The individual search behavior of consumers visualized by means of sequence analysis

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Abstract

This paper measures consumer preferences for different (ethical) product attributes of meat products by questionnaires and compares these results to the ones obtained using an individualized Information Display Matrix (IDM). The products considered in the study are pork and chicken cutlet. The findings firstly confirm that the IDM is able to reduce social desirability effects, a problem which likely is of importance in surveys investigating the relevance of ethical product characteristics. Secondly, using sequence analysis the paper provides information on the intensity of the information search process. In fact it can be shown that many consumers neglect almost half of the attributes presented. Thirdly, the paper shows that it is possible and can be considered a methodological advancement in IDM research to apply sequence analysis to data acquired via an IDM. Different indicators allow quantifying main characteristics of consumers' information search process and make it possible to test for differences between data obtained from different IDM experiments.

1. Introduction

A noticeable gap seems to exist between what many consumer studies unveil as consumers' preferences for specific products and process attributes and consumers' revealed preferences observed by their purchase behavior in the market place (see e.g. Auger et al., 2007; Carrigan and Attalla, 2001; Chatzidakis et al., 2007; De Pelsmacker et al., 2005; Devinney et al., 2010; Vermier and Verbeke, 2006). In particular surveys that directly ask consumers what is important to them often overstate consumers' interest in altruistic product attributes such as ethical and ecological process characteristics. This is partly related to the fact that this method to elicit consumer preference is not incentive compatible as e.g. it does not force respondents to consider trade offs of different attributes, as they have to in real market places (e.g. higher price for products produced with specific ecological or ethical standards, see e.g. Langen, 2013). To overcome this limitation and to unveil consumers' true preferences and their drivers more sophisticated methods such as discrete choice experiments (e.g. Lusk et al., 2007; Chung et al., 2009; Dransfield et al., 2005; Loureiro and Umberger, 2007; Tonsor et al., 2005) or experimental auctions (e.g. Alfnes and Rickertsen, 2003; Feuz et al., 2004; Umberger et al., 2003) are increasingly applied. The Information Display Matrix (IDM) used in this paper also falls into this latter group of methods (e.g. Aschermann-Witzel and Hamm, 2011; Langen, 2013, Zander and Hamm, 2012).

The IDM (also called information display board) is a (computer-based) information acquisition technique recording the information search process of individuals which precedes a choice.[1] Respondents are confronted with a 'N times M' matrix of blank cards, with N referring to the number of products to choose from and M to the number of attributes considered. Study participants' task is to choose a product out of a bundle of products characterized by a number of attributes with the attribute level being different for each product. Thus, to make an informed choice respondents have to assess information regarding the attribute levels. The underlying assumption of the IDM approach is that information search is strongly linked to information usage (Johnson et al., 2002). This implies that only

[1] For an overview on other techniques, as well as fields in which the IDM has been applied, see Langen (2013).

information requested by participants can also be processed at a cognitive level. In addition, it is assumed that information is more relevant (the so-called cue information) the earlier and the more often it is considered (Muehlbacher and Kirchler, 2003). Accordingly, the IDM allows investigating not only the type of information considered but also the sequence and the frequency in which consumers take it into account before they make their choice (Jacoby et al., 1977; Jasper and Shapiro, 2002; Payne et al., 1993). Thereby it elicits consumers' cognitive structures in their decision making process while reducing socially desirable answers (Ott and Roidl, 2008), thus helping to uncover consumers' true preferences (Johnson et al., 1988; Schkade and Johnson, 1989). Thus, the IDM has been applied to determine those product attributes (most) relevant for consumers' decision making. For firms the results are of interest to develop new product varieties and/or product labels which best suit consumers' preferences (Jasper and Shapiro, 2002). Moreover, for policy makers this technique delivers interesting insights, regarding e.g. the regulation of product labeling.

The analysis is based on a survey, measuring the relative importance of different product and process attributes (1), stated on a Likert Scale, and (2) making use of the IDM. The research object of the study are meat products (pork and poultry cutlet). Data were obtained via an online survey. The study makes use of an individual specific version of the IDM. Thus, while in traditional and standardized forms of the IDM all attributes are equal for all participants, in the individualized case only those attributes are included in the IDM which the respective respondent, at an earlier stage of the experiment, has stated to be of highest importance out of several presented product characteristics. Besides traditional purchase criteria such as price and brand also perceived 'altruistic' criteria such as environmental aspects of production or animal husbandry were included in the study. To analyze the data obtained via the IDM experiment sequence analysis was used.

The objective of the study is twofold. Firstly, it wants to assess the bias introduced to the measurement of the relative importance of different product attributes by using simple questions in a questionnaire in comparison to using other techniques . This is done comparing the results obtained through statement batteries with the findings of the IDM. Secondly, the paper explores whether making use of sequence analysis, in contrast to standard descriptive analysis, allows to better account for the complexity of sequences as obtained by the IDM experiment.

The article is structured as follows. In section 2 the design of the study is introduced. Section 3 presents the sample and the results. A discussion of the results and conclusions are given in section 4.

2. Study design

The study focuses on meat products more precisely pork/chicken cutlet and was conducted online in Germany in 2012. A sample of adult consumers stratified by age, gender and education was drawn by a marketing agency. As an incentive for participation EUR 4 were paid[2]. The questionnaire started with questions regarding respondents' meat purchase behavior in general and more specifically about, e.g. how well informed they feel about ethical product characteristics, such as animal welfare or transportation time to the slaughterhouse, which labels presented on product packages they know and whether those influence their purchase decision. After this part socioeconomic characteristics were collected. Most important for the following discussion, participants had to evaluate the relevance of different traditional (e.g. price) and ethical (e.g. animal welfare) product characteristics on a scale from 1 (not important) to 5 (very important) imagining a usual pork or chicken cutlet purchase situation in the supermarket. The properties of the cutlets refered to the following 16 dimensions: animal husbandry, brand, environmental aspects of production, feeding practices, fresh versus frozen, health related information, packaging size, preparation instructions, price, region of origin, retail store, seal, slaughtering, slaughtering conditions, special offer, transportation time to slaughterhouse, use by date.

This was followed by the IDM experiment which started with a short explanation of the IDM task. Participants were randomly splitted into two groups. One group received questions and the IDM for pork cutlet, the other group got the same for chicken cutlet. Participants were asked to choose either pork or chicken cutlet for their daily use from a choice set of three. The meat differed with respect to the levels of eight attributes. For each participant those eight characteristics out of the 16 above mentioned dimensions that ranked highest were automatically used to build the pork or chicken cutlet attributes in the personalized IDM. This allows to confront respondents only with those eight attributes that they had stated to be of particular importance for their individual decision making. With three pork cutlets/chicken cutlets (column of the matrix) to choose from and eight dimensions (rows of the matrix) the IDM consisted of 24 pieces of information presented by means of a computerized version of the IDM.

At first, respondents had no information about any of the three pork or chicken cutlets, as the 24 pieces of information were all hidden behind blank cards. The participants were told that they could uncover up to eleven of the 24 cards before making their purchase decision. This restriction encouraged respondents to concentrate on those attributes most relevant for their purchase decision. In addition, it tries to capture, to some extent, the situation in a normal purchase situation as time constraints in general, limit the search for information. The information behind each card was revealed by moving the mouse pointer and clicking on the respective card. Once a card had been turned over, the card remained turned. The whole sequence, as well as the time of information search, was documented by the computer program. The choice was hypothetical as consumers did not have to buy the product at the end of the experiment.

[2] This is a standard allowance for online surveys as respondents have no expenses, need no time to come to the interviews etc.

3. Sample and experimental results

Information regarding the sample

A total of 926 consumers participated in the study[3]. Regarding the full sample of 926 participants, there was an equal representation of males and females. Participants were on average 42 years old, with the youngest being 18 and the oldes 65 years old. Compared to the German census, younger people were slightly overrepresented in our sample (StBa, 2012). This deviation from the German population is typical for online-users (Bandilla et al., 2001; Verhovar et al., 2002). Furthermore, 38 % of the sample lived in urban areas, 27 % in rural areas and 35 % in small-towns. Table 1 provides further details of the sample characteristics:

Table 1: Demographics of the sample (n = 926)

Characteristic	% of the sample	Characteristic	% of the sample
Gender		*Age*	
Female	49,1	18-25 years	18,8
Male	51,9	26-45 years	38,7
		46-65 years	42,5
Income per month in €		*Education*	
Lower than 900	13	Without any graduation	0,4
900 to 1499	23,7	Low school education	33,2
1500 to 1999	13,1	Medium school education	26,3
2000 to 2599	18,3	University entrance diploma	23,7
2600 to 3599	18,8	University degree	15,6
3600 to 4999	9,4	Holding a doctorate	0,9
Greater than 5000	3,9		

Assessment of preferences via questionnaire

The relevance of different product characteristiccs for consumers' meat purchase decision was assessed on a scale from 1 (not important) to 5 (very important). The results obtained reveal a somewhat heterogeneous picture (see Table 2). While 'animal husbandry' is for 33.9 % of the respondents of very high importance this holds with respect to other animal welfare attributes such as 'transportation time to slaughterhouse' only for 22.7 % or 'slaughtering conditions' only for 22.0 %. Regarding the attribute 'environmental aspects of production' this share is with 28.2 % again relatively high. The same share of respondents state that 'price' is very important (28.7 %). Some of the other traditional purchase criteria such as 'use by date' (51.7 %) and 'fresh versus frozen' (33.9 %) are considered by an even larger share of respondents to be very important while the opposite holds for other attributes in this group (e.g. brand 10.3 %). Overall, the results based on consumers' assessment of different product characteristics via questionnaires reveals that several ethical and ecological attributes are considered by consumers of being of similar relevance as traditional purchase criteria. .

[3] Whereof 483 answered the pork cutlet questionaire and IDM while 443 applied the ones for chicken cutlet.

Table 2: Importance of the criteria for respondents' meat purchase decision

	Mean	Not at all important [%]	Not important [%]	Neither/ Nor [%]	Quite important [%]	Very important [%]	N
Use by date	4.27	1.20	3.90	12.90	30.40	51.70	925
Fresh versus frozen	3.93	2.30	5.60	22.90	35.30	33.90	926
Region of origin	3.88	3.10	5.50	25.20	32.60	33.50	925
Animal husbandry	3.84	3.00	7.10	26.60	29.40	33.90	926
Price	3.79	3.50	6.20	27.10	34.60	28.70	926
Environmental friendly	3.76	4.00	5.40	29.40	33.00	28.20	926
Retail store	3.73	3.00	6.90	30.60	33.00	26.50	926
Health	3.68	4.40	8.50	28.10	32.70	26.20	926
Feeding	3.61	4.50	9.70	31.70	28.60	25.40	926
Slaughtering	3.57	3.90	9.90	34.90	28.30	23.00	926
Label	3.46	6.40	10.20	32.60	32.70	18.10	926
Transportation time	3.44	6.50	13.20	32.80	24.90	22.70	925
Packaging Size	3.42	7.30	11.20	32.00	30.90	18.60	926
Special offer	3.27	10.00	13.20	32.90	27.60	16.20	926
Brand	2.89	13.60	21.50	37.70	17.00	10.30	926
Preparation instructions	2.70	22.20	23.30	27.30	16.10	11.00	926

Note: Scale from 1 to 5; 1=very unimportant, 5=very important.
Source: Own calculation.

Assessment of preferences via IDM

The IDM provides not only insights regarding the kind of information (information content) considered by the respondents but also regarding its sequence (order) and its intensity (frequency) (Jacoby et al., 1977; Jasper and Shapiro, 2002; Payne et al., 1993). For analyzing the information search process, the method of sequence analysis using Stata SQ ados (Brzinsky-Fay et al., 2006) was applied. Sequence analysis covers techniques for describing and analyzing sequence data. It allows taking the full complexity of sequences into account. For example, it considers the number as well as the order and length of different sequences. Sequence analysis has gained relevance in different scientific fields. In biology e.g. DNA sequences are analyzed while in the social sciences life courses, marital histories or employment biographies can be studied as sequences (e.g. Brzinsky-Fay et al., 2006). A sequence is defined as an ordered list of elements (e.g. Brzinsky-Fay and Kohler, 2010), whereby in this study an element is a product attribute such as price a respondent uncovers via a mouse click. In the following, the sequences of consumers' information search process are described with regard to their overall length (total number of clicks), number of different elements (number of clicks that refer to different attributes) and number and length of episodes (identical successive elements). Furthermore, the coefficient of concentration will be calculated. This index is equal to the number of different sequences divided by the number of all possible sequences and multiplying this by 100. It provides information regarding the diversification of the sequences. In case that all sequences are distinct from each other there

would be no concentration and the index is equal to 100. If all sequences were identical, concentration would be highest, and the index converged to zero. For visualizing the sequences we make use of sequence index plots which draw a horizontal line for each sequence, separating the elements with different colors (Brzinsky-Fay et al., 2006). Finally, sequences will be depicted via parallel-coordinates plots which is a tool for visualizing high-dimensional data.

To understand the intensity of the information search process it is interesting to investigate the length of the sequence and thus the number of information pieces respondents requested before making their choice. A maximum of eleven clicks was allowed, thus restricting the possible length of the sequence to eleven. As Table 3 reveals, on average consumers stopped their information search process after they had obtained 9.4. Table 4 provides additional information on the information search process. It shows that more than one half (57,9 %) of the participants used a total of 11 clicks in their information search process and thus the maximum possible number of information allowed to request. However, it is also interesting to see that every seventh respondent used only 6 or less pieces of information and thus just about half of the one (s)he could have requested before making the purchase decision.

The average number of different episodes in the sequence indicates how often individuals switch from one of the eight attributes to another. With a maximum of eleven possible clicks the highest possible number of episodes is again eleven. This number would be reached if a participant never considered two levels of the same attribute sequently. The average number of episodes was 6.1 in this study (see Table 3).

Table 3: The information search process: sequences and episodes

	M	SD	Min	Max
Length of click-sequence	9.4	2.3	1	11
Number of different elements in click-sequence	5.6	1.8	1	8
Number of episodes	6.9	2.6	1	11

Source: Own calculation.

The maximum number of different attributes participants could potentially investigate was eight. On average respondents looked at 5.6 different attributes (see Table 3). This implies that on average each participant neglected three of the eight presented attributes in the information search process. Table 4 provides additional information with respect to the number of different attributes considered by respondents. The share of participants investigating four or five different attributes is with 20.0% and 19.4 %, respectively, the highest. The percentage of participants considering more than 5 attributes is with almost 48.6% considerable. In fact, almost every fourth participant (24.0%) examined all eight attributes before deciding which pork cutlet/chicken cutlet to buy.

Table 4: Number of different elements in click sequences and length of click sequences

Length of click-sequences	Freq.	%
1	5	0.5
2	4	0.4
3	26	2.8
4	15	1.6
5	30	3.2
6	46	5.0
7	58	6.3
8	74	8.0
9	64	6.9
10	68	7.3
11	536	57.9
Total	926	100

Number of different elements in click-sequences	Freq.	%
1	13	1.4
2	20	2.2
3	78	8.4
4	185	20.0
5	280	19.4
6	112	12.1
7	116	12.5
8	222	24.0
Total	926	100

Source: Own calculation.

In Table 5 the coefficient of concentration provides information on the diversification of sequences via the percentage of different sequences. With 16 different elements in the study and a maximum sequence length (number of clicks) of eleven the number of theoretically producible sequences is equal to $16^{11} = 1.76 \times 10^{13}$. We can observe a high level of diversification as the percentage of different sequences is with 99.46 % very high. Table 5 reveals that 921 of the 926 sequences are distinct, of which 919 are only observed for 1 respondent, one sequence is shared by two and another one by five persons.

Table 5: Concentration and diversification of sequences

Obs. Click-sequences	926
Obs. elements	16
Max. sequence length	11
Producible sequences	1.759E+13

Obs.	Sequences	%
1	919	99.24
2	1	0.11
5	1	0.11
Total	921	99.46

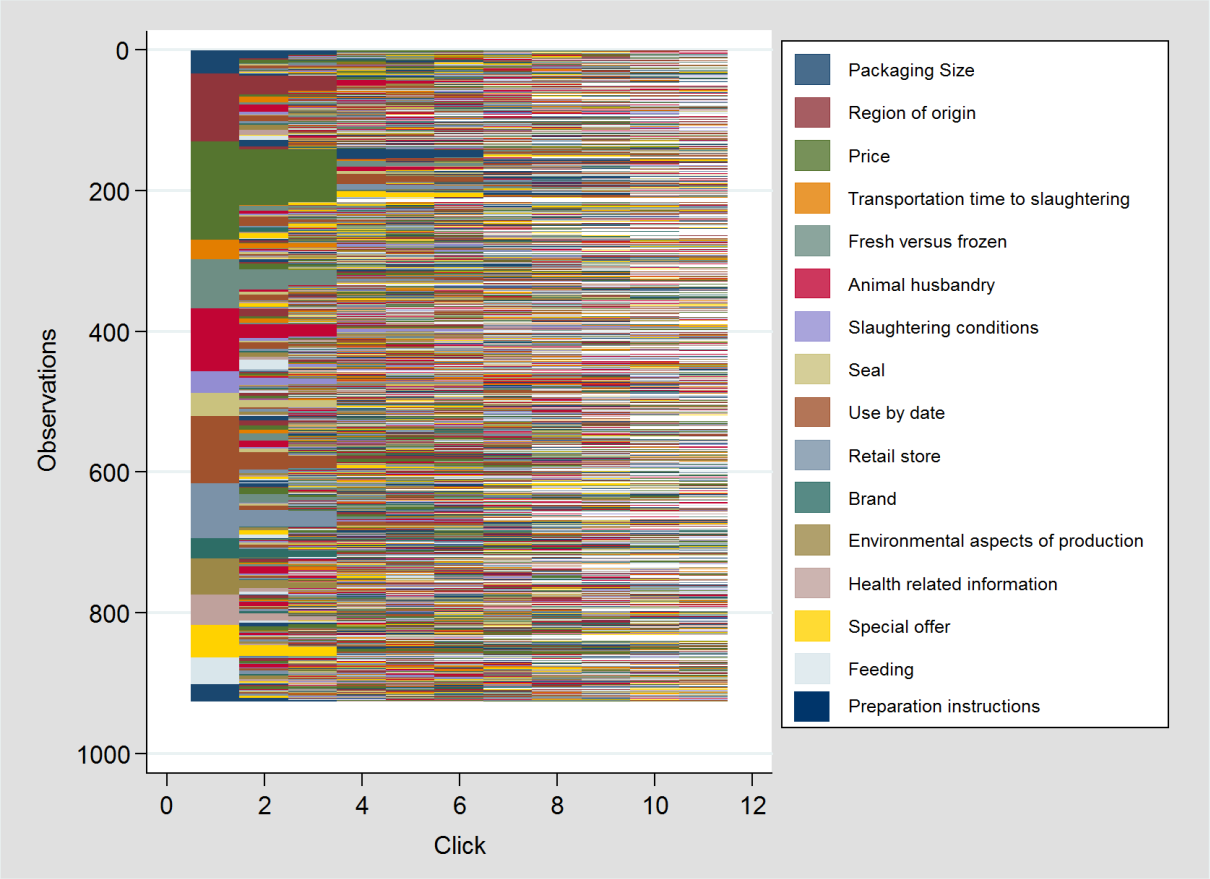
Source: Own calculation.

Figure 1 shows the sequence index plots for the data obtained. The advantage of visualizing the sequences is that it unveils which attributes are of special importance in consumers' information search process. In addition, the combination of attributes requested can be detected. Figure 1 reveals that 'price' is the attribute most often considered first in the information search process (15.1%). Considering the first click also the attributes 'region of origin', 'use by date' and 'animal husbandry' and are of great relevance for participants, each

accounting for about 10% of the first clicks, followed by ‘retail store’ (8.3%) and ‘fresh versus frozen’ (7.5%). Only a small share of respondents considers any of the other attributes at the beginning of their information search process.

Overall, about every second consumer (51.5%) considers the attribute price at least once before making a choice. The share is even a bit higher for ‘use by date’ (57.2%). Besides those traditional purchase criteria also ‘animal husbandry’ is assessed by a considerable share of consumers (45.5%) before deciding which pork cutlet/chicken cutlet package to buy. Information on ‘Environmental aspects of production’, in contrast, is with 36.9 % less important. ‘Brand’, however, is only for 17.0% of consumers part of their information search process.

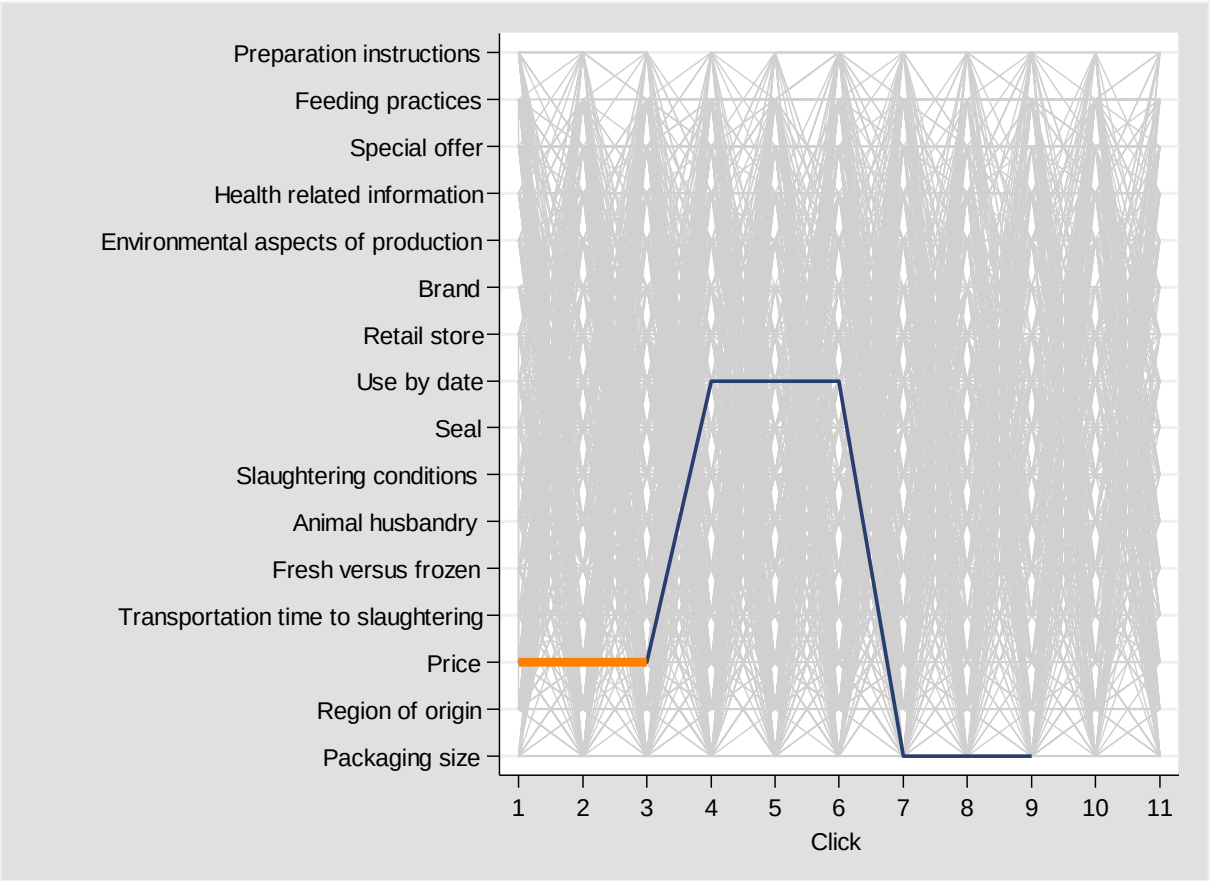
Figure 1: Sequence Index Plot



Source: Own calculation.

The parallel-coordinates plot in Figures 2 shows on the horizontal axis the first to eleventh clicks and on the vertical axis the elements of the sequence (16 attributes). The thicker lines indicate frequent sequences. The weighting factor applied for these figures was 0.5. Figure 2 indicates that the most frequent sequence for the first three clicks is ‘price’ (orange line). It is also important to note, that participants who clicked on ‘price’ for the first, second and/or third click, most frequently switched to ‘use by date’. The parallel-coordinates plots for the meat study also shows that participants often click after ‘price’ and ‘use by date’ at ‘packaging size’. Besides, the parallel-coordinate plots reveal, similar to Figure 1, that consumers often switch between the different attributes that provide information on the good.

Figure 2: Parallel-coordinates plots



Source: Own calculation.

4. Discussion and conclusions

Bias of assessing preferences via questionnaire

The first objective of this study was to assess whether using simple questions in measuring the relative importance of different product attributes leads to a bias. The results reveal that preferences measured via a questionnaire differ to some extent from those assessed through an IDM. Some ethical aspects of production such as animal husbandry are of high importance for consumers regardless of the method applied. But self-related attributes are ranked high in the survey as well. For example ‘use by date’ is of crucial importance for consumers according to the results of the questionnaire. 57.2% of respondents considers this item as being very relevant for their pork/chicken cutlet purchase decision. The results based on the IDM confirm this finding. However, price which is of medium importance based on the statements of respondents moves to first rank if the results of the IDM are considered. Also other more price related attributes such as ‘special offer’ play a stronger role in the information search process than anticipated by the statements of the respondents. Thus, there is evidence for the existence of a social desirability bias in the results of the stated preferences. Using an IDM might be one possibility to reduce this bias being closer to real purchase decicion. Especially with regard to the labelling of ethical product characteristics such as animal welfare the reduction of bias due to social desirable answers is valuable.

Use of sequence analysis

Results show that it is possible, and can be considered as a methodological advancement in IDM research, to apply sequence analysis in analysing data acquired via an IDM. Different indicators allow quantifying main characteristics of consumers' information search process and make it possible to test for significant differences between data obtained from different IDM experiments. In addition, visualization techniques applied in sequence analysis allow an easy and intuitive understanding of main characteristics of the data. In a next step we plan to use optimal matching techniques followed by a cluster analysis to investigate whether different patterns of information search can be detected for various groups of respondents.

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