

Discovering Missing Dimensions:
A Comparison of Sorting and Nappe
Analyses by Multidimensional Scaling
and Multifactor Analysis

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Sorting

- Products grouped (2 to N-1 groups)
 - Nominal level data
 - Sum of co-occurrences counted as an index of similarity for MDS input
- Avoided the paired comparison dilemma
 - $N \times (N-1)$ pairs to test, unwieldy for foods
- Lawless, H. T. 1989. Exploration of fragrance categories and ambiguous odors using multidimensional scaling and cluster analysis. *Chemical Senses*, 14, 349 - 360.

Projective Mapping

- Introduced by Risvik and colleagues in 1994
- Products placed on a surface, positions recorded, distances computed (interval data)
- Aka “nappe” from Fr. “tablecloth” (Pages, 2005)
- Analyzed by multifactor analysis (MFA)
- Risvik, E., McEwan, J. A., Colwill, J. S., Rogers, R., & Lyon, D. H. (1994). Projective mapping: A tool for sensory analysis and consumer research. *Food Quality and Preference*, 5, 263 – 269.
- Pagès, J. (2005). Collection and analysis of perceived product interdistances using multiple factor analysis: application to the study of 10 white wines from the Loire Valley. *Food Quality and Preference*, 16(7), 642-649.

Subsampling

- Subjects attend to different dimensions of a multidimensional product

Sorting, nappe, MDS

May give a distorted picture

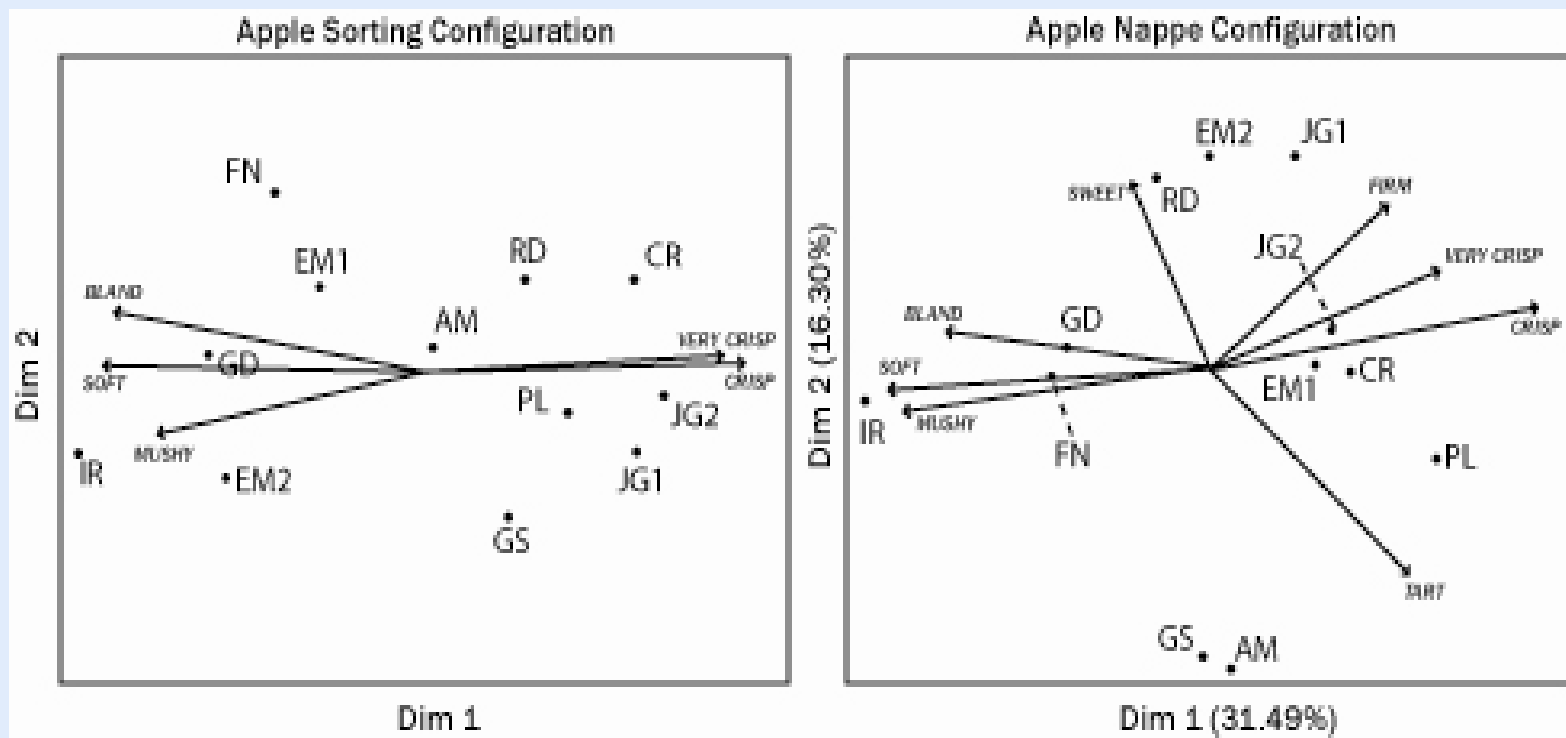
Unless individual differences modeling is used

Projective Mapping/Sorting Issue?

- What happens if different subjects attend to different sensory attributes (dimensions)?
- If some attributes are “left out” by some groups of subjects, can the analyses recover those dimensions?
 - MFA should, in theory do this, as it is an individual differences model
 - Sorting/MDS, based on group totals, may not

Recent Studies (Cornell Sensory Group)

- Nestrud, M. and Lawless, H. T. Perceptual mapping of citrus juices using nappe and profiling data from culinary professionals and consumers. Food Quality and Preference, 19, 431 – 438.
- Nestrud, M. and Lawless, H. Perceptual mapping of apples using projective mapping and sorting (see poster, this meeting).



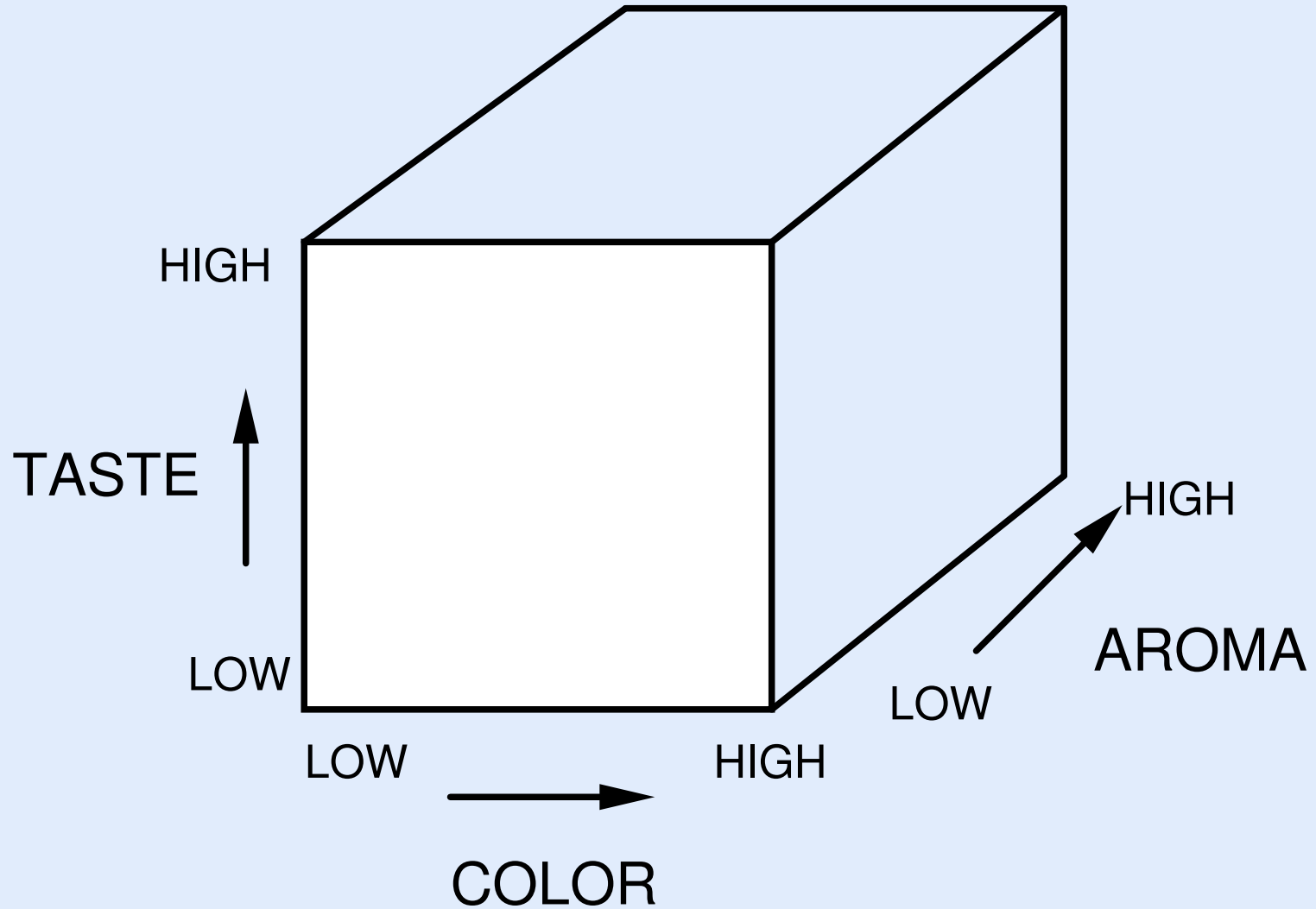
The Simulations

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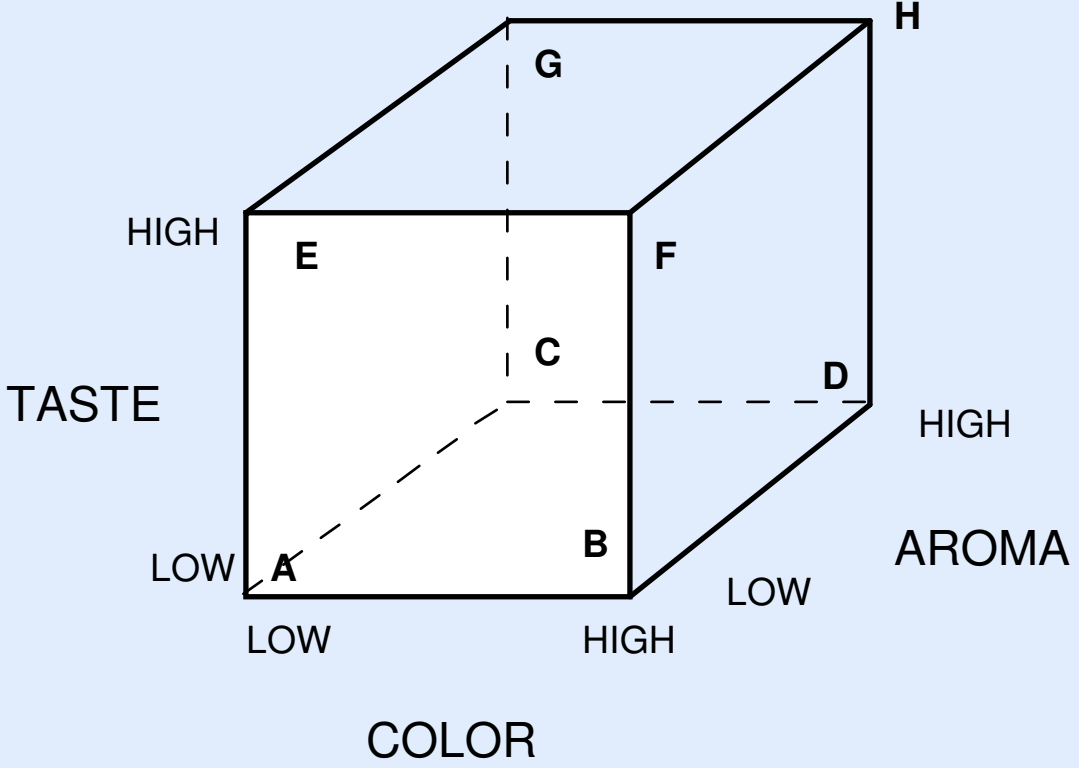
Design

- 8 products in a 2 X 2 X 2 factorial
 - E.g low and high levels of taste, aroma, color
- 15 subjects in three subgroups
- Each group attends to only 2 attributes, omits one
- Simulated placements (e.g. mean of 3 and 8 for nappe with added error ± 0.2)
- Simulated groupings for sorting (four groups per subject)

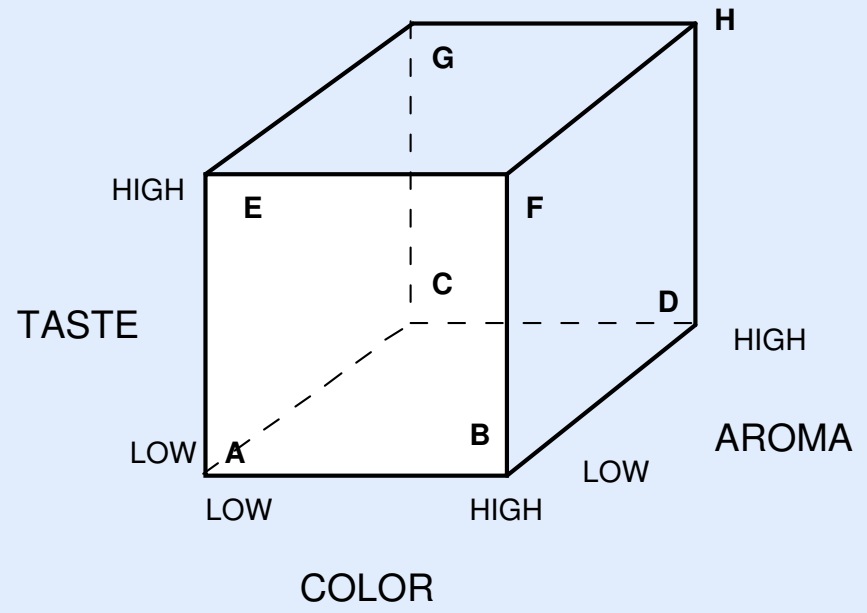
ORIGINAL DESIGN



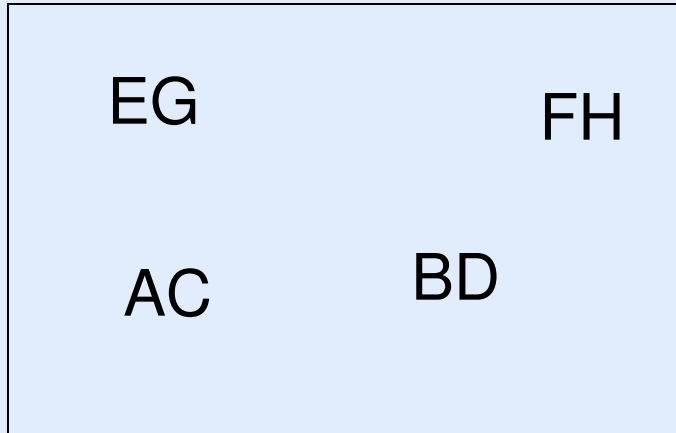
Products: A - H



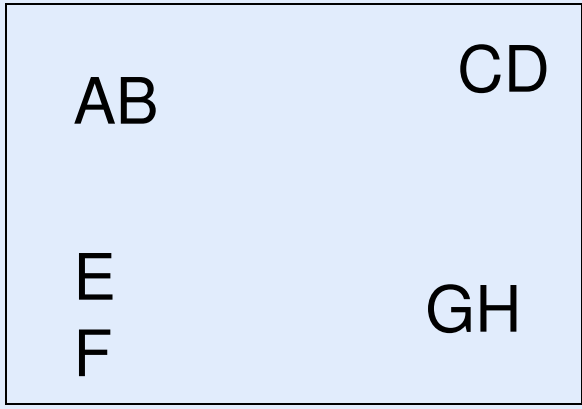
Products: A - H



Subsampled nappe:
Color/taste (ignores aroma)



Subsampled nappe:
Taste/aroma (ignores color)



Analyses

- Multifactor analysis,
FactoMineR for nappe data
- SYSTAT MDS
nonmetric, Kruskal stress
(KYST-type algorithm)

MFA Percent of Variance

Factor:	1	2	3	4
2 group	49.4	25.6	24.4	0.3
3 group	34.1	34.1	30.2	1.0

Results - MFA

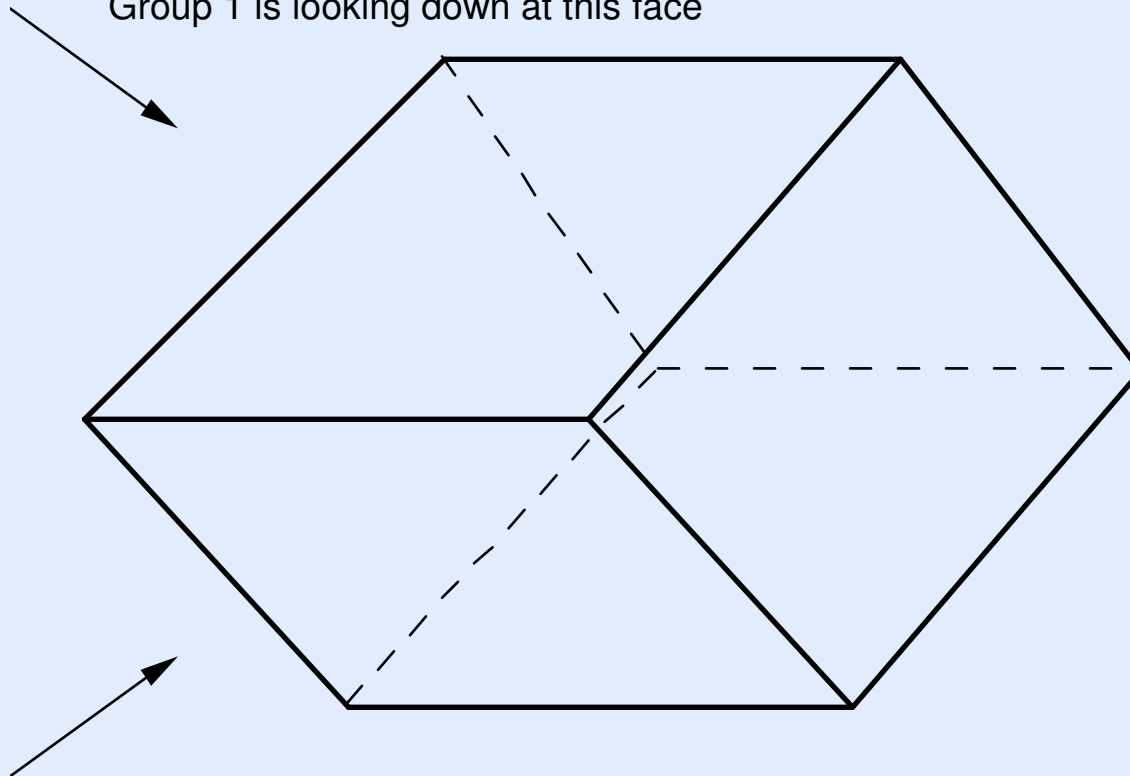
- For two-group analyses, inertia was ~25% for two factors (each unique attribute?) and 50% for the other factor (the common attribute?)
- For three group analysis, inertia was ~ 33% for each of the first three factors.

Results - MFA (cont.)

- The plotted factor scores recovered the “cube” of the original design, but it was not in an orientation where obtained factors were parallel to the original design factors (e.g. cube on an edge or on a vertex)
- Inspection of the factors with no prior knowledge would not lead to interpretation.

MFA solution of 2 group simulation

Group 1 is looking down at this face



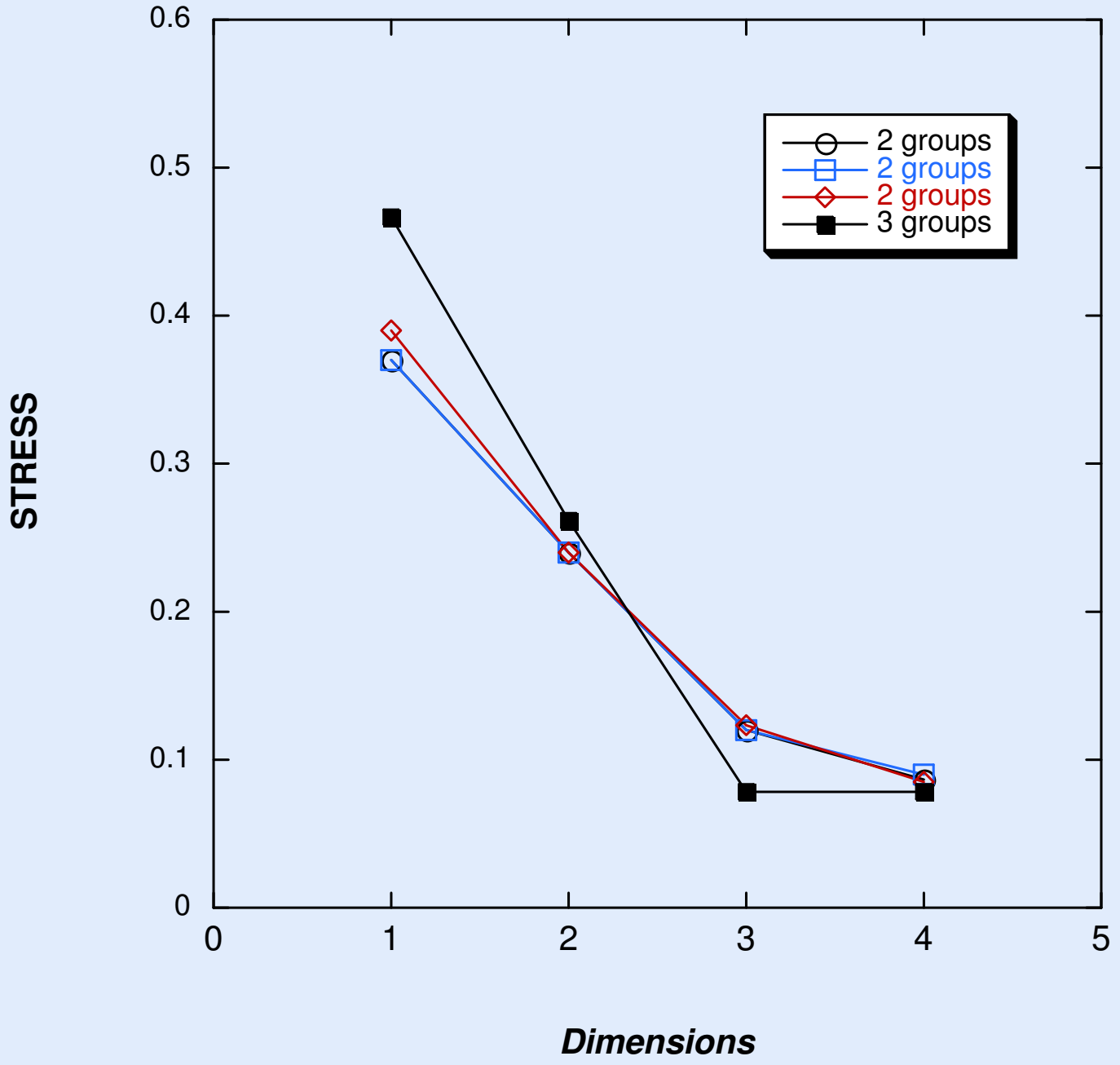
Group 2 is looking up at this face

The MFA orients Factor 1 to the shared dimension and "discovers the third dimension" but angles the two subsampled (weak) dimensions at 45 degrees of the plotted factors.

Because of the 45 deg rotation of the configuration
(vs. the original design)
The panelists are partially correlated/weighted
with both Factors 2 & 3
even though they only “considered” two original dimensions

Results - MDS

- Scree plots of stress vs. dimensions indicate three dimensions are appropriate.
- Two group analyses always recovered the common dimension
- However, the plotted configurations did not produce dimensions parallel to the original design factors
 - E.g. two opposing pyramids



Simulation Part 2

- Simulated “rating data” regressed against coordinates (analogous to external Prefmap) to plot best fitting vectors (in 3-D)

Results:

- Vectors fit design factors
 - AND nearly orthogonalfor both MDS and MFA

Conclusions

- Both MDS of sorting data and MFA of nappe data can recover subsampled dimensions (MFA somewhat “cleaner”)
- However, configurations yielded may not be readily interpretable.
- Use of additional scaling data may aid significantly in interpretation

Practical Value

- Projective mapping (nappe) with MFA need not constrain output and discovery to two dimensions/attributes.

Unanswered Questions

- What does GPA do with this problem?
 - Groups in this simulation not rotatable!
- What do people do with the tablecloth?
 - Emphasize the horizontal?
 - Use 2 or more than 2 attributes?
 - How much subsampling or individual variation occurs?