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Comparison of three sensory profiling methods based on consumer perception: CATA, CATA with intensity and Napping®

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ABSTRACT

The present study compares three profiling methods based on consumer perceptions in their ability to discriminate and describe eight beers. Consumers ($n = 135$) evaluated eight different beers using Check-All-That-Apply (CATA) methodology in two variations, with ($n = 63$) and without ($n = 73$) rating the intensity of the checked descriptors. With CATA, consumers rated 38 descriptors grouped in seven overall categories (berries, floral, hoppy, nutty, roasted, spicy/herbal and woody). Additionally 40 of the consumers evaluated the same samples by partial Napping® followed by Ultra Flash Profiling (UFP). ANOVA- and Discriminant Partial Least Square Regression (A-PLSR, D-PLSR) were used to evaluate the discriminative ability of the methods and descriptors. A-PLSR results showed that all samples were perceived as different in all three methods, whereas D-PLSR showed that all three methods had similar numbers of discriminating descriptors. For the two CATA variants, 29 and 24 descriptors for without and with rating intensity were significant, for Napping/UFP the number was 26. Multiple Factor Analysis was used to derive an overall product map and to compare it to product configurations from individual methods. Both qualitative and quantitative analysis (comparison of R_V coefficients of the MFA configurations) revealed a very high agreement of the three methods in terms of perceived product differences. R_V coefficients were used to compare sample configurations obtained in the three descriptive methods. For all comparisons the R_V coefficients varied between 0.90 and 0.97, indicating a very high similarity between all three methods. These results show that the precision and reproducibility of sensory information obtained by consumers by CATA is comparable to that of Napping. The choice of methodology for consumer descriptive methods should then be based on whether it is desired to have consumers articulate their own perception of descriptors, or if it sufficient to present them to an existing vocabulary. Napping is slower and more laborious, and better for explorative studies with smaller number of consumers whereas, CATA is faster, less labor-intensive and thus more suitable for larger groups of consumers.

1. Introduction

Descriptive sensory profiling is important for the food industry as it can guide product development and reformulation of products as well as identify key sensory drivers essential for consumer acceptance and marketing of products. Conventional descriptive profiling is performed with a trained panel to obtain an objective description of the food products investigated (Lawless & Heymann, 2010). The need for less time-consuming and economical descriptive methods in the food industry has supported the development and use of more dynamic and fast descriptive sensory profiling methods assessed by panelists, food experts and consumers (Ares, Deliza, Barreiro, Gimenez, & Gambaro, 2010; Dehlholm, Brockhoff, Meinert, Aaslyng, & Bredie, 2012; Giacalone, Machado Ribeiro, & Frøst, forthcoming; Nestrud & Lawless, 2010). The fast methods include projective mapping (Risvik, McEwan, & Rødbotten, 1997) and Napping® (Pages, 2003, 2005), Flash Profiling (Dairou & Sieffermann, 2002) based on Free-Choice Profiling (Williams & Langron, 1984) and different sorting techniques such as free (Lawless, Sheng, & Knoops, 1995) single (Rosenberg & Kim, 1975) and multiple sorting (Dehlholm et al., 2012). Napping® is a method in which food samples are projected on a two-dimensional space based on similarities, and is often combined with Ultra Flash Profiling (Perrin & Pages, 2009) to add a semantic description to the product differences. Napping can performed as a "global" Napping, including all sensory aspects, or as "partial" Napping focusing on specific sensory modalities (e.g. appearance, taste or mouthfeel) (Dehlholm et al., 2012; Pagès, 2005).

Other consumer-friendly methods, such as just-about right scales (JAR), attribute liking, emotional questionnaires and check-all-that-apply (CATA) are increasingly used to capture consumer perception of food products. In particular the CATA method, in

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which a product is described by selecting appropriate words from a given list, is a simple and valid approach to gather information about sensory and non-sensory perception, and is believed to have smaller effect on liking and consumer perception of the product than similar methods (e.g. JAR) (Adams, Williams, Lancaster, & Foley, 2007; Ares et al., 2010; Giacalone, Bredie, & Frøst, 2013; Lado, Vicente, Manzoni, & Ares, 2010). Consumer-elicited CATA profiles have shown good agreement with traditional panel-developed sensory profiles (Dooley, Lee, & Meullenet, 2010; Ares et al., 2010), suggesting that CATA could be a valuable alternative to understand perception of product sensory attributes.

The various methodologies to capture consumer perceptions are generally easier to perform and less time-consuming than traditional descriptive analysis with a trained sensory panel. Some methods are reductionist and based on a predefined list of descriptor (e.g. CATA), while other methods are more holistic and explorative (e.g. Napping). One of the suggested drawbacks of CATA is that this method produces relatively impoverished dichotomized data (1/0), which allegedly would mask relative differences between specific attributes. Including intensity scaling of attributes in the CATA method may therefore improve the accuracy of descriptive profiling and lead to a better product differentiation. This hypothesis could be tested by comparing CATA with CATA combined with intensity scaling. Data on consumer ratings of intensity generally show large variability and thus it is not clear if the scaling element would actually improve the CATA descriptions made by the consumer. Additionally, it would be of interest to compare how reductionist methods, with and without scale elements (CATA and CATA with intensity ratings), would fare compared to a more holistic and explorative one, such as Napping.

The aim of the present study was to compare the effectiveness of three profiling methods, CATA, Napping and a novel method combining CATA with intensity scaling in studying consumer perception of a sample of eight beers. Three comparative criteria were considered in this study:

(1) *Discriminative ability*: i.e. the method's ability to successfully discriminate between the samples;
(2) *Descriptive ability*: the degree to which the three profiling methods would agree on the sensory characterization;
(3) *Configurational congruence*: the degree to which the sample spaces obtained by the different methods would be closely related to one another.

2. Materials and methods

2.1. Consumers

One hundred and thirty-five consumers between 18 and 65 years were recruited in and around of University of Copenhagen (UCPH), through advertisement on websites, social networks, beer magazines and flyers. Approximately half of the consumers ($n = 73$, 46 males and 27 females) described the flavor of the beers using a CATA questionnaire. The other half ($n = 62$, 46 males, 16 females) completed a modified version of the CATA questionnaire where we introduced the possibility of scaling the intensity of checked attributes. Additionally, some of the consumers ($n = 40$, 23 males, 17 females) returned after approximately 10 days for a second session to perform a partial Napping focusing on the smell and taste attributes of the eight beers.

After the testing, consumers received a token incentive for their participation (a bottle of craft beer, value ≈ 6 €).

2.2. Samples

Eight beers were chosen for the study (Table 1), five that represented the flavor diversity of the Danish beer marked (e.g. fruity, floral, woody, nutty or spicy), two beers were developed for the study to represent novel ingredients (sea buckthorn and pine) and finally a standard pilsner was included to represent the most consumed beer type in Denmark.

40 ml of beer was served at approximately 10 °C in 24 cl beer glass covered with watch glasses and coded with three-digit random numbers. Serving orders were randomized to balance first order and carry-over effects (MacFie, Bratchell, Greenhoff, & Vallis, 1989).

2.3. CATA variants

Sensory perception of the eight beers was evaluated by respectively CATA and CATA combined with a 15-point intensity scale. On the CATA ballot seven overall flavor categories were presented (Table 2). For each flavor category consumers were asked to check *yes*, if the flavor was present, and *no* if the flavor was not present. This formulation[2] differs from the classical "check-all-that-apply", and was adopted in order to enhance the likelihood that consumers actually read through the whole list, reducing the behavior known as *satisficing* (Krosnick, 1991; Rasinski, Mingay, & Bradburn, 1994). Briefly, satisficing is a theory in behavioral decision making maintaining that when most people examine alternative sequentially, they tend to choose the first alternative that seem reasonable, as opposed to the optimal situation in which they would evaluate all alternatives comprehensively before taking a decision (Simon, 1955).

Further, some overall flavor descriptors were supplemented with sub-descriptors to enable consumers to specify the exact flavor they perceived (Table 2). The list of flavor attributes was developed with inspiration from the "Danish beer language" (Det Danske Ølakademi [Eng. *The Danish Beer Academy*], 2006), and the ballot was pre-tested informally to assess that the appropriateness of the attribute list. On the CATA ballot with intensity scaling, the seven overall flavor attributes were presented with the *yes*/*no* checkboxes, the flavor sub-descriptors and one horizontally oriented 15-point intensity scale per flavor category anchored with 'very weak' and 'very strong' in the ends to enable consumers to rate the intensity of the appropriate beer flavors. The choice of including only flavor terms, which differs from earlier CATA applications where often more holistic terms (e.g. emotions, usage attributes, conceptual attributes, etc.) are included, was motivated by our aim to restrict the focus on the descriptive profiling applicability of CATA.

2.4. Partial Napping

Napping was performed as a partial Napping focusing on the smell and taste of the eight beers. Each consumer was provided with a 60 × 40 cm blank paper (the Napping sheet), a pen, post-its, a tray with eight beer samples and a spittoon. The sample order on the individual trays was randomized to counter-act first order carry-over effect, even though the Napping methodology allows and requires subjects to go back and forth between samples. Consumers were instructed to evaluate the beer samples according to similarities or dissimilarities in smell and taste attributes by placing similar samples close to each other and more dissimilar samples further apart on the Napping sheet. After they had reached a final configuration, consumers noted down appropriate descriptors for the smells and tastes of the beers on the post-its, which were moved around the Napping sheet, when needed. This procedure is known as Ultra-Flash profiling and is commonly used to add a descriptive dimension to a Napping task (Perrin et al., 2008). When

[2] A very similar formulation has been recently tested by Ennis and Ennis (2011), who coined their approach "applicability scores". Although unaware of this contribution at the time of designing this experiment, it is interesting to notice that we came to very similar conclusions regarding the need to account for unchecked items in CATA questionnaires.