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Two-step rating-based 'double-faced applicability' test for sensory analysis of spread products as an alternative to descriptive analysis with trained panel

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ABSTRACT

Descriptive analysis with a trained sensory panel has thus far been the most well defined methodology to characterize various products. However, in practical terms, intensive training in descriptive analysis has been recognized as a serious defect. To overcome this limitation, various novel rapid sensory profiling methodologies have been suggested in the literature. Among these, attribute-based methodologies such as check-all-that-apply (CATA) questions showed results comparable to those of conventional sensory descriptive analysis. Kim, Hopkinson, van Hout, and Lee (2017a, 2017b) have proposed a novel attribute-based methodology termed the two-step rating-based 'double-faced applicability' test with a novel output measure of applicability magnitude (d'_A) for measuring consumers' product usage experience throughout various product usage stages. In this paper, the potential of the two-step rating-based 'double-faced applicability' test with d'_A was investigated as an alternative to conventional sensory descriptive analysis in terms of sensory characterization and product discrimination. Twelve commercial spread products were evaluated using both conventional sensory descriptive analysis with a trained sensory panel and two-step rating-based 'double-faced applicability' test with an untrained sensory panel. The results demonstrated that the 'double-faced applicability' test can be used to provide a direct measure of the applicability magnitude of sensory attributes of the samples tested in terms of d'_A for sensory characterization of individual samples and multiple sample comparisons. This suggests that when the appropriate list of attributes to be used in the questionnaire is already available, the two-step rating-based 'double-faced applicability' test with d'_A can be used as a more efficient alternative to conventional descriptive analysis, without requiring any intensive training process.

1. Introduction

Sensory descriptive analysis is one of the most broadly applied sensory methodologies of sensory characterizations for products for various objectives such as product specification, optimization, and innovation (Lawless & Heymann, 2010; Stone, Bleibaum, & Thomas, 2012). Sensory descriptive analysis in industry is conventionally performed by training sensory panels to become analytical instruments and hence generate the separable sensory attributes for a specific product and perform intensity scaling for each of them separately (Lawless & Heymann, 2010; Stone et al., 2012). However, such training requires learning each attribute dimension for attribute alignment and acquiring scaling techniques for intensity scaling of each attribute. Obtaining detailed, robust and reliable outcomes via this process is intensive and time-consuming (Delarue, 2014; Valentin, Chollet, Lelievre, & Abdi, 2012; Varela & Ares, 2012). Conventional sensory descriptive analysis with attribute and scaling training is a costly and sometimes impractical method for companies where many different types of products need to be studied quickly. Often in industry and academia, internal sensory panels available who have been experienced with sensory evaluation of various products. Thus, in practical terms, it would be ideal if using such experienced sensory panel but not trained on the target product – without performing further product attribute training, we could get results similar to conventional descriptive analysis with a trained panel. It could increase flexibility and efficiency of corporate (and academic) sensory researchers in terms of panel planning and product evaluations.

Therefore, as an alternative to conventional descriptive analysis using trained sensory panels, various rapid sensory profiling methods have been suggested using both consumers and sensory panels without attribute and scaling training. These methods can collect information

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about the important sensory characteristics that affect the differences between products in a more efficient and flexible way (Delarue, 2014; Valentin et al., 2012; Varela & Ares, 2012). These rapid sensory profiling methods include Flash profile (Delarue & Sieffermann, 2004), Free Sorting (Courcoux, Qannari, Taylor, Buck, & Greenhoff, 2012; Lawless, Sheng, & Knoops, 1995), Projective mapping and Napping (Mielby, Hopfer, Jensen, Thybo, & Heymann, 2014; Risvik, McEwan, Colwill, Rogers, & Lyon, 1994), and Check-All-That-Apply (CATA; Adams, Williams, Lancaster, & Foley, 2007; Dooley, Lee, & Meullenet, 2010). Examination of the product spaces obtained from conventional descriptive analysis and rapid sensory profiling methods has demonstrated that these rapid methods can provide information about the sensory characteristics of products similar to conventional descriptive analysis (Antúnez, Vidal, de Saldamando, Giménez, & Ares, 2017; Cadena et al., 2014; Dehlholm, Brockhoff, Meinert, Aaslyng, & Bredie, 2012; Moussaoui & Varela, 2010; Oppermann, de Graaf, Scholten, Stieger, & Piqueras-Fiszman, 2017). Comparing the outcomes from different methods, attribute-based methods such as CATA questions can provide results that are more similar to conventional descriptive analysis results than those provided by holistic approaches such as projective mapping (Blancher et al., 2007; Cadena et al., 2014; Moussaoui & Varela, 2010). This can be explained by the fact that attribute-based methods are designed to evaluate specific sensory characteristics of a product - as in conventional descriptive analysis - while holistic approaches are based on the global similarities and differences between products (Ares & Varela, 2014). This suggests that attribute-based methods can be considered as a more appropriate alternative approach for sensory characterization to descriptive analysis performed with trained sensory panels.

Nevertheless, CATA questions might be limited for studying product discrimination when the product set contains subtle differences in intensity only, as data analyses of CATA questions are mainly based on comparisons of relative differences in applicability frequencies. Thus, in order to improve product discrimination, Kim, Hopkinson, van Hout, and Lee (2017a) proposed a novel attribute-based two-step rating-based 'double-faced applicability' test that uses a modified format of CATA, combining forced-choice Yes/No questions with sureness ratings. Like other rapid profiling methods, it does not require training for attribute alignment and intensity scaling. Since it utilizes two-step ratings and 'double-faced' attributes (a pair of semantic differential descriptors), it can provide more stable ratings and better sample discrimination than simple ratings utilizing a single descriptor per attribute for applying consumer research and collecting the information of sensory characterization. For analysis of the data obtained from this method, the novel quantitative measure of affect magnitude (d-prime affect magnitude, d'_A) has been developed as an output measure for each attribute (Kim, Hopkinson, van Hout, & Lee, 2017b). By measuring over a series of product usage stages in terms of d'_A, an individual affective usage experience profile in attribute applicability (description) was generated for each product to provide information on how the affect valence (positive, negative or neutral) changed throughout the product usage stages (Kim et al., 2017b). In addition to constructing temporal profiles of attribute applicability over time, these affective usage experience profiles could be used for product discrimination of multiple products because it can be generated independently for each product as well as it does not require a physical reference product (Kim et al., 2017b). A similar output measure computed from sensory data generated by sensory panels might be beneficial for companies to build sensory knowledge on their products rapidly.

The study aim was to investigate the potential of the two-step rating-based 'double-faced applicability' test using sensory panels with participants who are naïve to the target product (without training on attribute alignment and intensity scaling), as an alternative to conventional sensory descriptive analysis, used routinely in companies. With this, the novel output measure of d'_A for each attribute was applied to the responses collected from two-step rating-based 'double-faced applicability' test to provide the degree of applicability of each attribute and to generate a sensory profile for sensory characterization and multiple products discrimination. In order to compare the test utility and efficiency of the two-step rating-based 'double-faced applicability' test with an untrained sensory panel, conventional sensory descriptive analysis was also performed with a sensory panel trained on sensory attributes and intensity scaling for the target product. As a case study, these two sensory profiling methods were compared in terms of sensory characterization and product discrimination using twelve commercial spread products.

2. Materials and methods

2.1. Samples

Twelve spread products commercially available at supermarkets in the Netherlands were used and were coded P01 to P12. P12 was a butter product and P09 and P10 were butter/margarine blended mélange products. P05 was a margarine product for baking. The remaining samples were margarine products for spreading on bread. P06, a margarine product well known to the trained sensory panelists, was used as the physical reference sample for the trained panel assessment and as the warm-up sample for the untrained panel assessment.

2.2. Experimental design and sensory panel

The test efficiency and utility of the two methods (descriptive analysis vs. two-step rating-based 'double-faced applicability' test) were evaluated and compared in terms of sample characterization and product discrimination by using an independent samples design. The trained sensory panel and untrained sensory panel were formed from the members of the trained sensory panel of the Unilever Research & Development Vlaardingen (URDV), according to their experience with different product categories. Panelists from both groups had passed all screening tests to work as a sensory panelist. The trained panel (N = 11, all female, 53.5 ± 11.1 years old) had evaluated various Unilever products, including spread products, for 10 to 25 years and were thus highly experienced in such evaluation. The untrained panel (N = 11, all female, 55.6 ± 7.4 years old) had been trained on products such as bouillon, soup, tea and ice cream, but had no experience in evaluating spread products. The trained panel was assigned to perform conventional descriptive analysis, while the untrained panel was assigned to perform the novel two-step rating-based 'double-faced applicability' test.

Panelists were not allowed to wear lipstick, perfume or any other strong odorants (e.g., deodorant, body cream, and hairspray) during panel sessions. They were instructed not to eat any food except water for at least 30 min before starting a test and were not allowed to smoke before each session or during the break. All panelists submitted written informed consents and received financial compensation for their participation.

2.3. Attributes and their descriptors used in the evaluation

Attributes and their positive and negative descriptors used for each group are listed in Table 1. All attributes were categorized according to the sensory modalities in order of occurrence. The list of attributes for descriptive analysis was created from the margarine sensory evaluations that were previously conducted by URDV (second column in Table 1). During prior margarine sensory evaluations, the trained sensory panelists were trained on the scoring of samples and they agreed with the definitions of each attribute. Definitions of the attributes and the agreed scores of the physical reference sample are given in the Supplementary material.

The list of pairs of semantic-differential descriptors for the 'double-faced applicability' test with the untrained panel was established by