

## Multivariate techniques for sorting data: DiSTATIS and Discriminant DiSTATIS

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**Problem:** Sorting tasks are frequently used to study the psychology of sensory perception and consumer preference. In a sorting task, participants sort items into groups based on perceived similarity. Sorting usually reveals an intuitive structure amongst the items of interest. Sorting tasks are advantageous because they require little-to-no training and do not quickly fatigue participants (Cartier et al., 2006; Chollet, Valentin, & Abdi, 2014). Furthermore, sorting tasks can be used to compare experts and non-experts: populations that may use different vocabulary, but may or may not report the same relationships between items of interest. Sorting tasks have been analyzed by various univariate and multivariate approaches (for review see Ares '14), but most often—especially in the food sciences—they are analyzed by metric multidimensional scaling (MDS; Abdi, 2007). However, MDS loses data from individual assessors, and so cannot investigate effects of assessor expertise.

**Methods:** A recent adaptation of MDS called DiSTATIS (Abdi, Williams, Valentin, & Bennani-Dosse, 2012; Valentin, Chollet, & Chrea, 2007) can investigate effects of assessor expertise. MDS and DiSTATIS both convert distance (dissimilarity) matrices into cross-product matrices so they can be analyzed with the eigen-decomposition (which provides features such as explained variance, orthogonal components, and component maps). Unlike MDS, DiSTATIS is specifically adapted to reveal the perceived dissimilarity among items of interest (as does MDS), but also allows us to investigate individual (or group) differences.

**Results:** Here we present DiSTATIS—and its discriminant extension—applied to two studies in music cognition. In one experiment, assessors sorted into 3 categories 21 sound clips of classical music written by 1 of 3 composers (Bach, Beethoven, or Mozart) as played on a midi-synthesizer. In the other experiment, assessors sorted 36 sound clips of classical music written by 1 of (the same) 3 composers but played by 1 of 4 pianists (Arrau, Barenboim, Pirès, or Richter). Assessors were binned into low and high musical experience (i.e., expertise). In addition to investigating effects of composer, effects of pianist, and composer-pianist interactions, DiSTATIS (unlike MDS) revealed effects of musical expertise and differences between individuals.

**Conclusions:** This study was selected because music cognition involves both implicit and (for expert assessors in particular) explicit knowledge, and so a sorting task (analyzed by DiSTATIS) could reveal effects of musical expertise (i.e., between-assessor effects). We highlight how sorting tasks are useful in studies on perception, and how DiSTATIS and its discriminant extension provide insight into the intuitive structures within sorting data.