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Comparison of descriptive analysis, projective mapping and sorting performed on pictures of fruit and vegetable mixes

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ABSTRACT

In this study the ability of three sensory methods to describe differences among visual stimuli was evaluated. We compared the two fast alternative sensory methods, projective mapping (PM) and sorting, to a generic descriptive analysis (DA), using visually different pictures of fruit and vegetable mixes. Thirty-two pictures of different fruit and vegetable mixes were evaluated by two different panels (11 assessors each) using the three sensory methods. The results were compared to each other to find which of the two alternative descriptive methods, PM and sorting, lead to most similar results compared to DA. Further, the effect of replicate evaluations in fast alternative methods was assessed for visual stimuli, where the 11 assessors, conducting both the PM and sorting tasks, evaluated all pictures in duplicates. Last, an alternative analysis method to multidimensional scaling (MDS) for sorting data was evaluated, to elucidate if more detailed results could be obtained with the alternative DISTATIS procedure.

Compared to DA, results obtained from both sorting and PM were similar, and similar main conclusions could be drawn from all three sensory methods. However, both PM and sorting were able to separate the samples to a higher degree than DA. With regards to the two data analysis techniques for sorting data, samples were found to group more tightly when analyzed by DISTATIS compared to MDS. Even for visually different samples, product maps changed over the replicates in the PM and sorting tasks, indicating that assessors changed their evaluation criteria when performing a holistic product evaluation.

1. Introduction

Visual appearance is a key factor for affective responses towards the food we choose and eat (Zellner, Lankford, Ambrose, & Locher, 2010). In sensory and consumer evaluation this fact can be used to the researchers' advantage as pictures of food stimuli have been found to be predictive of actual food choice in both adults, children and adolescents (Kildegaard, Olsen, Gabrielsen, Møller, & Thybo, 2011; Mielby, Edelenbos, & Thybo, 2012; Olsen, Kildegaard, Gabrielsen, Thybo, & Møller, 2012; Reisfelt, Gabrielsen, Aaslyng, Bjerre, & Møller, 2008). This is particularly true if the stimuli are well known to the consumers, as they have a basis for creating realistic expectations of the food (Reisfelt et al., 2008). The use of visual stimuli in consumer studies is also increasing during the last couple of years, indicating an increasing use of visual stimuli in consumer as well as analytical sensory settings. A quick browse through papers in Food Quality and Preference resulted in seven published papers of which only one was more than 5 years old (Arce-Lopera, Masuda, Kimura, Wada, & Okajima, 2013; Kildegaard et al., 2011; Manzocco, Rumignani, & Lagazio, 2013; Mielby, Kildegaard, Gabrielsen, Edelenbos, & Thybo, 2012; Mielby et al., 2012; Olsson, Skog, Lundström, & Jägerstad, 2005; Schechter, 2010). In many cases the use of pictures instead of actual food products can minimize the time for sample preparation and hereby the costs of the experiment.

Methods from the sensory and consumer sciences are often used to relate descriptive panels' objective responses to the consumers' affective responses in order to elucidate important drivers for liking (Murray, Delahunty, & Baxter, 2001). Generic sensory descriptive analysis (DA) as described by Lawless and Heymann (2010) has been widely applied and is, among others, known for its ability to correlate with and help understanding consumer affective responses (Bastian, Collins, & Johnson, 2010; Delgado & Guinard, 2011; Nikkisha, Sanders, Drake, Osborne, & Civille, 2005). DA represents the benchmark of descriptive methods as it provides detailed information and reliable and consistent results. However, there are some implications using this test. The

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analytical nature of the test forces the assessors to dissect their otherwise overall perception into independent sensory dimensions, and thus, information about complex perceptions and interactions might be lost (Lawless, 1999; Saint-Eve, Enkelejda, & Martin, 2004). Further, the method is time consuming and, moreover, costly (Cartier et al., 2006).

Alternatively, more holistic and faster methods have been introduced as alternatives to DA, including projective mapping (PM) (Risvik, McEwan, Colwill, Rogersa, & Lyon, 1994; Risvik, McEwan, & Rødbotten, 1997) and sorting (Lawless, 1989).

In PM, the assessors place samples in a two-dimensional space according to perceived similarities and dissimilarities. The coordinates of each sample on the map constitute the data used in the subsequent analysis. When PM was first introduced by Risvik et al. (1994), assessors were instructed to use an A4 paper sheet with unstructured line scales on which to place the samples. Later, other formats as well as structured line scales have also been used (Risvik et al., 1997; Kennedy & Heymann, 2009; King, Cliff, & Hall, 1998; Nestrud & Lawless, 2010). One of the advantages with this method is its ability to provide a sample map in a relatively short time. However, one of the drawbacks of this method is that it constrains the panelists to two dimensions to discriminate among samples (Chollet, Lelièvre, Abdi, & Valentin, 2011; Perrin et al., 2008). A re-invention of PM under the name Napping® was performed by Pagès, together with a new way to analyze PM data by the name of Multi-Factor Analysis (MFA) (Pagès, 2005). There seem to be disagreement as to whether Napping® is the same as PM, stated by Nestrud and Lawless (2010), or a restricted and defined case of PM with a restricted data collection space, argued by Dehlholm, Brockhoff, Meinert, Aaslyng, and Bredie (2012). Either way, analysis of PM and Napping® data is usually performed using MFA (Nestrud & Lawless, 2010). PM has been used on a variety of foods and beverages, and with different findings. For a summary of studies applying PM and Napping® the reader is referred to Hopfer and Heymann (2013). Besides a study on sound (Dehlholm, 2012), no studies on PM and Napping® have been published for nonfood products, such as visual stimuli (pictures).

In contrast to the two-dimensional task of PM, in sorting each subject sorts a given sample set into groups according to perceived similarities and differences. Across all subjects, the assumption is that similar samples will be sorted in the same groups more often than dissimilar samples (Nestrud & Lawless, 2010). Besides being a fast and simple to use method, no forced agreement among panelists is required, and sorting can also be done by inexperienced and untrained panelists (Cartier et al., 2006; Chollet et al., 2011). One of the benefits of sorting is that it can be performed on a relatively large sample set (Abdi, Valentin, Chollet, & Chrea, 2007), even in a single session (Cartier et al., 2006). A large variety of foods and beverages has been evaluated with sorting, with different scopes such as benchmarking of different products, flavor exploration and wine typicality (Maitre, Symoneaux, Jourjon, & Mehinagic, 2010; Nestrud & Lawless, 2010). Sorting has also been performed successfully on nonfood samples such as car fabrics (Picard, Dacremont, Valentin, & Giboreau, 2003), clothes (Soufflet, Calonnier, & Dacremont, 2004), as well as plastic devices (Faye et al., 2004). Sorting data can be analyzed with different methods but it is usually analyzed using multidimensional scaling (MDS) (Nestrud & Lawless, 2010). An alternative method is the DISTATIS procedure (Abdi et al., 2007) which allows the analysis of three-way distance tables, hereby being able to handle individual sorting data as opposed to the global frequency tables, generated over all assessors, used in MDS.

The efficiency and "trueness" of fast descriptive methods is usually assessed by comparison to DA (Albert, Varela, Salvador, Hough, & Fiszman, 2011; Cartier et al., 2006; Hopfer & Heymann, 2013; Kennedy & Heymann, 2009). For example, Cartier et al. (2006) compared sorting to DA by comparing the results of a Principal Component Analysis (PCA) on the descriptive data to the results of a MDS on the sorting data. While both methods led to similar sample maps and sensory spaces, DA results were found to be more detailed. Fast descriptive methods have also been compared to one another (Dehlholm et al., 2012; King et al., 1998; Nestrud & Lawless, 2010). Nestrud and Lawless (2010) compared PM and sorting results of apples and cheeses and concluded that both methods produced similar sample maps, but that PM has advantages over sorting if applied to relatively similar samples.

Based on this existing knowledge we extended the use of fast alternative descriptive methods to new sample stimuli. It is generally acknowledged that results of such methodological studies can be generalized to other products and modalities as it is not always possible to test all methods on all products and modalities. However, in light of visual stimuli increasingly being used in consumer studies it can be assumed that visual stimuli are going to be used in (fast) descriptive analysis in the near future as well. We tested the applicability of fast alternative descriptive methods for visual food stimuli. We evaluated three sensory methods to describe differences among visual stimuli. Hence, we compared the two fast sensory methods PM and sorting to DA using visually different pictures of fruit and vegetable mixes. Previously, DA was shown to describe differences among pictures of fruit and vegetable mixes (Mielby, Jensen, Edelenbos, & Thybo, 2013), however, the applicability of fast alternative methods, such as PM and sorting, has not yet been studied for visual stimuli. Based on previous studies on aroma, flavor and textural properties of foods and beverages (e.g. Albert et al., 2011; Cartier et al., 2006; Dehlholm et al., 2012; Hopfer & Heymann, 2013; Kennedy & Heymann, 2009; Nestrud & Lawless, 2010), we hypothesize that PM and sorting will give similar results to DA when being used on visual stimuli. The increasing use of visual food stimuli as a substitute for real food samples in consumer studies makes it necessary to study the implications for the analytical sensory methods applied on visual stimuli. Previous studies (e.g. Hopfer & Heymann, 2013; Kennedy, 2010; Risvik et al., 1994) on PM and sorting have shown that replicates vary to some degree. In the current study we thus studied the hypothesis that replicates in sorting and PM will also vary to some degree when visually different samples are evaluated. Finally, new ways of analyzing data from fast sensory methods are continuously being developed. There is a need to compare these new methods with more established analysis methods. We included a comparison of two analysis methods for sorting data, namely the commonly used MDS, and DISTATIS. The underlying hypothesis used was that DISTATIS will produce more detailed results compared to MDS as DISTATIS uses individual data sets instead of averaged data. Further this feature of DISTATIS makes a comparison of individual assessor differences and assessor agreement possible.

2. Methods

2.1. Samples

A total of 32 pictures made up of four sets of 8 pictures of fruit and vegetable mixes were used in the study (see Fig. 2), including 8 pictures of fresh vegetable mixes (V), 8 pictures of fresh fruit mixes (F), and 8 pictures of combined fresh fruit and vegetable mixes (FV). To study the perception of freshness, additional 8 pictures of the 8 fruit mixes (Fxxx), which had been stored at room temperature for 4 h (Fxxx+4) prior to taking the pictures, were included. Pictures varied in among others complexity/simplicity, using an underlying 2^3 design for each set of 8 pictures, as described in detail in Mielby et al. (2012).