# So close, yet so far?

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# So close, yet so far? A methodological investigation of the potential of and optimal sample sizes for the application of Napping as rapid sensory method in marketing contexts.

**Abstract**:

Despite of the recent bridge building between consumer and sensory science, methods applied in sensory science haven`t yet attracted the attention of marketers. This holds particularly true for rapid sensory methods, whose application offers manifold benefits for marketing research. Napping aims at producing sensory maps by arranging products in two-dimensional spaces according to their sensory differences and similarities, providing information about perceived sensory characteristics of products and their relevance for consumers. So far no empirical work critically investigates methodological issues of Napping. This paper introduces a large-scale Napping study, serving the purpose of identifying the optimal sample size for a scientific employment of Napping in marketing contexts. In contrast to current standards recommending sample sizes of 9-15 respondents, our results suggest Napping sample sizes of ideally over 30 respondents in order to get statistically sound results.

*Keywords: Napping, MFA, sensory marketing*

*Track: Methods, Modelling & Marketing Analytics*

# 1 Introduction of paper

Sensory profiling, serving the purpose of defining and quantifying sensory characteristics on which products differ, has been an established and essential tool for food scientists and food manufacturers for a long time. The numerous applications of traditional descriptive profiling techniques include classical "sensory" tasks, such as product development, product improvement and quality control (Valentin, Chollet, Lelièvre, and Abdi, 2012), however, also expand to the fields of marketing and consumer science, involving advertising claim substantiation (Lawless & Heymann, 2010) and the understanding of consumer preferences (Greenhof & MacFie, 1994).

Though being referred to as "one of the most powerful, sophisticated and most extensively used tools in sensory science" (Varela & Ares, 2012), sensory profiling, as conducted with trained assessor panels, is time-consuming and cost-intensive. Consequently, despite of the relevance of traditional profiling, several alternative methods have evolved in recent years, following industrial demand for faster and more cost-effective methods. The resulting rapid sensory methods, however, may – as novel methods for product characterization – not only be regarded as efficient alternatives to traditional methods in sensory science, but expand their range of application to new fields of use (Delarue, Lawlor, and Rogeaux, 2014): Particularly the suitability of these rapid sensory methods for sensory product characterization with consumers (rather than trained assessors) substantiates their noteworthy relevance for the field of marketing, even inducing researchers to refer to these novel methods as the "blurred line between sensory and consumer science" (Varela & Ares, 2012).

While three categories of rapid sensory methods may be distinguished, namely verbal-based methods (flash profile and check-all-that-apply), reference-based methods (polarised sensory positioning and pivot profile) and similarity-based methods (free sorting task and projective mapping aka Napping) (Valentin, Chollet, Lelièvre, and Abdi, 2012), the paper at hand exclusively focuses on the latter.

Napping, also being referred to as a holistic approach in sensory analysis (Pagès, Cadoret, and Lê, 2010), represents a similarity-based, rapid descriptive sensory method with a wide range of potential applications in marketing and consumer research contexts.

However, while numerous studies focus on applications of Napping in different contexts, methodological issues, such as the optimal sample size for the usage of Napping in consumer research, have yet not been subject to a thorough discussion, neither in sensory, nor marketing literature. While, according to some standards, samples for Napping should comprise nine to 15 untrained or trained persons who, on average, sample twelve samples at a time (Derndorfer & Schneider-Häder, 2016), several other publications report rather vague recommendations, such as that "the appropriate sample size will probably depend on the objectives of the study" (Delarue, Lawlor, and Rogeaux, 2014).

A review of extant studies on Napping (*n* = 74) reveals that, surprisingly, within the field of sensory science, most authors refrain from challenging the recommendation of nine to 15 persons, wherefore only slight inconsistencies regarding the authors' conceptions of appropriate sample sizes can be observed. While several studies consider 15 panellists as optimal for projective mapping methods including napping (see, for instance, Leliévre-Desmas, Valentin, and Chollet, 2017; Louw et al., 2015), there are some downward (e.g. Liu, Grónbeck, Di Monaco, Giacolone, and Bredie (2016), whose sample comprises eight participants) as well as slight upward deviations (Kemp, Pickering, Willwerth, and Inglis, 2018, with 16 participants).

To summarize, it can be noted that there is a lack of systematical methodological investigations and statistically validated reference points, wherefore it remains unclear how large a Napping panel should be in order to provide statistically sound and reproducible results. Resting upon these considerations, the paper at hand aims at identifying the optimal sample size for a scientific employment of Napping in marketing contexts.

## 2 Theoretical background on Napping as methodolgy

Seen historically, the idea underlying Napping may be traced back to projective tests in clinical psychology. Projective tests, such as the also in marketing contexts well-known Rorschach inkblot test, enabled subjects to "indirectly reveal their personalities […] by projecting themselves through their responses to the stimuli" (Lê, Le, & Cadoret, 2015).

In sensory science literature, the idea of "the idea of asking subjects to reveal themselves through the way they are positioning stimuli (products) on a sheet of paper based on their perceived similarities" (Lê, Le, & Cadoret, 2015) arose in 1994, encouraged by a publication of Risvik, McEwan, Colwill, Rogers, and Lyon (1994), who come to the conclusion that this approach "…could be a potentially useful technique for linking sensory analysis and consumer research data" (Risvik, McEwan, Colwill, Rogers, and Lyon, 1994).

Indeed, despite of initial warnings of sensory scientists, emphasizing that "...as with any untrained panel, beyond the overall acceptance judgment there is no assurance that the responses are reliable or valid" (Stone & Sidel, 1993) or that "...consumers can only tell you what they like or dislike" (Lawless & Heymann, 1999), recent studies provide empirical evidence for the fact that the use of consumers seems to be a good alternative to classical sensory profiling techniques provided by a trained panel (Worch, Lê, & Punter, 2010).

Napping represents a rapid sensory descriptive method, more precisely, a similarity measurement, in sensory sciences, pursuing the goal of obtaining a sensory comparison of several products in terms of their relative similarity to one another. By providing valuable information about products and their sensory properties, as well as consumers' preferences, Napping facilitates comparisons of products with competing products and may provide valuable insights for product development (Derndorfer & Schneider-Häder, 2016).

According to literature, three sub-categories of Napping may be distinguished: In general napping, all samples are served at the same time and arranged by the participants on a sheet of paper, usually with the dimensions 400 x 600 mm, relative to each other. The paper thereby represents a two-dimensional space. If the samples differ, they are placed far away from each other, whereas if they are similar, they are positioned close to each other. Each product can be assigned a position in the coordinate system and be characterized by sensory attributes (Derndorfer, 2016).

In the so-called partial napping, samples are analyzed focusing on individual product features, such as appearance, smell, taste or texture (Pfeiffer & Gilbert, 2008)

Sorted Napping extends the positioning of the products by grouping arranged samples with similar sensory properties into product groups. Subsequently, these clusters are described verbally with defined attributes. As a result, in addition to the positioning data of the individual samples, statements about the respective clusters are obtained. Similarities and differences between the individual products can be determined (Kermarrec, 2010).

## 3 Empirical work

### *3.1 Study design*

We conduct a large-scale Napping study with $n$ = 104 participants, hence drastically deviating upwards from current standards, recommending that samples for Napping should comprise nine to 15 persons (Derndorfer & Schneider-Häder, 2016). The rationale for the large sample size is that, after completion of the Napping procedure and coding of the data, several random samples systematically varying in size may be drawn out of this sample. This procedure (i.e., the drawing of random samples out of a large-scale sample) allows a systematical analysis of sets of variables collected on the same observations with Multiple Factor Analysis (MFA) and a subsequent Procrustes analysis, providing an index of consensus (Tucker's congruence coefficient) between the different random samples and the whole sample. Building on these analyses, recommendations pertaining to the optimal sample size for Napping studies may be derived.

For sensory testing, a combination of partial and sorted napping was used, pursuing the aim of not only obtaining the positioning data of the individual samples, but also statements about the respective formed sample clusters. This procedure should allow the drawing of conclusions about the similarities or differences between the different samples and a description of them. The sensory testing was carried out in the sensory laboratory of a Central European University.

### *3.2 Selection of product category and stimuli*

As stimuli, 15 different commercially available strawberry yoghurt samples were selected. Each of the yogurts was provided in transparent plastic cups (filling quantity: 20 g), which were served at room temperature. All samples were purchased in the morning of the day of testing and stored at room temperature until sensory testing. In addition, the samples were coded with four-digit, randomly selected sample numbers.

### *3.3 Procedure*

104 voluntary and untrained students of the University participated in the sensory testing. In advance to their participation, respondents were familiarized with the method of Napping.

During sensory testing, each of the 104 subjects was provided with all 15 samples simultaneously. In addition to the samples, each participant received three sheets of white paper in DIN A3. Respondents were instructed to systematically cluster the samples based on perceived similarities and differences in a way that similar samples were arranged close to each other. In a next step, the positions of each sample were marked on the paper. Moreover, respondents were requested to verbally describe each cluster with sensory attributes, whereby they used their own vocabulary. Overall, three rounds of Napping were performed, as participants were asked to first rate samples based on their appearance, followed by taste and texture.

The marked positions of all samples as indicated by the test persons were transferred into a coordinate system, whereby the lower edge of each sheet of paper formed the x-axis and the left side edge the y-axis. As this coding procedure has to be performed manually, this is a quite time-consuming procedure.  Based on the thus evolving coordinate system, all sample positions were recorded in form of coordinates and entered into a table in Microsoft Office Excel for each participant and for all three characteristics (appearance, taste, texture).

The verbal descriptions (sensory attributes) were also collected in the Excel file, regardless of the assessors for each sample and all three characteristics regarding the frequencies of the responses. Very similar attributes (e.g. thick, viscous, gooey) were combined into one. Subsequently, these data were analyzed with the help of XLStat® using multiple factor analysis (MFA).

### *3.4 Analysis*

Due to poor data quality, 4 respondents had to be excluded from the analysis, resulting in an analyzable sample of $n = 100$. In a next step, several random samples were systematically drawn out of this sample. Following the objective of identifying an optimal sample size, random samples consciously varied with regard to their sample size. *Table 1* provides an overview of the sizes and numbers of samples drawn.

| sample size | $n = 10$ | $n = 15$ | $n = 20$ | $n = 33$ | $n = 50$ |
|---|---|---|---|---|---|
| number of samples drawn | 10 | 6 | 5 | 3 | 2 |

*Table 1: Characteristics of random samples*

The whole sample as well as all randomly drawn subsamples were analyzed using Multiple Factor Analysis (MFA). MFA, as an extension of principal component analysis, is “tailored to handle multiple data tables that measure sets of variables collected on the same observations” (Abdi, Williams, and Valentin, 2013, p. 1).

Subsequently, the two-dimensional coordinates for each of the 15 stimuli resulting of the various MFAs were subject to Generalized Procrustes Analyses (GPA), following the purpose of analyzing metric multidimensional scaling between each sub-sample and the whole sample by means of scaling, rotation and translation techniques. Tucker’s congruence coefficient ($r_c$) serves as an index of consensus between the different random samples and the whole sample.

Procrustes analyses of the sub-samples with $n = 10$ and $n = 15$ reveal Tucker’s congruence coefficient ($r_c$) values below 85 %, thus indicating that, in fact, Napping sample sizes below 15 are not recommendable. For the sub-samples with *n* = 20 respondents, congruence coefficients range between 85 % - 94 %, indicating fair similarity between the factors (Lorenzo-Seva & ten Berge, 2006).

*Figures 1-3* illustrate results of Procrustes analyses for three sub-samples of the sample size *n* = 33, which emerges as the optimal sample size. As can be seen from Tucker's congruence coefficients (Rc), all consensus indices for sample sizes of *n* = 33 are equal to or higher than 97 %, indicating exceptional high consensus of the separate sub-samples with the whole sample. According to literature, congruence coefficient values above 95 % can be considered as virtual identical factors (Lorenzo-Seva & ten Berge, 2006).

Against the background that current standards in sensory science recommend Napping sample sizes of nine to 15 respondents (Derndorfer & Schneider-Häder, 2016), and considering the fact that the majority of publications reporting Napping studies stick to this recommendation, we consider this a remarkable finding.

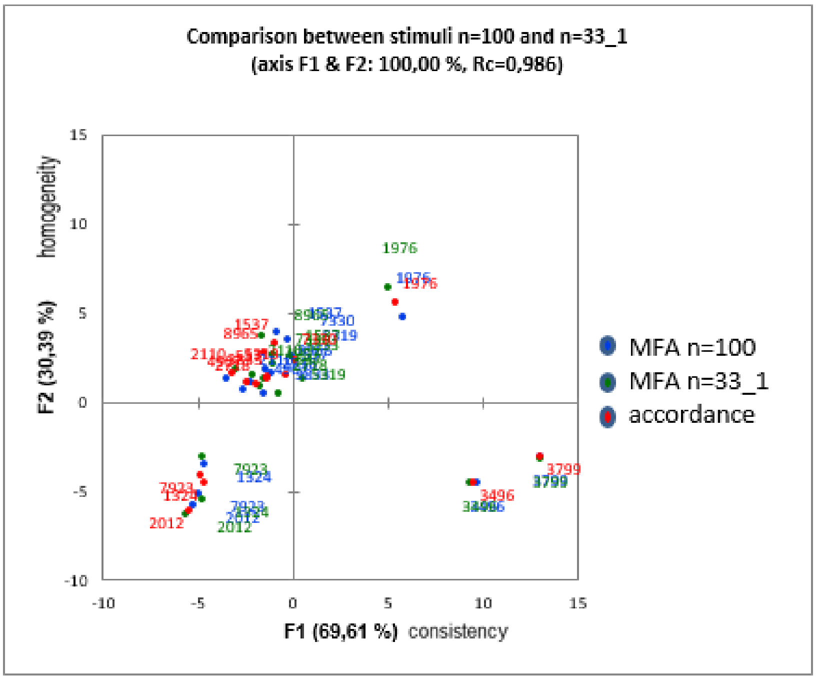


*Figure 1: Comparison between whole sample and sub-sample $n_1$ =33*

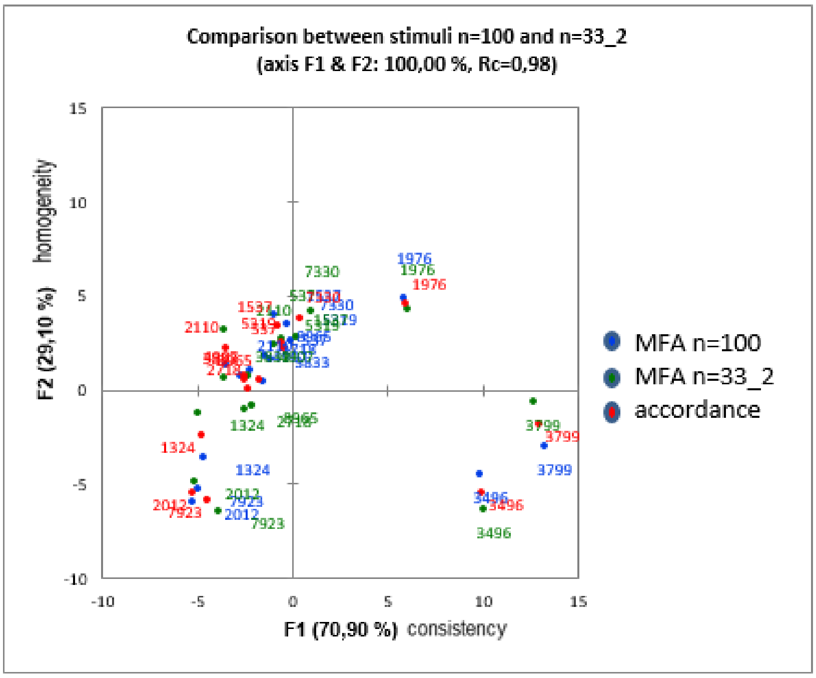


*Figure 2: Comparison between whole sample and sub-sample $n_2$ =33*

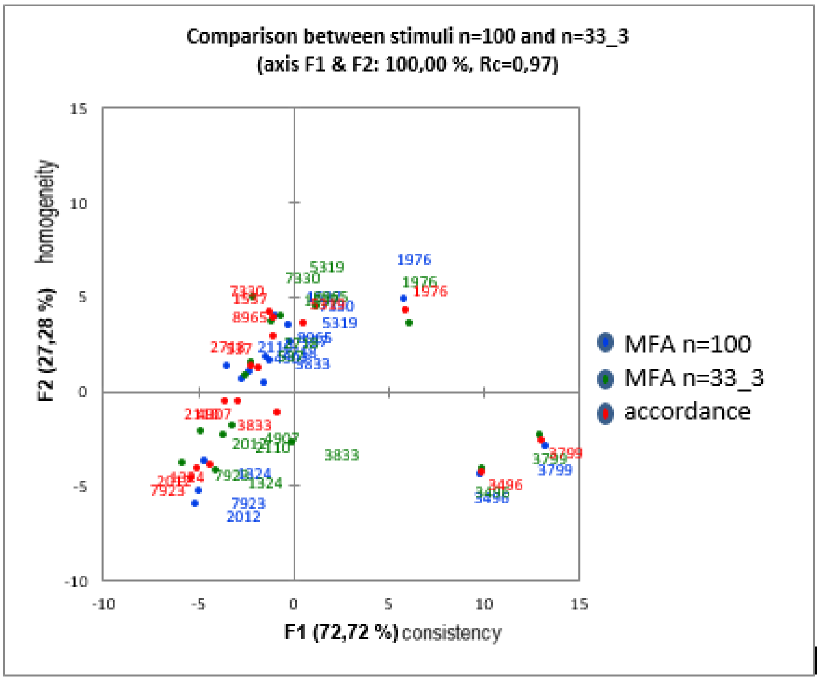


*Figure 3: Comparison between whole sample and sub-sample $n_3$ =33*

## 4 Conclusion

Being based on our analyses, current recommendations for Napping sample sizes (9-15 respondents) deliver, at best, average results, with all of our sub-samples ($n \leq 15$) exhibiting not even fair similarity to the whole sample.

In conclusion, we consider Napping a promising method for the application not only in sensory science, but also in marketing contexts. However, we advise researchers to build their Napping studies on at least 20, ideally over 30 respondents in order to get reliable and statistically sound results.

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