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Modeling target group heterogeneity in experimental consumer studies

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ABSTRACT

Acceptance of a product by a consumer may result from a convoluted interplay between product attributes and individual characteristics of that consumer. Different methods that systematically combine product properties with consumer groups segmented on such characteristics have provided unprecedented insight, but ignore heterogeneity in acceptance within each consumer group. Although such knowledge is invaluable for targeted marketing, dedicated methods for consumer group heterogeneity are lacking. The authors aim to fill this gap by the Individual Differences (InD) method, which models differences between consumers within the same target group. The method scores the 'diffusion' within each group, shows how much each consumer contributes to that, and relates this information to product properties. Thereby also novel groups may be discovered, with attributes not covered in the consumer segmentation. The illustrative consumer study on apple juice reveals how young women differ in their price-consciousness and their acceptance on specific preparation technologies more than older women. Although men exhibit heterogeneity on the same product attributes, their mutual variability is considerably lower and they thereby form more homogeneous target groups.

1. Introduction

In consumer studies, conjoint analysis (Green & Rao, 1971; Green & Srinivasan, 1978) is widely used to systematically study how several product factors may affect consumer acceptance, preference or choice. These factors are combined into product "prototypes" that are presented to consumers, which are subsequently asked to rate, rank or choose products based on their preferences (Louviere, 1988; Louviere, Hensher, & Swait, 2000). The resulting data may then be analyzed by Analysis of Variance (ANOVA) (*e.g.* Næs, Brockhoff, & Tomic, 2010) or Generalized Linear Models (GLM) (Nelder & Wedderburn, 1972). The present paper will focus on rating-based methods.

In conjoint analysis both general tendencies in the population and individual differences between consumers are important (Green & Krieger, 1991; Moore, 1980; Næs, Kubberød, & Sivertsen, 2001; Menichelli, Hersleth, Almøy, & Næs, 2014). The understanding of consumer acceptance can also go beyond the general population and differences between consumer target groups, uncovering acceptance at the level of an individual consumer, *i.e.* the individual differences within consumer target groups. Quantitative information on such 'consumer group heterogeneity' is crucial for developing optimally targeted marketing strategies. Consumer heterogeneity is a long-standing research subject, in econometrics and business studies (Allenby, Arora, & Ginter, 1998; Allenby & Rossi, 1998; Chintagunta, Jain, & Vilcassim, 1991; Rossi, McCulloch, Allenby, & Greg, 1995). Allenby and Rossi have considerably developed this concept in marketing studies, as complementary to 'aggregate studies' that regard heterogeneity as a 'nuisance' (Allenby & Rossi, 1998). Other studies aimed to model this heterogeneity according to either product attributes (Fader & Hardie, 1996; Keane & Wasi, 2012; Otter, Tüchler, & Frühwirth-Schnatter, 2004) or consumer characteristics (Ortega, Wang, Wu, & Olynk, 2011). Only few studies have been devoted to understanding consumer individual differences according to both product and consumer information (Endrizzi, Menichelli, Johansen, Olsen, & Næs, 2011; Menichelli, Almøy, Tomic, Olsen, & Næs, 2014; Menichelli, Hersleth et al., 2014). However, none of these studies focuses on quantifying the heterogeneity among consumers within the same target group, and on associating such heterogeneity to specific product attributes or the relevant consumer characteristics, such as age and gender.

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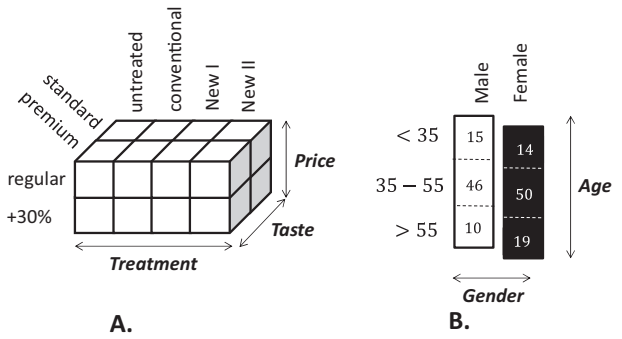

Fig. 1. (A) Conjoint product design of 16 products that systematically vary in treatment, taste and price. (B) Consumer segmentation according to gender and age cohort. The number of consumers in each segment is indicated in the figure.

Insight on relevant consumer characteristics may be extracted by two alternative approaches for consumer segmentation in acceptance studies (Næs et al., 2010; Wedel & Kamamura, 1998; Westad, Hersleth, & Lea, 2004). *A posteriori* segmentation starts by analyzing the acceptance pattern of all consumers and then subdividing them into groups with similar acceptance, thus relating these to the consumer characteristics by regression (Menichelli, Olsen, Meyer, & Næs, 2012; Næs et al., 2001) or tabulation (Helgesen, Solheim, & Næs, 1997). *A posteriori* segmentation introduces such consumer characteristics at a late stage of the analysis and is therefore highly unsupervised; the data-driven findings from such models are thereby highly reliable, but relevant target groups may be lost and quantification of the heterogeneity within each consumer target group is challenging.

A priori segmentation, that defines consumer target groups according to their characteristics before associating their acceptance patterns to the conjoint product design (*e.g.* Menichelli, Hersleth et al., 2014) is more supervised, thereby more likely to find patterns that link consumer characteristics to product attributes. Introducing consumer characteristics as factors in an ANOVA model of consumer acceptance (Næs et al., 2010) thereby requires statistical validation. It furthermore holds the risk of leaving out relevant consumer segments, based on characteristics not used in the segmentation. Although both approaches have proven their merit on associating product attributes to specific target groups in explaining acceptance, neither explores the variability among consumers within each target group.

However, consumer group heterogeneity – the 'diffusion' of acceptance within each group – is essential to comprehensively understand the interaction between individual consumers and product attributes. Acceptance may be more variable in one target group than in another, which may depend on the characteristics of the targeted consumer groups in several ways. For example, when the acceptance of a specific target group is relatively high, the variability of that acceptance among individual consumers within that group may be large too (*i.e.* heteroscedastic, see Huber, Herrmann, & Wricke, 2001). Specific consumer groups may also be affected by heterogeneity in personality characteristics (Dall, Houston, & McNamara, 2004), which may reflect in larger or smaller deviations in consumer acceptance. Thirdly, when (maybe even unknown) relevant consumer characteristics were not used in the segmentation, the associated differences in acceptance end up in the residuals of an *a priori* segmented model of consumer acceptance.

In this paper we propose the multivariate data analysis approach Individual Differences (InD) to quantitatively model and reveal such advanced patterns of systematic consumer group heterogeneity, by extending *a priori* segmentation. InD is novel to consumer studies, but has already provided highly insightful understanding of experiments in ecology, personality research and personalized health (Jansen, Szymańska, Hoefsloot, & Smilde, 2012; Jansen et al., 2012; Timmerman & Kiers, 2003). We will show how this model-driven approach gives an information-rich and targeted view on consumer group heterogeneity, by multivariate components that are familiar from standard techniques like Principal Component Analysis (PCA; Jolliffe, 2005; Mardia, Kent, & Bibby, 1979).

We demonstrate InD by an *a priori* segmented consumer study based on a conjoint product design of apple juices (Endrizzi et al., 2011; Olsen et al., 2011). Methodologically, we adapt the existing InD approach here to build upon the results of an ANOVA-based method presented in Endrizzi et al. (2011) for the insight into consumer individual differences; the specifically built residuals of this model are used here as input to explore the variation in consumer heterogeneity within age and gender-segmented target groups and its relationship to the conjoint juice properties.

2. Materials and methods

2.1. Data set

The data set is obtained from a conjoint consumer study on the effect of information about production technology on stated choice preferences for apple juice (Endrizzi et al., 2011; Olsen et al., 2011). The conjoint design was fully factorial in three factors, being the production/storage *treatment* (untreated, conventional and two new production methods), *taste* (standard or premium) and *price* (regular or +30%). This design is depicted in Fig. 1A.

In total, 154 Norwegian consumers were asked to imagine that they were going to the store for buying apple juice and to carefully read each of the sixteen product descriptions, presented in a randomized order. They were then asked to indicate, on a 7 point Likert scale, with 1 = "not very likely" and 7 = "very likely", the likelihood they would choose these juices. The consumers were split in two groups: one of the groups got the questionnaire in their house and tasted real samples, the respondents in the other group received only verbal information since recruited via web. *Information* was thus incorporated as additional factor in the analysis, but is not of main interest in this study of consumer group heterogeneity. The consumers answered also questions about socio-demographic attributes such as age and gender. We segment consumers into target groups based on gender and three age cohorts (<35, 35–55, >55).

Fig. 1B shows the segmented consumer target groups. The relatively small number of consumers in each of the groups is justified by our main purpose of illustrating the novel InD methodology, which means the model observations should be regarded as overall tendencies. We however support these by thorough, bootstrap-based statistical validation. For the purpose of this paper only the experimental aspects relevant for presenting the methodology will be covered, full details are available in Olsen et al. (2011).

2.2. Conjoint analysis

The effect that the conjoint factors have on the target groups can be quantified by a linear model that decomposes consumer acceptance into contributions given by the different conjoint factors in the product design, the characteristics along which we segmented the consumers, interactions between these two and an additive level effect in acceptance for each individual consumer. With for instance three conjoint factors and three consumer characteristics taken into account, the model can be written as: