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Health Information and the Choice of Fish Species: An Experiment Measuring the Impact of Risk and Benefit Information

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Working Paper 06-WP 421
April 2006

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This project was supported by funding from INRA-INSERM PRNH. The authors thank Christophe Martin for his precious support in Dijon. They thank Pierre Combris, Sylvie Issanchou, and Youenn Loheac for comments that helped in designing the experiment. The authors also thank Sean Fox, Dermot Hayes, and Helen Jensen and the participants of a seminar at Iowa State University for their comments.

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Abstract

An experiment was conducted in France to evaluate the impact of health information on consumers' choice between two different types of fish. Successive messages revealing risks (methylmercury) and benefits (omega-3s) of consuming the fish, along with consumption recommendations, were delivered. Results show a significant difference of reaction according to the order and type of information. The information about risks had a larger marginal impact on change in willingness to pay (WTP) than did the information about benefits. While the results show that detailed messages on risks/benefits, including recommendations for nutrition behavior, matter in the modification of WTP, 40% of respondents did not change their initial choices after the revelation of health information.

Keywords: experimental economics, fish consumption, health information, nutrition.

JEL Classification: C9, D8, I1.

1. Introduction

Public health communication programs aim at informing consumers about health benefits and risks associated with particular products or types of behavior. They affect consumers' choices by reducing uncertainty about the "true value" of goods, making room for improvement in their consumption behavior.

Recently, several health agencies around the world issued messages regarding fish consumption, since it involves a complex balance between benefits (with nutritional considerations) and risks (with toxicological considerations). Intense debate about whether or not the benefits of eating fish outweigh the risks has ensued. However, an aspect overlooked in these debates concerns the large differences among fish species regarding their safety or health-promoting content. Hence, knowledge about consumers' tendency to substitute different fish species for each other is essential for designing efficient health communication.

The purpose of this paper is to evaluate the impact of heath information on consumers' choice between a relatively "risky" type of fish (i.e., tuna) and a type of fish that is not only "less risky" but in addition offers health benefits (i.e., sardine). The risk and the benefit considered in this paper are, respectively, methylmercury and omega-3 fatty acids.

An experiment was conducted in France with women of childbearing age, since fish is particularly important during pregnancy. Messages successively revealing risks and benefits were delivered, along with consumption recommendations. The women were endowed with a given quantity of "healthy" or "risky" fish and they were asked their willingness to exchange this endowment against a varying quantity of the other fish. This experimental procedure allowed us to evaluate the substitution between products and the willingness to pay (WTP) a premium for one product over another.

Results show significant differences in reaction depending on the revelation and the order of information. The information about the risk had a larger marginal effect on the change in WTP than did the information about the benefit. Detailed messages on risks/benefits, including recommendations for nutrition behavior, matter in the modification of WTP. Nearly 24% of women in the study were very sensitive to the information and largely substituted the "less risky" type of fish (sardines) for the risky one (tuna). Nearly 36% of the women weakly modified their behavior and nearly 40% of the women did not change their initial choices after the revelation of health information. Strong preferences for species explain this relatively large percentage of women who did not react. Eventually, our results showed the presence of an endowment effect, since choices are significantly different according to the initial endowment (namely, tuna or sardines). In other words, the effect of information is not symmetric in the initial endowment.

Our approach focuses on substitution and differs from papers evaluating the impact of information on WTP with an auction mechanism (see, e.g., Hayes et al., 1995, and Fox et al., 2002). Very few empirical studies have considered the measurement of substitution. MacCrimmon and Toda (1969) were among the first in the experimental determination of indifference curves. As their experiments proceed by consecutive choices between two consumption bundles in order to evaluate rates of substitution for varying endowments, the methodology is too "heavy" for testing the revelation of successive types of information to consumers. This explains why our approach is based on Masters and Sanogo (2002) and Sanogo and Masters (2002), focusing on a single endowment point (see also Binswanger 1980).

However, in contrast to the previous studies that estimate WTP for four almost perfect substitutes that differ only in their information content, we are interested in estimating the substitution between two imperfect substitutes, i.e., two fish species, tuna and sardines, that differ not only in the risk/benefit dimension but also in other preference dimensions such as taste. While we adopt the mechanisms of Masters and Sanogo (2002) and Sanogo and Masters (2002), our procedure differs, as we evaluate the same choice situation in different informational environments whereas they concurrently change goods and information at different stages of their experiment. We also show that the good with which the consumers are endowed also matters. This endowment effect was not tested by Masters and Sanogo (2002). Hence, a complete measure of the substitution between two goods should consider different initial endowments in order to have a complete view regarding consumers' choices.

The paper continues with a brief presentation of risks and benefits of fish consumption. In the following sections, we describe the experiment and discuss the results. The paper concludes with a discussion of the implications for public health policy.

2. Fish consumption, health benefits/risks, and regulatory decisions

Safety and nutrition linked to fish consumption have become an increasing public health concern in recent years. In particular, methylmercury, an organic form of mercury, is a toxic compound that alters fetal brain development when there is significant prenatal exposure (EFSA, 2004). Children of women who consume large amounts of fish during pregnancy are particularly vulnerable to the adverse neurological effects of methylmercury (Budtz-Jorgensen et al., 2002). A high level of methylmercury is concentrated in long-lived, predatory fish, such as tuna, shark, and swordfish (Mahaffey et al., 2004).

The regulatory choice of how to manage this risk is complex since the nutrients in fish are also essential to the health of a developing fetus. More precisely, omega-3 polyunsaturated fatty acids, along with iodine, selenium, and phosphorus, confer benefits to the fetus such as infant cognition and improvement in cardiovascular health (FDA, 2002). According to the European Food Safety Agency (EFSA, 2005, p. 1), "Fatty fish is an important source of long chain n-3 polyunsaturated fatty acids (LC n-3 PUFA)…. There is evidence that fish consumption, especially of fatty fish (one to two servings a week), benefits the cardiovascular system and is suitable for secondary prevention in manifest coronary heart disease. There may also be benefits in fetal development, but an optimal intake has not been established." In addition, there is still a lot of uncertainty and controversy about whether these benefits may outweigh the harm from mercury exposure.

Several countries have decided to broadcast specific advisories, including the US beginning in 2001, Canada in 2002, the UK in 2003, and Ireland, Australia, and New Zealand in 2004. The responsible health or food agencies of these countries have given an advisory that vulnerable groups (small children, pregnant women, and women of childbearing age) should consume fish while avoiding species at the high end of the food chain such as shark, swordfish, king mackerel, tilefish, and tuna because of high levels of mercury contamination (EFSA, 2004).[1] The use of this advisory is of interest, as it mitigates the broad applicability of the

[1] In general, women who may become pregnant, pregnant women, nursing mothers and young children are the target population of the advisories regarding methylmercury. In contrast, the Food Safety Authority in New Zealand considers the overall population as the relevant target population. Pregnant women are considered as particularly vulnerable. As the SACN (2004, p. 133, point 6.46) mentions, "The risk is greater for women who are pregnant or likely to become pregnant within the following year because of the effects of methylmercury on the developing central nervous system of the fetus."

general recommendation by nutrition and health experts to consume fish (in general without further qualification) twice or three times a week. This latter recommendation is motivated through the health benefit of a sufficient consumption of omega-3 fatty acids, a level that is considered to lower dramatically the risk of heart disease in adults. However as Kolata (2006, p. 1) mentions, "for years, people have been urged to eat fish rich in omega-3 fatty acids. But fish can be expensive, not everyone likes it…," which obviously limits the efficiency of the recommendations.

Since 2001, the US has been active in disseminating the information for childbearing and pregnant women by using mass media or brochures distributed by gynecologists and obstetricians (EPA, 2004). The 2004 US advisory begins by explicitly mentioning the benefits of regular fish consumption because of the content of omega-3 polyunsaturated fatty acids.[2] The advisory then stipulates that some fish species should be avoided, such as shark, swordfish, king mackerel, and tilefish. It also advises consumption of up to two average meals of fish per week that are "lower in mercury," such as shrimp, canned light tuna, salmon, pollock, and catfish, and limiting to only one meal per week the consumption of "albacore" (white) tuna because of a larger concentration of methylmercury compared to canned light tuna. Note that bluefin tuna (used for steak, sashimi, or sushi) is not mentioned in the US advisory despite an average content in methylmercury similar to the one for swordfish and king mackerel (banned by the advisory).[3]

The 2001 US advisory was found to have its intended effect, as pregnant women reduced their consumption of fish (Oken et al., 2003). However, the US advisory raised some criticisms by doctors (e.g., Drs. Hibbeln and Golding), who argued in favor of the large benefits of omega-3 fatty acids for fetuses (*The Economist,* 2006b). According to *The Economist* (2006a, p. 14), "the researchers note that American guidelines recommending that pregnant women should not eat fish because it may contain mercury have the perverse effect of cutting off those women (and their fetuses) from one of the best sources of omega-3s."

From a risk management perspective, it is essential to understand how the target audience is receiving consumption advisories. The relationship between the type of information and consumers' behavior is complex but understanding this relationship is very important for the efficiency of public regulation.

The French situation is interesting because no major diffusion of information has been decided upon yet. Some warnings have been posted on the website of the Agence Française de Sécurité Sanitaire des Aliments, the French food safety agency (AFSSA, 2002 and 2004). However, despite few articles in the popular press (see, for instance, Miserey, 2003), no major broadcasting of information via obstetricians, maternity hospitals, or booklets was implemented by the sanitary authorities. This absence of national informative campaigns suggests that in France very few childbearing women are informed regarding the potential risk of methylmercury exposure. In contrast to the methylmercury issue, information on omega-3 fatty acids is subject to relatively widespread diffusion in France by mass media or advertising campaigns.[4]

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[2] On the FDA website, the recommendation for pregnant women about methylmercury does not mention the omega-3 benefits (FDA, 2006).

[3] According to Knecht (2006, p. P6), "Tuna, perhaps the most popular sushi fish, may contain high levels of mercury. 'A lot of people think sushi is a health food, but it isn't if you eat tuna sushi twice a week,' says Eli Saddler, a public health analyst with Gotmercury.org, an environmental advocacy group."

[4] For instance, the brand "Connétable" launched an advertising campaign about canned sardines (used in this experiment) and the benefit coming from omega-3s. From April to June 2005, this advertising was published in two national health magazines, five national women's magazines, six cooking magazines, and three TV magazines. See http://www.connetable.com/ communication/index.asp (accessed February 2006).

Since no advisory about risks linked to fish has been communicated to the general public in France, we proceeded by employing an economic experiment rather than by observing choice data in a real market setting. Because of the potential costs to society from inefficient regulation, the following experiment was designed to give evidence on which to base communication by taking into account the consumers' reaction regarding two different fish species.

3. The experiment

The previous discussion suggests the choice of some relevant variables for the experiment in order to fit real situations and thus help the public decisionmaker. We will successively detail the sample, the choice of products, the revealed information, and the experiment.

3.1 The sample

As pregnancy and breastfeeding status or being a young child are crucial indications for the risks linked to methylmercury, we focus on women of childbearing age, namely, women between 18 and 45 years old.

We conducted the experiment in Dijon, the main city of Burgundy in France, in multiple sessions from January 23, 2006, to January 27, 2006. A sample of 115 women in Dijon was randomly selected based on the quota method and is representative for age groups and socio-economic status for the population of the city. Women in the targeted age and socio-economic classes were contacted by phone. Once they agreed to attend the session, they received a formal invitation letter and a reminder call a few hours before the experimental session.

We used the INRA (Institut National de la Recherche Agronomique) sensory laboratory with kitchen facilities and computers for collecting subjects' responses. Each experimental session lasted one hour and included between 4 and 12 women.

3.2 The products

Tuna and sardines were selected as products (*i*) because they are frequently consumed in France and (*ii*) because their nutritional content is significantly different.

(*i*) This experiment focused on canned fish, known and consumed by almost all French consumers. Canned tuna and canned sardine are commonly consumed types of canned fish in France: surveys show 90% of French households consume canned tuna and 57% consume canned sardines (Ofimer, 2005). The quantities consumed, however, are quite different, since 65% of canned fish consumed in France is tuna and 11% is sardines (Ofimer 2005).

The reader should keep in mind that there is an asymmetry in the consumption habits, with an "a priori preference" for tuna. The choice between tuna and sardines was mainly imposed by the available products on French grocery shelves in 2005. As we are interested in estimating the substitution between two imperfect substitutes (namely, two types of canned fish), we tried to assure the similarity in the maximum number of elements for the experiment, namely, the same brand, the same sauce, the same weight, the same packaging, and almost the same price. This requirement allows us to isolate the substitution between the two different types of canned fish and the impact of information on consumers' choices.

In the context of a large diversity of cans of different brands and weights on the French market, we selected two cans of the French brand "Connétable" that satisfied numerous common criteria (see the appendix A). Table 1 shows that the weights and the prices from the selected cans were very close.[5] The only difference was in the shape of the can (see appendix A).[6] The closeness in weight and price allowed a direct comparison of the products by the consumers in the experiment. However, the price per kilogram was significantly larger than the average price in France, which means that we selected high-quality products (see table 1).

(*ii*) The other reason for the selection of tuna and sardines was the considerable difference in the contents of mercury and omega-3, as shown in table 2. Tuna contains high mercury and low omega-3 levels, whereas sardines contain high omega-3 (the highest levels in fish; see Sidhu 2003, table 5, p. 341) and low mercury levels. It should be noted, however, that data from different sources in the literature can show large variations because of the inherent variability in concentrations of samples as a function of species, age, and size, which are difficult to reflect in controlled sampling plans.[7] This explains the two figures proposed for omega-3 in canned tuna in table 2.

The contrasted contents in mercury and omega-3s have important consequences for information revealed during the experiment. We now turn to a description of the revealed messages.

3.3 The revealed health information

During the experiment, different types of information about risk and benefits were communicated. We restricted our attention to one benefit, namely, omega-3 fatty acids, and one risk, namely, methylmercury.[8] The messages were inspired by elements coming from health agencies in different countries as described in the previous section.

While the complete information revealed to subjects is given in appendix B, it is possible to sum up the types of information delivered at different times as follows:

- (1a) Information revealed about the existence of omega-3 fatty acids with the ratio of omega-3s in sardines to omega-3s in tuna equal to 6.
- (1b) Explanations about the health benefit coming from omega-3 fatty acids and recommendation regarding the weekly consumption of fish.
- (2a) Information revealed about the existence of methylmercury with the ratio of methylmercury in tuna to methylmercury in sardines equal to 4.
- (2b) Explanations about the health risk coming from methylmercury and recommendation for avoiding tuna.

We detailed ratios quantifying the relative content of nutrients and contaminants based on table 2, which is unusual compared to current public health advisories. This choice provides scientific credibility in our context and it fits the restricted choice between only two types of fish in the experiment. We were conservative in the choice of the values of the ratio, which means that we took the values leading to the lowest differences in content between both types of fish.[9]

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[5] Note that for this experiment we used the 87g can for sardines that was replaced by the 115g can in January 2006 (see appendix A).

[6] The presentation of fish inside the two selected cans is the same as in other cans.

[7] Canned tuna encompasses a variety of fish species, namely, the Skipjack, the Yellowfin, and the Albacore. According to EFSA (2005, table 8, p. 19) the average methylmercury content is 0.15 for the Skipjack, 0.3 for the Yellowfin, and 0.49 for the Albacore.

[8] For simplicity, we abstract from communication on other risks of dioxins and PCBs or specific communication on other benefits coming from iodine or selenium in fish.

[9] For the ratio of methylmercury, we did not consider the Albacore value (equal to 0.49 mg) that would be the specific level of the can used for this experiment. Our aim is to focus on tuna without detailing the species (which differs from the EPA, 2004). This choice is justified by the partial existence of labels mentioning species on tuna

In particular, we took the values given by Sidhu (2003) for omega-3s, namely, 0.5g and 3.3g in table 2.

For information (1) and (2), we separate the information regarding the nutrient and hazard content in fish ((1a) and (2a), respectively) from the description of the health effect and the consumption recommendation ((1b) and (2b), respectively). This split allows us to measure consumers' ability to interpret "raw" information ((1a) and (2a), respectively) and to modify their purchasing decisions after recommendations ((1b) and (2b), respectively). These recommendations were simplified in order to avoid confusion and the need to provide additional information about species. This explains why we mention the advisory to eat fish twice a week in (1b), while some recommendations mention the fatty fish (salmon, sardines, or mackerel), and why we maintain the advisory to avoid eating tuna in (2b), without differentiating among tuna species, such as the Albacore mentioned in the US advisory (EPA, 2004).

3.4 The experimental procedure

During the choice procedure, women were asked to choose between an endowment of six cans of Fish I and a variable number of cans of Fish II. The experiment was divided into several stages.[10]

(1) Participating women read some general instructions and signed a form stipulating that they accept and will follow the rules of the experiment.
(2) They filled in a computer-assisted questionnaire on health and nutrition behavior and socio-demographic characteristics.
(3) They had one minute to examine cans of both tuna and sardines (see appendix A).[11] Then the can price of the endowed Fish I was posted on the computer screen and participants were asked to give an estimation of the retail price of a can of Fish II.
(4) They had two minutes to taste both kinds of fish.
(5) The choice procedure was explained and the choice experiment was conducted
    (i) under no health information;
    (ii) after receiving message (1a) in groups A and C or (2a) in groups B and D;
    (iii) after receiving message (1b) in groups A and C or (2b) in groups B and D;
    (iv) after receiving message (2a) in groups A and C or (1a) in groups B and D;
    (v) after receiving message (2b) in groups A and C or (1b) in groups B and D.
(6) Participants replied to a short questionnaire on their understanding of information received and choices made.
(7) The experiment concluded by randomly selecting the products to be remitted to participants based on the selected choices. Participants also received €10 of indemnity and a brochure explaining the risks linked to methylmercury.

During the choice procedure, women were asked to choose between an endowment of six cans of Fish I and a variable number of cans of Fish II, varying from 1 to 12. We endowed participants with either six cans of tuna (groups A and B) or six cans of sardines (groups C and D). We started with a relatively large number of cans (6) since cans of fish are a highly storable product (up to five years).

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cans in France, so that communication on species would be shaky. Therefore, the mention of "canned light tuna" in advisories such as in the US (see EPA, 2004) is not possible in France.

[10] No communication between subjects was allowed during the choice process.

[11] Note that the nutritional information presented in appendix A is not posted on the cans, since there is no mandatory nutrition information required in France.

The choice procedure was divided into five stages. In each stage, participants had to indicate their choices for 12 situations. The 12 choice situations were presented on a single sheet of paper (see appendix C). The number of cans of Fish II varied from 1 to 12, each corresponding to one situation. For each line corresponding to one situation, participants had to choose either the six cans of Fish I or the indicated number of cans of Fish II. To avoid satiation effects, only one choice situation was selected randomly (at the end of the experience) among the 60 overall choices made during the five stages. This situation was selected at random and each woman received the number of cans of Fish I or Fish II she indicated to be her preferred choice in this choice situation.

Before starting, the choice mechanism was explained and illustrated in a trial round.[12] After this warm-up round, women were asked in the first stage to make their definitive choices for the 12 situations without any health information. These choices represent an evaluation of preferences after products testing and before revelation of health information.

For the following stages, information was successively revealed on the computer screen. Each message was posted for least 30 seconds before participants could proceed to the following instructions. Each time, the speaker invited the women to read carefully the message on the screen before making new choices regarding the substitution between Fish I and Fish II. When new information was provided, the previous message was maintained in grey, while the new message appeared in blue. We conducted the choice in four treatments, varying the fish species in the initial endowment (tuna or sardine) and changing the order of information about the risk of methylmercury (2a) and (2b) before the information about benefits of omega-3 fatty acids (1a) and (1b) and vice versa. Table 3 describes the experimental design and the number of attendants.

3.5 The interpretation of results

The idea developed by Binswanger (1980) and Masters and Sanogo (2002) is to use respondents' choices to infer their WTP. This procedure is simpler than Vickrey (1961) auction mechanisms and it focuses on the relative value of a good relative to another product. Based on products substitution, this methodology is particularly tailored to our empirical question searching for details regarding the consumption of fish species. The number of cans of Fish II at which the consumer switches from six cans of Fish I can be interpreted as the point at which the consumer reveals indifference (Sanogo and Masters, 2002, p. 257).

In this experiment, the known price of Fish I is $\overline{p_I}$ and the known quantity of Fish I is six.[13] The experiment provides the selected quantities of Fish II, q_{II}, which allows us to determine the implicit price p_{II}. Assuming separability from all other goods, we can isolate preferences about Fish I and Fish II. The two goods have equal values for consumers when

$$p_{II} q_{II} = \overline{p_I} 6 . \qquad (1)$$

Based on the 12 situations, the experiment allows us to isolate the situation with a quantity $\widetilde{q_{II}}$ for which

[12] The explanation was read by the organizer before choices were made for all 12 situations. We recalled the price of Fish I and the value of endowment of six cans (namely, €9.90 for six cans of tuna or €10.14 for six cans of sardines). We included this training and explanatory phase to make the choice-revealing mechanism more transparent. From these 12 training choices, we simulated some random choices among the 12 choices as an example to facilitate their understanding that each choice could determine what they would actually take home. Participants were allowed to ask questions.

[13] As can quantities are almost similar (see table 1), we abstract from the grams difference between the two cans.

$$p_{II}(\widetilde{q_{II}}-1) < \overline{p_I}6 \quad and$$
$$p_{II}\widetilde{q_{II}} \geq \overline{p_I}6. \qquad (2)$$

This means that for an observed value of $\widetilde{q_{II}}$, a consumer will prefer six cans of Fish I to ($\widetilde{q_{II}}$ -1) cans of Fish II and $\widetilde{q_{II}}$ cans of Fish II to six cans of Fish I. The quantity at which subjects switch serves as an approximation of their WTP. Equations (2) lead to the following inequality: $\frac{\overline{p_I}6}{\widetilde{q_{II}}} \leq p_{II} < \frac{\overline{p_I}6}{\widetilde{q_{II}}-1}$, where p_{II} is the unknown variable. Then, the implicit WTP for the good *II* in terms of the price of good *I* is approximated by

$$WTP_{II} = \frac{\overline{p_I}6}{\widetilde{q_{II}}} \qquad (3)$$

where $SWQ_{II} = 6/\widetilde{q_{II}}$ is defined as the switching-point quantities coming from the experiment. If during the experiment every $q_{II} \in \{1,12\}$ only satisfies $p_{II}q_{II} > \overline{p_I}6$ (only cans of Fish II were selected for situations 1 to 12), we arbitrarily determined a value $\widetilde{q_{II}}$ =1. If during the experiment no $\widetilde{q_{II}} \in \{1,12\}$ is observed for some respondents, we arbitrarily determined a value $\widetilde{q_{II}}$ =13. Based on this convention, the switching-point quantities are $SWQ_{II} \in [6/13,\ 6]$.

Several limitations described by Masters and Sanogo (2002) are relevant for this method. One important limitation concerns the evaluation of the WTP_{II}, defined by equation (3). Masters and Sanogo (2002, p. 982) note that “the overall level of each respondent’s willingness-to-pay value is set by the market price of [Fish I], irrespective of that respondent’s actual willingness to pay for that product.” Despite some limitations, the methodology is useful for providing information regarding the consumers’ substitution for fish that varies in nutrient and hazard components and the effect of information on relative preferences.

4. Results

4.1 Experimental results

From respondents’ choices, we computed the WTP for products according to the different stages regarding the revelation of information (complete results are available from the authors by request). Based on equation (3), figure 1 presents the average WTP in euros (on the Y axis) for both types of fish according to the successive stages of information revelation (on the X axis). Recall that in groups A and B (respectively, C and D), consumers were initially endowed with six cans of tuna (respectively, sardines).

The first bar recalls the market price, which was not known by the participants, since only the price for the initial endowment was revealed. However, subjects were quite close when estimating the retail price at stage 3 (described in subsection 3.4). The average estimated price for sardines in groups A and B was €1.56 (with a standard deviation equal to 0.42) and for tuna in groups C and D it was €1.58 (with a standard deviation equal to 0.38).

The second bar for every group in figure 1 indicates the participants’ WTP for a product after tasting both products and without any health information (initial stage). This first measure reveals their preferences without considering any health information. The WTP for sardines by groups A and B is slightly lower than the market price (€1.69). Conversely, the WTP for tuna by groups C and D before information is much higher than the market price (€1.65). This means that among women attending the experimental sessions, the preferences for tuna are higher than for sardines, which is consistent with the product shares in the French market. An endowment effect exists for this initial stage (and for the following stages too).[14] Indeed, for this initial stage, the comparison of WTP of groups A and B and groups C and D leads to a 2-Sided Mann-Whitney-U-Test of 589.500 (p-value 0.000), which means that the H_0 of both samples coming from the same distribution is rejected at the 1% significance level.[15]

The revelation of information leads to several interesting results in figure 1. First, the information leads to an increase in WTP for sardines and a decrease in WTP for tuna, a result that implies that health information matters to the women. Table 4 shows that the effect of information is significant in changing substitution rates for most stages and groups.

The overall effect of the information linked to the complete revelation of the four consecutive messages (the difference between the sixth bar and the second bar in each figure) has a larger effect on the WTP for sardines than on the WTP for tuna. Indeed the average WTP for the sardines increases by €1.67 in group A (the difference between the sixth bar and the second bar), while the average WTP for tuna decreases from €1.16 in group C (the order of information was the same for both groups). Moreover, the WTP for the sardines increases from €0.91 in group B, while the WTP for tuna decreases from €0.69 in group D. This suggests that the change in WTP is larger when consumers are endowed with tuna, the more heavily consumed but, according to the health messages, less desirable good. These numbers indicate that the effect of information is not symmetric in the initial endowment.

Second, the order (equivalent to some extent to the emphasis) of the messages is crucial. If we consider the difference between the sixth bar and the second bar, the WTP increase for sardines is €0.76 larger in group A than in group B and the WTP decrease for tuna is €0.47 larger in group C than in group D. If messages (2a) and (2b) on methylmercury precede messages (1a) and (2b) on omega-3s, then the major shift in the WTP is coming from the methylmercury effect. In other words, the information on omega-3s does not lead to a subsequent change in the substitution rate. If messages (1a) and (1b) on omega-3s precede messages (2a) and (2b) on methylmercury, the information on omega-3s has a larger effect on the WTP than the one when messages (2a) and (2b) precede messages (1a) and (1b). The information about methylmercury has a still larger marginal effect on the WTP than the information about omega-3s.

This previous result means that the information on risks has more impact than the information on benefits. This concurs with the results of Fox et al. (2002) and Rousu et al. (2004), who found that negative information on product attributes has stronger impacts than positive information. However, our results differ, since these authors revealed positive and negative messages on the *same* question issued by different actors in the information environment. Here the situation is different, as the risk message makes tuna less attractive as does the benefit message. There is no countervailing effect, and we show that the benefit and risk messages are different in terms of efficacy in changing consumption behavior.

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[14] The literature showed that an endowment effect exists if consumers prefer to keep their endowed good (Kahneman et al., 1990) and if goods are not close substitutes (Haneman, 1991, and Shogren et al., 1994).

[15] For comparing groups A and B and groups C and D, we used the switching points defined according to equation (3). The switching-point quantities are, respectively, $SWQ_{sardines} \in [6/13, 6]$ for groups A and B and $\widetilde{SWQ}_{sardines} = 1/SWQ_{tuna}$ with $\widetilde{SWQ}_{sardines} \in [1/6, 13/6]$ for groups C and D. Only the points between 6/13 and 13/6 were considered for computing the 2-Sided Mann-Whitney-U-Test. This led us to consider 45 observations for groups A and B and 56 observations for groups C and D.

Third, the explanation of the health effect and the corresponding recommendation revealed in messages (1b) or (2b) (respectively, the fourth bar and the sixth bar in figure 1) matters since the WTP shifts compared to the first rounds of information in messages (1a) and (2a) detailing only the relative content in the nutrient/contaminant (respectively, the third and the fifth bar). The effect is larger at the beginning of the experiment (stage (*iii*) corresponding to the fourth bar in the charts of figure 1) than at the end of the experiment (stage (*v*) corresponding to the sixth bar).

Hence, while the stronger impact of the methylmercury information may be partially explained by the fact that information about omega-3s was publicly available before subjects received it in the experiment, the fact that the order of information matters (comparison of groups A and B or groups C and D) suggests that information satiation is easily achieved.

This result is also apparent in table 5, which shows the number of subjects who change their switching point after receiving a message. Apparently, the order of information is most important for the recommendation on fish consumption for omega-3s (1b). While 12 and 9 subjects change their switching point in groups A and C, respectively, only 3 and 4 change in groups B and D. Table 5 also shows that there is a stronger preference for tuna than for sardines. Many more people constantly choose tuna no matter how large the number of cans of sardines they can receive (10 subjects in group A and B combined), or how small the number of cans of tuna they receive (4 subjects in Group C and D).

4.2 The value of information

We search for the distribution of the WTP shifts among women. We represented the WTP increase for sardines for groups A and B (respectively, the WTP decrease for tuna for groups B and C) coming from the information after the complete revelation of the information (at stage (*v*)). We computed for each woman the differences between WTP after the revelation of all messages (at stage (*v*)) and WTP before revelation of (at stage (*i*)). This value gives an approximation of the WTP for information about health characteristics.

Figure 2 provides interesting results. The figure for groups A and B allows us to characterize women in three sub-groups (the results are almost equivalent for groups C and D since both figures are almost symmetric). First, of the women, 24.1% are very sensitive to the health problems since they are ready to pay more than €1 for the health characteristics. Second, 36.2% of women weakly modify their behavior with the health information, since their WTP for a health characteristic is less than €1. Third, 39.7% of women did not change their initial choices with the revelation of health information (the right part of figure 3), which means they are not concerned by the information.

It is interesting to detail the choice of these 39.7% of women in groups A and B who did not change their choices during the experiment. Among them, eight women preferred the sardines since their switching quantities $\widetilde{q_{II}}$ (defined in equation (2)) were lower than 6 (namely, the canned tuna endowment). Indeed, the revelation of information comforts their initial choice without entailing a modification. Only one woman was indifferent between both types of fish, with $\widetilde{q_{II}} = 6$. Eventually, 14 women preferred tuna, with a switching quantity $\widetilde{q_{II}}$ greater than 6. Among, these 14 women, 9 women had a quantity $\widetilde{q_{II}}$ =13, which means that they never selected sardines. Their sardine reluctance was never counterbalanced by the health information, since they never selected sardines during the five stages. Strong taste is really a crucial parameter to consider for issuing health campaigns.

Recall that our sample of women, recruited via the quota method, is representative for Dijon, the city where the experiment was conducted. In this context, the previous percentages mean that a large percentage of women in the French population is likely to have no reaction or only a weak reaction to the information.

4.3 Determinants of substitution reaction to information

The questionnaires provide a detailed description of consumer characteristics. The sample statistics are described in table 6. In their fish purchasing decision, subjects considered the taste of the fish as more important than the species.[16] They were more sensitive to the methymercury problem than to the omega-3 issue. Before the experiment, participants' concern about heavy metals (including mercury) in food is high (average at 4.8 on a 5-point scale with 5 meaning a strong impact), and after the choice experiment and receipt of information, the average concern about risk of mercury during pregnancy ranks at 4.1 (on a 5-point scale with 5 meaning a strong risk).[17] The attention that subjects pay to their intake of omega-3s ranks last on a list of six nutrients.[18] This attention on average is weak, at 3.6 (on a 5-point scale with 5 meaning the absence of concern).

In order to identify consumers' sensitivity to information, a probit model was estimated, identifying the determinants of the probability that a subject changes (Y = 1) or does not change (Y =0) her switching point after the reception of information at a given stage. Overall, in table 7, four probit models were estimated, one for each message :(1a), (1b), (2a), and (2b). For this analysis we formed a data panel of all 115 subjects, partially controlling for subgroups with dummy variables.

We use the age of a person, the household's income, education, and socioeconomic status (as defined by the occupation of the household head, the left out dummy being "worker") as explanatory variables. Furthermore, fish consumption habits as well as the risk perception and the attention the subject pays to omega-3s in her nutrition were considered.

Although many of the variables turned out to be often insignificant, the explanatory power of the models is quite good. Between 89 and 92 out of 115 observations are correctly predicted, and in particular, about 50% of the predictions are correct for the observations at 1. Subjects often consuming fish and paying attention to taste are more likely to react to the messages, significantly for (2a), and those paying a lot of attention to the species when buying fish are significantly less likely to react to the message on omega-3s, (1a), but are more likely to react to the message on mercury, (2a). As could be expected from the outset, those having a strong preference for the tuna or sardine in the experiment are significantly less likely to react to any of the messages (significant but for (1b)). This confirms the previous finding that taste matters a lot. Those already paying attention to the intake of omega-3 fatty acids are more likely to respond to the recommendation, (1b), but not to the information of relative content in omega-

[16] After the product testing, consumers had to indicate their preference between the tuna and the sardines on a continuous scale from 0 to 10 (5 meaning the indifference between the two products). Although participants in the experiment were required to be consumers of tuna and sardines about 42.6% of participants had a very strong preference for either the tuna or sardines.

[17] This concern ranks fourth behind active smoking (4.904), alcohol consumption (4.887), and passive smoking (4.391) but before excessive consumption of caffeine (3.922) or raw foodstuff (3.617). In order to measure their sensitivity to risk information, participants were asked if they changed their behavior in response to a number of food safety crises; here we report the results for the crisis of benzene found in Perrier water in 1990.

[18] On average, subjects most often pay attention to calcium (2.565) followed by fiber (2.748), vitamins (2.860), magnesium (3.296), and iron (3.357).

3s, (1a). Finally, accounting for the order of information is important in explaining the reaction to message (1b).

Overall, it appears that there is no clear age or socioeconomic pattern in the receptiveness of subjects, though education seems to count. Behavioral change is associated with costs, and these costs are higher the stronger is the inherent hedonic preference for a type of fish. Appreciation of a general risk or benefit seems also to be required if new information is supposed to lead to change.

5. Conclusion

Public health communication about fish consumption is a difficult issue because of the complexity of health risks and benefits involved that pose themselves in different weights for different parts of the population. In order to test the ability of benefit and risk advisories to change consumer behavior, we present results of an economic choice experiment involving the evaluation of substitution rates.

It turns out that the experimental procedures have important implications for the evaluation of WTP. We show that the order of information and the consumption recommendations matter. By observing the shifts in rates of substitution and associated relative WTP, consumers seem more concerned about avoiding risks than about obtaining benefits, as the reaction to risk information about methylmercury contamination is much stronger (this fact is confirmed by the table 6 statistics about mercury/omega-3 sensitivity). However, the results also show that efficiency of information can be improved by first talking about benefits before talking about risks, as then the information about benefits is still absorbed. It seems very useful to begin an advisory to pregnant women by insisting on the benefits coming from omega-3 polyunsaturated fatty acids, followed by a clear consumption recommendation.

Another important finding is that 40% of respondents did not change their initial choices after the revelation of health information. Moreover, 36% of respondents showed a relatively weak reaction. These figures mean that the potential benefits of a campaign to inform women regarding fish consumption could be relatively weak in France if the group at risk is not clearly targeted. Thus, the distribution of brochures by obstetricians or hospitals during the first pregnancy visits could be one possible way to target women who are particularly concerned by methylmercury.

Of course, our results are limited to the substitution between two fish species. One extension should consider the introduction of more species (such as salmon or cod), fully representing French consumption. This could possibly lead to a figure lower than 40% for women not reacting to the information, since women would have broader alternative choices. One other extension should introduce the possibility for consumers to reduce their consumption, since we voluntarily constrained their choices to six cans.

By correcting idiosyncratic characteristics, the experiment could also be replicated in other countries for understanding consumers' reactions. It could complete studies focusing on women's observed reactions to fish consumption advisories. For instance, it could be useful for evaluating the US 2004 advisory, since Cohen (2006, p. 6) pointed out that "it is critical that additional information be gathered on how people are actually reacting to the 2004 advisory."

The experimental work on health information emphasizes that when an advisory is issued, it is imperative that the regulatory agency takes into account several important factors, such as consumers' reaction and preferences for some fish species, before deciding the type of information and/or the media to use. The results of this paper point to the importance of developing economic analyses prior to the diffusion of an advisory regarding methylmercury.

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Table 1. Description of fish cans

Connétable cans	Grams	Price per can in supermarket (€)	Price per kilogram (€)	Average price in France (€)
Tuna (Albacore)	80	1.65	20.62	6
Sardine	87	1.69	19.42	8

Source: authors and Ofimer (2005) for the last column.

Table 2. Average content in omega-3s and in methylmercury for canned tuna and canned sardines in Europe

	Omega-3s (n-3 PUFA) in g/100g raw fish	Methylmercury in mg/kg fresh matter
Canned tuna	0.25 *	0.210***
	0.5 **	
Canned sardines	3.3 * and **	0.052

Sources: * EFSA (2005, table 23 p.63) and ** Sidhu (2003, table 5 p. 341) for omega-3s and Crépet et al. (2005, table 1, pp. 181-182) for methylmercury. ***The methylmercury level for canned tuna is a lower bound given by scenario 3 in table 1, p. 182 in Crépet et al. (2005).

Table 3. Experimental design

Initial Endowment (Fish I)	Information about: Omega-3 fatty acids ((1a) and (1b)) → Methylmercury ((2a) and (2b))	Information about: Methylmercury ((2a) and (2b)) → Omega-3 fatty acids ((1a) and (1b))
Tuna	**Group A** 27 women	**Group B** 31 women
Sardines	**Group C** 28 women	**Group D** 29 women

Table 4. Wilcoxon Test for paired sample comparing choices after successive information revelation (z-value, p-value in parentheses)

	Choice 1 = Choice 2	**Choice 2 = Choice 3**	**Choice 3 = Choice 4**	**Choice 4 = Choice 5**
Group A	-0.984 (0.325)	**-2.944* (0.003)**	**-2.399* (0.016)**	**-2.585* (0.010)**
Group B	**-2.832* (0.005)**	-1.721 (0.085)	-1.638 (0.101)	0.000 (1.000)
Group C	**-2.671* (0.008)**	**-2.178* (0.029)**	**-2.072* (0.038)**	-1.941 (0.052)
Group D	**-2.393* (0.017)**	**-1.029* (0.303)**	-1.006 (0.314)	-0.877 (0.380)

Note: The estimation was based on the number of cans $\widetilde{q_{II}}$ of Fish II defined for the equation (2).

* Denotes rejection of H_0: equal distribution at 5% significance level.

Table 5. Description of experimental groups

	Group A	Group B	Group C	Group D
Number of subjects	27	31	28	29
Number of subjects changing after omega-3 (1a)	8	9	11	7
Number of subjects changing after omega-3 recommendation (1b)	12	3	9	4
Number of subjects changing after mercury (2a)	8	11	9	8
Number of subjects changing after mercury recommendation (2b)	8	10	8	9
Number of subjects choosing 1 can of Fish II on any of the five sheets	13/135	12/155	21/140	19/145
Number of subjects choosing always Fish I on any of the five sheets	43/135	38/155	20/140	31/145
Number of subjects constantly choosing Fish I	5	5	2	3
Number of subjects constantly choosing Fish II	0	0	3	1

Table 6. Descriptive statistics linked to the questionnaires

Variables	Definition	Mean	Std. Dev.
Age	Age in years	30.157	8.263
AGE25	=1 if age of respondent < 25, =0 otherwise	0.261	
AGE30	=1 if age of respondent > 35, =0 otherwise	0.417	
AGE40	=1 if age of respondent > 40, =0 otherwise	0.157	
Income	Net monthly household income 1 = <600 €, 2 = 600-900 €, 3 = 900-1200 €, 4 = 1200 – 1500 €, 5 = 1500-2300 €, 6 = 2300-3000 €, 7 = 3000 – 6000 €, 8 = more than 8000 €	4.643	1.812
Education	1 = without degree, 2 = Highschool 3 = Bac, 4 = 2 years college, 5 = more than 2 years college	3.878	1.133
Management position	= 1 if household head is in higher/management position, 0 otherwise	0.235	
Employed	= 1 if household head is in intermediate or employed position, = 0 otherwise	0.313	
Student	= 1 if household head is a student, = 0 otherwise	0.061	
Unemployed	= 1 if household head is unemployed or houseman/wife, =0 otherwise	0.113	
Fish consumption	How often do you eat fish: 0 = Daily, 2 = 4-6 times per week, 4 = 2-3 times per week, 6 = Once per week, 8 = 1-3 times per month, 10 = less often	5.461	1.822
Taste	How important is the taste of fish in your purchasing decision: 1 = not important … 5 = very important	4.426	0.773
Species	How important is the fish species in your purchasing decision: 1 = not important … 5 = very important	3.583	1.185
Strong preference for tuna or sardines	= 1 if hedonic grade is <1 or >9 (on a scale from 0 to 10)	0.426	
Women pregnant or with young kids	= 1 if respondent is pregnant, nursing or if children under the age of 6 are living in the household	0.374	
Concern about heavy metals (dioxin, lead, mercury…)	How strong do you consider the health impact of heavy metals (dioxin, lead, mercury) in food? 1 = no impact… 5 = strong impact	4.800	0.499
Risk of mercury during pregnancy (question after the experiment choices and the revelation of information)	How dangerous do you consider mercury consumption during pregnancy (after information) 1 = no risk … 5 = very strong risk	4.139	0.877
Reaction to benzene in Perrier	Did you change your behavior after the crisis 1 = not at all … 5 = completely	1.783	1.290
Concern about omega-3	Do you watch your consumption of omega-3 fatty acids: 1= always … 5 = never	3.626	1.195
First message about omega-3	1 = if first message about omega-3, 0 if not		

Table 7. Results of the probit model predicting a reaction to the messages

Variables	Omega-3	Recommendation Omega-3	Mercury	Recommendation Mercury
	1a	1b	2a	2b
Constant	1.3126	-0.1971	2.6583	-0.2265
	(2.0188)	(2.3499)	(2.2042)	(2.0894)
AGE25	-0.0702	0.2712	0.1167	-0.1830
	(0.4463)	(0.5776)	(0.4685)	(0.4755)
AGE30	0.5118	-0.2520	0.3961	-0.5226
	(0.4035)	(0.4895)	(0.4930)	(0.4160)
AGE40	0.1509	0.8768	0.6800	-0.0075
	(0.5201)	(0.6320)	(0.5436)	(0.6204)
INCOME	-0.0110	0.1216	-0.0850	**0.2076****
	(0.0888)	(0.1052)	(0.0917)	(0.0952)
Education	0.2092	-0.0518	-0.0835	**0.3080***
	(0.1508)	(0.1729)	(0.1599)	(0.1681)
Management position	**-1.0532****	-0.5730	0.5806	-0.7790
	(0.4832)	(0.6611)	(0.5243)	(0.5086)
Employed	-0.6022	**0.8324***	-0.1302	-0.3902
	(0.3983)	(0.4948)	(0.4183)	(0.4418)
Student	**-1.2113***	-0.8056	0.1679	0.5039
	(0.6736)	(1.2249)	(0.6817)	(0.7543)
Unemployed	-0.7196	-0.2163	-0.7008	-0.0580
	(0.5424)	(0.6623)	(0.6574)	(0.5776)
Fish consumption	-0.0518	0.0432	**-0.1584***	-0.1303
	(0.0807)	(0.0991)	(0.0909)	(0.0904)
Taste	0.2263	-0.2236	**-0.3562***	-0.2532
	(0.2208)	(0.2163)	(0.2018)	(0.2179)
Species	**-0.2886****	0.1260	**0.3252****	-0.0697
	(0.1315)	(0.1511)	(0.1422)	(0.1366)
Strong preference for tuna	**-0.5325***	-0.1642	**-0.5522***	**-0.6488***
or sardines	(0.3021)	(0.3629)	(0.3186)	(0.3360)
Women pregnant or with	-0.2014	0.3068	-0.4998	**0.8640****
young kids	(0.3800)	(0.4221)	(0.4322)	(0.4178)
Concern about mercury	-0.2544	**-0.6858***	-0.2996	-0.3888
	(0.2880)	(0.3609)	(0.3398)	(0.2940)
Risk of mercury during	-0.0802	0.1309	-0.1939	0.0595
pregnancy	(0.1278)	(0.1506)	(0.1348)	(0.1421)
Reaction to benzene in	0.0633	-0.0192	0.2960	**0.4118****
Perrier	(0.1723)	(0.2168)	(0.1832)	(0.1958)
Concern about omega 3	-0.1894	**0.3962****	-0.2099	-0.0124
	(0.1209)	(0.1665)	(0.1308)	(0.1332)
First message about	0.2277	**1.1955****	0.2056	0.1192
omega 3	(0.2833)	(0.3736)	(0.3053)	(0.3068)
McFadden R^2	0.157	0.351	0.265	0.254
Total number of observations	115	115	115	115
Observations at 1	35	28	36	34
No. of correct pred. at 1	12	16	18	19
Total no. of correct pred.	87	94	89	93

Standard errors in parentheses. *, ** marks significance at the 10%, 5% level, respectively.

Figure 1. Mean WTP in euros for Fish II by treatment group and information stage

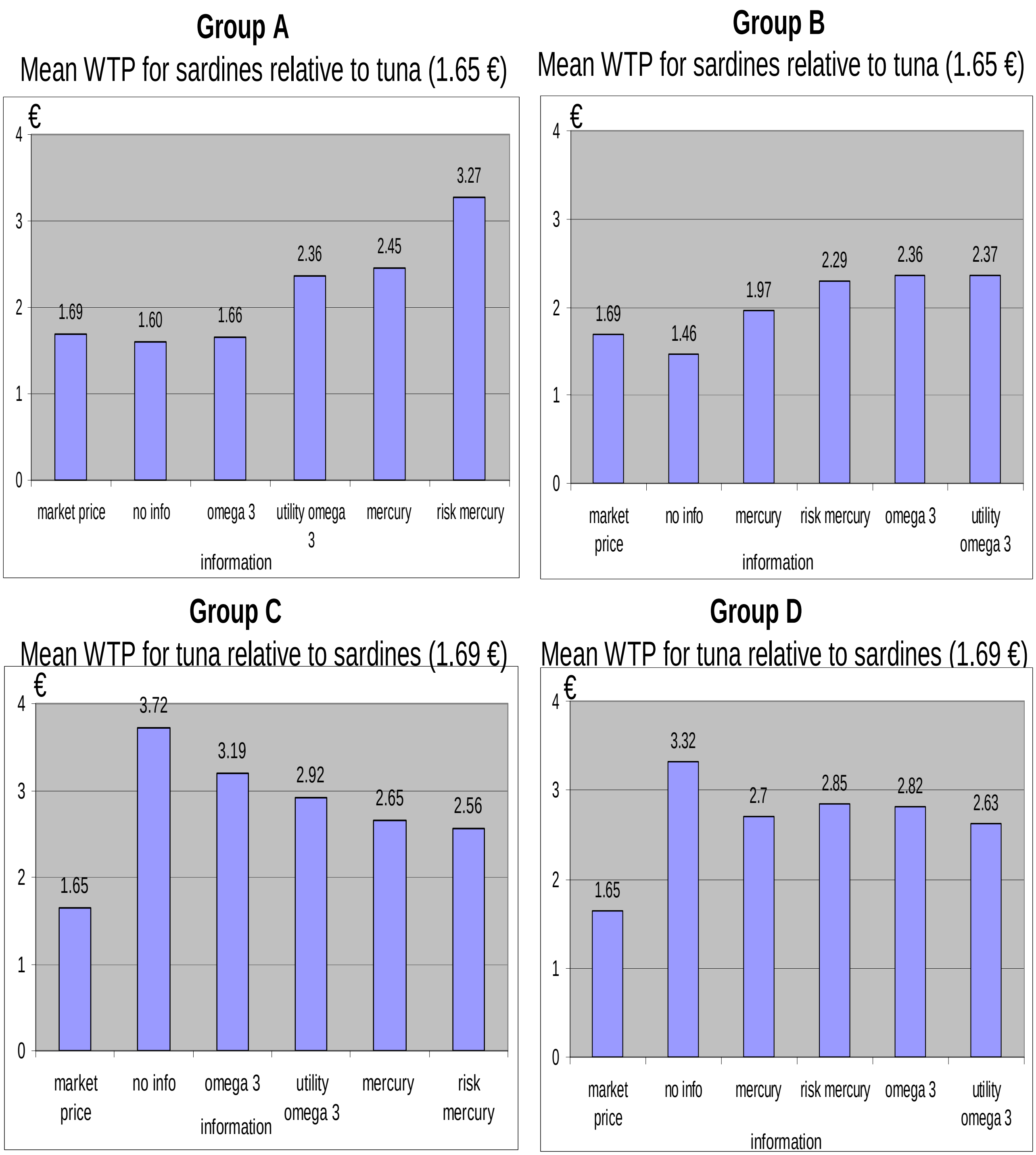
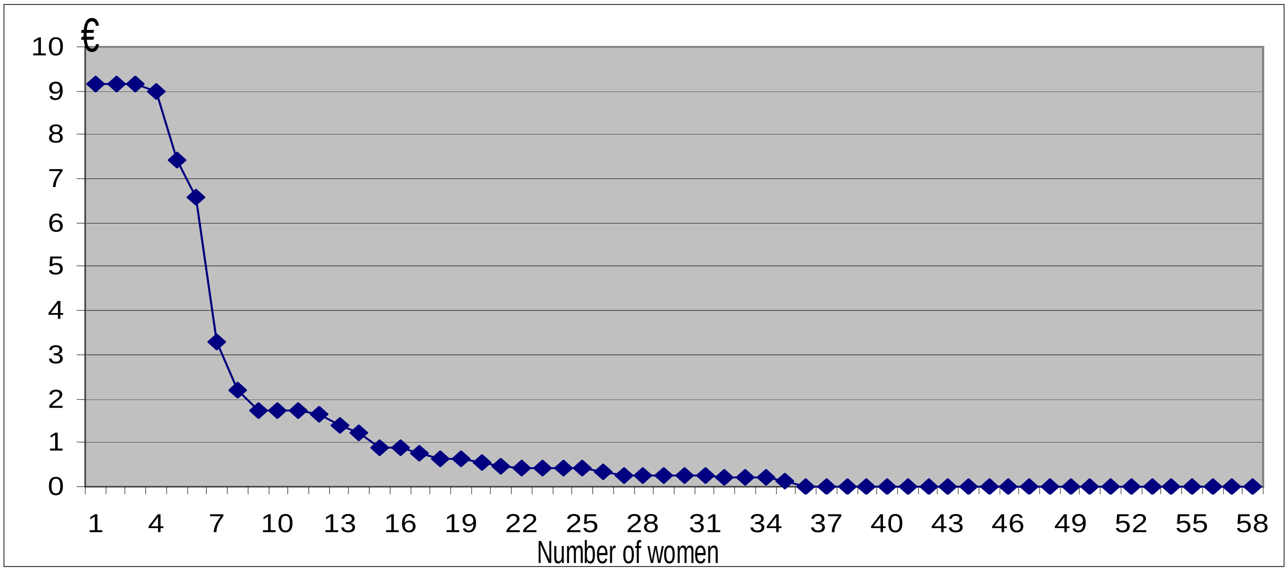
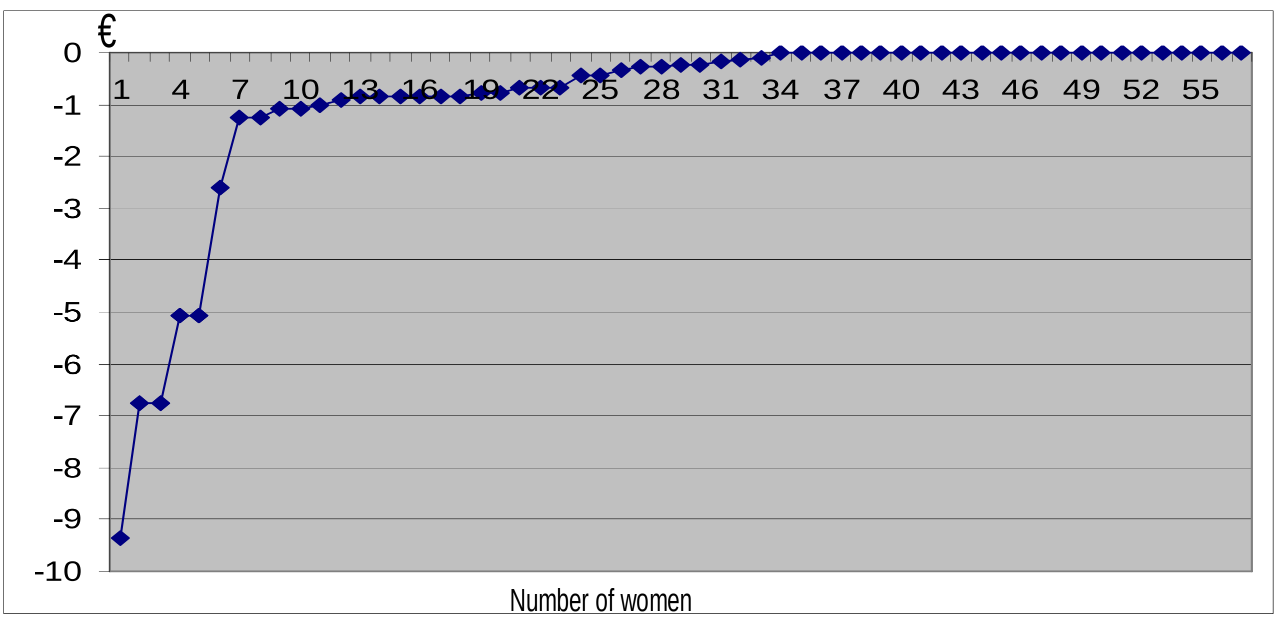


Figure 2. The value of information (in euros)

Groups A and B: Differences in WTP for sardines coming from the information



Groups C and D: Differences in WTP for sardines coming from the information



APPENDIX A
Description of the products used in the experience provided on the Connétable website (accessed February 2006)

Tuna (albacore) to olive oil

Thon blanc à l'huile d'olive vierge extra

- **Poids:**
  80 g
- **Ingrédients :**
  Ingrédients : thon blanc germon,
  huile d'olive vierge extra, sel.
- **Valeurs nutritionnelles :**
  Protéines : 20,6 g / Glucides :
  0,3 g / Lipides : 32,9 g
- **Valeur énergétique :**
  380 kcal – 1574 kJ

Source http://www.connetable.com/nos_produits/detail.asp?pid=35

Note that the nutritional values (Valeurs nutritionnelles) and the energetic values (Valeur énergétique) do not appear on the can. Women did not get this information during the experiment when they inspected the cans.

Sardines to olive oil

Sardines entières à l’huile d’olive vierge extra

•**Poids :**
115 g
•**Ingrédients :**
Ingrédients : sardines sélectionnées (80%), huile d’olive vierge extra, sel.
•**Valeurs nutritionnelles :**
Protéines : 23,5 g / Glucides : 0 / Lipides : 14,5 g dont acides gras : - saturés : 3,6 g - mono-insaturés : 7,6 g - poly-insaturés : 3,3 g dont Oméga 3 : 2,5 g
source d'OMÉGA3
•**Valeur énergétique :**
219 kcal – 912 kJ

Source : http://www.connetable.com/nos_produits/detail.asp?pid=1

Note that the nutritional values (Valeurs nutritionnelles) including the omega-3 label source d'OMÉGA3 and the energetic values (Valeur énergétique) do not appear on the can. Women did not get this information during the experiment when they inspected the cans.

APPENDIX B

The precise messages are translated from the original French.

Messages linked to the omega-3 fatty acids

Message (1a) for groups A and B (with the endowment of 6 cans of tuna)

Fish is important for the diet equilibrium. Fish is a good source of proteins, vitamins, and minerals. Fish content is high in omega-3 fatty acids and low in saturated fat.
Tuna contains six-fold less omega-3 fatty acids than sardines.

Message (1a) for groups C and D (with the endowment of 6 cans of sardines)

Fish is important for the diet equilibrium. Fish is a good source of proteins, vitamins, and minerals. Fish content is high in omega-3 fatty acids and low in saturated fat.
Sardines contain six-fold more omega-3 fatty acids than tuna.

Message (1b) for all groups

The regular consumption of omega-3 fatty acids helps to reduce the risks of cardiovascular diseases and it contributes to brain development and growth of children. Public health authorities advise eating fish at least twice a week.

Messages linked to the methylmercury

Message (2a) for groups A and B (with the endowment of 6 cans of tuna)

Fish contains methylmercury (organic form of mercury) naturally present in water and coming from industrial pollution. All fish contain traces of methylmercury. By accumulation, larger fish that have lived longer have the highest level of methylmercury. Tuna contains four-fold more methylmercury than sardines.

Message (2a) for groups C and D (with the endowment of 6 cans of sardines)

Fish contains methylmercury (organic form of mercury) naturally present in water and coming from industrial pollution. All fish contain traces of methylmercury. By accumulation, larger fish that have lived longer have the highest level of methylmercury. Sardines contain four-fold less methylmercury than tuna.

Message (2b) for all groups

The mercury effects on health have been shown by several medical studies. The results of these studies show a lack of brain development in the fetus and in children exposed to mercury. Public health authorities advise pregnant women, childbearing women and young children to avoid the consumption of predatory fish such as tuna.

APPENDIX C

The 12 situations to select for groups A and B.

Situation 1	O 6 tuna cans	**or**	O 1 sardine can
Situation 2	O 6 tuna cans	**or**	O 2 sardine cans
Situation 3	O 6 tuna cans	**or**	O 3 sardine cans
Situation 4	O 6 tuna cans	**or**	O 4 sardine cans
Situation 5	O 6 tuna cans	**or**	O 5 sardine cans
Situation 6	O 6 tuna cans	**or**	O 6 sardine cans
Situation 7	O 6 tuna cans	**or**	O 7 sardine cans
Situation 8	O 6 tuna cans	**or**	O 8 sardine cans
Situation 9	O 6 tuna cans	**or**	O 9 sardine cans
Situation 10	O 6 tuna cans	**or**	O 10 sardine cans
Situation 11	O 6 tuna cans	**or**	O 11 sardine cans
Situation 12	O 6 tuna cans	**or**	O 12 sardine cans

The 12 situations to select for groups C and D.

Situation 1	O 6 sardine cans	**or**	O 1 tuna cans
Situation 2	O 6 sardine cans	**or**	O 2 tuna cans
Situation 3	O 6 sardine cans	**or**	O 3 tuna cans
Situation 4	O 6 sardine cans	**or**	O 4 tuna cans
Situation 5	O 6 sardine cans	**or**	O 5 tuna cans
Situation 6	O 6 sardine cans	**or**	O 6 tuna cans
Situation 7	O 6 sardine cans	**or**	O 7 tuna cans
Situation 8	O 6 sardine cans	**or**	O 8 tuna cans
Situation 9	O 6 sardine cans	**or**	O 9 tuna cans
Situation 10	O 6 sardine cans	**or**	O 10 tuna cans
Situation 11	O 6 sardine cans	**or**	O 11 tuna cans
Situation 12	O 6 sardine cans	**or**	O 12 tuna cans