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Using QR codes to access food information: a behavioural study with European consumers

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Contents

Abstract

We present an experiment to evaluate the impact of providing digital access to food information via QR codes. We measure consumers' willingness to access digital food information by scanning QR codes on paper labels, and how this affects their knowledge about food products. The experiment was conducted online with 3420 participants from three Member States of the European Union (Spain, Germany, and Bulgaria). The sample was stratified in terms of age, gender, regions, place of residence (rural vs. urban) and education level. Participants made a number of choices between pairs of food products across a wide range of food categories. We varied the mode of display of some of the food information: it was either available directly ("paper label") or only after the participants clicked on a QR code ("hybrid label"). We found that participants were as likely to choose food products with hybrid labels as those with paper labels. However, they were unlikely to access digital food information. As many as 37% of the participants never scanned any QR codes. Only 4% scanned all of them. On average, QR codes were scanned 24% of the time. Furthermore, products with hybrid labels slowed choice down and reduced the accuracy of what consumers knew about the product. We conclude that providing food information via QR codes rather than on paper labels has a negative impact on consumers.

1 Introduction

Purpose:

In 2020 the European Commission adopted the Farm to Fork (F2F) Strategy for a fair, healthy, and environmentally friendly food system. One of its goals is to provide European consumers with clear and easily accessible information to facilitate their choice of a healthy and sustainable diets.

As part of the F2F Strategy, we explore ways to provide more information to consumers through other means than reading the paper labels that are printed on or affixed to products. These other ways predominantly involve hybrid labels, which combine paper and digital sources of information (Werle et al., 2022).

In this study, we therefore seek to understand how consumers *behave* with respect to such hybrid labels and the information provided through them. Specifically, we want to know how providing digital information affects consumers compared with providing information on paper. To do so, we measure to what extent people are willing and able to use and remember food information provided digitally, as compared to food information provided on paper.

The legal and policy context

Rules for food labelling are set under Regulation (EU) 1169/2011 (CELEX 32011R1169) on the provision of food information to consumers. Different rules apply to pre-packed and non-prepacked foods.

Prepacked food labels must contain the following information items, to which we will henceforth refer to as Mandatory Food Information items ("MFI"):

- The name of the food
- The list of ingredients, with clear highlighting of allergens
- The quantity of certain ingredients or categories of ingredients
- The net quantity of the product (mass or volume)
- The date of minimum durability or the 'use by' date
- Any special conditions for storage and/or use
- The country of origin or place of provenance (in some cases)
- Instructions for use (in some cases)
- Alcoholic strength by volume (when above 1.2 % by volume of alcohol)
- The name or business name and address of the food business operator
- A nutrition declaration with energy value and amounts of fat, saturates, carbohydrate, sugars, protein, and salt in the food.

Those labelling requirements hold for all prepacked foods, whether sold online, by distance selling or in a shop. This mandatory food information must be available **before** the purchase is concluded.

2 The literature

We review in this part the literature on the motivations for the acquisition of information on food items. We move from the more general literature about the value and use of information, to the literature on food information in particular. We focus on studies that are of direct relevance for our experiment, the reader may want to refer to Werle et al. (2022) for a wider picture. We then discuss how food labels contribute to knowledge about food being purchased, and finally, how digital food labels can contribute in that respect.

Value and use of information: The natural starting point for the investigation into willingness to obtain information via QR codes is why information is desirable in the first place. The standard normative approach is the pragmatic theory of information. It sees information as a means or resource to solve a problem by overcoming uncertainty. The value of information is determined by the extent to which it can guide action, that is, help evaluate which of two or more options available will, in expectation, yield highest utility. Thus, information must not only be truthful and relevant to the choice at hand; to be valuable, it must have the potential of changing the choice.

For example, suppose that two options, A and B, are available and substantial uncertainty remains concerning the utility of Option A. It is possible to reduce this uncertainty by acquiring additional information about A. However, no matter which of the possible results such an inquiry yields, the expected utility of A will be, say, higher than that of B. In such a case, the pragmatic value of information that can be gained is zero. This means that when there is any positive cost of information (which is often non-monetary, e.g. corresponds to time and cognitive effort required to collect and process the information), it should not be paid.

There is ample empirical evidence that such an instrumental view of information is overly simplistic, as humans and other animals are often willing to collect information also when it has no pragmatic value (Kang et al., 2009; Zental and Stagner, 2012). It could be motivated by sheer curiosity or willingness to have one's opinions confirmed. It could also be a mistake, a case of incorrect calculation of pragmatic value. In some cases, patterns of anticipatory emotions, such as hope, and dread might lead people to *avoid* obtaining information despite its positive pragmatic value (Golman et al., 2017), most strikingly in the case of medical diagnostic tests (Ganguly and Tasoff, 2017). Some of these cases may arguably be welfare-enhancing; if someone enjoys eating a dessert more when not knowing how many calories it has and the negative effect for their health is limited, then it may be optimal if nutritional information is not provided.

Informed food choices: As a rule, though, consumers benefit from making informed food choices. Sensory inputs (but also reviews and recommendations) may help them assess the quality and palatability of the food. Providing consumers with information about ingredients allows them to account for allergies and other dietary restrictions. Nutritional information helps them balance their daily intake of calories and macronutrients. Use-by dates, quality control recommendations and certificates of adherence to food safety regulations allow them to decide whether the product is safe to consume. Information about the product's origin, sourcing and its environmental impact/sustainability enables them to make ethical food choices. Usage instructions are indispensable when it comes to properly storing and preparing food. Finally, almost every consumer wants to know the price and quantity. Apart from being able to make more informed choices, Lacroix et al. (2019) argue that consumers also appreciate the availability of information even if they have no intention of actually using it.

Labels as a source of food information: Labels are the single most important source of information about food, but consumers often find food labels confusing (Roberto and Khandpur, 2014; Temple and Fraser, 2014). Full and correct processing of the information they provide cannot be taken for granted. On average, consumers may be making up to 200 food decisions a day (Wansink and Sobel, 2007), so the vast majority of those decisions must be made very quickly. This means that they cannot take into account all information on labels at the time of purchase.

Food choices typically follow the "direct heuristic route" corresponding to rough, error-prone "system 1", as found in eye-tracking research (Ma and Zhuang, 2021). So-called top-down attention, driven by consciously formulated goals and plans, plays a limited role in food choice (Fenko et al., 2018). Bottom-up attention, which is driven by external stimuli, is a more important factor.

Some studies find that labels have a limited effect on actual food choice (see Ma and Zhuang, 2021 for a review). However, they may still affect consumers' willingness to try new foods (McFarlane and Pliner, 1997) and to pay for dietary products (Øvrum et al., 2012). Large, prominently placed, and salient labels that capture attention (Orquin et al., 2020) can also affect choice.

The question thus arises as to whether hybrid labels can guide consumers' decisions as well as traditional paper labels.

QR codes: The channel for accessing information on which we focus in this study is via QR codes that link to dedicated online sources of product information.

Currently, QR codes are an option that may be used to give access to information, for example about the origin of certain foods (Lombardi et al, 2017), the manufacturing process (Bradford et al, 2022) and the sustainability practices of the firm producing them (Kim and Woo, 2016). QR codes can also unlock access to audio and videos as well as interactive and personalized content (including targeted offers). For some consumers, QR code may be more convenient than paper labels. This may, *inter alia*, be the case of visually impaired people, for whom the font used on labels may be too small.

On the other hand, there are also important barriers to the use of QR codes on labels. These include lack of competence or familiarity, lack of a device capable of scanning them, slow or missing Internet connection and, importantly, concerns about cyber security and privacy. Again, heterogeneity of consumers is expected.

3 Research questions and hypotheses

Within this policy context, and given the paucity of relevant literature, we ran an experimental study to address the extent to which people prefer, access, and remember food information that is presented on printed labels vs. accessible only digitally.

We want to understand if people **prefer** having food information provided on-label rather than receiving (the same) information digitally, how often they **access** food information when it is provided digitally rather than on-label, and whether they **remember** food information similarly well when it is provided digitally rather than on-label.

These questions are important for predicting acceptance of regulations concerning provision of food information and their effects on the welfare of consumers. While corporations push for digitalization of food labels (allowing them to cut the costs of packaging, attract consumers to their websites, strengthen brand loyalty and personalize offers), consequences for the consumers must be carefully examined.

This experimental behavioural study therefore measures participants' preferences as well as their access to, and knowledge of food information presented either via a QR code or directly or on-label. To improve control over the information participants could access, the experiment featured and compared labels containing no QR code (henceforth "paper labels") to those with one type of information (e.g. caloric contents) accessible via QR code and other types of information available directly (henceforth "hybrid labels"). All the details of the design and procedures will be explained in Section 3.

We have formulated several hypotheses concerning various aspects of participants' behaviour. The hypotheses have been pre-registered at the Open Source Framework's open registries network (https://osf.io/nwv38/) and are reproduced below, with some trivial editing and re-ordering.

To the extent possible, the hypotheses are based on existing literature. Below each hypothesis, we provide references to previous work, zooming on some particularly important or relevant studies. However, as can be inferred from reviews such as (Werle et al., 2022), literature on QR code use is often fragmentary. Moreover, most of it is not directly relevant to the issues central for our study, namely preference for, and ability to access and accurately report paper vs. digital information. Finally, in most studies on QR codes, the data is not incentivized, which might make a difference. Lacking references on the impact of *digital food information ("DFI")*, some of our hypotheses are thus based on general insight concerning willingness and ability to access, process, remember and utilize information.

Hypotheses

1. Preferences:

1.1. When choosing between products A and B, participants will be more likely to choose A when A has a paper label and B has a hybrid label than when both have paper labels.

1.2. Participants will be more likely to choose a product with a paper label than a product with a hybrid label.

The first hypothesis compares choice likelihood for both products in a pair when we vary the type of label on them. It is tested by comparing choices between participants, depending on how products in a given pair were presented to each of them. The second hypothesis states that choices of each given participant will be affected by the type of label on a product. It is tested by comparing choices within all choices made by a participant.
Those hypotheses are based on the well-established general tendency to choose options that are easier to evaluate (Garbarino and Edell, 1997). As paper labels provide all the information in the same manner, they also probably make it easier to compare and thus evaluate products with respect to each other. However, the evidence on QR codes is very scarce. Oonk (2013) found that purchase intentions were independent of whether information was provided digitally or on-label.

2. DFI access

2.1. Overall, the prevalence of DFI access will be low. DFI will be accessed no more than one fourth of the time in our experiment on average.

2.2. The share of participants accessing DFI will diminish over the course of the experiment.

This hypothesis is based on the pragmatic theory of information, whereby participants will access information only if the gain in doing so is higher than the cost of accessing that information. There is a gain in accessing information only if it is likely to affect choice. The costs involve, in the case of QR code, the effort and time of picking up one's smartphone, opening the camera or a dedicated app, scanning the QR code, waiting for the information to load, and reading it. In our experiment, the costs will involve simply clicking on a QR code. The benefit depends on the information that is accessed via the QR code and how important it is to the consumer.

The Technology Adoption Model also emphasises the role of those two antecedents of use, namely perceived usefulness and perceived ease of use. Most studies find spontaneous use of QR codes to be low (Li & Messer, 2019; Bashir, 2022) unless a dedicated device is readily available (Li & Messer, 2019; Tongze and Messer, 2019). Relatedly, Bray et al., (2019) reported that consumers tend to prefer on-label information when given a choice.

Perhaps the most relevant reference for our purposes is the field experiment by Li & Messer (2019) which investigated how the willingness to use DFI (about oysters) depends on how it can be accessed. They found very large differences between different use scenarios. In the most typical, ecologically valid scenario involving a QR code that could be scanned by means of participant's own device, only 1.2% of them did it. By contrast, as many as 52.6% of participants scanned the QR code when a smartphone (with a QR scanner installed) was also provided to them at the marketplace. In the case of a device (a tablet) being provided but enabling access to DFI via a link rather than a QR code, 20.2% of participants accessed it. In other words, the convenience of accessing DFI had a dramatic effect on its actual use. Our implementation is most comparable to the treatment in Li & Messer (2019) that involved a link on a tablet. This is why we expect DFI access to be lower than 25%.

We expect the fraction of consumers accessing DFI to diminish as they go on making choices during the experiment as the novelty of accessing information via QR codes wears off, and as participants get tired over the course of the experiment, thus lowering their ability to process information and their willingness to do the effort of accessing DFI.

3. Speed of choice

3.1. Choices involving products with hybrid labels will take more time than choices involving only products with paper labels.
3.2. Among choice situations with at least one product with a hybrid label, choices in which DFI is accessed will take more time than those in which it is not.
3.3. Choice involving products with hybrid labels where the DFI is accessed will take more time than choices involving only products with paper labels (this is a weaker version of hypothesis 3.1)

We are not aware of directly relevant studies comparing speed of choice depending on the means by which food information is delivered. Hypotheses 3.1 and 3.3 seem natural given the extra time (if short) necessary to access DFI. For Hypothesis 3.2., the Elementary Information Processes perspective (Bettman et al, 1990) predicts that with more information being processed, the processing time becomes longer. It should be noted that later literature nuanced this picture, showing that additional information may, in fact, speed up decisions if it improves coherence (Glöckner and Betsch, 2012). In our experiment, however, this is not systematically the case – the means by which the information is accessible are independent of the contents of this information.

The correlation described in Hypothesis 3.2 could also be triggered by the mechanism operating in the reversed direction: pragmatic theory of information predicts that the decision maker will be more inclined to acquire information (with non-zero cost) when they are closer to indifference between products (so that it is more likely to matter for their choice). Drift-diffusion models, in turn, predict that response time is inversely related to the absolute difference in the perceived value of the products under consideration (Konovalov and Krajbich, 2019). In other words, in cases in which they happen to be close to indifference, participants will tend to take more time to decide and will also tend to be more likely to access DFI.

4. Product knowledge

4.1. Participants are more likely to know information about a food item if that information is displayed on a paper label than as DFI on a hybrid label.

4.2. Participants are less likely to know the information in the QR code if they do not access it than if they do. This tests whether not accessing the QR code is because the information is known already from experience, is not interesting to the participant, or alternatively because accessing the information takes too much time.
4.3. Participants will be more likely to know information if it is displayed via a QR code and they access it than if it is simply printed on a paper label. This is because accessing it indicates interest in the information. On the other hand, accessing it may also mean one is not aware of the possible values of that information, leading to lower rates of correct product knowledge.

The main reason why participants may know less about an information item that is shown as DFI is that it is more difficult to access it than if it is shown directly on label. In other words, they are more likely to read the information if it is on the paper label than they are likely to access the DFI, which then allows them to read the information. Against this simple reasoning, one may argue that participants who are not interested in the information item, or already know it, will neither read it on label nor access the DFI with that information, while the opposite will hold for those who are interested. In that case, the mode of delivery would not matter. Finally, one may even theoretically have a case where providing the information item as a DFI draws attention to it, so more participants end up knowing it.

Directly relevant literature is scarce. The most closely related studies we are aware of involve comparison of knowledge precision for news (online vs. print), such as Neijens & Voorveld (2018). They typically find a small advantage of reading from paper. Relatedly, there is some general evidence that using the screen has a small negative impact on reading performance (Clinton, 2019). As the reasons for this difference are poorly understood, it is not clear to what extent it would be relevant for our design.

5. Individual differences

5.1. The following factors will make accessing DFI more likely and product knowledge more accurate: higher education, younger age, from urban area, higher income, higher score on the need for cognition scale, and lower score on the consumer confusion scale.

Different demographic groups may differ systematically in terms of perceived usefulness and perceived ease of use of QR codes. However, Ozkaya et al. (2015) observed no effect of age or gender on self-reported QR code use. The latter result must be taken with caution as their sample was generally quite young (aged 20-39, mean 24). Investigating a wider range of age groups, Mendelson and Bergstrom (2013) found the younger to be much more likely to use QR codes.

Numerous studies have also found substantial, robust, and multi-dimensional differences in information processing and digital technology use between younger vs. older adults (Francis et al, 2019). In particular, we should expect older individuals to remember food information less accurately (Riddle, 2007).

6. Impact of the type of information shown as DFI

6.1. There will be differences in the rate of access to DFI depending on the specific food information item being shown as DFI.
6.2. Showing a MFI that has an overall high rate of access as DFI results in lower likelihood of choice of that product among those who do not access the DFI. This is because high rate of access indicates high value of the information, so not having that information results in more uncertainty and thus lower likelihood to choose the product.

To the best of our knowledge, the literature is scarce on this topic. The most closely related study we are aware of is Dickinson and Kakoschke (2021). They elicited their respondents' self-reported relative importance of taste vs. healthiness when making food choices. They subsequently invited them to choose, repeatedly, between "Taste Matters Most" and "Health Matters Most" information clips. They found evidence of confirmation bias: respondents avoided exposure to information on the dimensions that (they said) were less important for their choices. Anticipation of an analogous tendency in our study is reflected in hypothesis 6.1, although we are not in a position to make any specific predictions as to which DFI will be considered more important and thus will be more likely to be accessed. In other words, our hypotheses here were somewhat speculative given the exploratory nature of this particular manipulation.

7. Impact of the food category and characteristics

7.1. Propensity to access DFI and errors in estimates will depend on the food category. In particular, best-before dates will be more likely to be displayed and known in the case of perishable products.

We expect heterogeneity in the impact of DFI depending on the characteristics of the goods, but existing literature makes it difficult to make specific predictions. Perhaps the most closely related concept is that of the distinction between "haptic" products, whereby the sense of touch is of particular importance in choice, and "non-haptic" products, whereby choice relies less on touching the product (Jha et al., 2020). DFI is presumably less important for haptic products. In our case, products in the vegetable category are probably more "haptic" than products in the other three categories (dairy, proteins, and carbohydrates). However, the vegetables we selected are all pre-packaged, thus reducing the role of touch in choosing them. Overall, we would however expect DFI to be less likely to be accessed for the vegetable category.

4 Design of the experiment

4.1 General methodology

We designed an incentivized discrete choice experiment, whereby participants were presented with choices between food products, and bought the ones they wanted. Our panel of participants was drawn from a range of countries in the EU, and a range of different socio-demographic profiles.

In the same way as in a supermarket, participants were presented with a relatively broad array of food products that covered most nutritional needs and were selected to be representative of food consumption in their country.

Participants only saw *mandatory food information ("MFI")* about each products, along with their price, and a picture of their package. We varied the mode of delivery of MFI, whereby some MFI items could be read on the paper label, and others were accessible via QR code only.

Box 1 Mode of delivery of mandatory food information

MFI must be printed on labels according to EU legislation. In our experiment, we varied whether individual MFI items were accessible only via a QR code or not. This is only for the purpose of this experiment. Our experiment was **not** meant to investigate whether and which MFI may be provided digitally. We varied the presentation of MFI only in order to investigate the difference between hybrid and paper label.[1]

We motivated participants by giving them a budget that covered the purchase of four items of one of the products they chose during the experiment. At the end of the experiment, five items of one of the products they chose was sent to them, at the price shown to them, which was subtracted from the budget they were given. The money remaining was also sent to them.

Choice was therefore incentivized, meaning that participants were motivated to make choices that correspond to what they would really prefer to consume. This is because, as in a supermarket, they would get what they chose at the price shown to them, which came out of the budget we gave them for their purchases. This method whereby we ask participants to make choices that have real consequences differs from the usual "stated choice" experiment, where consumers simply state which product they would prefer but do not either get them or pay for them. In that case, their choice is only hypothetical, meaning that it has no real implication for them.

We thereby avoid what has been called the "hypothetical bias" of such studies, whereby participants are not motivated to consider their choice carefully. Instead, they may choose what they think the experimenter wants them to choose ("experimenter demand effect"), or products that make them feel socially approved or that correspond best to their own ideal image of themselves ("warm glow effect").

4.2 Implementation

The experiment was run online, whereby participants received an e-mail invitation and, if they decided to participate, clicked on a link to the experiment that could be accessed from their PC or Tablet. The experiment was programmed by Open Evidence in collaboration with Schlesinger Group Spain, based on a design provided by the authors. The experiment was translated in the local languages of each country in which it took place (Bulgaria, Germany and Spain).

[1] An alternative to our choice to vary presentation of MFI would have been to consider digital delivery of voluntary food information, such as measures of a product's Environmental, Social and Governance dimensions, or nutritional aspects of the food that are not yet generally provided (such as their Nutriscore and/or alternatives and variations thereof). We decided not to do so because that type of information is not available for all products, and consumers are not yet knowledgeable about their meaning and importance.

4.2.1 Design of the choice menu

Participants in this study had to make incentivized choices among 16 pairs of existing products (see **incentives**). There were 4 pairs of products in each of four food categories (see **selection of food categories and products**). Each pair of products featured two real products that were selected to be similar to each other. For example, a 500g pack of rice at 2€ was compared to a 450g pack of rice at 1€90, and the consumer had to make a choice between the two.

Table 8 in Annex 1 provides a list of the pairs of products that were presented in each country.

Information about each product (see **food information**) was the same as shown on label on the actual physical product. We then varied whether all that information was provided on label in the traditional way ("paper label") or part of it was provided as DFI ("hybrid label"); see **food information conditions** below).

Participants were asked to **choose** one product in each of the pairs proposed. Their choice was recorded, as well as whether they **accessed** the DFI (if any was accessible). We also recorded how long they took to make their choice for each pair of products, and how long they accessed the DFI (if at all). For the last three choices, they were also asked to **report** information about the products they just chose from (see **knowledge questions**).

Selection of food categories and products

There were **four** food categories, with four sub-categories each: **carbohydrates (**pasta, bread, lentils and rice), **dairy** (milk, butter, yogurt and cheese), **proteins** (fish, peas, meat and a vegetarian meat alternative) and **vegetables** (such as green beans, carrots, tomatoes and salad). Consumers had to choose between two products in each sub-category, selected to be close substitutes, in particular in terms of price. Consumers thus had to make 4x4=**16 pairwise choices**.

Food categories were selected to be representative of the typical food basket of a European consumer in countries selected for this study (Bulgaria, Germany and Spain). Food categories were the same across the three countries. Furthermore, sub-categories were very similar across countries. We varied, however, the type of cheese, the type of fish, the type of meat, or the specific vegetables. The specific products in each sub-category were country-specific, so as to correspond to actual brands available in each country. Finally, products in each sub-category were selected to be **similar** in terms of brand reputation, popularity and availability, quality and relative price across countries.

Display of food information

As explained below, we varied whether a product was presented with all Mandatory Food Information items on the label ("paper"), or with one of the Mandatory Food Information items accessible only by clicking on a QR code that was printed on the label ("hybrid"). The experiment was run online, so that "scanning a QR code" meant clicking on the QR code on screen, which opened a popup window that showed the missing information.

Figure 1: An example of a choice screen presented to participants

Figure 1 shows a screenshot of such choice situations. A participant can click at the bottom on "Option 1" or "Option 2" to indicate his or her choice. As stated, we chose products in each pair to be close substitutes, that is, they are both tomato sauce in this case. We show a picture of both products, their price, and a label containing all mandatory food information (see "food information" below). The screenshot in Figure 1 is only one example of a choice situation. We varied the type of information that could be accessed via the QR code (cf. "Food information" below), and we also varied which products included a QR code. In the above example, the QR code is on the product on the left. It could also be on the product on the left, on none of them, or on both. (cf. "Information condition" below).

The label for Option 1 includes a QR code, with a text above it saying that it gives access to the "best before" date (via a pop-up window). The label for Option 2 on the other hand does not have a QR code, the "best before" date being provided directly on the label. Participants know they only need to click on the QR code for a "popup" to appear, which shows the "missing" information. They are given an opportunity to train to do this before starting to make choices.

Box 2 External validity

The experiment was conducted entirely online: even the "paper" labels had to be read from the screen. On the one hand, this may be seen as a limitation on the external validity of the experiment. In particular, this design choice made "scanning the QR code" as quick as possible, without the need to reach for the device, launch the QR code scanner etc. As a result, the fraction of cases in which the QR code was actually "scanned" in our experiment cannot be directly taken as a predictor for the prevalence of QR code use in naturally occurring food choices.

On the other hand, this feature of the design allowed us to control for various factors identified as potentially affecting the willingness to make use of digital food information. For example, as mentioned in our brief review, people may be reluctant to use QR codes out of concern for cyber security, a concern that was very unlikely to play a role in our experiment. As a result, we could focus on the essence, namely how information processing and choice depend on whether all food information is displayed immediately (paper labels) or an additional step is necessary to unlock some bits of information (hybrid labels).

Food information

For every product, we showed a picture of the product, its price, as well as the following Mandatory Food Information items:

1. Brand name of the food;
2. List of ingredients (including those causing allergies or intolerances);
3. Nutrition declaration;
4. Net quantity of the food;
5. Date marking (use by/best before);
6. Any special storage conditions and/or conditions of use (when relevant);
7. Name or business name and address of the food business operator.

Of those, the brand name and allergens were always shown on label. Other ingredients, and other types of information could be shown either on label or as DFI.

Information conditions

There were four information conditions (ICs) for each product pair.

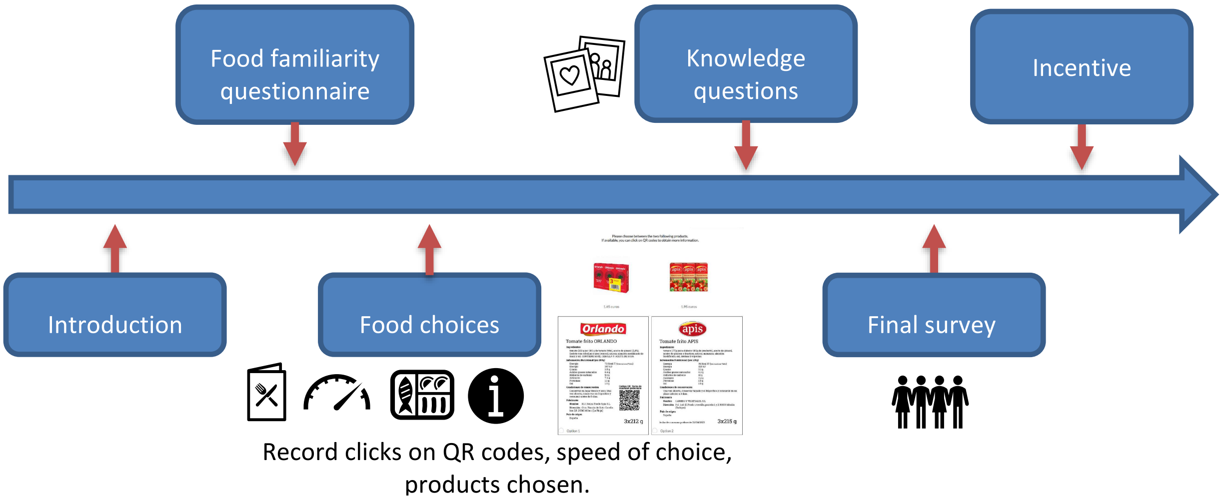
The ICs were as follows:

- Paper-Paper: both products have paper labels, meaning that all information are shown on-label for both products in a pair;
- Paper-Hybrid: only the label on the right is hybrid, meaning that all information is shown on-label for the product on the left, while one of the Mandatory Food Information items is shown only via the QR code for the product on the right;
- Hybrid-Paper: only the label on the left is hybrid, meaning that all information shown on-label for the product on the right, while one of the Mandatory Food Information items is shown only via the QR code for the product on the left;
- Hybrid-Hybrid: both products have hybrid labels, meaning that both products show the same Mandatory Food Information item only via the QR code.

Those ICs were systematically varied across pairs for a given participant, and across participants for a given pair (see Table 9 in Annex 2, for more details on the randomization).

4.2.2 Timeline of the experiment

Figure 2: Timeline of the experiment



The timeline of the experiment is represented in Figure 2. The experiment started with a short introduction explaining that participants would have to make choices between food products and answer a questionnaire and that their answers were anonymous. We then explained to them the incentive system in the experiment, whereby there was a one in four chance that four units of one of their chosen products would be sent to them. We ensured they agreed to take part in the experiment and to give us their address in case they were chosen to receive one of their chosen products.

1. **Food familiarity questionnaire.** After explaining how to make choices and what information about products would be available to them, we asked participants to fill a **food familiarity questionnaire.** This consisted in a list of products that were going to be offered for choice, shown as pictures. Participants selected which products they already knew or had purchased in the past.
2. **Food choices.** Participants then had to make 16 choices between food products presented in pairs, as explained in the previous section on the design of food choices. Namely, in each choice situation, they saw two food products, whereby both, one or none of the products had a hybrid label (see "Information condition"). They decided whether to click on the QR code(s), if available, and then chose one of the two products. They then went on to the next choice situation.
3. **Knowledge questions.** Immediately after each of the last three choice situations the participants faced, we asked them to report their best estimate of the weight, best before date, or number of calories, for both products in the last three pairs.[2]
4. **Final survey.** Participants were asked a range of questions covering socio-demographic variables (age, gender, education ...), use of Internet and digital tools, familiarity with QR codes, dietary and food related habits, as well as questions about their health, welfare and ability to process choice information. Table 10 in Annex 3 lists all questions asked.
5. **Incentive.** A lottery was played at the end of the experiment, whereby each participant had a **one in four chances** to get a budget of 20€ to pay for purchasing **4 units** of one of the 16 products they had chosen, at the price shown to them.
   In expected terms therefore, each participant received one of the products they had chosen. This was sent to them at their address with postage paid by us. They also received any money remaining from the 20€ budget after taking out the cost of the products. The lottery itself was verifiably random, whereby we told participants how to access the page source with the code of the program that drew a random number between 1 and 4.

[2] We asked this only for the last three choices in order to make the first 14 choices as close to normal choice as possible. In the last two choices, participants may anticipate they will be asked to recall information they consulted, which may affect their choice and information search.

Postal addresses were collected at the end of the experiment from those participants who won the lottery. However, we made sure at the beginning of the experiment that all participants were ready to give their address in case of a win. This guarantees that all participants participated with the knowledge that one of their choices would be implemented.

5 Sample and data collection

The study was run in three Member States of the European Union, namely Spain, Germany and Bulgaria. Data collection was done by Open Evidence in collaboration with Schlesinger Group Spain. The experiment took place between the 8th of February and the 15th of April 2023.

The target population was EU residents above 18 years of age, with a target sample size of 1000 participants for each of the three countries. In each country, the sample was stratified to ensure a good representation of the population in terms of age, gender, regions, place of residence (rural/urban) and education level.

The country selection provides good variation in terms of European regions, with a coverage of Eastern (Bulgaria), Central (Germany), and Southern (Spain) Europe. Households' internet access as a percentage of households also varies, with Germany close to the EU's average, Spain above and Bulgaria below. GDP per capita also varies, with Germany above the EU average, and Spain and Bulgaria below, Bulgaria having the lowest. Dietary habits also vary across the countries selected, with Spain having relatively healthier dietary habits (in terms of food and vegetable consumption), while Bulgarian dietary habits can be considered less healthy (as almost half do not consume any fruits or vegetables a day). Germany lies somewhere in between. Finally, Germany has a high percentage of individuals who buy groceries online, while Spain's percentage is closer (although slightly lower) than the EU average, and Bulgaria's percentage is quite low by comparison.

Mode of recruitment and administration of the survey

The experiment was self-administered, online, using a computer or a tablet. Participation by smartphone was excluded due to the amount of information being shown about each product. Participants could start the experiment whenever they wanted and take as much time as they needed to complete it.

Participants were recruited using a panel-blending approach, meaning that the sample was drawn from multiple panels simultaneously, which warrants greater representativeness of the population of reference and increases the likelihood to reach specific representativeness targets in terms of gender, age, place of residence and education. This also allows us to draw samples from panels that have been generated through different methods.

Participants were sampled by notifying potential participants from panels in each country about the purpose of the experiment and the incentives involved. Panellists were informed that they would remain anonymous and that that their data would remain private and would only be used for the purpose of this experiment. Thus, panellists were adequately informed to freely and voluntarily consent or decline participating in the research.

The invitation instructed respondents how to access the experiment using a link that only allowed one-time access. Each invitation included a link to the SGS Research Privacy Policy, a removal link, and a link to contact the project manager if desired.

Pre-registration

The following exclusion criteria, as well our hypotheses and the analysis of results, were pre-registered at the Open Source Framework's open registries network (https://osf.io/nwv38/). Pre-registration guarantees that none of our results are affected by hindsight bias or subject to fishing for significance (Nosek et al., 2018).

Exclusion criteria

In total, **3835 participants** completed the experiment. We excluded 35 participants who failed a basic attention question. As stated in our pre-registration, we then excluded both speeders and slow participants from the sample by excluding the bottom and top 5% percentile in terms of time spent completing the experiment. This resulted in excluding participants who spent less than 7 minutes or more than 47 minutes on the experiment.

The effective sample size was then **3420 participants**. The average duration of the experiment for that sample was 19 minutes.

Evaluation of the experiment by the participants

In general, participants considered the survey to be simple (mean score of 2.7 on a 1-10 difficulty scale), and interesting (mean score of 8.1 on a 1-10 interest scale)

Socio-demographics

Table 1 shows the distribution of participants by country, gender, age, education and place of residence. There were 1039 participants from Bulgaria, 1203 from Germany and 1178 from Spain. There is nearly equal representation of different age groups from 18 to 65. The sample was also balanced in terms of gender. All education levels and location types are also well represented. Samples in each country slightly differ in terms of their composition. For example, compared to Bulgaria and Spain, German participants are a bit less educated and more likely to live in a village. Participants from Bulgaria are more likely to live in big cities.

Box 3: Vulnerable groups

In the following analyses, we systematically test the robustness of our results to socio-demographic heterogeneity in our sample. In particular, we focus on vulnerable participants, defined as those who are older (above 55), less educated (primary and high school education), with lower income (monthly household income less than 1400 LEV in Bulgaria, less than 2400€ in Germany, less than 1500€ in Spain),[3] who report being in fairly difficult or very difficult financial situation, and who live in rural settings (in villages or the countryside).

Table 1 Distribution of age, gender, education level, place of residence, income and financial situation, by country

		Country		
		Bulgaria	Germany	Spain
Age	18-25	12%	16%	18%
	26-35	22%	18%	19%
	36-45	27%	23%	24%
	46-55	24%	20%	22%
	56-65	15%	23%	17%
Gender	Men	51%	51%	50%
	Women	49%	49%	50%
Education	Primary	2%	10%	7%
	High School	24%	48%	27%
	Some Uni	10%	8%	16%
	Graduate	39%	20%	36%
	Post_Grad	25%	15%	14%
Location	Big city	60%	33%	49%
	Suburbs	3%	11%	8%
	Town	31%	26%	31%

[3] Those thresholds are chosen to correspond to the bottom 40% in terms of household income in our sample in each country.

	Village	7%	29%	12%
	Countryside	0.1%	1%	1%
Income	High	63%	59%	56%
	Low	37%	41%	44%
Financial situation	Very easy	8%	14%	9%
	Fairly easy	21%	27%	18%
	Neither easy or difficult	50%	40%	50%
	Fairly difficult	17%	14%	17%
	Very difficult	5%	5%	6%
	NA	3	1	3
N		**1039**	**1203**	**1178**

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Experience with digital devices, shopping online and product labels

Table 2 shows that about 97% of participants own a smartphone, and 96% use it to access the Internet. 73% of participants had scanned a QR code on a food product; this number was higher in Spain (83%) than in Germany (69%) or Bulgaria (66%).

80% said they would be either very likely or quite likely to scan a QR code on a food product in the future. This percentage was highest in Spain and lowest in Germany. 82% of participants said they really liked or liked the idea of having QR code on food products. Again, this percentage was lowest in Germany.

We also asked participants what they thought would be the main benefits and drawbacks of having QR codes on food products. In terms of benefits, 57% of participants mentioned being able to get more information on food products, and 51% mentioned easier access to that additional information. In terms of drawbacks, 34% of participants mentioned the time and effort to scan QR codes, and 33% mentioned the issue of having to go on the Internet to access that information.

Spanish participants were more likely than others to sometimes or regularly shop for groceries online (43% in Bulgaria, 42% in Germany, and 63% in Spain). Most participants claimed they "always" or "frequently" read food labels. They also expressed relatively high trust in those labels (mean of 7 on a 1-10 trustworthiness scale).

Table 2 Experience with digital devices, shopping online, and product labels.

		Country		
		Bulgaria	Germany	Spain
Own a smartphone	Yes	97%	96%	99%
	No	3%	4%	1%
Access Internet on smartphone	Yes	97%	94%	98%
	No	3%	6%	2%

Scanned QR code on food in the past	Yes	66%	69%	83%
	No	34%	31%	17%
Likelihood to scan a QR code on food	Very likely	43%	29%	48%
	Quite likely	37%	42%	40%
	Quite unlikely	16%	22%	10%
	Very unlikely	4%	8%	2%
Attitude to QR code on food	Really like	42%	30%	46%
	Like	44%	46%	37%
	Dislike	10%	18%	14%
	Really dislike	3%	7%	3%
Have done groceries online	Never	46%	40%	26%
	Once	12%	18%	12%
	Sometimes	35%	32%	47%
	Regularly	8%	10%	16%
Read labels on food products	Always	23%	14%	18%
	Frequently	43%	45%	43%
	Sometimes	26%	30%	29%
	Rarely	5%	9%	8%
	Never	2%	3%	2%
	Don't know	1%	0.3%	0.08%
Level of trust in food labels	mean	6.6	7.0	7.2
N		**1039**	**1203**	**1178**

6 Main results

In this section, we report the analyses of the choices, in particular related to the use of DFI.

6.1 Preference for or against DFI

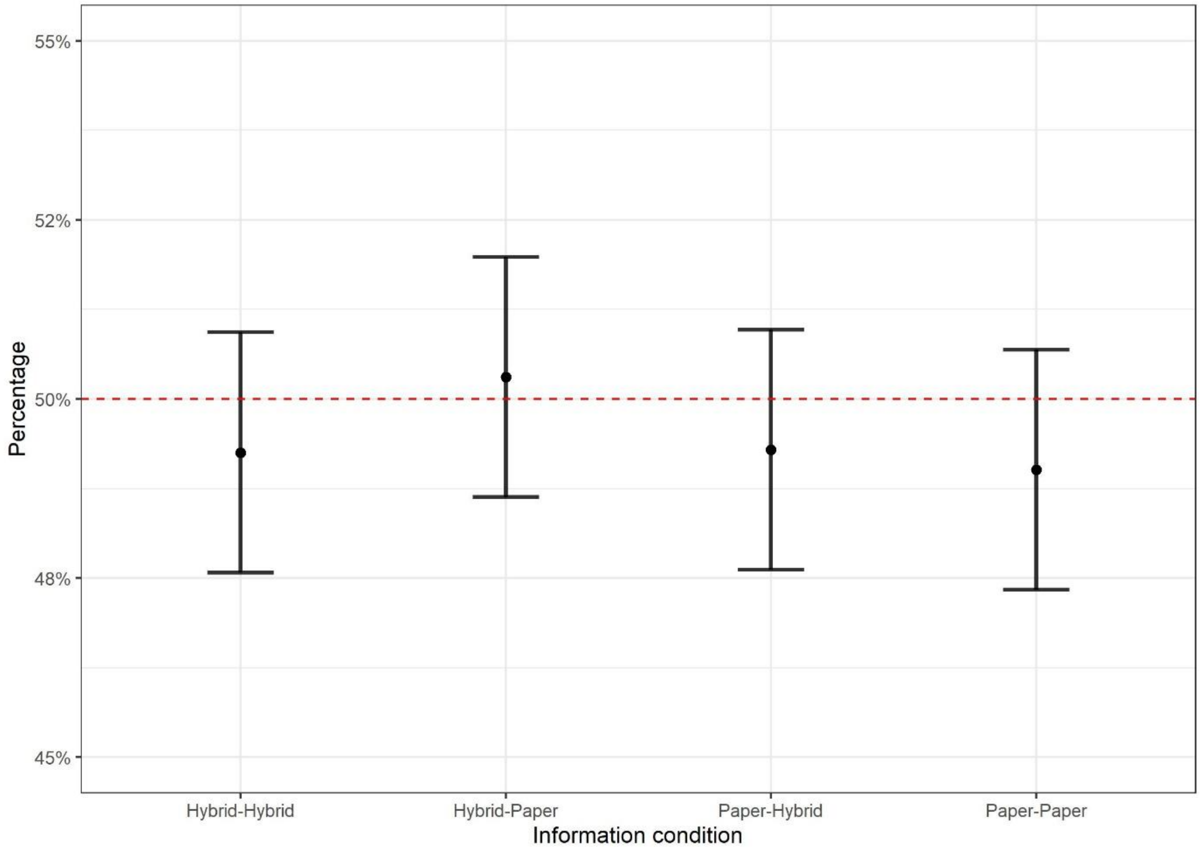
In this subsection, we test whether participants preferred products with DFI or products without DFI, when both types were available. For each participant, we compute the average frequency with which they chose the product on the left of the screen in the four information conditions, namely

- Hybrid-Hybrid: both products have hybrid labels
- Hybrid-Paper: only the label on the left is hybrid
- Paper-Hybrid: only the label on the right is hybrid
- Paper-Paper: both products have paper labels

Figure 3 shows the average and 95% confidence interval for this statistic depending on the information condition across all participants. For example, in the Hybrid-Paper condition, the product on the left has a Hybrid label and the other does not.

Figure 3: Likelihood to choose the product on the left depending on the information condition

The graph shows average and 95% confidence intervals.



We find that in the "Hybrid-Paper" condition, the Hybrid product is chosen 50.3% of the time, while in the "Paper-Hybrid" condition, the Paper product is chosen 49.3% of the time. The one percentage point difference is not statistically significant.

Similarly, in the "Hybrid-Hybrid" condition the Hybrid product on the left is chosen 49.3% of the time, while it is chosen 50.3% of the time in the "Hybrid-Paper" condition. Again, this small difference is not significant. Other comparisons also yield no significant differences.

Overall, this means that, on average, the choices were not affected by the type of label. This would suggest that, on average, whether some information was available via QR codes or directly on paper labels had no impact on the likelihood of choosing a product. In other words, consumers appear not to be affected in their choice by whether some information was only available by scanning a QR code or not.[4]

Product differences: We can simply rely on the results reported because we systematically randomized the presence of a QR code on a product, whereby, for the same pair of products, we varied whether the product on the left had a QR code or not. This means we can compare mean fraction of choice of the product on the left depending on information conditions while ignoring other characteristics of the products.

However, we also want to know what influences the likelihood of choosing products with Hybrid labels, such as for example the product category or the type of information in the QR code. For that purpose, we run fixed-effects (within-individual) panel regressions, whereby we consider how labels affect choice while controlling for characteristics of the product on the left and on the right.

Column 1 in Table 11, Annex 4, confirms that choice is not affected by whether the product on the right is with a paper or a hybrid label. Column 2 controls for the order in which products were presented, and for differences between products other than their labels. This includes their price, weight, number of kilocalories per 100g, and best before dates of the two products, and whether the consumer knew or purchased either product before. We find that consumers become more likely to choose the Hybrid product in later choices than in earlier choices (Choice order, +0.001 per choice period, $p<0.05$). In terms of product differences, we find that a product is more likely to be chosen if it is known by the consumer while the other product is not known (diff_known, +0.181, $p<0.001$), if it has a higher weight (diff_weight, +0.0003 per gram, $p<0.001$), or if it has a later expiry date (diff_date, +0.001 per day, $p<0.001$). Similarly, it is less likely to be chosen if it is more expensive (diff_price, -0.109, $p<0.001$), or more calorific (diff in kcal/100g, -0.0002 per kcal, $p<0.001$).

We furthermore test if the likelihood to choose Hybrid products depends on the category the product is in, and on the type of food information accessible through the QR code (column 3). We find no such dependence on the category and the food information, except in the case when the QR code holds information about the name of the producer (+2.9%, .$p<0.05$).

Finally, we test if differences in weight, calories and best before date matter less if that information is shown via a QR code for the hybrid product (column 4). This would be the case if the consumer does not access the QR code and therefore cannot assess the difference between the two products. We find no difference in the impact of the information on weight and calories depending on whether it is shown digitally or on paper, but the impact of the best before date is lower if it is shown digitally.

Individual differences: We also test whether there were differences in the likelihood to choose DFI products across different socio-demographic groups, focusing in particular on vulnerable groups (column 5). We find that

- Germans are more likely to favor hybrid labels, though this is only marginally significant (+0.014, $p<0.1$),
- Older individuals (>55 years) are less likely to choose hybrid labels (-0.017, $p< 0.05$),
- Less educated individuals are also less likely to choose hybrid labels, but again this is marginally significant (-0.012, $p<0.1$)
- There are no significant differences in the likelihood to choose a product with DFI depending on place of residence, income or financial situation.

Discussion: We expected that consumers would be less likely to choose a product with a Hybrid label. As we will see in the following sections, QR code scanning frequency is relatively low and choice takes longer if there is a QR code. Consumers end up knowing less about products that have a Hybrid label. All those issues should have resulted in a lower likelihood to choose a product with a Hybrid label. However, this is not the case in our experiment.

[4] We considered whether there were differences across participants, whereby some participants always avoided products with DFI and others always chose them. However, the number of participants who never chose products with DFI was not significantly higher than what one would expect to happen by chance if they were in fact indifferent. The same was true of the number of participants who always chose products with DFI.

Some specificities of our design can explain this result.

1. First, consumers knew that all Mandatory Food Information items were available for all products, if only by scanning a QR code. Products with Hybrid labels did not therefore provide less information per se about the product.
2. Second, the two products in each pair were selected to be close substitutes, so consumers could infer to some extent the information in the „Hybrid" product from the information in the „Paper" product. For example, if the weight of the product with a paper label was 100g, then they could infer the weight of the product with a hybrid label was close to that value, even if weight was shown only via the QR code.
3. Third, they could infer form the experimental set-up that the decision to adopt a Hybrid label was not made by the firm offering the product, but rather by the experimenter. There was therefore no reason for them to avoid products with a Hybrid labels out of a belief that firms that do not show information directly on the paper label are trying to hide negative information.

6.2 Frequency of access to DFI

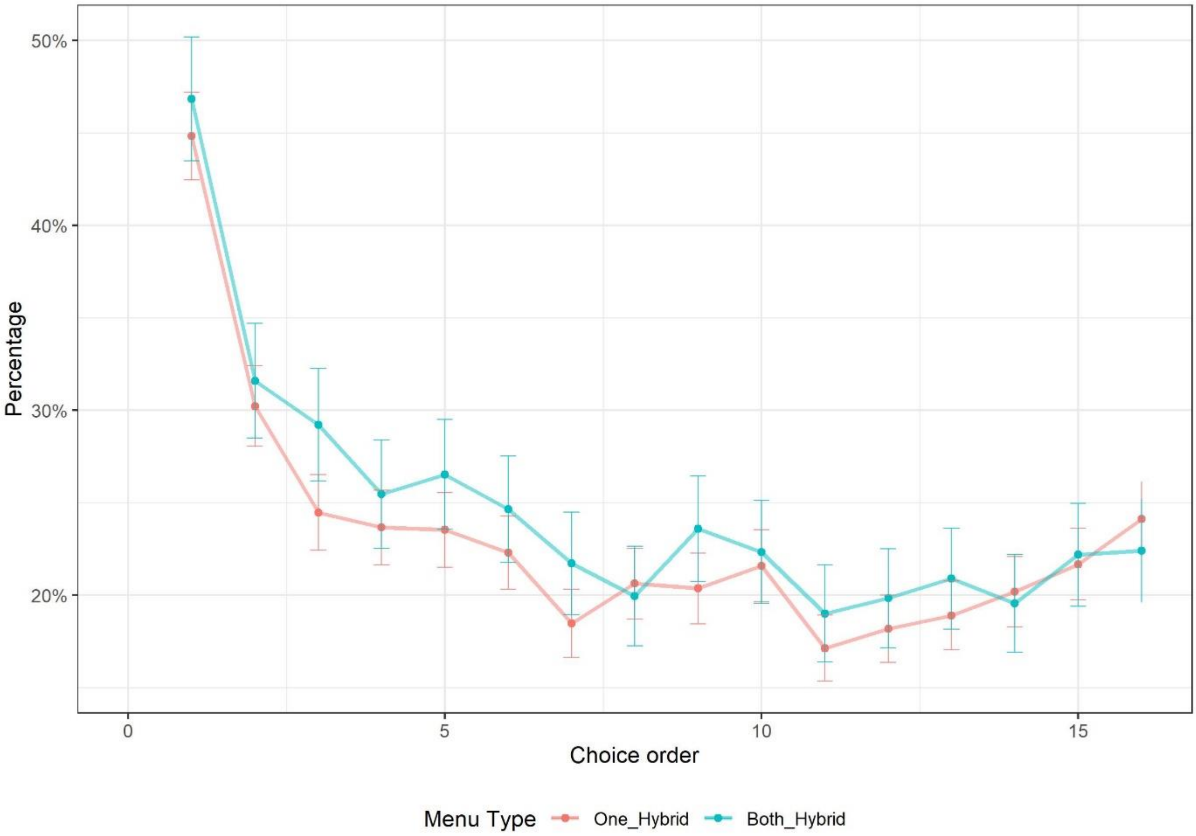
On average, across all menus where there was at least one product with a QR code, participants clicked on one or both QR codes only 24% of the time. More precisely, if only one of the two products in a pair had a hybrid label, then its QR codes was "scanned" 23% of the time. If both products had hybrid labels, then participants scanned both QR codes 20% of the time, and only one of the QR codes 5% of the time (Table 3).

Table 3 Number of QR codes scanned, by menu type.

	Menu type	
Number of QR codes scanned	One hybrid label	Both hybrid labels
0	76.86%	75.26%
1	23.14%	4.83%
2	0%	19.90%
N	27360	13680

Participants were more likely to scan a QR code the first time they encountered one. As many as 46% scanned the QR code if one was available in their first choice. The QR scanning frequency then dropped and stabilized from round 5 at 20% (Figure 4).

Figure 4: Likelihood of scanning a QR code as a function of the order in which a product is presented



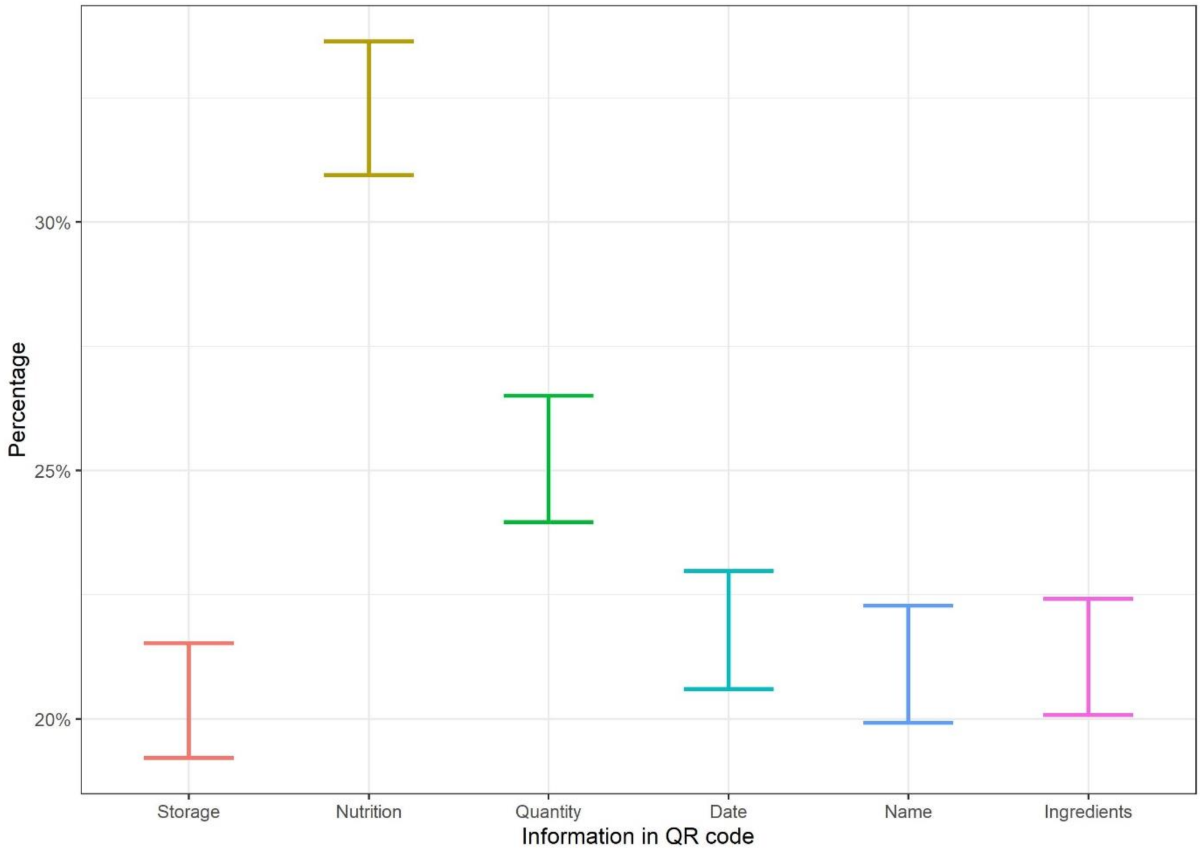
The graph shows 95% confidence intervals for the mean.

Product differences: We run panel regressions to find determinants of the likelihood to open a QR code (Table 12, Annex 4). We find that participants were more likely to scan at least one QR code if both products had hybrid labels rather than only one (variable "both hybrid", +1.6%, p<0.01) (column 1). As mentioned previously, we also find they are less likely to scan a QR code in later choices (variable "order", column 2). They are also less likely to open a QR code if there is a large difference in price or in weight between the two products in the pair, possibly because their choice is then made on that basis (variables "diff_weight", "diff_price", column 2).

We also find that the likelihood to scan a QR code does not depend on the food category (column 3). However, the likelihood depends on the type of information in the QR code, whereby consumers are significantly more likely to open QR codes with Nutrition information (IC Nutrition, +0.111, p<0.001), with Quantity information (IC Quantity, +0.048, p<0.001), or with the best before date (IC Date, +0.014, p<0.01).

Figure 5 shows that they are indeed most likely to scan a QR code giving access to nutrition information (32%), followed by quantity information (25%), and best before date information (22%).

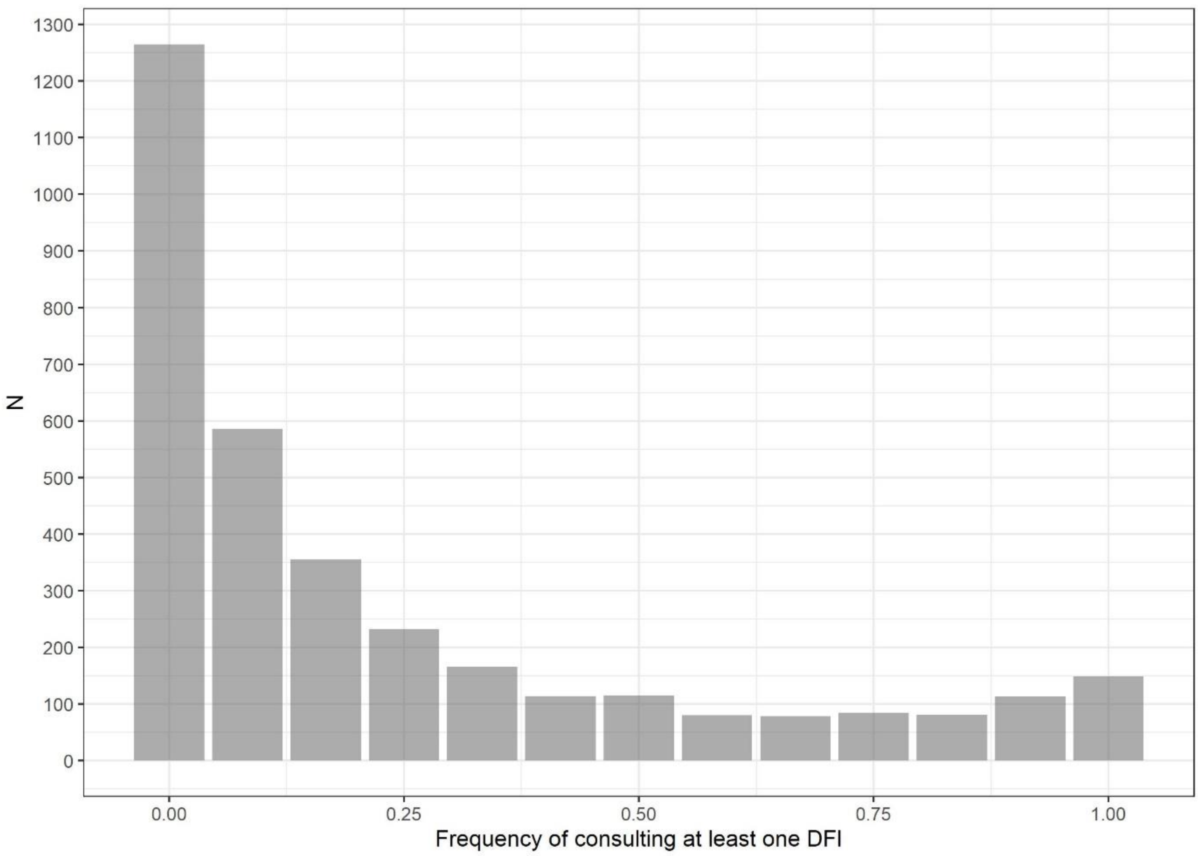
Figure 5: Likelihood of scanning a QR code as a function of the information accessible through it



The graph shows 95% confidence intervals for the mean.

Individual differences: When considering now differences in behavior across participants, we find that 1265 participants, or about 37% of the total, never scanned any QR code across all the 16 choices they had to make (Figure 6). An additional 586 participants, or about 17% of the total, scanned a QR code only once. Only 149 participants, or about 4% of the total, scanned all QR codes across all choices they made. Averaging scanning frequency across all participants gives us the average scanning rate of 24%.

Figure 6: Likelihood of scanning a QR code, average across participants



Finally, we consider the impact of socio-demographic characteristics of participants (column 4, Table 12, Annex 4). We find that Spanish participants are more likely to scan QR codes (+3.6%, $p<0.01$) compared to the base category of Bulgarians. Vulnerable participants are not statistically different from the rest of the sample, regardless of whether vulnerability was defined in terms of age, education, income or place of residence.

Discussion: Rates of QR code scanning in our experiment were quite high compared to rates observed in previous studies (see "literature review". This is what we aimed for: we made QR code scanning as easy as possible in order to be able to identify the effect of scanning QR code on behaviour.

Our setting was indeed a *best case scenario* for the use of QR code, whereby QR code scanning meant only clicking on the screen, and participants only had 16 choices to make, of which 12 where at least one of the products had a QR code. Yet, participants made that effort only 24% of the time. Furthermore, a large proportion (37%) never scanned any QR code. This shows that delivering food information by that channel cannot possibly ensure participants are exposed to it.

Our experiment allowed us to identify interesting differences across participants, whereby 37% never scanned any QR codes. We will see in the next section that those participants were also those who made the fastest choices. We will also see in section 6.4 that not scanning QR codes increased errors in estimates of the information shown in the QR code. Therefore, consumers do not choose not to scan the QR code simply because they already know the information that is given there. They choose not to scan the QR code either to speed up choice, or because they are not interested in the information given there.

We do find variability in terms of likelihood to scan QR codes depending on the information given there. Nutrition information leads to higher rates of QR code scanning. We will see in the "knowledge section" that those who scan QR codes with nutrition information do indeed have better knowledge of information given there (namely, kcal per 100g).

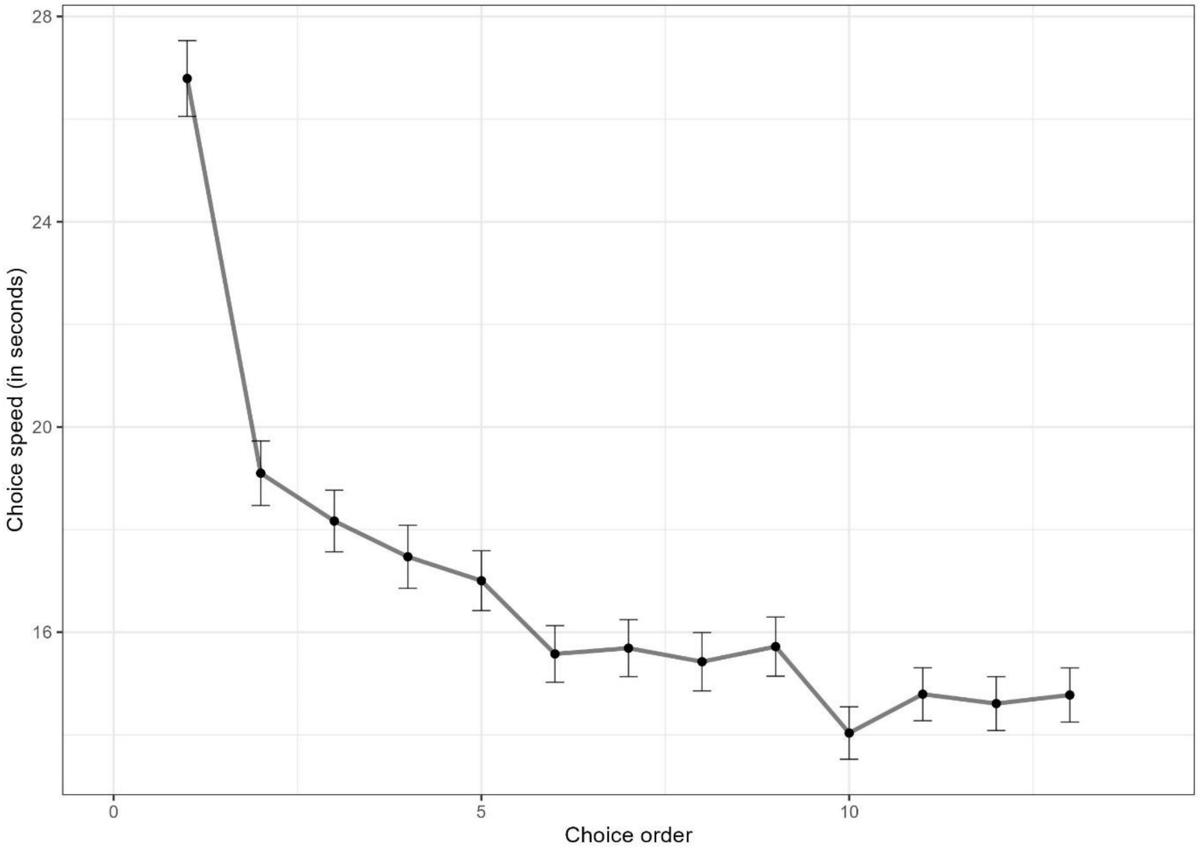
6.3 Speed of choice

We measured how long participants took to make choices for each of the 16 choice situations they faced. We also measured how long they took to access information via the QR code.

We report statistics after eliminating outliers, namely the 1% of participants who were the slowest (more than 2 minutes and 46 seconds). This makes our comparisons of statistics across situations more robust, as such outliers may not be equally distributed in our sample and may thus unduly influence our statistics.

We consider only choices up to the last three ones. Indeed, we asked participants to report information about their chosen product in the last three periods, and this was included in their choice time, which was then longer.

Figure 7: Choice speed (in seconds) by order in the choice sequence



Once we exclude such outliers and the last three choices, we find that participants took 16.9 seconds on average to make a choice, and spent 3.6 seconds accessing DFI if they clicked on the QR code. Choice became faster as participants progressed through choice (Figure 7). The first choice took 26.8 seconds on average, while the 13th choice took only 14.8 seconds on average.

We find that mean decision times were longer if there were some QR codes to be opened. Choice took 15.9 seconds on average when there were no QR codes ("Both Paper"), 16.9 seconds if one product in the pair had a QR code ("One Hybrid"), and 17.5 seconds if both products in the pair had QR codes ("Both Hybrid") (Table 4).

Table 4 Average choice speed, in seconds, depending on the information condition.

	Menu type		
	Both Paper	**One Hybrid**	**Both Hybrid**
mean	15.9	16.9	17.5
sd	12.3	11.8	13.6
N	3420	3420	3420

These differences in total time spent making a choice are consistent with the likelihood to access DFIs and time spent accessing them. Indeed, participants opened about 25% of the QR codes and spent about 4 seconds reading the information in them, so this would explain why time spent making a choice is about 25% times 4 seconds = 1 seconds more when there is a QR code.

We now consider how time spent making a choice varies depends on whether a QR code was opened or not (Table 5).

Table 5 Time spent making a choice, in seconds, as a function of information conditions and number of QR codes opened.

	Menu type		
	Both Paper	**One Hybrid**	**Both Hybrid**
No QR opened			
Mean	15.9	14.6	14.3
sd	12.3	11.0	12.3
N	3420	3190	3031
One QR opened			
Mean		26.4	21.6
sd		17.1	19.2
N		1746	434
Two QR opened			
mean			31.1
sd			19.4
N			1185

We find that if both products in a choice pair have a paper label, then average choice speed across individuals is 15.9 seconds. Choice is faster if one products has a QR code and it is not opened (14.6 seconds). This may be due to the fact there is less information read since some of it is shown only via the QR code, or to a selection effect whereby people who do not open QR codes are also those who make fast choices, or to the fact that people are less likely to open QR codes as they progress through the 16 choices to be made in the experiment and their choice becomes faster. We run regressions later on in this section to isolate those different explanations.

Choice is slower if one QR code is opened: 26.4 seconds vs. 14.6 seconds when there is only one QR code, 21.6 seconds vs. 14.3 seconds when there are two QR codes. If both QR codes are opened, then choice is slower again, at 31.1 seconds.

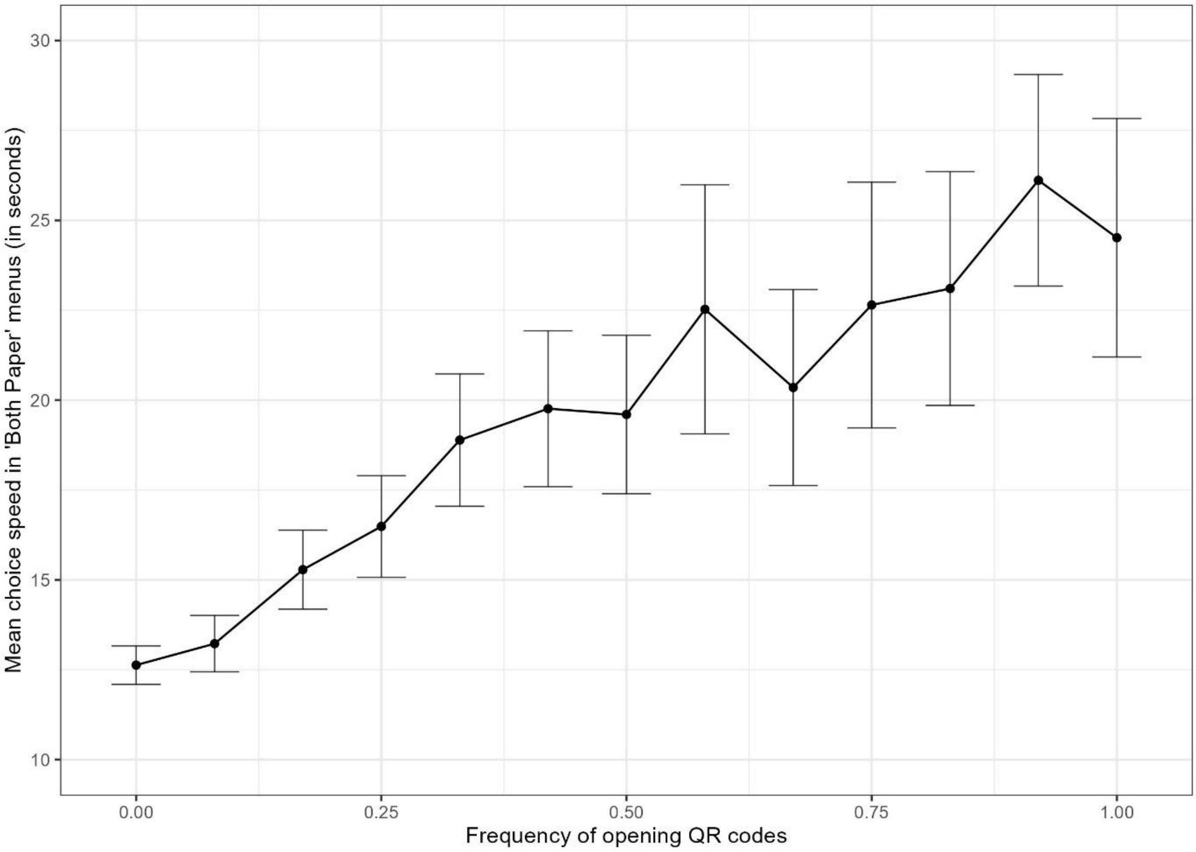
The increase in time spent making a choice when there are QR codes and they are opened is more than could be explained simply by the time spent accessing the DFIs (we saw this was about 4 seconds for each QR code).

As mentioned already, part of the reason choice takes longer if a DFI is accessed may be a selection effect, whereby participants who access DFIs also take more time making a choice even when choosing between products with Paper labels.

We test this possibility by relating average individual time spent making a choice in menus without QR codes and the individual likelihood to open QR codes when some are available (Figure 8). We do find a relation in the expected direction between the two, whereby participants who never open QR codes also are the fastest in making choices when there are no QR codes (12.6 seconds). Conversely, those who always open QR codes take an average of 24.5 seconds to make choices when there are no QR codes.

This points to the existence of different types of participants, those who try to make fast choices at the expense of taking less information into account, and those who try to make more considered choices at the expense of spending more time gathering information (Kahneman, 2011).

Figure 8: Choice speed in the Paper-Paper condition as a function of the likelihood to open at least a QR code in other menus



Given the various reasons for differences in choice speed depending on information conditions, we run fixed effect ("within") panel regressions to control for variability in choice speed across individuals and focus in differences in choice speed across choice situation. In those regressions, we compute the mean choice speed of each individual, and then consider deviations from that speed depending on the information condition. This allows us to abstract from differences in choice speed across individuals (Table 13, Annex 4).[5]

Product differences: We find that hybrid labels do slow choice down even when controlling for individual differences. Choice is 0.882 seconds slower on average when there is one hybrid label compared to when both labels are paper only. Choice is 1.625 seconds slower when both labels are hybrid (column 1, Table 13, Annex 4).

We further control for choice order (column 2), and find that individuals make faster choice over time, as also seen in figure 7. Choice is also faster if only one product is known ("diff_known"), when there is a larger price difference ("diff_price"), or when there is a large difference in best before dates ("diff_date"). This presumably

[5] We need to do so because as we saw, slower individuals are also more likely to open QR codes, which would explain why choice is slower when the QR code is opened.

is due to simple heuristics such as going for the known product, the cheaper one or the one that will last longer. Those heuristics help consumer make faster choices.

In terms of differences in product categories and type of information in QR codes (column 3), we find that choice for vegetable products is fastest, and that choice is slowest when the QR code contains nutritional information. This may result from consumers being then more likely to access the DFI, as we saw earlier (Figure 5), which thus slows down their choice.

Individual difference: Finally, we consider the impact of individual difference on choice speed (column 4), and how the presence of a QR code on one or both products impact this speed differentially for vulnerable participants (column 5). We find that German consumers are the fastest in making choice, followed by Italians, whereas Bulgarians are the slowest. Aged participants (>55) take 5.6 seconds more to make a choice, while those with low income take 1.3 seconds less time (column 4). We also see that hybrid labels impact aged participants more than others, whereby they slow their choice by an additional 0.953 second ("DFI*Age>55", column 5).

Discussion: This part shows that Hybrid labels slow down choice by about one second for each product in a pair that has a Hybrid label. This is due to two effects: the first is that participants who are slow in making choices are also more likely to open QR codes, which slows their choice further down. The second is that even taking into account of differences in choice speed across participants, participants are slower in making choices when there is a QR code on one or both of the products. Their choice is 0.886 second slower when one product has a Hybrid label than when there both products have a paper label, and 1.625 seconds slower when both products have a hybrid label. Unlike what could have been expected, consumers do not compensate for time spent scanning QR codes and accessing DFIs by spending less time considering other information on food labels. Rather, the time spent scanning QR codes is directly reflected in an increase in time spent making choice.

This finding helps predict how much slower choice would be if Hybrid labels were introduced in the field. We would expect QR code scanning to be much less prevalent than in our experiment, where scanning QR codes was much easier and faster than in reality. However, time spent scanning the QR code and accessing information would also be much higher than in our experiment, for the same reasons. It is hard to put a number for the net effect, but it would result in slower choice overall. The introduction of QR codes would particularly affect slow decision makers, who would be the most likely to want to access DFIs and would thus lose the most time.

6.4 Product knowledge

We asked participants to report their best estimate of information about products they chose from, such as their weight, their number of kilocalories / 100g, or their "best before" dates. This was asked for the last three choices they had to make, right after each of those three choices, and for both products in the pair of products they had to choose from. We varied whether the information they were asked about was shown on the product label or accessible only via a QR code.

We measure errors in their report in two ways: For the weight and the number of calories, we consider report error=|ln(stated value / true value)|. In words, we take the absolute value of the logarithm of the ratio between the value reported by the participant and the true value. Report error is 0 if the participant reported the true value. This is a good way to normalize report error because for example, report error is the same, equal to ln(2)=0.69 whether the participant reported twice the true value, or half of the true value. Those are indeed errors of analogous magnitude.

We compute report error in a slightly different way when considering best before dates, by considering the number of days left before the best before date, as estimated by the participant vs. as shown to them with the best before date. Report error is then |ln(stated days left / true days left)|.

Weight

We find that average report error for weight is 0.39 (Table 6), which is equivalent to estimating weight as 48% higher, or equivalently 32% lower, than what they actually were.

Table 6: Report error, by type of information

	Weight	Calories	Best before date
Mean (sd)	0.3878 (0.4227)	0.7922 (0.7495)	1.1968 (1.0220)
N	6768	6768	5439

We exclude outliers (top 1%), and observations where participants reported "best before" dates that were in the past.

We consider below whether report error depended on whether the weight information was in the QR code or directly accessible on either of the two products (Table 7).

Table 7: Report error for weight, calories and best before date, depending on menu type

		Menu type			
		Both paper	One Hybrid		Both Hybrid
			Paper	Hybrid	
Weight	Mean (sd)	0.38 (0.43)	0.39 (0.40)	0.39 (0.40)	0.42 (0.43)
	N	4205	856	852	855
Calories	Mean (sd)	0.84 (0.78)	0.82 (0.77)	0.84 (0.76)	0.49 (0.45)
	N	5039	429	428	872
Best before date	Mean (sd)	1.17 (0.97)	1.21 (1.04)	1.27 (1.09)	1.25 (1.16)
	N	3364	700	697	678

We show average report error depending on if none, one or both products in the pair had a hybrid label. In case only one had a paper label, we show report error for the product with a paper label and report error for the product with a hybrid label.

We find that report error was higher if weight information was in the QR code, increasing from 0.38 if weight was shown on paper for both products, to 0.42 if weight was shown as DFI for both products (Table 7).

Disaggregating further the statistic in case weight was in the QR code, we find that report error was 0.44 if the person did not access the DFI, vs. 0.26 if the person did access the DFI. This is to be compared with report error of 0.38 if the information is on the label.

We thereby see a selection effect at play, whereby the report error if the information is on the label is lower than if the information is in the QR code but was not accessed, but higher than if the information is in the QR code and was accessed. However, few consumers access the DFI, so the overall effect of putting information in the QR code is to increase report error.

Nutrition information

We find that average report error for nutrition information (number of kilocalories per 100g) was 0.79 (Table 6), which is equivalent to estimating kilocalories as 120% higher, or equivalently 55% lower, than what they actually were. Individuals were thus significantly worse at reporting caloric content of the food than in reporting weight. This is probably because most consumers are less experienced estimating caloric content per 100g, which does not obviously relate optically to the product in the way that weight does.

We consider whether report error depended on whether the calorie information was in the QR code or directly accessible on either of the two products (Table 7). We find that report error is significantly lower if calories information was in the QR code, decreasing from 0.84 if calories were shown on both product labels to 0.49 if calories were accessible only as DFI for both products. However, if only one product had DFI, then report errors were higher for that product than for the one with a paper label.

Disaggregating further the statistic in case calories was in the QR code, we find that report error was 0.62 if the person did not access the DFI, vs. 0.54 if the person did access the DFI. This is to be compared with report error of 0.84 if the information is on the label.

Accessing the calorie information in the QR code therefore does reduce as expected report error, but paradoxically report errors are higher if calorie information is shown on label than if calorie information is in the QR code and is not accessed.

Best before date

In terms of best before date report, we consider days left between the time at which the participant took part in the experiment and the best before date shown on the product. We find that average report error for days left was 1.20 (Table 6), which is equivalent to estimating days left as 232% more, or equivalently 70% less, than what they actually were. Individuals were thus significantly worse when reporting days left than when reporting weight or even calories.

We consider whether report error depended on whether the best before date was in the QR code or directly accessible on the two products (Table 7). We find that report error is significantly higher if "best before" dates was in the QR code, increasing from 1.17 if "best before" dates were shown on the paper label for both products to 1.25 if "best before" dates were accessible only as DFI for both products. If only one product had DFI, then report errors were higher for that product than for the one with a paper label.

Disaggregating further the statistic in case the "best before" date was in the QR code, we find that report error was 1.39 if the person did not access the DFI, vs. 0.80 if the person did access the DFI. This is to be compared with report error of 1.18 if the information is on the label.

Accessing the "best before" dates in the QR code therefore does reduce as expected report error, and not accessing the "best before" dates does increase error rates. This explains how, given low rates of access of DFIs, report error is higher if "best before" dates are only accessible with the QR code.

We run fixed effect ("within") panel regressions to control for differences across individuals. This allows us to check how differences in label presentations affect report error while controlling for a possible selection effect whereby for example those who do not click on QR codes are those who already know the information in the QR code. Results are shown in Table 14, Annex 4. We find that providing the information via a QR code consistently increases report error, but significantly so only for date information (columns 1-3). German and Spanish participants appear to make higher report error than Bulgarians. We do not find a consistent or significant effect of vulnerability statistics on report errors (columns 4-6). Similarly, the impact of providing information via a QR code does not appear to differ consistently for vulnerable participants (columns 7-9).

Discussion: This part on report errors confirms that a consequence of participants not scanning QR codes is that they know less about the product they choose. Hybrid labels result in them knowing less about product characteristics than if all information is on a paper label. This issue particularly affects consumers who make fast decisions, since they are also the least likely to scan QR codes.

7 Conclusion

We found that most consumers did not show a preference for or against products that displayed some information through a QR code compared to products that displayed all information on printed paper labels. However, this was not the case for older and less educated consumers, who were less likely to choose products with QR codes.

There was low willingness to access information through QR codes, even though our experiment was designed to make it comparatively easy to access digital food information. As many as 37% of the participants in the experiment never scanned any QR code over all the choices they made in our experiment. Only 4% scanned all of them. Overall, participants scanned QR codes in only 24% of the cases when one was shown on product labels.

There were further reasons why providing food information via QR codes had a negative impact on consumers:

- Scanning QR codes slowed choice down. Participants took longer making choices when a product had a QR code. This was especially the case among older participants. This slowdown was proportional to the time spent accessing the digital food information and to the likelihood of accessing it. This means that consumers did not compensate for the time they spent scanning QR codes by accelerating other aspects of their choice process.
- Participants were less precise in their knowledge of product information if it was shown via a QR code than if it was shown printed on the labels. Indeed, consumers made more mistakes when reporting information about products with digital food information. They were not able to correctly report product information when they did not scan the QR codes. This means that consumers who did not scan QR codes did not do so because they already knew the information therein. Rather, they simply chose to forgo knowledge about the product.

In summary, we found that consumers were unlikely to access information provided through QR codes. Giving access to information via QR codes slowed choice down. Providing food information digitally also resulted in consumers knowing less about the food products they chose from. However, consumers did not respond to this by avoiding products with QR codes.

In conclusion, this study illustrates that printed paper labels are more effective than QR codes in giving access to food information. Labels that require digital means to access food information are not a good substitute for printed paper labels that give direct access to food information. This is due to the time cost of scanning QR codes, the low likelihood to scan them, and the resulting lack of knowledge about the characteristics of the products.

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List of abbreviations and definitions

DFI: Digital Food Information

MFI: Mandatory Food Information

QR code: Quick Response code

Hybrid label: Label with one information item provided via clicking on a QR code

Paper label: Label with all information items printed on the label

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Annexes

Annex 1 List of products

Table 8 List of products and their characteristics, by country and category

Country	Category	Product	Description	Price	Weight	Kcal	Limit Date
BG	Carbs	A	Bread	2.35	650	267	06/03/2023
BG	Carbs	B	Bread	2.35	550	283	08/03/2023
BG	Carbs	C	Rice	1.99	500	339	26/10/2023
BG	Carbs	D	Rice	2.49	500	340	30/11/2023
BG	Carbs	E	Pasta (orzo)	2.79	500	362	31/10/2023
BG	Carbs	F	Pasta (orzo)	3.29	500	354	30/09/2023
BG	Carbs	G	Lentils	3.49	500	353	01/02/2024
BG	Carbs	H	Lentils	2.89	500	384	14/11/2023
BG	Dairy	A	Milk	3.39	1000	64	09/03/2023
BG	Dairy	B	Milk	3.39	1000	63	08/03/2023
BG	Dairy	C	Yoghurt	1.79	400	59	05/03/2023
BG	Dairy	D	Yoghurt	1.69	400	62	09/03/2023
BG	Dairy	E	Cheese	6.99	200	354	28/05/2023
BG	Dairy	F	Cheese	5.99	200	279	11/06/2023
BG	Dairy	G	Butter	6.79	250	767	15/07/2023
BG	Dairy	H	Butter	6.79	250	735	02/06/2023
BG	Protein	A	Chickpeas	2.79	400	163	12/08/2023
BG	Protein	B	Chickpeas	3.99	400	364	18/07/2023
BG	Protein	C	Chicken	10.88	580	137	03/03/2023
BG	Protein	D	Chicken	10.03	570	125	08/03/2023
BG	Protein	E	Smoked salmon	9.29	100	183	15/03/2023
BG	Protein	F	Smoked salmon	9.99	100	171	17/03/2023
BG	Protein	G	Veggie burger	5.99	230	211	01/09/2023
BG	Protein	H	Veggie burger	6.99	113	270	30/10/2023

BG	Vegs	A	Peas	3.89	680	77	18/11/2023
BG	Vegs	B	Peas	4.19	680	77	30/11/2023
BG	Vegs	C	Tomatoes	2.79	400	26	31/12/2023
BG	Vegs	D	Tomatoes	2.79	400	23	11/12/2023
BG	Vegs	E	Corn	2.39	425	58	14/10/2023
BG	Vegs	F	Corn	2.29	400	103	25/10/2023
BG	Vegs	G	Bagged salad	4.29	250	22	05/03/2023
BG	Vegs	H	Bagged salad	3.69	250	15	07/03/2023
DE	Carbs	A	Pasta	1.99	400	361	12/08/2023
DE	Carbs	B	Pasta	1.89	400	352	29/09/2023
DE	Carbs	C	Bread	0.89	500	220	04/04/2023
DE	Carbs	D	Bread	1.69	500	224	29/03/2023
DE	Carbs	E	Rice	2.29	500	157	15/08/2023
DE	Carbs	F	Rice	1.99	500	351	12/07/2023
DE	Carbs	G	Red lentils	2.79	750	322	15/07/2023
DE	Carbs	H	Red lentils	2.29	750	337	23/07/2023
DE	Dairy	A	Milk	1.39	1000	67	24/03/2023
DE	Dairy	B	Milk	1.79	1000	64	26/03/2023
DE	Dairy	C	Yoghurt	1.19	500	65	06/04/2023
DE	Dairy	D	Yoghurt	1.29	500	70	02/04/2023
DE	Dairy	E	Butter	3.39	250	747	23/05/2023
DE	Dairy	F	Butter	3.49	250	748	17/05/2023
DE	Dairy	G	Mozzarella cheese	0.99	120	245	08/04/2023
DE	Dairy	H	Mozzarella cheese	0.99	250	246	05/04/2023
DE	Protein	A	Smoked salmon	3.99	100	216	30/03/2023
DE	Protein	B	Smoked salmon	4.09	100	180	02/04/2023
DE	Protein	C	Chickpeas	1.69	265	120	05/09/2023

DE	Protein	D	Chickpeas	1.49	240	72	22/09/2023
DE	Protein	E	Meat	2.99	250	234	23/03/2023
DE	Protein	F	Meat	4.79	250	176	28/03/2023
DE	Protein	G	Vegetarian bacon	2.99	130	140	15/05/2023
DE	Protein	H	Vegetarian bacon	1.99	90	228	09/05/2023
DE	Vegs	A	Green beans	0.79	220	24	27/08/2023
DE	Vegs	B	Green beans	1.69	220	26	13/09/2023
DE	Vegs	C	Mushrooms	2.29	230	20	30/07/2023
DE	Vegs	D	Mushrooms	1.19	230	16	13/07/2023
DE	Vegs	E	Tomatoes	0.69	240	23	11/09/2023
DE	Vegs	F	Tomatoes	2.6	260	22	28/09/2023
DE	Vegs	G	Corn	1.19	285	79	15/10/2023
DE	Vegs	H	Corn	1.69	285	80	09/10/2023
ES	Carbs	A	Pasta	1.95	500	353	15/10/2023
ES	Carbs	B	Pasta	2.41	500	356	04/11/2023
ES	Carbs	C	Bread	2.45	600	249	29/03/2023
ES	Carbs	D	Bread	2.89	590	272	27/03/2023
ES	Carbs	E	Rice	1.55	1000	343	15/08/2023
ES	Carbs	F	Rice	1.69	1000	346	24/08/2023
ES	Carbs	G	Lentils	1.6	1000	281	12/09/2023
ES	Carbs	H	Lentils	1.75	500	281	01/10/2023
ES	Dairy	A	Milk	0.99	1000	46	15/03/2023
ES	Dairy	B	Milk	1.05	1000	46	21/03/2023
ES	Dairy	C	Yoghurt	2.09	500	79	28/03/2023
ES	Dairy	D	Yoghurt	2.29	500	73	31/03/2023
ES	Dairy	E	Butter	3.35	250	739	04/05/2023
ES	Dairy	F	Butter	3.13	250	742	15/05/2023

ES	Dairy	G	Cheese	2.67	150	338	03/04/2023
ES	Dairy	H	Cheese	2.35	130	353	08/04/2023
ES	Protein	A	Tuna	3.35	195	286	04/09/2023
ES	Protein	B	Tuna	2.89	210	198	24/10/2023
ES	Protein	C	Peas	2.25	500	378	15/05/2023
ES	Protein	D	Peas	2.05	500	348	03/06/2023
ES	Protein	E	Chicken	3.04	400	83	26/03/2023
ES	Protein	F	Chicken	3.58	400	101	24/03/2023
ES	Protein	G	Quinoa	2.99	500	368	13/07/2023
ES	Protein	H	Quinoa	2.61	500	382	29/07/2023
ES	Vegs	A	Green beans	2.59	360	12	15/06/2023
ES	Vegs	B	Green beans	2.65	350	14	25/06/2023
ES	Vegs	C	Green peas	3.79	400	31	30/06/2023
ES	Vegs	D	Green peas	3.59	660	30	20/06/2023
ES	Vegs	E	Tomatoes	1.95	630	76	23/08/2023
ES	Vegs	F	Tomatoes	1.65	636	73	03/09/2023
ES	Vegs	G	Salad	1	200	15	25/03/2023
ES	Vegs	H	Salad	1.99	100	18	01/04/2023

Annex 2 Randomization

Table 9 specifies the way we randomized the presentation of products for different consumers. There were four **random orders**, which differ in which **label types** were shown for each products in each category. The order of pairs of products was kept fixed within categories, but the order in which categories were shown was also randomized, and the position of products was randomized as well (either to the left or to the right).

We also varied what information was shown in the QR code, whereby

- IC1: Nutrition declaration;
- IC2: Net quantity of the food;
- IC3: Date marking (use by/best before);
- IC4: Any special storage conditions and/or conditions of use (when relevant);
- IC5: Name or business name and address of the food business operator;
- IC6: Ingredients;

If both products had DFI, then they both showed the same information type in the QR code.

Finally, we varied what information participants were asked to remember in case the product pair was among the last three choices.

Table 9 Randomization of information condition and knowledge questions

Random order	Category	Menu in category	Label types	Info in DFI	Info asked about if last three
1	1	1	DFI-DFI	IC1	
1	1	2	DFI-Label	IC2	IC2
1	1	3	Label-DFI	IC3	IC3
1	1	4	Label-Label	NA	IC1
1	2	1	DFI-DFI	IC4	
1	2	2	DFI-Label	IC5	IC2
1	2	3	Label-DFI	IC6	IC3
1	2	4	Label-Label	NA	IC1
1	3	1	DFI-DFI	IC1	
1	3	2	DFI-Label	IC2	IC2
1	3	3	Label-DFI	IC3	IC3
1	3	4	Label-Label	NA	IC1
1	4	1	DFI-DFI	IC4	
1	4	2	DFI-Label	IC5	IC2
1	4	3	Label-DFI	IC6	IC3
1	4	4	Label-Label	NA	IC1
2	1	1	DFI-Label	IC1	
2	1	2	Label-DFI	IC2	IC1
2	1	3	Label-Label	NA	IC2
2	1	4	DFI-DFI	IC3	IC3
2	2	1	DFI-Label	IC4	
2	2	2	Label-DFI	IC5	IC1
2	2	3	Label-Label	NA	IC2
2	2	4	DFI-DFI	IC6	IC3

2	3	1	DFI-Label	IC1	
2	3	2	Label-DFI	IC2	IC1
2	3	3	Label-Label	NA	IC2
2	3	4	DFI-DFI	IC3	IC3
2	4	1	DFI-Label	IC4	
2	4	2	Label-DFI	IC5	IC1
2	4	3	Label-Label	NA	IC2
2	4	4	DFI-DFI	IC6	IC3
3	1	1	Label-DFI	IC6	
3	1	2	Label-Label	NA	IC3
3	1	3	DFI-DFI	IC5	IC2
3	1	4	DFI-Label	IC4	IC1
3	2	1	Label-DFI	IC3	
3	2	2	Label-Label	NA	IC3
3	2	3	DFI-DFI	IC2	IC2
3	2	4	DFI-Label	IC1	IC1
3	3	1	Label-DFI	IC6	
3	3	2	Label-Label	NA	IC3
3	3	3	DFI-DFI	IC5	IC2
3	3	4	DFI-Label	IC4	IC1
3	4	1	Label-DFI	IC3	
3	4	2	Label-Label	NA	IC3
3	4	3	DFI-DFI	IC2	IC2
3	4	4	DFI-Label	IC1	IC1
4	1	1	Label-Label	NA	
4	1	2	DFI-DFI	IC6	IC1
4	1	3	DFI-Label	IC5	IC3

4	1	4	Label-DFI	IC4	IC2
4	2	1	Label-Label	NA	
4	2	2	DFI-DFI	IC1	IC1
4	2	3	DFI-Label	IC3	IC3
4	2	4	Label-DFI	IC2	IC2
4	3	1	Label-Label	NA	
4	3	2	DFI-DFI	IC6	IC1
4	3	3	DFI-Label	IC5	IC3
4	3	4	Label-DFI	IC4	IC2
4	4	1	Label-Label	NA	
4	4	2	DFI-DFI	IC1	IC1
4	4	3	DFI-Label	IC3	IC3
4	4	4	Label-DFI	IC2	IC2

Annex 3: Final survey

Table 10 Final survey

Block 1. Socio-demographic profile
Q1. How old are you? Include list of numbers
Q2. Are you...? Male Female Other Prefer not to respond
Q3. What is the highest level of education you have successfully completed (usually by obtaining a certificate or diploma)? Primary school or less High school Some years of university (not completed) University degree completed

Post-graduate (master, PhD, other)
Q4. What is your legal marital status? Married or in Civil Partnership Single (Never married) Separated/Divorced Widowed
Q5. What is your household's monthly income? [adapted country by country by considering income distribution by quintile, Eurostat, 2021] Bulgaria: 500 Lev or below (Quintile 1) 501 Lev – 700 Lev (Quintile 2) 701 Lev – 1000 Lev (Quintile 3) 1001 Lev – 1400 Lev (Quintile 4) 1401 Lev or above (Quintile 5) Germany: 1400 Euro or below (Quintile 1) 1401 Euro – 1900 Euro (Quintile 2) 1901 Euro – 2400 Euro (Quintile 3) 2401 Euro – 3200 Euro (Quintile 4) 3201 Euro or above (Quintile 5) Spain: 800 Euro or below (Quintile 1) 801 Euro – 1200 Euro (Quintile 2) 1201 Euro – 1500 Euro (Quintile 3) 1501 Euro – 2000 Euro (Quintile 4) 2001 Euro or above (Quintile 5)
Q6. Which of the following situations best describes your current situation? Employed full time Employed part time Unemployed or unable to work Homemaker Student Retired Other

Q7. Which of the following best describes where you live? A big city The suburbs or outskirts of a big city A town or a small city A country village A farm or home in the countryside
Block 2. Internet/smartphone/app/QR usage and familiarity
Q1. Do you have a smartphone (that is, a mobile phone with a touchscreen)? Yes No
Q2. Do you use your smartphone to access the Internet? Yes No
Q3. Have you ever scanned a QR code for a food product? Yes No
Q4. In the future, how likely would you scan a QR code on a food product to access food information? Very likely Quite likely Quite unlikely Very unlikely
Q5. How do you feel about the idea of having QR codes on food products to access food information? I really like it I like it I dislike it I really dislike it
Q6. What would be a problem with having QR codes on food products? [allow multiple answers] It would take too much time and effort to scan them I think it is not safe to scan QR codes I would need to read additional information about the product I would have to go on the Internet to access food information It would be difficult to read information on my phone I do not have a smartphone, or I often do not have my phone with me For another reason (write down):

I cannot think of any problem with QR codes
Q7. What would be a benefit of having QR codes on food products? [allow multiple answers] It would be easier to get information about the product I would get more information about the product I would have access to food information on the Internet It would be easier to read the information on my phone I would be able to read product information in my own language For another reason (write down) I cannot think of any benefit of QR codes
Block 3. Dietary and food-related habits
Q1. How often do you PERSONALLY buy groceries for your household? Daily or almost daily About once a week Once or twice a month Once every two months Never or almost never
Q2. Have you ever purchased groceries online? No, never Yes, one time Yes, a few times Yes, regularly
Q3. How often do you cook your own meals and eat them at home? Daily or almost daily About once a week Once or twice a month Once every two months Never or almost never
Q4. What is your average daily consumption of fresh fruits and vegetables? (A portion is for example one tomato, or one apple) 0 portions 1 to 4 portions 5 or more portions
Q5. Do you have any of the following dietary restrictions? Vegan

Vegetarian Lacto Vegetarian Ovo Vegetarian Kosher Halaal Food Allergy (e.g. gluten free, peanut free) I have other dietary restrictions (specify) I do not have any of these dietary restrictions
Q6. How often do you read the labels on the food products you purchase? Always Frequently Sometimes Rarely Never or almost never I don't know / I am not sure
Q7. When buying food, how much do you rely on, and trust, the information provided on the label? Scale from 0 to 10 (0 = means you do not trust at all; 10 = you have complete trust)
Q9. When you buy food, which of the following are the most important to you? Whether the item complies with your ethics and beliefs, (e.g in terms of religion, animal welfare or fair payment of producers) Whether the food is safe to eat The price of the product Nutrient content (e.g., the amount of vitamins, fiber, proteins, sugar, or fats) How the food tastes Where the food comes from (e.g., geographical origin) Convenience (e.g., the easiness to use, prepare) How much processing the food went through The amount of shelf-life available The product's impact on the environment and climate (e.g., carbon footprint) Other (please specify) I don't know
Block 4. Consumer vulnerability
Q1. What is your native language? Bulgarian German Castellano

Català Valenciano Gallego Euskera Aranés Other (please specify)
Q2. How do you perceive your health in general? Very good Good Fair Bad Very bad
Q3. What is your height? (In cm)
Q4. What is your weight? (In kg)
Q5. Thinking about your household's financial situation, how easy or difficult would you say it is to make ends meet? Very easy Fairly easy Neither easy nor difficult Fairly difficult Very difficult I don't know
Q6. In the following, please indicate if the statement corresponds to your experience or not: (all responses on the 1-5 scale, 1 = "corresponds to me perfectly" to 5 = "does not correspond to me at all") There are too many similar products to choose from There is too much information to consider when choosing products Product information is often unclear and confusing It takes me a long time to decide what product to buy I always buy the same products when I go shopping
Q7. In the following, please indicate if the statement corresponds to you or not: (all responses on the 1-5 scale, 1 = "corresponds to me perfectly" to 5 = "does not correspond to me at all") 1. I prefer complex to simple problems. 2. I like handling situations that requires a lot of thinking. 3. Thinking is not my idea of fun. 4. I would rather do something that requires little thought than something that is sure to challenge my thinking abilities. 5. I really enjoy a task that involves coming up with new solutions to problems.

6. I would prefer a task that is intellectual, difficult, and important to one that is somewhat important but does not require much thought.

Annex 4. Regressions

Table 11 Choice of product with a Hybrid label in Hybrid-Paper and Paper-Hybrid information conditions

	Hybrid_chosen				
	(1)	(2)	(3)	(4)	(5)
Paper-Hybrid	0.004	0.006	0.011	0.002	
Choice order		0.001*	0.001*	0.002*	
diff_known		0.181***	0.181***	0.181***	
diff_price		-0.109***	-0.109***	-0.109***	
diff_weight		0.0003***	0.0003***	0.0003***	
diff_kcal		-0.0002***	-0.0002***	-0.0003***	
diff_date		0.001***	0.001***	0.001***	
Category Dairy			-0.005	-0.004	
Category Protein			0.003	0.003	
Category Vegs			-0.008	-0.007	
IC Nutrition			-0.018	-0.020	
IC Quantity			-0.019	-0.017*	
IC Date			0.007	0.011	
IC Name			0.011		
IC Ingredients			-0.023		
diff_weight & IC == "Quantity"				0.00002	
diff_kcal & IC == "Nutrition"				0.0001	
diff_date & IC == "Date"				-0.001*	
Germany					0.014
Spain					-0.001
Age>55					-0.017*

Low Education					-0.012
Rural Location					0.005
Low Income					0.005
Financial Constraint					-0.010
Constant					0.508***
Observations	27,360	27,360	27,360	27,360	3,420
R^2	0.00002	0.068	0.069	0.069	0.004
F Statistic	0.447	250.747***	118.356***	110.809***	1.936

*p<0.05 **p<0.01***p<0.001

Table 12 Likelihood to scan one or both QR codes in a pair, by menu characteristics and vulnerability indicators

	Dependent variable:			
	At least one QR code scanned			
	(1)	(2)	(3)	(4)
Both_Hybrid	0.016^{***}	0.016^{***}	0.006	
Choice order		-0.009^{***}	-0.008^{***}	
abs(diff_known)		-0.006	-0.004	
abs(diff_price)		-0.015^{***}	-0.005	
abs(diff_weight)		-0.0001^{***}	-0.0001^{**}	
abs(diff_kcal)		0.0001^{**}	0.0001	
abs(diff_date)		0.00001	-0.0001	
Category Dairy			-0.009	
Category Protein			-0.002	
Category Vegs			-0.008	
IC Nutrition			0.111^{***}	
IC Quantity			0.048^{***}	
IC Date			0.014^{**}	
IC Name			0.004	
IC Ingredients			0.004	
Germany				-0.015
Spain				0.036^{**}
Age>55				0.013
Low Education				0.009
Rural Location				0.022
Low Income				-0.011
Financial Constraint				-0.001

Constant				0.225***
Observations	41,040	41,040	41,040	3,420
R^2	0.001	0.020	0.037	0.006
F Statistic	24.139***	111.739***	97.427***	2.819**

*p<0.05 **p<0.01***p<0.001
abs(x) means absolute value of x

Table 13 Speed of choice by menu characteristics and vulnerability indicators

	Dependent variable: choice speed (in seconds)				
	(1)	(2)	(3)	(4)	(5)
One Hybrid	0.882^{***}	0.880^{***}	1.507^{***}		
Both Hybrid	1.625^{***}	1.623^{***}	2.048^{***}		
Choice order		-0.669^{***}	-0.674^{***}		
abs(diff_known)		-1.335^{***}	-1.247^{***}		
abs(diff_price)		-0.616^{***}	-0.584^{**}		
abs(diff_weight)		-0.0001	-0.001		
abs(diff_kcal)		0.016^{***}	0.009^{***}		
abs(diff_date)		-0.017^{***}	-0.026^{***}		
Category Dairy			-0.660^{**}		
Category Protein			0.838^{***}		
Category Vegs			-1.008^{***}		
IC Nutrition			0.549^{*}		
IC Quantity			-0.915^{***}		
IC Date			-0.571^{*}		
IC Name			-1.860^{***}		
IC Ingredients			-0.788^{**}		
Germany				-2.922^{***}	
Spain				-1.514^{**}	
Age>55				5.606^{***}	
Low Education				-0.232	
Rural Location				0.125	
Low Income				-1.305^{**}	
Financial Constraint				0.912	

DFI					0.764*
DFI*Germany					0.112
DFI*Spain					0.076
DFI*Age>55					0.953*
DFI*Low Education					-0.027
DFI*Rural Location					0.003
DFI*Low Income					0.079
DFI*Financial Constraint					0.467
Constant				17.807***	
Observations	44,234	44,234	44,234	3,420	44,234
R^2	0.002	0.040	0.044	0.050	0.001
F Statistic	36.364***	210.994***	116.770***	25.628***	7.582***

*p<0.05 **p<0.01***p<0.001

abs(x) means absolute value of x

Table 14 Report error by menu characteristic and vulnerability indicators

	Dependent variable: Report error								
	(1) weight	(2) calories	(3) date	(4) weight	(5) calories	(6) date	(7) weight	(8) calories	(9) date
QR code	0.009	0.016	0.053*				0.008	-0.008	0.122*
Germany				0.075***	0.001	0.198***			
Spain				0.156***	0.188***	0.184***			
Age>55				-0.037*	0.025	0.035			
Low Education				0.006	0.008	0.052			
Rural Location				-0.041*	-0.017	-0.022			
Low Income				0.027	0.068*	0.069			
Financial Constraint				0.004	-0.042	-0.001			
QR & Germany							-0.020	0.026	-0.137*
QR & Spain							0.011	0.008	-0.060
QR & Age>25							-0.036	0.006	-0.108
QR & Low Education							0.014	-0.029	0.028
QR & Rural Location							0.019	0.062	-0.034
QR & Low Income							0.003	0.055	-0.055
QR & Financial Constraint							0.007	-0.041	0.148*
Constant				0.310***	0.713***	1.049***			
Observations	6,768	6,768	5,439	3,393	3,399	2,873	6,768	6,768	5,439
R^2	0.0005	0.0003	0.002	0.027	0.017	0.011	0.003	0.002	0.008
F Statistic	1.548	1.178	4.741*	13.404***	8.270***	4.651***	1.116	0.971	2.501*

*p<0.05 **p<0.01***p<0.001

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