Combining Likert scale attitudinal statements with choice experiments to analyze preference heterogeneity for functional dairy products

Kai-Brit Bechtold and Awudu Abdulai*

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*Both authors are at the Department of Food Economics and Consumption Studies, University of Kiel, Olshausenstrasse 40, 24098 Kiel, Germany. Email: kbbecht@food-econ.uni-kiel.de for correspondence.

Abstract

This study employs a discrete choice experiment to examine preferences for functional dairy product attributes and willingness-to-pay estimates with a focus on heterogeneity among consumers in Germany. The intent of this paper is to estimate preference heterogeneity by linking stated preference choice data not only to socioeconomic characteristics but also to attitudinal statements in a latent class framework. The empirical results indicate the existence of class-specific preference heterogeneity based on the consumers' attitude towards functional foods emphasizing the importance of attitudinal data in explaining consumers' choice behavior. Our estimates demonstrate that within a class consumers' preferences are in accordance with their responses to attitudinal statements, that is functional food skeptics prefer non-functional dairy products, while functional food advocates have a negative preference for non-functional dairy products. The findings also show that all consumers place high value on dairy products enriched with known functional ingredients such as omega-3 fatty acids. Finally, we find that different groups of consumers reveal differing preferences for the same set of health benefits.

Keywords functional food attributes, choice experiments, preference heterogeneity, attitudinal statements, willingness-to-pay

JEL code C25, D12

1. Introduction

In most industrialized countries, the markets for functional foods have been growing rapidly over the last two decades (Chema et al. 2006). In general, functional food is defined as any food or food component providing health benefit beyond basic nutrition. Estimates show that the market share of functional foods in Europe is expected to increase from less than 1% in 2000 to about 5% in 2013 (Menrad 2003). U.S. sales of functional foods grew from $11.3 billion in 1995 to $18.5 billion in 2001 (Markosyan, McCluskey, and Wahl 2009). This trend is mostly due to the fact that consumers have increasingly recognized the link between health and diet, and as such are taking special interest in functional foods. Furthermore, developments in the functional foods market are being driven by changes in demographic patterns combined with advances in food technology and nutritional sciences.

Considering the fact that functional foods are increasingly gaining significance in consumers' food choices in industrialized countries, several studies have investigated the consumers' choice behavior in terms of functional foods (e.g., Labrecque et al. 2006; Peng, West, and Wang 2006). However, there are only a few studies that have recently considered German consumers, although Germany belongs to the four biggest functional food markets in Europe (Bech-Larsen and Scholderer 2007). Hence, the present study contributes to the literature by examining consumers' preferences and willingness-to-pay (WTP) estimates for functional dairy products, using choice experiment (CE) data of 1309 consumers in Germany. As noted by Menrad (2003), the functional dairy market is continuously growing, bringing the market volume in Germany from around 5 million U.S. $ in 1995 to 419 million U.S. $ in 2000.

Although consumers have accepted many different functional products there is evidence that consumers differ by the extent to which they purchase food products with explicit functional properties (Bitzios, Fraser, and Haddock-Fraser 2011). Given that new technologies are used to produce functional foods, some consumers even reject these kinds of food. This may be attributed to the fact that they perceive the use of new technologies in food as risky. Other consumers prefer to consume “natural” foods and describe functional foods as “unnatural” and “potentially unsafe” (Markosyan, McCluskey, and Wahl 2009). These findings give some support to the idea of heterogeneity in preferences for functional foods within the population. It is reasonable to assume that preferences are not unique to the individual, but rather a group or class of individuals (e.g., Hu et al. 2004), and as such the present study employs a latent class approach in order to account for heterogeneous class-specific preferences.

The viewpoint underlying this study is that heterogeneity in preferences is important and should be fully examined using both objective and attitudinal data. Specifically, we assume that we are able to observe socioeconomic characteristics and indicators of an individual’s general attitude. Given that functional foods are foods providing health benefits beyond basic nutrition, the present study accounts for the consumers’ attitudes towards functional foods and healthy diet. As noted by Swait (1994), preferences are indirectly affected by attitudes through the latent class to which the consumer belongs, and as such attitudinal data are quite important in explaining choice behavior. However, very little work has been undertaken to incorporate attitudinal data in the estimation of discrete choice models describing the choice behavior of functional food consumers. Calls advocating the use of attitudinal data and combining choice data with attitudinal data go back to McFadden (1986) and Swait (1994).

The objective of this study is to examine heterogeneous consumers’ preferences for functional dairy products in Germany by analyzing primary data from a discrete choice experiment. Specifically, a latent class model is employed to investigate the sources of heterogeneity in preferences across classes of consumers and to estimate class-specific WTP measures for the attributes. Our study incorporates all sources of heterogeneity: both socioeconomic data and attitudinal data. Given that the markets for functional dairy products have shown a rapid growth, the study is partly designed to provide a better understanding of heterogeneous consumers’ preferences for functional dairy products. We define segmented consumer markets on the basis of socioeconomic and attitudinal data as well as on observed choice behavior and product characteristics. Furthermore, our study makes a contribution to the empirical literature by incorporating insights from behavioral sciences (such as attitudinal variables) in micro-econometric choice models.

This paper is organized as follows. The next section presents the econometric formulation of the general CE framework, followed by a description of the design of our survey and the data in the third section. Empirical results of the latent class model are then reported. Finally, concluding remarks are addressed.

2. Estimation Technique and Econometric Model

The random utility model of McFadden (1974) is the standard statistical economic framework for CEs used to estimate behavioral models of consumer choice. In this framework, an individual chooses from a number of alternatives (e.g., dairy products) and selects the one that yields the highest utility level on any given choice occasion. The overall utility of an alternative can be decomposed into separate utilities for its constituent attributes (Lancaster 1966). For functional food, this permits the analysis of consumers' preferences in terms of the utility they perceive to result from several functional food attributes.

A consumer n receives utility U from choosing an alternative j equal to $U_{nj} = U(X_{nj})$, where X_{nj} is a vector of the attributes of j. Utility is modeled as two components, where one component is deterministic and depends on the attributes of the alternative, and the remainder is stochastic. Hence, $U_{nj} = V(X_{nj}, \beta_n) + \varepsilon_{nj}$ where V is the deterministic and ε_{nj} the stochastic component. The deterministic component V is a function of the attributes X_{nj} and the coefficient vector β_n. The probability π that alternative j is chosen is equal to the probability that the utility received from its choice is greater than or equal to the utilities of choosing another alternative k within the choice set C. Hence, the probability π of choosing j is:

$$\pi(j) = \mathrm{Pr}ob\{V_{nj} + \varepsilon_{nj} \geq V_{nk} + \varepsilon_{nk}; j \neq k, \forall k \in C\}. \quad (1)$$

Unlike the conditional logit model where consumers' preferences are assumed to be homogeneous, heterogeneity in preferences for functional dairy product attributes is accounted for using a latent class model. The latent class model simultaneously groups consumers into relatively homogeneous classes and explains the choice behavior of class members (Swait 1994). Within each latent (that is, not observable by the analyst) class, preferences are assumed to be homogeneous; however, preferences and hence utility functions can vary between classes. A primary benefit of this approach is being able to explain the preference variation across consumers conditional on the probability of membership to a latent class. Another major advantage of the latent class approach may be its ability to enrich the traditional economic choice model by including attitudinal data.[1] Furthermore, it is reasonable to assume that preferences are not unique to a consumer, but rather a group of consumers (e.g., Hu et al. 2004).

In the latent class model, heterogeneity in preferences is assumed to occur discretely (Boxall and Adamowicz 2002). That is, the mixing distribution $f(\beta_n)$ is discrete, with β_n taking a finite set of distinct values (Train 2003). It is assumed that consumers are sorted into a number of latent classes based on their tastes. Members of each class have similar tastes. The probability π that consumer n chooses dairy product j from a choice situation t of K alternatives, given that he belongs to latent class s is

$$\pi(njt \setminus \mathrm{s}) = \prod_{t=1}^{T} \frac{e^{\beta_s X_{njt}}}{\sum_{k=1}^{K} e^{\beta_s X_{nkt}}}, \quad (2)$$

where X_{njt} is a vector of observable attributes associated with dairy product j, and β_s is a class-specific coefficient vector used to capture heterogeneity in preferences across classes; t de-

[1] McFadden (1986) also advocates the use of attitudinal data and posed an integration of information from choice models with attitudinal and socioeconomic factors using a latent variable system.

notes the number of choice situations for consumer n. Since the classes are latent, class membership probabilities are specified by the conditional logit form:

$$(3) \qquad \pi(\text{s}) = \frac{e^{\theta_s' z_t}}{\sum_{s=1}^{S} e^{\theta_s' z_t}},$$

where z_t is a set of observable classification variables that enter the model for class membership. Classification variables influencing class membership are related to attitudinal data as well as socioeconomic characteristics of the consumers; θ_s is the coefficient vector for consumers in class s.[2] The sth coefficient vector is normalized to zero to secure identification of the model (Greene 2008). This model does not impose the independence of irrelevant alternatives on the observed probabilities.

Since the classes are unknown, the conditional probability in equation (2) cannot be used, instead an unconditional probability is employed. The unconditional probability that consumer n chooses dairy product j in choice situation t is obtained by combining the conditional probability with the class membership probability in equations (2) and (3) to yield (4):

$$(4) \qquad \pi(\text{j}) = \sum_{s=1}^{S} \left[\frac{e^{\theta_s' z_t}}{\sum_{s=1}^{S} e^{\theta_s' z_t}} \prod_{t=1}^{T} \frac{e^{ß_s X_{njt}}}{\sum_{k=1}^{K} e^{ß_s X_{nkt}}} \right].$$

The coefficients in equation (4) are estimated using maximum likelihood estimation. Given that the number of classes s cannot be defined in advance, s must be imposed by the analyst and statistical criteria must be used to select the “optimal” number of classes. Within the literature several criteria are employed as a guide to determine the size of s including the minimum Akaike Information Criterion (AIC), the minimum Bayesian Information Criterion (BIC) and ρ^2.

The latent class model can be employed to estimate class-specific WTP values for the different attributes.

[2] Note that if $\theta_s = 0$ then homogeneity in preferences is assumed, and as such the latent class model becomes the standard conditional logit model.

3. Survey Instrument and Data

Functional food is defined as a food product fortified with specific ingredients providing health benefits beyond basic nutrition. In general, functional foods bear health claims (HC) describing the health benefit that can result from consuming the given product. Due to a heightened awareness of the link between health, nutrition, and diet, functional foods are increasingly becoming popular with consumers (Malla, Hobbs, and Perger 2007). As indicated previously, the present study focuses on consumers' preferences for functional dairy products in Germany, since Germany represents one of the most important countries within the functional food market in Europe and functional dairy products constitute one of the most important groups of functional foods in Germany. The dairy products chosen for the present survey include yoghurt, cream cheese, and ice cream.

In our CE each choice alternative was defined by three attributes: functional ingredient, health claim, and purchase price. Functional ingredient and health claim are quite important attributes in terms of functional foods, since they are normally displayed on the product package, and as such tend to influence consumers' purchasing decisions. Purchase price was selected to capture WTP for the attributes. Each attribute was described by four different levels. The complete set of attributes employed in the CE and their respective levels are presented in Table 1.

Attributes and their levels were combined according to an experimental design to create choice sets. Given that a full factorial design which includes all possible combinations of the attributes would yield 192 (4^3 x 3) possible choice sets for yoghurt, cream cheese, and ice cream and considering the fact that it is not practically feasible to work with such a large number of choice sets, an orthogonal main effects design combined with a blocking strategy was generated (Hensher, Rose, and Greene 2005). As a result, 28 generic choice sets per product were created each consisting of two functional food alternatives. Given that the design was broken down into four different blocks, each respondent answered seven choice sets per product. In order to ensure a realistic CE, each choice set further included a conventional non-functional food alternative offered to the basic price (see appendix for an example of a choice set).

The data used in the analysis are from a survey conducted nationwide in Germany from November 2010 to January 2011. A total of 2683 questionnaires were mailed to households in Germany, after the questionnaires had been tested with a preliminary pilot study with 55 individuals. In the questionnaire, after welcoming the respondent and explaining the purpose of the research in the cover letter accompanying the questionnaire, information was provided about the term functional food. Next, respondents were asked to score several functional food and healthy diet related statements on a 7-point Likert scale with categories ranging from "completely disagree" to "completely agree".[3] After providing information about the attributes used in the CE, the choice sets for yoghurt, cream cheese, and ice cream were presented and respondents were asked to indicate which product they would purchase in each choice set. Finally, the questionnaire gathered information about socioeconomic aspects, as well as health behavior and lifestyle issues such as cigarette consumption and level of physical activity.

Summary statistics for the sample of usable responses are reported in Table 2. The total number of respondents was 1309 corresponding to a response rate of 49%. Table 2 shows that the average age of respondents is 45 years, which compares well with the national average age of 44 in 2011 (Statistisches Bundesamt 2011). We have more female respondents (55%) than males (45%). The actual proportion of females in Germany is about 51% (Statistisches Bundesamt 2011). However, this is not unusual in food related surveys as females tend to be the main food shoppers. Twenty three percent of sample households contain

[3] The statements used for this purpose were derived from research by Roininen, Lähteenmäki, and Tuorila (1999) and Urala and Lähteenmäki (2007).

children under the age of 12. In terms of education, 53% of respondents have an intermediate education, while 26% (18%) of respondents have an advanced (basic) level of education.

In order to reduce the functional food and healthy diet related statements to a reasonable amount of variables, two principal component analyses (PCA) were conducted (Kline 1994). The PCA results of the 27 functional food related statements suggested that four components should be retained. Similarly, the second PCA for the 15 healthy diet related statements found four components to be statistically important.[4] These eight attitudinal components as well as socioeconomic characteristics are used as the z_t vector in equation (3) to explain latent class membership.[5] To assess the adequacy of our principal components, we rely on common statistical tests summarized in Table 3.

4. Empirical Results

In the following section we first identify the number of latent classes and assess the fit. The maximum likelihood estimates for the best-fitting latent class model for yoghurt, cream cheese, and ice cream are then presented. Finally, class-specific WTP values for the different attribute levels are calculated using latent class estimates.

Number of Classes and Fit

Models with one through five classes were estimated using NLOGIT software version 4.0.[6] For each model the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC) and ρ^2 were calculated in order to determine the optimal number of latent classes (Boxall and Adamowicz 2002). The aggregate statistics for these models are presented in Table 4.

[4] Components were extracted until eigenvalues were less than or equal to one.
[5] Attitudinal variables represented by the components have a mean of zero and a standard deviation of one.
[6] The five class model for all three dairy products failed to converge.

The log likelihood values at convergence (LL) reveal improvement in the model fit as classes are added to the procedure up to the three class model in terms of yoghurt. This is evident in the ρ^2 values which increase from the base of 0.073 to 0.245 with the three class model. Inspection of the AIC and BIC values also suggests that the three class model is the optimal solution for yoghurt, since the minimum BIC and AIC statistics are clearly associated with this class model.

For cream cheese and ice cream, a similar pattern is observed with regard to the fit criteria. Once again, the log likelihood values at convergence reveal improvement in the model fit as classes are added to the model for both cream cheese and ice cream. Furthermore, the ρ^2 values increase rapidly up to the four class model also indicating improvement in the model fit. Given that the minimum BIC statistic is clearly associated with the three class model and considering the fact that the change in the AIC values is markedly smaller for the three to four class models than for the one to two and two to three class models, the three class model is the optimal solution for cream cheese. Similarly, the inspection of the AIC and BIC values for ice cream suggests that the three class model is more intuitive since the change in AIC and BIC is also markedly smaller for the three to four class solutions than for the one to two and two to three class solutions, indicating that adding an additional class beyond the third may not be gaining much improvement in the model fit. We estimate, therefore, a three class latent class model for yoghurt, cream cheese, and ice cream, respectively.

Interpretation of best-fit specification

Having determined the model with the optimal number of classes, both the utility function and class membership estimates are now interpreted. The maximum likelihood estimates for all three dairy products are presented in Tables 5, 6, and 7. The results indicate significant heterogeneity in preferences across latent classes as revealed by the differences in magnitude and significance of the utility function estimates. For instance, results for all three dairy products indicate a strongly negative price parameter estimate for class three in comparison to the other two classes, while the non-functional alternative estimate is strongly positive for class one and strongly negative for class two. Several likelihood ratio tests across competing models were used in order to decide on the covariates to be included in the model as determinants of class membership. The class membership estimates for the third class are equal to zero for all three dairy products due to their normalization during estimation. The probability of being in a class is significantly related to the consumers' attitude towards functional foods, as indicated by the class membership estimates presented in Tables 5, 6, and 7. Members of class one are likely to be functional food skeptics in terms of all three dairy products, since most of the functional food related component estimates are negatively significant relative to class three. For instance, the class membership estimate for the component "safety of functional foods" is negatively significant for all three dairy products, indicating that members of class one perceive the consumption of functional foods as less safe than members of class three. Most of the functional food related component estimates for class two are, however, positively significant in terms of all three dairy products, implying that this class is likely to be associated with being a functional food advocate. For example, class two believes more in the rewarding aspect of and in the necessity for functional foods compared to class three, as indicated by the positive and strongly significant class membership estimates for the components "reward from using functional foods" and "necessity for functional foods" with regard to yoghurt, cream cheese, and ice cream. Class three could subjectively be associated with functional food neutrals in terms of all three dairy products.

Table 5 (6/7) shows that 21.5% (24.8%/26%), 40.5% (33.9%/26.7%), and 38% (41.3%/47.3%) of the respondents participating in the CE for yoghurt (cream cheese/ice cream) have a fitted probability to belong to class one, two, and three, respectively.

The utility function estimates, presented in Tables 5, 6, and 7, reveal a strongly negative price parameter estimate for each class in terms of all three dairy products which is consistent with economic theory. The results further indicate a positive preference for omega-3 fatty acids for all classes in terms of almost every dairy product. This finding is consistent with the finding by Grunert et al. (2009), who found that consumers are more likely to accept functional ingredients they are familiar with, e.g. omega-3 fatty acids, than unfamiliar ingredients, e.g. bioactive peptides. As indicated previously, class one (functional food skeptics) prefers non-functional dairy products, whereas members of class two (functional food advocates) have a negative preference for non-functional dairy products. Furthermore, class two displays a positive preference for dairy products bearing HC 2 (Supports healthy blood vessels and healthy metabolism.) and a negative preference for dairy products bearing HC 3 (one property depending on the ingredient), whereas class three (functional food neutrals) prefers HC 3 but not HC 2 in terms of yoghurt and ice cream. The results for all three dairy products further reveal that members of class two dislike bioactive peptides and HC 1 (Supports healthy blood vessels.). This class has a positive preference for oligosaccharides in terms of yoghurt and cream cheese. Members of class three also have a positive preference for oligosaccharides and a negative preference for bioactive peptides and HC 1, as indicated by the strongly significant parameter estimates in terms of yoghurt and ice cream. The negative preference for bioactive peptides revealed by class two and three may be attributed to the fact that German consumers are not familiar with this functional ingredient because functional products enriched with bioactive peptides are not yet on the market in Germany. As indicated previously, consumers are more likely to accept functional ingredients they are familiar with (Grunert et al. 2009).

Significant heterogeneity in preferences across latent classes may be explained by the differences in significance of the class membership estimates. As indicated previously, most of the functional food related component estimates indicate that members of class one are likely to be functional food skeptics relative to class three in terms of all three dairy products, while members of class two are likely to be functional food advocates. However, both members of class one and two are associated with individuals that are more interested in healthy diet related aspects than members of class three, as indicated by the healthy diet related component estimates, with most of them being positively significant in terms of all three dairy products. For instance, class one and two membership estimates for the component „general health interest" are positive and strongly significant for all three dairy products, implying that class one and two are associated with individuals that are more interested in eating healthily in general compared to class three. Class two membership estimates for yoghurt, presented in Table 5, further indicate that members of this class (functional food advocates) are likely to be older individuals with an intermediate level of education relative to class three. Given that functional foods are products capable of generating health benefits and considering the fact that older people are more concerned with health than younger people (Roininen, Lähteenmäki, and Tuorila 1999), this finding is in line with expectations, since class two is associated with individuals with a positive attitude to functional foods. The latent class results for cream cheese and ice cream, presented in Tables 6 and 7, respectively, indicate that members of class two are more likely to be male and show a lower likelihood to have children under the age of 12 than members of class three. In contrast, class one shows a higher likelihood to have children under the age of 12 relative to class three, as indicated by the positive and significant parameter estimate in terms of cream cheese.

Class-specific Willingness-To-Pay Measures

Class-specific WTP estimates and confidence intervals for the different dairy product attributes are presented in Table 8. Following Layton and Brown (2000), 95% confidence intervals were calculated using the Krinsky-Robb parametric bootstrapping method. Comparison of WTP estimates for the attributes across the latent classes shows notable differences in preference structure.

Consumers in class one attach a high value to dairy products enriched with omega-3 fatty acids. Furthermore, non-functional products are highly valued in this class, especially for ice cream. The high valuations on non-functional dairy products, which are much higher than those on omega-3 fatty acids, may be attributed to the fact that members of class one (functional food skeptics) are skeptical towards functional food.

Class two, mainly associated with functional food advocates, places high value on dairy products enriched with omega- 3 fatty acids and bearing HC 2. However, they display a negative preference for non-functional dairy products and would be willing to accept up to 1.77€ (1.86€/2.23€) as compensation for utility reduction to choose non-functional yoghurt (cream cheese/ice cream). Members of class two also show a negative WTP for dairy products enriched with bioactive peptides and bearing HC 1 or HC 3.

Given that class three displays a relatively high price estimate value (in absolute value terms) relative to the other two classes, WTP estimates for the third class tend to be lower in terms of all three dairy products, indicating that members of class three are price sensitive. This may be attributed to the fact that functional food neutrals, the most likely members of this class, base their functional food purchasing decision more on price than on functional food attributes. For yoghurt and ice cream, class three exhibits a similar preference structure, with omega-3 fatty acids, oligosaccharides, and HC 3 being similar highly valued and with bioactive peptides, HC 1, and HC 2 being similar low valued. The non-functional alternative is not statistically significant in terms of yoghurt and ice cream, suggesting that this attribute is not important for class three.

5. Conclusions

This study employed a discrete choice experiment (CE) to examine consumers' preferences and willingness-to-pay (WTP) estimates for several functional dairy product attributes in Germany. Specifically, a latent class model including attitudinal data was used to reveal the presence of identifiable classes within the population.

The results revealed heterogeneity of preferences relating to both the consumers' attitudes towards functional foods and healthy diet and socioeconomic characteristics. In particular, three distinct classes of consumers in the sample population, each displaying differing preferences for the same set of functional dairy product attributes, were identified. The classes mostly comprise functional food skeptics, functional food advocates, and functional food neutrals, since heterogeneous preferences are mainly driven by the consumer's attitude towards functional foods. Functional food skeptics place high value on dairy products enriched with omega-3 fatty acids and being non-functional. For the functional food advocates, dairy products fortified with omega-3 fatty acids and bearing a health claim of support for healthy blood vessels and healthy metabolism (HC 2) were found to be the most preferred attributes, whereas non-functional dairy products were least preferred. For the class comprising functional food neutrals, omega-3 fatty acids, oligosaccharides, and a health claim displaying an ingredient dependent property (HC 3) are the most important attributes in terms of yoghurt and ice cream.

Several conclusions can be drawn from our results. First of all, our findings suggest that attitudinal variables are crucial in explaining class membership, and as such consumers' choice behavior. Furthermore, the results emphasize the importance of the familiarity of the functional ingredient, indicating that all consumers are willing to pay for functional dairy products enriched with known functional ingredients such as omega-3 fatty acids. Finally, our results suggest that the same type of health claim does not appeal to everyone. In particular, functional food advocates and functional food neutrals reveal differing preferences for the same set of health benefits.

Our study confirms that understanding preference heterogeneity requires more information about consumers than the simple socioeconomic characteristics typically collected by analysts. Given that only few economic studies have accounted for attitudinal variables in preference elicitation methods, further research is needed to get a better and deeper understanding of the sources of preference heterogeneity among consumers.

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Table 1 Attributes and attribute levels used in the CE

Attributes	Attribute levels		
Price[a]	Yoghurt	Cream cheese	Ice cream
	1. 1.29€/500g (basic[b])	1. 1.49€/200g (basic[b])	1. 3.19€/1000ml (basic[b])
	2. 1.49€/500g	2. 1.69€/200g	2. 3.49€/1000ml
	3. 1.79€/500g	3. 2.09€/200g	3. 3.99€/1000ml
	4. 2.09€/500g	4. 2.49€/200g	4. 4.49€/1000ml
Functional ingredient	1. Omega-3 fatty acids		
	2. Oligosaccharides		
	3. Bioactive peptides		
	4. Polyphenols		
Health claim	1. Supports healthy blood vessels. (HC 1)		
	2. Supports healthy blood vessels and healthy metabolism. (HC 2)		
	3. One property depending on the ingredient[c] (HC 3)		
	4. Two properties depending on the ingredient[d] (HC 4)		

[a]Exchange rate: 1 U.S. $ = 0.77€.

[b]The basic price represents the price of the conventional non-functional food alternative included in each choice set.

[c]a) Omega-3 fatty acids: Supports healthy blood triglyceride levels. b) Oligosaccharides: Supports healthy digestion. c) Bioactive peptides: Supports healthy blood pressure. d) Polyphenols: Protects body's cells against free radicals.

[d]a) Omega-3 fatty acids: Supports healthy blood vessels and healthy blood triglyceride levels. b) Oligosaccharides: Supports healthy blood vessels and healthy digestion. c) Bioactive peptides: Supports healthy blood vessels and healthy blood pressure. d) Polyphenols: Supports healthy blood vessels and protects body's cells against free radicals.

Table 2 Summary statistics and variable definitions

Variable	Definition	Sample mean	Standard deviation
Gender	Dummy (1 = female, 0 otherwise)	0.55	0.50
Age	Age in years	45.08	15.50
Children < 12	Dummy (1 = if respondent has children under the age of 12, 0 otherwise)	0.23	0.42
Education			
Basic[a]	Dummy (1 = if respondent has a basic education, 0 otherwise)	0.18	0.39
Intermediate[b]	Dummy (1 = if respondent has an intermediate education, 0 otherwise)	0.53	0.50
Advanced[c]	Dummy (1 = if respondent has an advanced education, 0 otherwise)	0.26	0.44

[a]Including: not graduated yet, no school degree, GCSE.
[b]Including: A-levels, professional training, master craftsman status.
[c]Including: university degree, Ph.D..

Table 3 Principal component analyses

Principal components	% of variance explained	Cronbach's alpha	Principal component statistics
Attitude towards functional food			
Reward from using functional foods	40.1	0.923	KMO = 0.951; Bartlett: $p < 0.000$
Necessity for functional foods	9.3	0.851	
Confidence in functional foods	5.5	0.848	
Safety of functional foods	4.4	0.783	
Attitude towards healthy diet			
General health interest	32.6	0.783	KMO = 0.882; Bartlett: $p < 0.000$
Natural product interest	9.5	0.615	
Hysteria	7.8	0.629	
Specific health interest	7.0	0.627	

Statements included in the PCA are not reported in the interest of brevity, but are available upon request. An individual's score on a component was calculated based on their scores for the constituent variables (statements). A high score on the functional food related components indicates a positive attitude towards functional food. Respondents having a high score on the healthy diet related components are interested in a healthy diet. The eigenvalues associated with each component represent the variance explained by that component, e.g. the component "reward from using functional foods" explains 40.1% of total variance. Cronbach's alpha indicates how closely related a set of statements are as a group (that is, how well a set of statements measures a single underlying construct); it is high when inter-statement correlations are high, so it measures the reliability of our scale. A value of at least 0.6 is desirable (its maximum is one). The Kaiser-Meyer-Olkin (KMO) statistic detects excessive correlations, which would lead to multicollinearity; a satisfactory KMO should exceed 0.5. Bartlett's test of sphericity tests whether the correlation matrix of the statements differs significantly from the identity matrix; if not, the principal component model is inappropriate. For PCA to work well, the Bartlett test should reject the null hypothesis that the correlation matrix is the identity matrix.

Table 4 Criteria for number of classes[a]

Number of latent classes	Number of parameters (P)	Log likelihood at convergence (LL)	AIC[c]	BIC[d]	ρ^{2e}
Yoghurt[b]					
Conditional logit	8	-7309.3	14634.6	7338.0	0.073
2	28	-6090.1	12236.3	6190.6	0.227
3	48	-5949.6	11995.2	6121.8	0.245
4	68	-5976.1	12088.3	6220.1	0.242
Cream cheese[b]					
Conditional logit	8	-6924.4	13864.9	6953.1	0.090
2	27	-5818.3	11690.5	5915.2	0.235
3	46	-5660.6	11413.1	5825.7	0.256
4	65	-5595.4	11320.7	5828.7	0.264
Ice cream[b]					
Conditional logit	8	-6350.7	12717.3	6379.4	0.096
2	29	-5402.4	10862.8	5506.5	0.231
3	50	-5254.3	10608.6	5433.7	0.252
4	71	-5156.7	10455.5	5411.5	0.266

Optimal number of latent classes is three for all three dairy products.
[a]Sample size is 7642 choices for yoghurt, 7676 for cream cheese, and 7695 for ice cream from 1309 individuals (N).
[b]The value of the log likelihood evaluated at zero (LL(0)) is -7883.5, -7606.3, and -7024.3 for yoghurt, cream cheese, and ice cream, respectively.
[c]AIC (Akaike Information Criterion) is calculated using -2(LL-P).
[d]BIC (Bayesian Information Criterion) is calculated using -LL+[(P/2)*ln(N)].
[e]ρ^2 is calculated as 1-(LL/LL(0)).

Table 5 Three latent class model: Maximum likelihood estimates of yoghurt attributes

	Class 1	Class 2	Class 3
Utility function estimates			
Price	-4.905***	-1.524***	-11.367***
	(1.693)	(0.069)	(0.500)
Omega-3-fatty acids	1.503***	0.369***	1.446***
	(0.536)	(0.034)	(0.158)
Oligosaccharides	-0.072	0.150***	1.232***
	(0.568)	(0.035)	(0.163)
Bioactive peptides	-0.965	-0.148***	-1.237***
	(0.594)	(0.033)	(0.157)
HC 1	-0.404	-0.621***	-1.423***
	(0.486)	(0.037)	(0.156)
HC 2	-0.620	0.351***	-0.943***
	(0.532)	(0.036)	(0.164)
HC 3	0.809	-0.275***	1.258***
	(0.548)	(0.036)	(0.153)
Non-functional alternative	2.312***	-2.700***	0.003
	(0.313)	(0.078)	(0.052)
Class membership estimates			
Constant	-2.074***	-1.722***	
	(0.578)	(0.239)	
Age	0.004	0.035***	
	(0.008)	(0.004)	
Reward from using functional foods	-1.159***	0.820***	
	(0.281)	(0.095)	
Necessity for functional foods	-0.118	0.487***	
	(0.196)	(0.084)	
Confidence in functional foods	-0.233	0.110	
	(0.156)	(0.075)	
Safety of functional foods	-0.370**	0.002	
	(0.168)	(0.071)	
General health interest	1.303***	0.656***	
	(0.205)	(0.093)	
Natural product interest	0.428***	0.290***	
	(0.154)	(0.073)	
Hysteria	0.814***	0.256***	
	(0.148)	(0.071)	
Specific health interest	0.051	0.227***	
	(0.157)	(0.075)	
Intermediate	0.382	0.298**	
	(0.328)	(0.136)	
Advanced	0.180	-0.086	
	(0.379)	(0.174)	
Latent class probability	0.215	0.405	0.380
Number of choice sets	7642		
Log likelihood	-5949.6		
Likelihood ratio test = 2719.4 ($X^2_{0.99}$ (40) = 63.7)			

Standard errors are in parentheses. Single (*), double (**), and triple (***) denote significant variables at 10%, 5%, and 1% levels, respectively.

Table 6 Three latent class model: Maximum likelihood estimates of cream cheese attributes

	Class 1	Class 2	Class 3
Utility function estimates			
Price	-2.506***	-1.428***	-13.191***
	(0.540)	(0.061)	(0.525)
Omega-3-fatty acids	0.885***	0.498***	0.734
	(0.260)	(0.038)	(0.475)
Oligosaccharides	-0.377	0.071*	0.596
	(0.293)	(0.039)	(0.480)
Bioactive peptides	-0.132	-0.257***	-0.586
	(0.260)	(0.037)	(0.476)
HC 1	0.059	-0.546***	-0.548
	(0.268)	(0.041)	(0.474)
HC 2	0.124	0.345***	-0.512
	(0.247)	(0.041)	(0.480)
HC 3	-0.155	-0.340***	0.459
	(0.285)	(0.040)	(0.476)
Non-functional alternative	2.431***	-2.651***	-0.215***
	(0.394)	(0.081)	(0.051)
Class membership estimates			
Constant	-1.617***	-0.114	
	(0.341)	(0.104)	
Gender	-0.062	-0.508***	
	(0.240)	(0.109)	
Reward from using functional foods	-0.112	1.129***	
	(0.183)	(0.084)	
Necessity for functional foods	-1.293***	0.241***	
	(0.420)	(0.080)	
Confidence in functional foods	-0.549**	-0.125*	
	(0.263)	(0.073)	
Safety of functional foods	-0.317**	0.054	
	(0.149)	(0.068)	
General health interest	1.097***	0.501***	
	(0.194)	(0.077)	
Natural product interest	0.510***	0.189***	
	(0.173)	(0.068)	
Hysteria	0.584***	0.269***	
	(0.152)	(0.066)	
Specific health interest	0.169	0.279***	
	(0.141)	(0.067)	
Children < 12	0.545*	-0.288**	
	(0.318)	(0.139)	
Latent class probability	0.248	0.339	0.413
Number of choice sets	7676		
Log likelihood	-5660.6		
Likelihood ratio test = 2527.6 ($X^2_{0.99}$ (40) = 63.7)			

Standard errors are in parentheses. Single (*), double (**), and triple (***) denote significant variables at 10%, 5%, and 1% levels, respectively.

Table 7 Three latent class model: Maximum likelihood estimates of ice cream attributes

	Class 1	Class 2	Class 3
Utility function estimates			
Price	-1.469***	-1.140***	-9.576***
	(0.452)	(0.054)	(0.387)
Omega-3-fatty acids	0.810***	0.467***	1.535***
	(0.279)	(0.044)	(0.235)
Oligosaccharides	-0.506	-0.005	1.501***
	(0.391)	(0.045)	(0.243)
Bioactive peptides	0.137	-0.185***	-1.460***
	(0.305)	(0.042)	(0.236)
HC 1	0.100	-0.526***	-1.346***
	(0.303)	(0.046)	(0.231)
HC 2	0.402	0.311***	-1.440***
	(0.291)	(0.046)	(0.244)
HC 3	-0.353	-0.458***	1.415***
	(0.378)	(0.046)	(0.234)
Non-functional alternative	3.149***	-2.536***	-0.040
	(0.364)	(0.088)	(0.050)
Class membership estimates			
Constant	-2.372***	-0.622***	
	(0.672)	(0.137)	
Gender	0.041	-0.430***	
	(0.262)	(0.100)	
Reward from using functional foods	-0.730*	0.915***	
	(0.400)	(0.082)	
Necessity for functional foods	-1.123***	0.311***	
	(0.265)	(0.083)	
Confidence in functional foods	-0.361**	-0.065	
	(0.158)	(0.068)	
Safety of functional foods	-0.599***	0.138**	
	(0.208)	(0.060)	
General health interest	0.969***	0.403***	
	(0.198)	(0.071)	
Natural product interest	0.173	-0.030	
	(0.139)	(0.060)	
Hysteria	0.387**	0.242***	
	(0.158)	(0.056)	
Specific health interest	0.164	0.215***	
	(0.141)	(0.060)	
Children < 12	-0.091	-0.460***	
	(0.360)	(0.124)	
Intermediate	1.048**	-0.070	
	(0.487)	(0.117)	
Advanced	0.457	-0.161	
	(0.426)	(0.141)	
Latent class probability	0.260	0.267	0.473
Number of choice sets	7695		
Log likelihood	-5254.3		
Likelihood ratio test = 2192.8 ($X^2_{0.99}$ (50) = 76.2)			

Standard errors are in parentheses. Single (*), double (**), and triple (***) denote significant variables at 10%, 5%, and 1% levels, respectively.

Table 8 Class-specific WTP for attributes (€)

Attribute	Class 1	Class 2	Class 3
Yoghurt			
Omega-3-fatty acids	0.31 [-0.05 – 0.67]	0.24 [0.19 – 0.29]	0.13 [0.11 – 0.15]
Oligosaccharides	NS	0.10 [0.05 – 0.14]	0.11 [0.09 – 0.13]
Bioactive peptides	NS	-0.10 [-0.14 – -0.06]	-0.11 [-0.13 – -0.09]
HC 1	NS	-0.41 [-0.46 – -0.35]	-0.13 [-0.15 – -0.10]
HC 2	NS	0.23 [0.18 – 0.28]	-0.08 [-0.11 – -0.06]
HC 3	NS	-0.18 [-0.23 – -0.13]	0.11 [0.09 – 0.13]
Non-functional alternative	0.47 [-1.76 – 2.71]	-1.77 [-1.93 – -1.62]	NS
Cream cheese			
Omega-3-fatty acids	0.35 [0.06 – 0.64]	0.35 [0.29 – 0.41]	NS
Oligosaccharides	NS	0.05 [0.00 – 0.10]	NS
Bioactive peptides	NS	-0.18 [-0.23 – -0.13]	NS
HC 1	NS	-0.38 [-0.44 – -0.32]	NS
HC 2	NS	0.24 [0.18 – 0.30]	NS
HC 3	NS	-0.24 [-0.30 – -0.18]	NS
Non-functional alternative	0.97 [0.24 – 1.70}	-1.86 [-2.01 – -1.70]	-0.02 [-0.02 – -0.01]
Ice cream			
Omega-3-fatty acids	0.55 [-1.77 – 2.87]	0.41 [0.33 – 0.49]	0.16 [0.12 – 0.20]
Oligosaccharides	NS	NS	0.16 [0.11 – 0.20]
Bioactive peptides	NS	-0.16 [-0.23 – -0.09]	-0.15 [-0.19 – -0.11]
HC 1	NS	-0.46 [-0.54 – -0.38]	-0.14 [-0.18 – -0.10]
HC 2	NS	0.27 [0.19 – 0.35]	-0.15 [-0.19 – -0.11]
HC 3	NS	-0.40 [-0.49 – -0.32]	0.15 [0.11 – 0.19]
Non-functional alternative	2.14 [-7.16 – 11.44]	-2.23 [-2.43 – -2.02]	NS

95% confidence intervals are estimated using the Krinsky and Robb method with 2000 draws and are in parentheses.
NS: attribute level is not statistically significant.

Appendix

An example of a choice set

Product	Yoghurt A	Yoghurt B	Yoghurt C
Price	2.09€/500g	1.79€/500g	1.29€/500g
Functional ingredient	Polyphenols	Bioactive peptides	
Health claim	Supports healthy blood vessels and healthy metabolism	Supports healthy blood vessels and healthy metabolism	Conventional
I would purchase…	O	O	O