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Stability of sample configurations from projective mapping: How many consumers are necessary?

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ABSTRACT

Projective mapping for sensory characterisation with consumers has been used for a relatively short period of time, which suggests that the development of guidelines regarding best practices is strongly needed. The present work aims to provide an insight on the minimum number of consumers needed to reach stable sample configurations. Data sets from 21 different consumer studies, differing in product category, number of samples and degree of difference among them, were used to evaluate the influence of the number of consumers on the stability of sample configurations by means of a resampling approach. For each study, 1000 random subsets of different number of consumers were generated from the original data set. For each virtual panel, sample configurations were obtained using Multiple Factor Analysis. The agreement between them and the reference configurations (obtained with all the consumers) was evaluated through the RV coefficient, using the first two and the first four dimensions of the MFA. Results showed that the stability of sample configuration clearly depended on the degree of difference and type of differences among samples and the number of samples in the dataset. Across the 21 data sets analysed, results suggested that when working with widely different samples, 50 consumers seems as a safe recommendation of minimum consumer panel size to obtain reliable results with projective mapping. However, after any characterisation by projective mapping is completed, it is highly recommended to check, *a posteriori*, the reliability of the sample space configuration using a bootstrapping procedure.

1. Introduction

Sensory profiling is one of the most important and widely used tools in sensory and consumer science (Lawless & Heymann, 2010), both in academic and industrial applications (Varela & Ares, 2012). Information about the sensory characteristics of a product is of great interest in the food and beverage industry, as it allows to make better informed business decisions with a lower level of risk and uncertainty (Lawless & Heymann, 2010; Meilgaard, Civille, & Carr, 1999).

Product sensory description by trained panels has been common practice for quality control, sensory shelf life determination, product and process development, to correlate with instrumental measurements and to better understand the mechanisms underlying sensory perception (Gacula, 1997; Moussaoui & Varela, 2010; Stone & Sidel, 2004). Most importantly, both in industrial and in academic fields, descriptive analysis has served as a link between product characteristics and consumer perception (Varela & Ares, 2012). The expertise of descriptive panels allows obtaining very detailed, robust, consistent and reproducible results, which are stable in time and within a certain sensory space (Moussaoui & Varela, 2010). However, in some situations creating and maintaining a well-trained, calibrated sensory panel can be economically challenging and time consuming for companies, and also in academic research when dealing with punctual projects or scarce funding (Lawless & Heymann, 2010; Murray, Delahunty, & Baxter, 2001; Varela & Ares, 2012).

In the last 10 years, the development of alternative descriptive techniques resulted in various methods for sensory characterisation, which can be successfully used with semi-trained assessors or even naïve consumers (Varela & Ares, 2012). These methodologies have been reported to provide sensory maps well correlated to classic descriptive analysis, with the advantage of being faster, while providing direct feedback from consumers (Valentin, Chollet, Lelièvre, & Abdi, 2012; Varela & Ares, 2012). Diverse product profiling methods are being used as never before in the food industry, as the hypothesis that consumers are able to accurately describe products is nowadays widely accepted within the sensory community. Those new techniques are sorting, flash profiling, projective mapping or Napping®, check-all-that-apply (CATA) questions,

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intensity scales with consumers, open-ended questions, paired comparisons, polarised sensory positioning (PSP) and preferred attribute elicitation method (for thorough reviews, see Varela and Ares (2012) and Valentin et al. (2012)).

Projective mapping, also known as Napping® (Pagès, 2005), was proposed by Risvik, McEvan, Colwill, Rogers, and Lyon (1994). In this methodology assessors are asked to provide a two dimensional projection of a group of samples, according to their own criteria (Risvik, McEwan, & Rodbotten, 1997). Although some articles were published using projective mapping in the past 20 years, almost 80% have been published in the last 5 years, demonstrating the increased interest in this sensory method. Sensory characterisation with projective mapping has been applied to a wide range of product categories such as chocolate (Kennedy & Heymann, 2009), red wine (Hopfer & Heymann, 2013; Perrin & Pagès, 2009; Ross, Weller, & Alldredge, 2012; Torri et al., 2013), beer (Reinbach, Giacalone, Machado Ribeiro, Bredie, & Frøst, 2014), apple (Nestrud & Lawless, 2010), hot beverages (Moussaoui & Varela, 2010), milk desserts (Ares, Deliza, Barreiro, Giménez, & Gámbaro, 2010), powdered juices (Ares, Varela, Rado, & Gimenez, 2011), sausages (Grossi, Søltoft-Jensen, Knudsen, Christensen, & Orlien, 2011, 2012) and enriched and reduced-calorie sweet biscuits (Carrillo, Varela, & Fiszman, 2012). These studies have reported that projective mapping is a quick and reliable method for profiling products with consumers, providing similar information to classic descriptive analysis with trained assessors (Dehlholm, Brockhoff, Mejnert, Aaslyng, & Bredie, 2012; Louw et al., 2013; Moussaoui & Varela, 2010; Risvik et al., 1994, 1997).

The rise in the use of projective mapping has increased the need for developing guidelines regarding best practices. As most of the novel methodologies, projective mapping has been used for a relatively short period of time, thus, further research on the applicability, reliability and reproducibility is still strongly needed (Valentin et al., 2012; Varela & Ares, 2012). The number of assessors is an important issue in the design of sensory studies. In particular, when using projective mapping with naïve consumers, the number of assessors could potentially influence the attainment of a stable consensus map. It is important to take into account that the cost associated with consumer studies increases with the number of participants to be gathered. Thus, projective mapping could be cheaper if the number of consumers used in a study is relatively low, but of course results should be reliable.

The number of consumers used in different studies ranges from 8 to 81 (Kennedy & Heymann, 2009; Risvik et al., 1997; Torri et al., 2013) and, to our knowledge, no studies have addressed the influence of the number of consumers on the outcome from projective mapping. Several studies have been published studying the optimal panel size for sensory descriptive analysis (Gacula & Rutenbeck, 2006; Heymann, Machado, Torri, & Robinson, 2012; King, Arents, & Moureau, 1995), the number of consumers needed for acceptability tests (Gacula & Rutenbeck, 2006; Hough et al., 2006; Mammasse & Schlich, 2014; Moskowitz, 1997), or for shelf life estimations (Hough, Calle, Serrat, & Curia, 2007; Libertino, López Osornio, & Hough, 2011).

To evaluate the reliability of novel descriptive methods some papers reported the use of repetitions (Hopfer & Heymann, 2013), other used duplicate samples within the sample set (Moussaoui & Varela, 2010), or RV coefficients to compare maps (Louw et al., 2013), while other authors have used bootstrapping to draw confidence ellipses around the products on the sensory map to get an overview of product confidence intervals (Dehlholm, Brockhoff, & Bredie, 2012).

Blancher, Clavier, Egoroff, Duineveld, and Parcon (2012) stated that a product space can be considered stable if similar results are obtained in repeated experiments under the same conditions. Faye et al. (2006) and Blancher et al. (2012) proposed a resampling approach to test the stability of a sorting map. Blancher et al. (2012) simulated experiments by repeatedly sampling from the population of interest. They used bootstrapping to obtain a large number of random subsets of different number of assessors from the original data. For each subset, a sample configuration was obtained and the correlation with the complete assessors' set configuration was calculated through the RV coefficient (Escoufier, 1973; Robert & Escoufier, 1976) and Mantell coefficient (Mantel, 1967). A similar approach has been recently used for the estimation of the adequate consumers' panel size in liking tests (Mammasse & Schlich, 2014) and to estimate the minimum number of consumers necessary to gather stable sample and term configurations from check-all-that-apply questions (Ares, Tárrega, Izquierdo, & Jaeger, 2014).

In the same line, the present work attempts to bridge the gap in the relation of the stability of projective mapping as a function of the number of consumers, so that informed decisions in this regard can be taken. The objective of the present work was to study the stability of sensory maps obtained using projective mapping with consumers, by means of a resampling approach on data from 21 different consumer studies, differing in product category, number of samples and degree of difference among them.

2. Materials and methods

Data sets from 21 different consumer studies (1–21) were used to evaluate the influence of the number of consumers on the stability of sample configurations. Studies were performed in three different cities: Montevideo (Uruguay), Salto (Uruguay) and Gualeguaychú (Argentina) from August 2008 to April 2013. Table 1 shows the description of the data sets.

2.1. Consumers

Between 26 and 101 consumers participated in the studies (Table 1). Consumers were recruited based on their consumption of the target product, as well as their interest and availability to participate in the study. Participants were aged 18–75 years old and in all the studies approximate gender balance was achieved. Consumer samples comprised varying household compositions, income levels, education levels, etc., but were not representative of the general population of the cities in which the studies were performed.

2.2. Samples

The 21 datasets widely differed in product category and degree of differences among samples. The number of samples included in the studies ranged from 5 to 14 (Table 1). When multiple studies were conducted with the same product category, samples were not identical.

Samples for studies 1–6 (champagne, red wine, powdered drinks, orange juice and chocolate milk desserts) and 14–17 (plain crackers) corresponded to commercial brands available in the market, which were purchased from local supermarkets.

Samples for studies 7–10 (vanilla milk desserts) were prepared using water, powdered skimmed milk, inulin, modified maize starch, commercial sugar, polydextrose, sodium tripolyphosphate, carrageenan, vanilla aroma, caramel aroma, egg yellow food colouring and sucralose. The formulations were selected to obtain sets with large differences in flavour among samples (study 7), large differences in flavour and texture (study 8), small differences in flavour (study 9) and small differences in flavour and texture (study 10).