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# When and why attribute sorting affects attribute weights in decision-making

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ABSTRACT

Information about alternatives often appears in a multi-option multi-attribute table, with the alternatives hierarchically sorted on attribute levels. This research shows that the choice of the primary sorting attribute can affect peoples' evaluations. Three studies show that the attribute on which options are primarily sorted becomes more important in preference formation, but only if this attribute is hard to evaluate. This sorting effect disappears if attribute level evaluation is rendered easier. Eye-movement data further show that the time to evaluate a given attribute level, a proxy for evaluation effort, mediates the effect of choice of sorting attribute on attribute weight in option evaluation.



## 1. Introduction

When having to make decisions, people may consult attribute information about different alternatives. This attribute information can be displayed in a table, with each row corresponding to an alternative and each column corresponding to an attribute (Cai & Xu, 2008; Diehl, Kornish, & Lynch, 2003). Multi-option multi-attribute tables provide a readily accessible summary of various choice alternatives available and are a popular way of presenting different choice options, especially on websites. Such tables often use a hierarchical sorting scheme in which all options are ranked on some attribute first, and in case of ties, on subsequent attributes. The aim of the present paper is to investigate how the choice of primary sorting attribute affects how people use the attribute information contained in the table. In particular, the current research examines why and when the choice of sorting attribute affects its weight in decision-making.

Prior research suggests that the choice of the primary sorting attribute may indeed affect the role of the included attributes and, hence, affect the way in which people evaluate the alternatives (Dhar & Simonson, 1992; Diehl & Zauberman, 2005). For example, when camera options are sorted by quality, cameras that score higher on quality may be evaluated better than lower quality cameras. Conversely, better-priced cameras may be evaluated higher than more expensive cameras when they are sorted by price (Cai & Xu, 2008). The present paper extends this work in three aspects. First, while prior research focuses on sorting (vs. not sorting), the current research focuses on sorting on one attribute (rather than another one). Second, prior research has not documented why sorting may affect decision-making. Understanding the underlying mechanism is important to identify potential boundary conditions. Third, the present paper uses eye-movement data to better understand how sorting impacts people's processing of information in multi-option multi-attribute tables.

## 2. Sorting and (ease of) evaluation

Evaluation of attribute levels often implies determining the relative position of a given attribute level in a relevant distribution of attribute levels (Stewart, Chater, & Brown, 2006). To determine this relative position, people can rely on distributional information acquired through learning from previous experiences. If they have only limited knowledge of alternative relevant attribute levels though, they may try to construct a reference distribution using attribute-level information in the immediate context in which a decision is made (Stewart et al., 2006).

Sorting options on a given attribute makes evaluation of attribute levels easier. In fact, the rank of an option informs on the ordinal position of its level on the primary attribute. In best-to-worst rankings for example, an attribute level in second place clearly refers to the second-best attribute level. So, sorting options on a particular attribute facilitates the interpretation of the options' values on this attribute (Suk, Lee, & Lichtenstein, 2012). Attributes that are easier to evaluate are more likely to become more active in peoples' minds. In turn, higher accessibility may affect the degree to which the attribute will be used in consumers' evaluation (e.g., Higgins, 1996). Conversely, a less evaluable attribute might be less accessible and, hence, be less processed by the consumer. Consequently, the primary sorting attribute likely will

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be more used in peoples' decisions (Slovic & MacPhillamy, 1974). In other words, the weight of an attribute in multi-attribute decision-making may increase when that attribute is selected as the primary sorting attribute in a hierarchical sorting scheme.

The idea that sorting renders attribute level evaluation easier implies that the distinction between relatively more and less evaluable attributes (González-Vallejo & Moran, 2001; Hsee, 1996; Hsee & Zhang, 2010) may be an important moderator of the sorting effect. Attributes are easily evaluable if the evaluator possesses an innate reference system for making attribute-level evaluations, or can draw on relevant past attribute-level information. In both cases, evaluations should be relatively effortless, and whether the options are sorted on these attributes or not should not influence the ease or difficulty of processing this information. Less evaluable attributes instead are those for which the evaluator has neither an innate reference system nor access to relevant past attribute-level information. Less evaluable attributes thus require that people compare attribute levels of the various available options to assess its position in a reference distribution. Because the processing of less evaluable attributes depends critically on the comparison of currently available options, the sorting effect should particularly influence the use of hard-to-evaluate attributes, and consequently their weight.

In sum, the current article proposes that 1) sorting renders attribute level evaluation for the sorting attribute easier, and 2) people more readily use information they find easy to process (Russo, Staelin, Nolan, Russell, & Metcalf, 1986; Simonson, Bettman, Kramer, & Payne, 2013). This idea implies that not all attributes may equally benefit from being selected as the sorting attribute but rather that the weight of an attribute only increases when selected as the sorting attribute if the attribute levels are hard-to-evaluate (Hsee & Zhang, 2010).

## 3. Study 1: the sorting effect and the role of attribute evaluability

Study 1 investigates how option attractiveness and attribute weight are affected by the choice of the attribute on which options are sorted. Options with a good value on a given attribute should be evaluated as more attractive when the options are sorted on this particular attribute versus when options are sorted on another attribute. Moreover, this study examines whether this sorting effect is moderated by attribute evaluability, as the theoretical framework proposes.

### 3.1. Method

Sixty-four students (mean age = 20 years, SD = 1.94; 40 women) participated in a lab experiment in return for a small fee. They received information about 10 different fictional Internet subscription options (labeled A to J) regarding two attributes: monthly *subscription cost* (in Euros) and *download speed* (in megabytes per second [Mbps]). The subscription costs ranged from 10 to 60 Euros per month, and the download speed ranged from 4 to 30 Mbps. Across the 10 Internet subscriptions, the values of these attributes were unrelated ($r = .06$). For half of the participants, the options were sorted on download speed, whereas for the other half, the options were sorted by monthly subscription cost. All participants indicated the attractiveness of the subscriptions on a scale from 0 (very unattractive) to 100 (very attractive).

A pretest assessed attribute evaluability (cf. Hsee, 1996). Fifty respondents (mean age = 37 years, SD = 15.76; 27 women) rated how well they could evaluate a given attribute level for both attributes on a four-point bipolar scale (1 = I don't have any idea; 4 = I have a clear idea). Subscription costs were regarded as significantly more evaluable than download speed ($M = 2.76$ vs. $M = 1.94$, $F(1,49) = 25.99$, $p < .001$).

### 3.2. Results and discussion

To investigate the effect of choice of sorting attribute on attribute weight, a regression analysis is used to derive these weights (Van Ittersum, Pennings, Wansink, & van Trijp, 2007). Because respondents have rated the attractiveness of all ten choice options, option evaluation is nested within respondents, which necessitates the use of multilevel regression analysis[1]. The estimated regression model includes the evaluation of the Internet subscriptions as the dependent variable, and the scores on both attributes as predictors. The choice of sorting attribute appears as a dummy predictor. The regression model also includes all possible interactions between the predictors. The beta weights reflect the relative influence (weight) of each attribute (Harte & Koele, 1995). The effect of choice of sorting attribute on the weight of attributes in peoples' evaluations is investigated by looking at the interaction terms between sorting and the attributes (*subscription cost* × *sorting* and *download speed* × *sorting*). To facilitate the interpretation of these interactions, both attributes are standardized, so the regression coefficients associated with the attributes indicate the increase in attractiveness associated with a 1 SD increase on the attribute, conditional on the other attribute having an average level.

The main effects for both attributes indicate that, on average, people evaluate an Internet subscription as more attractive when the monthly subscription cost decreases ($\beta = -19.75$, $t(62.06) = -21.75$, $p < .001$) and the download speed increases ($\beta = 19.48$, $t(62.14) = 20.86$, $p < .001$). An interaction between the two attributes ($\beta = -7.88$, $t(62.99) = -7.38$, $p < .001$) reveals that participants trade off the values of both attributes to evaluate attractiveness (Westenberg & Koele, 1994). More relevant for this research, however, are the interactions between each attribute and the choice of sorting attribute. A significant interaction between download speed and choice of sorting attribute ($\beta = -3.15$, $t(122.33) = -2.50$, $p < .014$) indicates that the influence of download speed on the perceived attractiveness is significantly higher when the options are sorted on download speed ($\beta = 19.48$, $t(62.14) = 20.86$, $p < .001$) rather than on subscription cost ($\beta = 16.33$, $t(62.92) = 19.30$, $p < .001$). In contrast, the influence of subscription cost on perceived attractiveness is not moderated by the choice of sorting attribute ($\beta = 2.00$, $t(124.03) = 1.56$, $p = .12$). Finally, the absence of a significant three-way interaction between download speed, subscription cost, and choice of sorting attribute ($\beta = 1.99$, $t(125.93) = 1.31$, $p = .19$) indicates that participants require approximately the same increase in download speed to accept a given price increase, in both rankings.

As Fig. 1 depicts, the slope of download speed – representing this attribute's weight – is steeper when the options are sorted on download speed than when they are sorted on subscription cost. However, although the three-way interaction between download speed, subscription cost and choice of sorting attribute is not significant, the trade-off between download speed and subscription cost (i.e., their two-way interaction) implies a qualification of the interaction of download speed and choice of subscription cost. In fact, simple slope analysis reveals that the slope of download speed increases significantly when sorted on download speed when the subscription cost is low (1 SD below the mean; $\beta = 5.14$, $t(119.92) = 2.46$, $p = .015$) but not when the cost is high (1 SD above the mean; $\beta = 1.16$, $t(122.42) = .63$, $p = .53$).

A spotlight analysis reveals that good options may benefit from sorting on download speed. Indeed, fast and cheap Internet subscriptions are evaluated as significantly more attractive when the subscriptions were sorted on download speed versus when sorted on subscription cost ($M = 89.22$ vs. $M = 82.14$, $t(58) = 2.62$, $p = .011$). This difference, however, is not obtained for more expensive and fast subscriptions ($M = 33.61$ vs. $M = 33.93$, $t(58) = .08$, $p = .93$), for slow and

[1] The interpretation of multilevel regression parameter estimates is the same as in an ordinary linear regression, but the standard errors of the parameters are adjusted to acknowledge the evaluation of all 10 Internet subscriptions. Statistical criteria such as Akaike's Information Criterion (AIC) specified the most suitable error covariance structure as unstructured, which supports both correlations between measurements and differing variances of measurements. Satterthwaite's approximation was used to estimate the degrees of freedom in the statistical tests, which may produce fractional degrees of freedom (Litell, Stroup, & Freund, 2002).