

PROJECTIVE MAPPING: A TOOL FOR SENSORY ANALYSIS AND CONSUMER RESEARCH

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ABSTRACT

Studies have indicated that profiling and (dis)similarity scaling yield different perceptual product maps. Conceptually, these two procedures are different. This paper looks at a third and alternative method of producing a two-dimensional, perceptual map utilizing a projective-type method whereby individual assessors themselves are required to place products on the space according to the similarities and differences they perceive. However, visual comparison of the final results provided by each assessor is difficult and, hence, generalized Procrustes analysis is applied to compare each assessor's map for similarity with the others. In this study it was found that the perceptual map derived from projective mapping was as similar to the map derived from profiling as from dissimilarity scaling. However, consistency over repeated trials was greater for projective mapping than for the other two methods. It is suggested that projective mapping could be a potentially useful technique for linking sensory analysis and consumer research data.

Keywords: Projective mapping; sensory analysis; consumer research.

INTRODUCTION

Sensory profiling (Amerine *et al.*, 1965; Williams & Carter, 1977; Powers, 1984; Risvik, 1985; Stone & Sidel, 1985; Meilgaard *et al.*, 1987) is a class of methods for the description and quantification of sensory attributes as perceived by humans. Hence, these tools are of major importance to the food industry, both for product development and marketing. Another class of methods, used to describe overall differences between

products, is (dis)similarity scaling (Schiffman *et al.*, 1981; Thomson *et al.*, 1987; McEwan, 1989). Using this technique each individual is required to quantify his/her perception of overall (dis)similarity between products within a pair.

Profiling and (dis)similarity scaling require sophisticated statistical analysis tools to allow the data to be readily interpretable by the sensory scientist and other users of these methods. Most commonly, some multivariate analysis tool is used to provide a multidimensional product map. This map is made up of a number of dimensions, usually two, three or four, which represent some underlying sensory phenomena with respect to the samples under investigation. The method used to derive these product maps will depend upon the experimental objective and the type of data collected.

The tasks required by the sensory assessor and the perceptual spaces derived from appropriate analysis techniques are conceptually different. In the latter case the assessor is required to consider the product as a whole and quantify the overall difference between pairs of products. With profile analysis the product is broken down into a number of components in the form of sensory attributes, which are combined in some way to enable similarities and differences between the whole product to be investigated. Unlike dissimilarity scaling, the profile approach allows qualitative information to be linked to the product map. However, in spite of the differences in philosophy associated with the two methods, other workers have found that they provide very similar product maps (Williams & Arnold 1985; Popper *et al.*, 1988; Tunaley, 1988). This is not surprising when the samples are very different, as the profiling method will be dominated by obvious (and large) differences between samples, while the (dis)similarity judgements will reflect these as an overall difference. In other words, when an assessor evaluates the product as a whole he/she will concentrate on the most obvious differences when making a judgement. Similarly, there will be a number of obvious differences between the products in terms of one or more of the individual sensory attributes. This being the case, both methods are

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likely to yield very similar product maps. However, in the case of small perceptual differences between samples, the sensory panel using the profile method have been trained to describe and identify the subtle differences between the samples and be consistent in their response. With dissimilarity scaling, the task of the assessor is to quantify overall differences between the products. The assessor, be she trained or not, may well use a different frame of reference from another assessor for defining the extent of a difference perceived between two products. On subsequent sessions of that experiment it is likely that the frame of reference might shift (small differences might be difficult to remember over time, and different attributes may be emphasized each time), as there has been no training to keep it constant. This latter problem may be overcome by introducing an element of training. However, the problem of standardizing the frame of reference between assessors is difficult without discussion which is in effect leading to product description and the method defaults to profiling.

An alternative approach to the generation of a perceptual map is to provide assessors with a piece of paper and ask them to place given samples on it, according to the relationship they have to each other. This type of approach is used frequently by those involved in market research and other fields, where associations between objects are under investigation. Projective mapping, as it is sometimes known, is one of the many existing projective techniques (Oppenheim, 1966) used in qualitative market research, where the aim is to use projections as a means of finding out more about the product or the consumer in terms of sensory attributes, packaging, attitudes and so on. It is a useful method where the aim is to elicit vague, ambiguous and unstructured ideas from the products. The purpose of this study is to investigate a possible way of allowing consumers (e.g. from a focus group setting) to evaluate samples in an overall and simple way. In so doing, this information could then be linked to trained panel profile information to aid evaluation on the importance of the attributes perceived by trained assessors.

In this study, the same group of trained assessors were used to make the procedure of comparison of the projective mapping, dissimilarity scaling and conventional profiling more comparable. Ideally, consumers should be used, but this was not practical in this experiment.

In previous studies where projective mapping was used, there appears to be no published reference to quantifying the information recorded. This paper adopts the approach of a coordinate system to quantify this information, and utilizes generalized Procrustes analysis (Gower, 1975) and the RV coefficient (Schlich & Guichard, 1989) for comparing information from different approaches. Since conducting this research, the authors note that a facility is available on the PSA data registration system (Oliemans, Punter & Punter,

Utrecht, Holland) for performing this task, hence reducing some of the workload in data collection as described in this paper.

MATERIALS AND METHODS

Samples

Five commercially formulated chocolate samples were moulded into standard form and are referred to by their codes, i.e. 19, 31, 51, 53 and 59 (Colwill, 1988). Sample 53 was made in two batches and unfortunately information as to which batch was which was not supplied. The chocolate was kept at a constant temperature of 10°C to delay the ageing process and to prevent the development of chocolate bloom. All samples were assessed at room temperature which was 20°C.

Sensory analysis

Sensory evaluation was undertaken at MATFORSK, Norwegian Food Research Institute. A trained panel of nine assessors, all with previous experience of sensory testing (Risvik *et al.*, 1992), participated in the test. The samples were not swallowed, and the assessors were asked to rinse well between each sample using either still or carbonated mineral water and non-salted crackers.

The conventional profiling and dissimilarity data were collected using the SENSTEC registration system (SENSTEC, Tecator AB, Sweden). Instruction forms were provided for guidance and for the recording of remarks which the assessors might wish to make on each sample. Three replicate judgements were obtained from each assessor in both experiments. The panels used standard procedures with an unstructured line scale, anchored with 'low intensity' on the left and 'high intensity' on the right, and the samples were marked with three-digit random codes and given randomized serving orders. The sensory profile procedure is reported more fully elsewhere (Risvik *et al.*, 1992).

In the dissimilarity scaling experiment, nine trained assessors provided dissimilarity ratings on all possible pairwise comparisons in a lower-half dissimilarity matrix using a 180-mm unstructured graphical scale. Anchors were in Norwegian and translated they read on the left 'the same' and on the right 'very different'. At each session the panel members were instructed to taste the first and then the second sample of the pair and rate how similar or different they were. Four pairs were presented in a session, and each session lasted 30 min. Assessors were instructed to rinse with mineral water and to eat a cracker between pairs of samples.

Introducing the idea of projective mapping to the panel did not cause any problems and, in fact, their response was favourable to trying out a new approach. For the projective mapping each assessor was provided

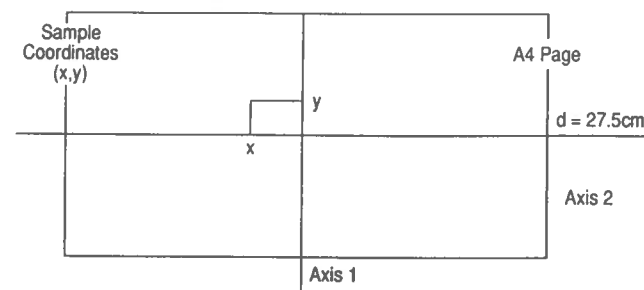


FIG. 1. Coordinate system used to derive each assessor's perceptual map using the projective mapping procedure.

with an A4 sheet of white paper marked with two crossed axes (Fig. 1). Assessors were asked to place the samples on this two-dimensional space according to how they perceived them to be related to each other. They were instructed that samples close together on the map would represent similar samples and the further apart samples were, the more different they were. The towns' map of Kruskal and Wish (1978) was used as a training example, together with the concept of individual differences and the rotation of perceptual maps. To avoid introducing the idea of a 'right' solution, alternative maps were generated using other and slightly less familiar aspects. These aspects were designed to illustrate individual differences (the opera fan's view of the USA), different weighting of attributes (small and large maps) and distortion due to the introduction of new samples (introduction of London to the USA map).

To prevent the assessors using the traditional profiling approach, colour chips were used in some examples. These did not have a uniform colour surface, and the panellists were asked to 'blur' the sight during the evaluation to get an overall colour impression and then do a colour-circle-like map of the samples.

This introduction took approximately 15–20 min, and the bottom line message was that 'everything is acceptable if you find it right'. Their actions after the test reflected this when they said 'this was fun', 'it was like playing a game' and other similar expressions.

Data treatment

The conventional profile data were analysed using GPA (Gower, 1975; Arnold & Williams, 1986; McEwan & Hallett, 1990). The data submitted to GPA (GENSTAT 4, Numerical Algorithms Group, Rothamstead, UK) consisted of nine assessors, fifteen samples (5 samples \times 3 replicates) and sixteen attributes. The dissimilarity scaling data were analysed using INDSCAL (Schiffman *et al.*, 1981). In this analysis each assessor had three lower-half dissimilarity matrices. The first matrix from each assessor was submitted to INDSCAL, then the second and then the third. As there were only five samples, a two-dimensional solution was requested. This

exercise of analysing the three replicates separately was repeated for the conventional profile data to provide better comparison of results for the three methods.

The mapping data were quantified using a coordinate system (Fig. 1). These data then took the form of nine matrices, each comprising of fifteen samples (5 samples \times 3 replicates) and two dimensions. These data can also be presented as three matrices for each assessor, each with five samples and two dimensions. The two-dimensional maps were compared visually and then submitted to GPA to allow a more formal comparison of the results. Four GPAs were run: the first where there were nine 15 \times 2 matrices and the other three analysed the first, second and third replicates of the projective mapping; hence these used nine 5 \times 2 matrices. In addition, the RV coefficient was used to measure the degree of correlation between the consensus spaces derived from GPA on the three replicate projective mapping experiments.

The RV coefficient was used to compare the amount of agreement in the structure of the configurations derived from the different methods.

The RV coefficient (Escoufier & Robert, 1979; Schlich & Guichard, 1989; Schlich, 1990) is a tool better known in France, and is a simple way of measuring the similarity between two sets of variables which have been measured on the same samples. These variables can be considered in the same light as X and Y variables. The RV coefficient is analogous to the R^2 goodness of fit measure used in regression analysis. It takes the values between 0 and 1; the nearer to one, the greater the similarity between the X and Y variables. In this paper, the RV coefficient is used to measure the similarity between sample spaces derived from different methods.

RESULTS AND DISCUSSION

Throughout this investigation, the same nine assessors were used to evaluate the three methods: conventional profiling, dissimilarity scaling and projective mapping. While it is expected that learning or familiarity will undoubtedly be present, it was not practical on this occasion either to train extra staff or to bring in consumers for the mapping exercise. The effect of familiarity was minimized as far as possible by allowing sufficient time between experiments. During this period, the panel were involved in evaluating a wide range of products, and hence their memory of the chocolate would have been dimmed. Ideally, the projective mapping exercise should be conducted with untrained assessors or consumers, and this particular point will be dealt with later.

Before presentation and discussion of results, the reader should bear in mind that five samples are not a large number to evaluate, but this is typical of product development situations, where consistent consumer responses are difficult to generate for large sample sets.

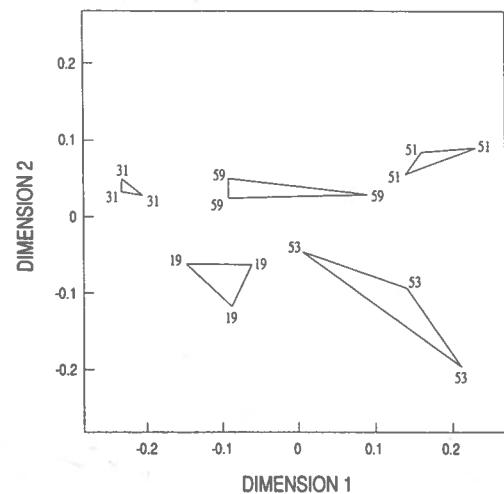


FIG. 2. Consensus perceptual space derived from generalized Procrustes analysis on the conventional profile data.

However, this is an initial investigation to look at the feasibility of the methodology, rather than an actual product development exercise.

Conventional profiling

GPA on the conventional profile data revealed an underlying two-dimensional perceptual map explaining 44% of the total variation on Dimension 1 and 11% on Dimension 2 (Fig. 2). Further dimensions described no additional differences between the samples. The three positions of each sample on the consensus space are joined together to form a triangle, thus allowing the user to visually compare within-sample variances. A corresponding attribute plot comprising appearance, flavour and texture terms can also be plotted, and the reader should refer to Risvik *et al.* (1992) for this, and more detailed discussion of the results. The two axes are in this paper identified as one colourtone and whiteness

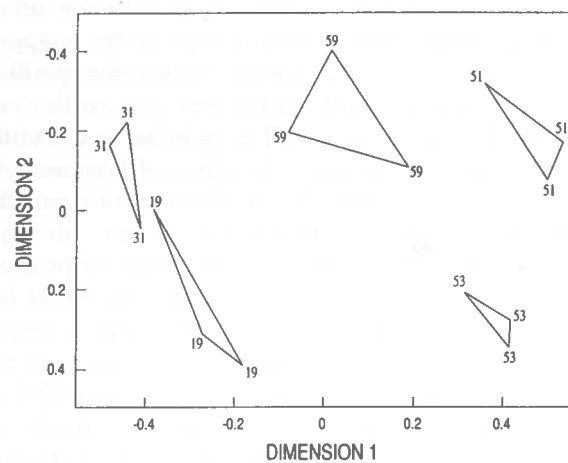


FIG. 3. Consensus spaces derived from GPA on each of the three conventional profile replicates, superimposed on the same plot.

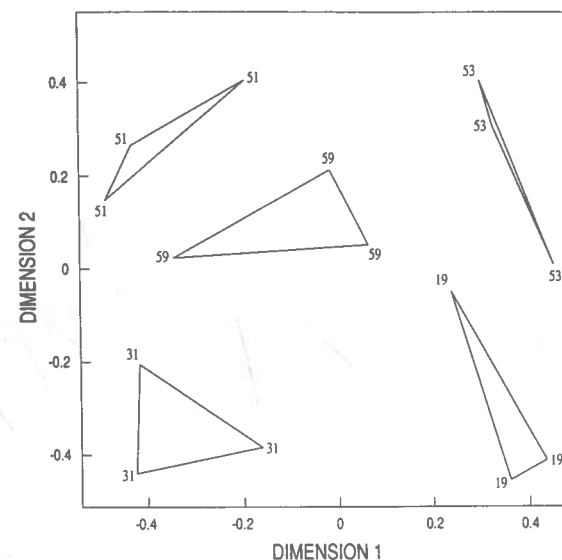


FIG. 4. Perceptual space derived from INDSCAL analysis on the dissimilarity scaling data.

axis, going from white to brown, and one texture axis going from hard to porous. The other attributes are highly correlated with these attributes. Figure 3 shows plots of each of the three consensus spaces superimposed on the sample plot, derived from GPA on each of the three replicate profile assessments subsequent to the three individual solutions. It is apparent that the figures are very similar (identical samples explaining dimensions 1 and 2 and the clockwise order is the same). Comparing projected spaces, with reduced dimensionality, in this fashion can only be performed as a pragmatic comparison, since the axes given by consumers are never labelled. It will thus have to be verified through subsequent tests that in this case the consumers emphasise colour and texture to be the main important attributes responsible for their special mapping. Using the mapping approach therefore is consistent with the analysis of the mapping data and does not alter the comparison in terms of sample structure.

Dissimilarity scaling

INDSCAL, followed by GPA, produced the two dimensional plot of the samples shown in Fig. 4.

Projective mapping

The reactions from the assessors (see Materials and Methods) triggered the potential of an introduction to this technique to be used with untrained consumers as a means of interpretation of dimensions in descriptive data. Samples both profiled and mapped in a focus group session, for example, will then provide information both on the underlying phenomena and the relative importance of these to the consumer.

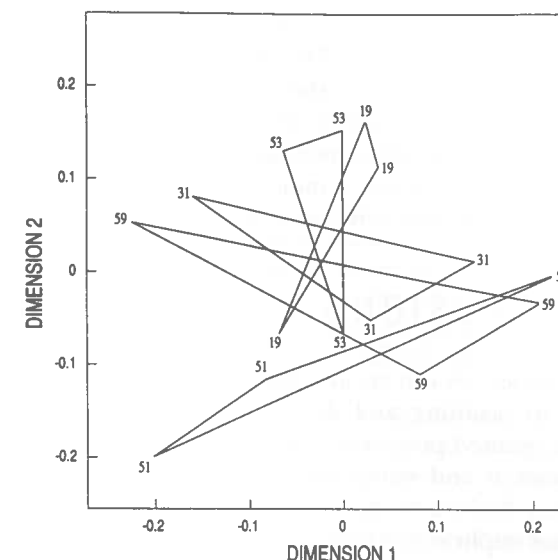


FIG. 5. Consensus perceptual space after generalized Procrustes analysis on the map coordinates for each individual.

The advantage of the projective map approach, rather than using dissimilarities between samples in a pair, is that there are less samples to evaluate, and hence less work for the assessor. It is also arguably an easier task for the assessor than profiling and dissimilarity scaling. However, to evaluate if all assessors have similar maps, it is first necessary to compare them; this is not easy visually when there are a lot of comparisons. Thus, the maps need to be placed on top of each other in order that groupings of the samples can be examined. One way of achieving a meaningful comparison is by the application of GPA.

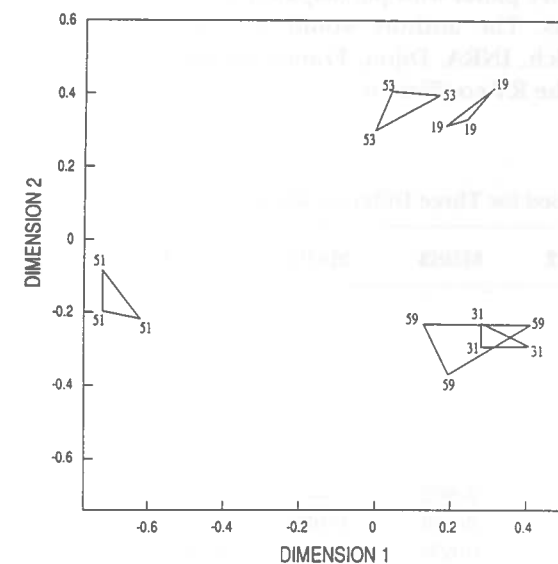


FIG. 6. Consensus perceptual space after generalized Procrustes analysis on the three replicate perceptual maps derived from generalized Procrustes analysis on the map coordinates.

Figure 5 shows the consensus perceptual space after GPA on the map coordinates for each individual. The poor replication is immediately apparent, though this is not as bad as it first seems. Since the three replicates provided by each individual were made on three separate occasions, it is perfectly feasible that they have flipped and rotated, stretched and shrunk, and translated their own perceptual spaces. This was apparent from further examination of the raw data. Thus, while an individual may provide a structurally similar sample space on three occasions, these must be adjusted to fit on a common sample space. To overcome this problem, the data from the three replicates were submitted to separate GPAs and three consensus spaces derived. The consensus coordinates from each space were submitted to further GPA to examine similarity of structure. Figure 6 shows the final result, and it is readily seen that a similar picture was obtained from the three replicates of the experiment. The question is whether this space (Fig. 6) is similar to that derived from the profiling or dissimilarity scaling experiment.

Comparison of the three methods

Figure 7 shows the result of the GPA to compare the projective mapping space with the sensory profiling space. It is apparent that a very similar sample space is obtained from both methods, with respect to overall structure. However, the variation between replicates for Samples 19 and 53 is greater for the sensory profiling space.

Figure 8 shows the result of the GPA to compare the projective mapping with the dissimilarity scaling space. It is apparent that the sample spaces are very similar in overall structure, though in the cases of Samples 19, 31,

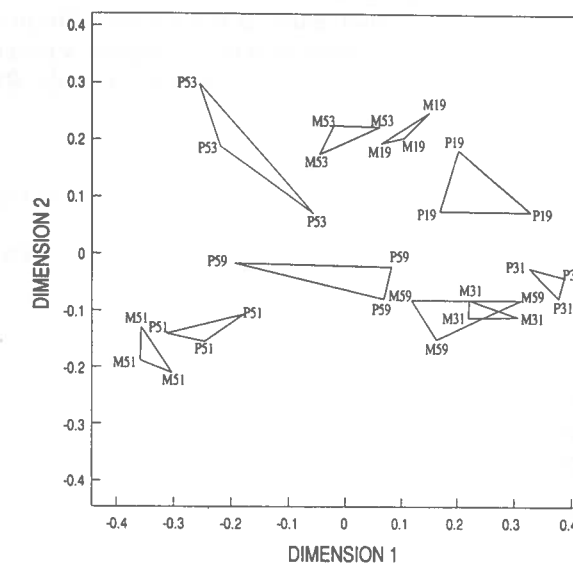


FIG. 7. Projective mapping and conventional profile sample spaces superimposed on the same plot, after generalized Procrustes analysis (M = Projective Mapping, P = Conventional Profile).

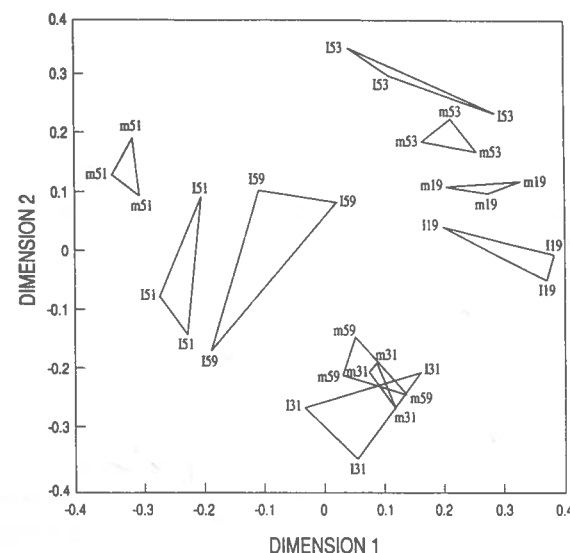


FIG. 8. Projective mapping and INDSCAL sample spaces superimposed on the same plot, after generalized Procrustes analysis (M = Projective Mapping, I = INDSCAL).

51 and 59, a much larger variation between replicate positions is evident for the dissimilarity space.

Table 1 shows the result of calculating the RV coefficient on each pair of sample maps produced. As there were in effect 9 sample maps, 3 for each method, a total of 36 comparisons were made. The idea behind this analysis was to determine whether any two methods of data collection were more similar, and to determine which method was most internally consistent.

Taking the first point, it is clear that no definite trend is suggested by the results, though there is an indication that the conventional profile results are more similar to the mapping than the multidimensional scaling results. On the other hand, it is clear that the projective mapping results show that the similarity between maps is high over repeated experiments with RV

coefficients of > 0.9. The MDS was the poorest performer in this respect. This is most likely to be due mainly to the data from the projective mapping being two-dimensional initially, whereas for the two other methods the two-dimensional results are approximations and there is much more freedom for differences between replicates to be present.

CONCLUSIONS

This paper set out to investigate an alternative procedure to profiling and dissimilarity scaling. The technique, named projective mapping, was successful in its application and could meaningfully be related to attributes derived from conventional profiling. This result has implications for linking consumer research and sensory studies. A common procedure in focus group discussions, and with individual interviews, is to ask the group or individuals to arrange products according to how they see them to be similar and different. This can either be with respect to the 'whole' product or the sensory attributes of the product. Reasons for the product placement are then discussed, but often a little more depth may be required for (re)formulating the products. Such depth from the sensory angle can therefore be obtained from the linking of the consumer projective maps and the trained panel sensory attribute data.

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TABLE 1. RV Coefficient Between Spaces Described for Three Different Methods

	CP1	CP2	CP3	MDS1	MDS2	MDS3	MAP1	MAP2	MAP3
CP1	—								
CP2	0.610	—							
CP3	0.538	0.865	—						
MDS1	0.612	0.679	0.423	—					
MDS2	0.644	0.767	0.657	0.894	—				
MDS3	0.574	0.724	0.814	0.226	0.431	—			
MAP1	0.487	0.885	0.824	0.438	0.498	0.805	—		
MAP2	0.537	0.839	0.756	0.464	0.535	0.789	0.952	—	
MAP3	0.373	0.829	0.724	0.522	0.517	0.669	0.967	0.935	—

CP = Conventional Profile.

MDS = INDSCAL, Multidimensional scaling.

MAP = Projective Mapping.

1, 2 and 3 relate to the three replicates.