidelines:

1. Decide how many oysters you want to buy (3, 6, 9 or 12)
2. Decide how you would like your oysters prepared (raw on the half shell, fried, in a bag with ice)
3. Decide if you want to buy the oyster options at the listed price by selecting 'Yes' or 'No'
4. Fill out a short survey
5. Roll a digital die to determine which oyster option will be implemented (only one will be implemented)

Example 1: If you selected 'Yes' for an oyster option that costs $7 and this option is implemented, you will receive the oysters and $3 cash ($10 − $7 = $3).

Example 2: If you selected 'No' for an oyster option and this option is implemented, you will receive $10 and will not receive any oysters.

Example 3: If you selected 'Yes' for an oyster option that costs $15 and this option is implemented, you will receive the oysters and owe $5 ($10 − $15 = −$5).