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# The Interactive Choice Aid: A New Approach to Supporting Online Consumer Decision Making

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## Abstract

Interactive Choice Aid (ICA) is a decision aid, introduced in this paper, that systematically assists consumers with online purchase decisions. ICA integrates aspects from prescriptive decision theory, insights from descriptive decision research, and practical considerations; thereby combining pre-existing best practices with novel features. Instead of imposing an objectively ideal but unnatural decision procedure on the user, ICA assists the natural process of human decision-making by providing explicit support for the execution of the user's decision strategies. The application contains an innovative feature for in-depth comparisons of alternatives through which users' importance ratings are elicited interactively and in a playful way. The usability and general acceptance of the choice aid was studied; results show that ICA is a promising contribution and provides insights that may further improve its usability.

**Keywords**: consumer decision-making, decision aids, online marketing, preferential choice, e-commerce

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# INTRODUCTION

As of today, the internet has almost 1.5 billion users worldwide[1] and the number of purchases that are made on the internet is constantly growing. According to Forrester research, European e-commerce will reach €263 billion in 2011, which translates to an average spending increase per customer from €1,000 in 2006 to €1,500 in 2011 (Favier and Bouquet, 2006). Given the considerable advantages that online shops provide for both buyers and sellers, this success of the internet as a platform for commerce is not surprising. As opposed to traditional brick-and-mortar stores, consumers can access online shops at any time of the day and from almost any place in the world. Online retailers, in turn, have lower expenses related to store rent and salaries of sales staff. In addition, they do not face physically imposed limits regarding the number of alternatives per product category, which typically leads to an increase in the number of products offered. This is not only an advantage for the retailer (i.e., a competitive edge), but also for the consumer who can choose from a larger set.

However, extensive choices lead to a problem that is well known to everyone who has searched for information on the World Wide Web: information overload. For example, at the time of writing, Amazon.com featured more than 3,600 products in the category "point & shoot digital cameras" alone. On one hand, having a large choice set is advantageous because the probability of finding a product that corresponds to one's needs is higher, resulting in the "allure of more choice" (White and Hoffrage, 2009). On the other hand, having many alternatives to choose from can also be problematic. In a large choice set, there are often many very similar alternatives—this makes it more difficult to decide which of the products matches the consumer's preferences best. Being confronted with too much choice has negative effects (e.g., Reutskaja and Hogarth, 2009), especially in online shopping environments where overwhelmed customers do not have assistants to guide them through the maze of products like they do in traditional shops.

We now discuss two types of decision aids that aim to reduce choice complexity and help consumers to make better decisions. Subsequently, we present the current version of the *Interactive Choice Aid* (ICA) that we developed, followed by a discussion of its strengths and weaknesses. We then briefly report a study that was conducted to provide a first test of the new choice aid and to assess its usability and acceptability in comparison to two other applications that were adapted from real-world shopping websites.

*Interactive decision aids* (Häubl and Trifts, 2000), which are implemented in many of today's shopping websites, aim to overcome the negative effects of too much choice by offering guidance and supplying functionality, thereby fulfilling some important responsibilities of shop assistants. Decision aids present and structure the available information according to the input provided by the users and can substantially increase the fit between a particular person's information needs and the information presented (Ariely, 2000). They are based on the idea that "resource-intensive but standardizable information processing tasks are performed by a computer-based system, thus freeing up some of the human decision maker's processing capacity" (Ariely, 2000, p. 6). Although the decision aids designed to achieve this functionality cannot execute a complete optimization process to find the overall best choice, they nevertheless prove to be useful because they reduce the complexity inherent in multi-attribute choice by guiding systematic exploration and structuring the solution space.

Häubl and Trifts (2000) identified two general types of decision aids: *recommendation agents* and *comparison matrices*. Recommendation agents[2] help consumers find products they are very likely to be interested in (for an excellent review of recommendation agents, see Xiao and Benbasat, 2007). The recommendations provided by these agents are either derived from past search behavior (i.e., implicit preference elicitation) or from preferences specified by the consumer (i.e., explicit preference elicitation), which typically results in a pre-selection of products (e.g., only products that are cheaper than €200). In contrast, comparison matrices display the product information in an attributes-by-alternatives matrix, which allows for a good side-by-side comparison of the products. Most of the sites featuring comparison matrices also allow users to make a pre-selection of products (e.g., www.shopping.com, www.de.o2.com); that is, the user can specify thresholds on some criteria, thereby selecting which products are displayed (e.g., only those cheaper than €200).

Electronic product recommendations can have a significant influence on the likelihood of a consumer purchasing a product. For instance, Senecal and Nantel (2004) found that consumers using a recommendation agent bought recommended products twice as often as consumers who did not receive any recommendations. Moreover, decision aids can influence not only the likelihood of a purchase, but also which product is purchased. Häubl and Trifts (2000) found that both recommendation agents and comparison matrices led to smaller but higher quality consideration sets. This is illustrated by the finding that only 7% of the participants selected a dominated alternative when using a recommendation agent as opposed to 35% without assistance. After making a purchase, aided participants also switched to another alternative far less often (21%) than unaided participants (60%). The authors concluded that each of the two types of decision aids, recommendation agents and comparison matrices, has two effects: decreased cognitive effort and increased probability of choosing a better product.

In a similar vein, Ariely (2000) conducted a series of experiments on the costs and benefits of control over the information that is displayed. He found that a high level of control was beneficial in terms of better matching of preferences, better memory of and knowledge about the examined domain, and higher confidence in making a judgment. He cautions, however, that these benefits became apparent only after participants had familiarized themselves with the application.

In sum, the rationale for the creation of a decision aid is to improve decision making; specifically, the objective is to help the decision maker to achieve a good decision outcome while keeping the effort of the decision process low. In our view, to accomplish these two goals it is useful to take into account how people typically proceed when making decisions. We argue that the *natural* process of human decision making should be assisted by providing explicit support for the execution of the users' decision strategies (cf., Reisen et al., 2008), rather than imposing a possibly objectively-ideal but unnatural decision procedure on the user (as do, for example, decision aids based on the Analytical Hierarchy Process AHP[3], Saaty, 1980; for an example, see Işıklar and Büyüközkan, 2007). The less consumers have to deviate from their natural process of choosing and the more transparent the choice aid is, the more likely they are to use and benefit from a choice aid. This assumption is supported by a recent study by Al-Natour and colleagues (2008) who found that decision aids were rated better in terms of usefulness and trustworthiness when their process was perceived to be similar to the one of the users (see, however, Aksoy and Bloom, 2001).[4] Therefore, we decided to create a decision aid that is based not only on considerations from prescriptive decision theory, but also, and explicitly so, on insights resulting from descriptive research on how people make choices.

## THE INTERACTIVE CHOICE AID: A NEW APPROACH TO SUPPORTING ONLINE CONSUMER DECISION MAKING

Probably the most important insight from descriptive research is that consumer decision making can be characterized as a two-step process; first, the choice set is screened and promising alternatives are retained, and second, the retained alternatives are subjected to an in-depth comparison (Edwards and Fasolo, 2001; Häubl and Trifts, 2000; O'Keefe and McEachern, 1998; see also Ford et al., 1989; Payne, 1976). Therefore, the choice aid that we propose has two phases: a pre-selection phase and a comparison phase. This is congruent with what can be found on many shopping websites.

Given that a plethora of satisfying approaches to making pre-selections already exist, we decided to use one of these existing solutions for the first phase of ICA. In contrast, in the second phase we implemented a new idea of how to facilitate a compensatory in-depth comparison between decision alternatives in modern shopping websites. Although such functionality has been proposed in the literature repeatedly (Edwards and Fasolo, 2001; Todd and Benbasat, 2000; Wang and Benbasat, 2009), it has been realized in a different form. It is not currently implemented in online shops, at least to our knowledge. ICA offers this functionality through the elicitation of user importance ratings in an interactive and explorative way, thereby improving the human-computer interaction and supporting the user in resolving difficult trade-offs.

We now describe ICA's two phases in more detail. The prototype was set up for two product categories, mobile phones and digital cameras. To avoid confusion, all following examples involve the mobile phone prototype.

### Phase 1: Pre-selection of Alternatives

In Phase 1, ICA helps the user to quickly and conveniently reduce the size of the choice set by setting exclusion criteria on some or all attributes (e.g., a maximum acceptable price of €100). Exclusion criteria can be set in two ways, depending on whether the attribute is continuous or discrete. For continuous attributes such as price, size, or stand-by time, ICA features sliders that can be moved to the desired cut-off-level (see Figure 1). The endpoints of the scale for a given attribute are always the lowest and the highest attribute value in the entire choice set. The value corresponding to the actual position of the slider is displayed to its right. For discrete attributes (e.g., whether the phone features a music player or Bluetooth), the user defines the acceptance threshold by checking (or not checking) a box for the attributes of interest (i.e., present/absent). As can be seen in Figure 1, the sliders and check boxes are placed on the left side of the screen and the alternatives that fit the user's requirements are presented on the right. Note that a very similar choice aid for pre-selections is the "Handyberater" (mobile phone advisor), a real-world choice aid that can be found on the websites of some German mobile phone carriers (T-Mobile, E-Plus, and O2).

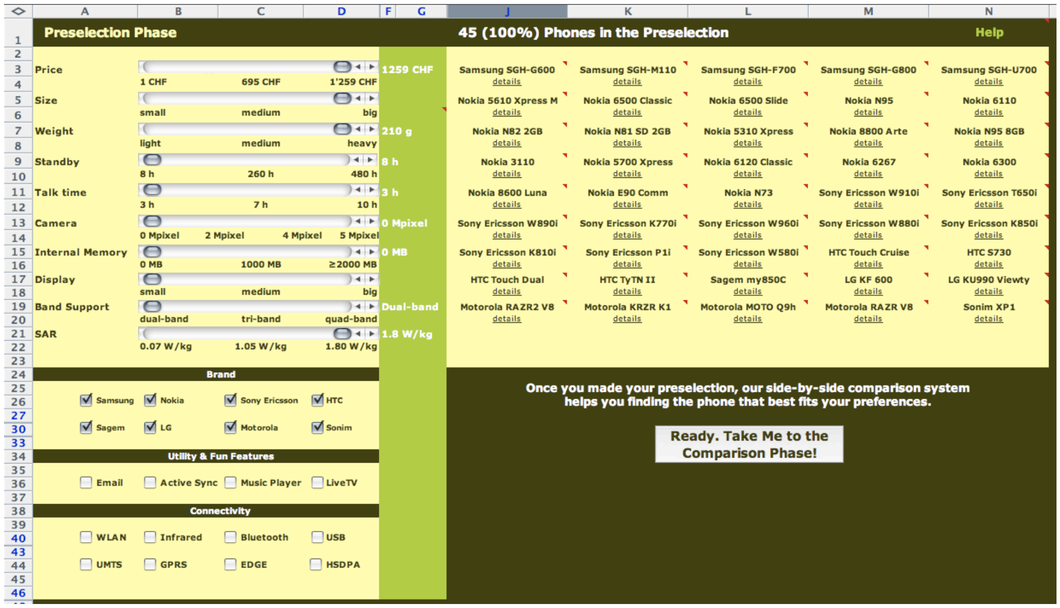


**Figure 1: The pre-selection phase of ICA at the outset**

*Note: For continuous attributes, acceptance thresholds can be set with the sliders on the upper-left side of the screen. The value corresponding to the actual position of the slider is displayed to its right. For discrete attributes, a desired presence (absence) of an attribute can be indicated by checking (unchecking) one of the boxes on the lower-left side of the screen. Alternatives that fail to meet the threshold(s) disappear from the field on the right side of the screen.*

By default, all sliders and check boxes are initialized so that all alternatives are included. For each alternative, the name and a link to another website containing further details about the product is provided. When users move the mouse over the name of a particular product, a window containing the product picture pops up.[5]When a slider is moved or a box is checked, all alternatives that fail to meet the acceptance threshold on the respective attribute are eliminatedand disappear from the screen (see Figure 2). In addition, the number of phones that are currently in the choice set is indicated on top of the field containing the alternatives. When a user feels that the choice set is of a manageable size for making more detailed comparisons, he or she can proceed to Phase 2 by clicking a button labeled "Ready. Take Me to the Comparison Phase!"

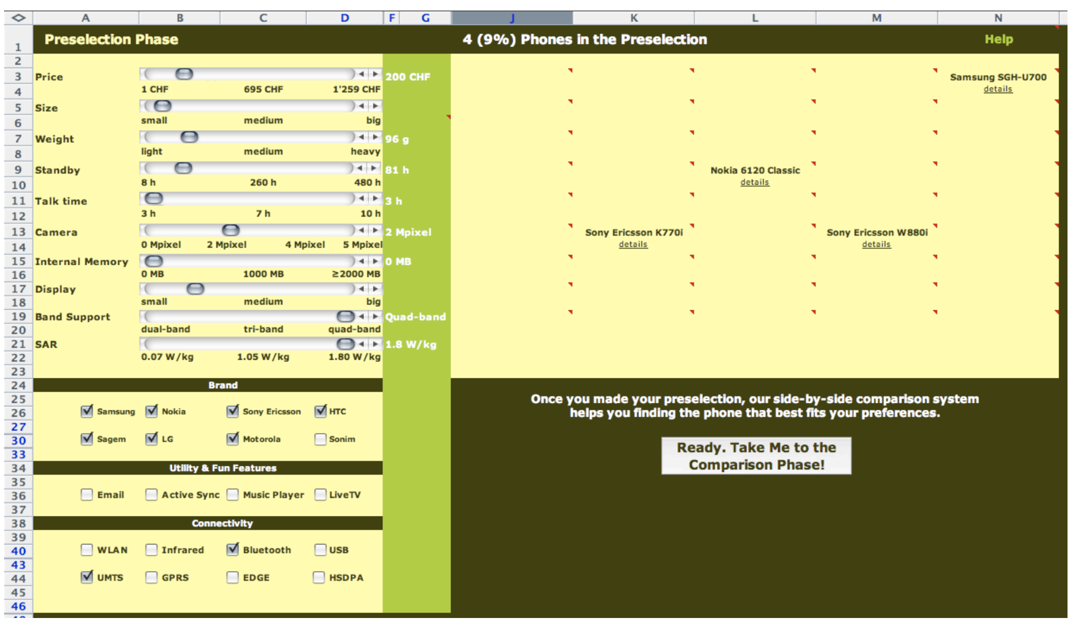


**Figure 2: The pre-selection phase of ICA after some eliminations**

## Phase 2: Comparison of Alternatives

As mentioned above, in the second phase ICA implements a new and unique way of helping the user to easily compare the alternatives that were pre-selected in the first phase. When proceeding to Phase 2, ICA presents only those alternatives which satisfy the previously defined thresholds.

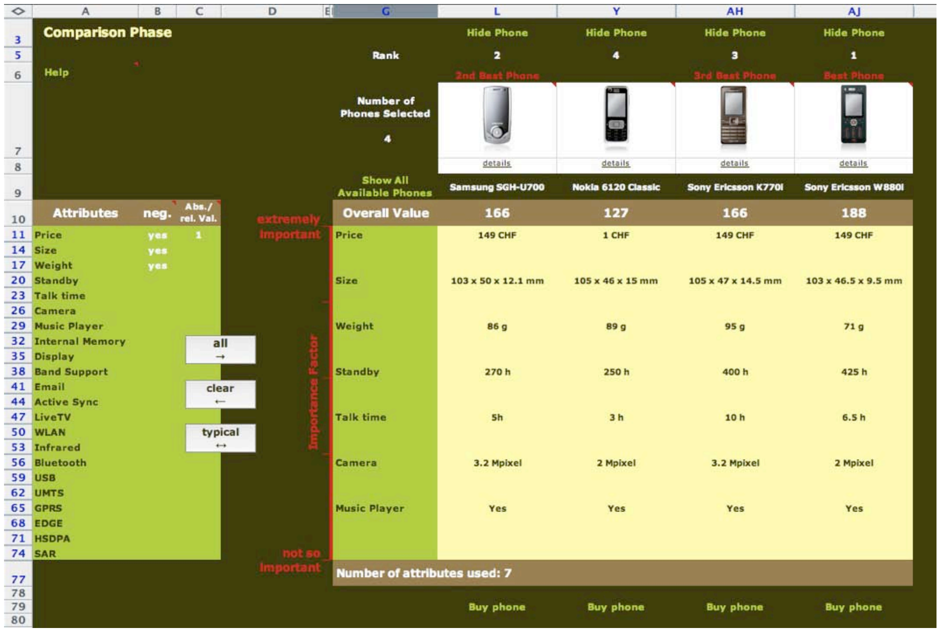


**Figure 3: The comparison phase of ICA with some attributes added**

As Figure 3 shows, these alternatives are displayed in an attributes-by-alternatives matrix (henceforth, the interactive comparison matrix), with the product features in the rows and the products in the columns. For each product, the name and picture are displayed along with a link to more details (as in Phase 1). Below that, an overall value is shown (see below for details regarding the calculation of this value). The rank of a particular product, which depends on this overall value, is displayed above the picture of the phone. Moreover, the three phones with the highest overall values are marked “Best Phone,” “Second Best Phone,” and “Third Best Phone,” respectively. A phone can be selected for purchase by clicking on “Buy Phone” on the bottom of the matrix.

When the user first views this page, the application displays only the products that were not eliminated in the pre-selection phase. However, at this point the matrix contains neither attributes nor attribute values. Rather, all available attributes for the particular product category currently in use are displayed in a list to the left of the comparison matrix. To see the attribute values of the alternatives displayed in columns, the user must type the name of the attribute in the left-hand column of the matrix. We made this design choice to ensure that users are not influenced as to which information they should consider important.[6]

When the name of an attribute is entered, the attribute’s values are shown for each product. Note that the vertical position of the attribute plays an important role here. As indicated by a red scale labeled “importance factor” to the left of the first column, more important attributes are placed nearer to the top (i.e., “extremely important”) and less important attributes closer to the bottom (i.e., “not so important”) of the column. Moreover, this importance rating is not simply a rank ordering; a larger distance between two attributes represents bigger differences in subjective importance. Technically, the level of importance of a particular attribute (as represented by the vertical position in the attribute hierarchy) is used as a weight for this attribute.[7] In other words, by determining where to place the attributes, the users define their *subjective* attribute weights. For each alternative, the weight of each attribute is multiplied by the corresponding attribute value. The sum of these values is the overall value shown for each product (the initial overall value before the addition of attributes is always 100). Thus, ICA executes a Weighted ADDitive strategy (WADD; commonly regarded as the “gold standard” for rational choices; Gigerenzer and Goldstein, 1999, p. 26). Because the attributes differ with respect to their measurement units, the attribute values must be normalized before being multiplied by their subjective weights. This was achieved by performing *z*-standardizations (see below for a discussion of this standardization procedure). The position of the attributes can be changed throughout the entire decision process to see how different weights affect the overall values of the alternatives (in terms of a sensitivity analysis; see Edwards and Fasolo, 2001).

For each attribute, the user can also specify whether a high value is desirable (by typing "yes" in the space to the right of the respective attribute) or undesirable (by leaving the space blank). The default is chosen to represent preferences that most consumers would agree upon (e.g., a higher stand-by time is more desirable than a lower stand-by time, but for weight, a lower value is more desirable than a higher one). This feature is advantageous in that each user can customize the computation of the overall value according to his or her preferences (e.g., someone who wants a large phone can change the default). Another option the users have here is to change between two different ways the information about the attributes is presented. In the standard setting, absolute attribute values are displayed (e.g., €149 for price, 95g for weight etc.; see Figure 3). In the alternative setting, relative attribute values are displayed. These values are percentages relative to all other products in the entire choice set. For instance, in the choice set used in the study described below, a stand-by time of 250 hours corresponds to 52% of the maximum stand-by time of all phones considered in the present study. The rationale for introducing this different representation format was to facilitate product comparison, especially for consumers who are not experts in the product domain. This is particularly functional for prominent attributes, such as size and weight, but also true in general: each attribute can be utilized within an in-depth comparison of alternatives.

To speed up the attribute selection process, there are three buttons to the right of the attribute list. The first, labeled "all," allows the user to move all available attributes at once into the matrix whereas the second, "clear," removes all attributes from the matrix. The button labeled "typical" moves a selection of attributes into the matrix that is based on the behavior of past consumers.[8] The last button is meant to assist consumers who have limited knowledge about the product category and are therefore unsure about which attributes to consider. The final two options allow users to hide or show phones manually. First, users can eliminate a particular product from the matrix by clicking on "Hide Phone" (at the top of each column). Second, the phones that have been eliminated in the pre-selection phase can be included in the matrix by clicking on "Show All Available Phones" (in the first column of the interactive comparison matrix).

With ICA, we implemented an environment that facilitates the winnowing-down of products and the in-depth comparison of these pre-selected products. While our solution facilitating the former relies on existing technologies, our approach to assisting users with the latter is a new development. We now discuss the strengths and weaknesses of the application.

## STRENGTHS AND WEAKNESSES OF ICA'S PRE-SELECTION PHASE

To avoid information overload, which is often inevitable given the very large choice sets that are common today, ICA enables the users to quickly eliminate undesirable (e.g., too expensive) alternatives by defining acceptable attribute values (i.e., via the sliders and check boxes). In contrast to other decision aids that also contain elimination features, ICA allows users to base their exclusions on all available attributes (simultaneously) as opposed to only one or a few. We used sliders and check boxes that have a directly visible effect on the size and the composition of the choice set to provide accurate and timely feedback about the effects of the threshold setting. For instance, if most of the phones cost less than €200, little elimination would take place before users reach this threshold (when starting from the most expensive phone). In contrast, when almost no phones have an infrared connection, checking this box has a big effect. Many consumers are not experts in the respective product domain and therefore have little or no knowledge regarding what is common for mobile phones that are on the market today. The direct feedback of ICA helps them to get an idea of the composition of the choice set, for example, that today most mobile phones have a Bluetooth connection. Moreover, due to the direct feedback, the sliders make this process even more dynamic and informative than just choosing a value from a drop-down menu or something similar. As a slider is moved from one end to the other, the users can discover the point at which products start to be eliminated and whether this happens slowly (i.e., one after the other) or suddenly (i.e., many at once). In the former case, this indicates that there is considerable variation among products on this attribute, whereas in the latter this means that many products have the same value on the respective attribute. In this way, the users can get a feel for the distribution of values for a given attribute.

A potential weakness of the sliders is, however, that only single point cut-offs and not intervals can be determined. Moreover, a consequence of the fact that all attributes can be used for eliminating what is displayed is that the screen is relatively densely packed. Another, more general characteristic of elimination features that is sometimes seen as problematic is that sequential eliminations can lead to local optima, which may be significantly less desirable than the global optimum. For example, if the price cut-off is set to €200, all subsequent eliminations and comparisons happen in this reduced choice set. This prevents the user from detecting a possible alternative that is only slightly worse on the respective elimination criterion (e.g., €210) but more desirable overall. Edwards and Fasolo (2001) refer to such alternatives as "winnowed-out winners." Likewise, in Phase 2, local optima can be reached when not all attributes are included in the interactive comparison matrix. However, making decisions based only on subsets of the available information is an inherent characteristic of heuristic procedures in general. It has been shown that heuristics—in spite of and sometimes also due to their simplicity—make decisions that are as good as or even better than those made by more complex decision strategies that use all available information (e.g., Gigerenzer, Todd, and the ABC Research

Group, 1999; Gigerenzer and Goldstein, 1996; Martignon and Hoffrage, 2002).

## STRENGTHS AND WEAKNESSES OF ICA'S COMPARISON PHASE

### Strengths

The problem of information overload is biggest in the pre-selection phase. However, in the comparison phase we also tried to present information such that users can focus exclusively on what really matters. Past research has shown that consumers are only interested in a small fraction of the available information (Reisen et al., 2008). Therefore, as opposed to most matrices that are available on the web today, our interactive comparison matrix does not automatically display all available information at once. Instead, users have the ability to select the information they want to focus on and even arrange it by subjective importance. Given the natural direction of reading in most of the world (i.e., from left to right and from the top to the bottom), it is straightforward to display more important information towards the top and less important information towards the bottom of the screen. The fact that attributes of similar importance are closer together than attributes of varying importance further helps users to establish and communicate their priorities. Another strength of ICA is the option to display relative values instead of absolute values. This form of information representation makes it especially easy to see how well an alternative fares in comparison to the others on a particular attribute. This feature is usually not present in a typical comparison matrix, but has been found on some web sites. For example, on www.tigerdirect.com, the ranges of some attributes are presented as lines (e.g., smallest to highest megapixels) and a cross on the line marks the relative position of the product in question.[9]

The second goal, namely, to facilitate information integration by providing assistance for resource intensive calculations, is achieved with the calculation of the overall value. This value aims to help the consumer resolve difficult tradeoffs that are not easy to calculate mentally. The interactivity of the application guarantees an overall value that is very specific to the users' preferences and at the same time immune to selective perception. In other words, it may bring a particular alternative to the user's attention which might have been overlooked, especially if he or she wanted a particular alternative to come out first in the evaluation. The sequential process of defining a choice set followed by selecting and arranging attributes reduces the inherent complexity of the task and helps decision makers to get a broader view of the decision problem and of what is actually important to them. Things that initially seemed to be very important are often reevaluated when the bigger picture becomes apparent. In sum, this feature supports a more normative decision process by promoting the use of a compensatory strategy (e.g., WADD). This, in turn, is likely to lead to more accurate choices, or, in other words, to better decisions.

### Weaknesses

There are some problems with the present implementation of ICA, which we hope can be overcome in the final version. The present prototype is implemented in an Excel spreadsheet rather than as a fully functional website. Therefore, its usability is far below what the interface could potentially realize. However, this prototype was engineered within an iterative software process; the first tests were intended to evaluate ICA's various features in terms of general acceptance and perceived utility, rather thanrigorously test the usability of a release candidate. Therefore, we will not go into more detail regarding usability issues. Further weaknesses are the following.

First, ICA's procedure for weight elicitation is very simple, and attribute importance could probably be assessed more accurately with other, more sophisticated techniques (for a discussion of different weight elicitation techniques, see Borcherding et al., 1991; Borcherding et al., 1995). The analytic hierarchy process (AHP), which is widely used in organizational contexts, is another technique that could be applicable to the kind of choices studied here. However, we are skeptical as to whether many consumers would be willing to engage in more complicated weight elicitation processes or even numerous repeated pairwise comparisons as required by the AHP, in particular when they do not understand exactly how it works (see also Edwards and Fasolo, 2001). Therefore, we think that in the present case the benefits of simplicity outweigh the costs of possibly reduced validity. With ICA, users can see the whole picture throughout the decision process and the effects of their actions are immediate.

Second, for the calculation of the overall value, the attribute values were normalized relative to all 45 alternatives by using a *z*-transformation. However, during the study reported below it became clear that this particular way of normalization was less than perfect, in particular because in some rare cases the resulting overall values did not make sense. This problem disappears when the attribute values are normalized relative to only the competing alternatives in the interactive comparison matrix. For the future development of ICA, this and other ways of normalization should be tested (for more details, see Reisen, 2009).

Third, and again related to the overall value, ICA uses values and not utilities. Given that it is reasonable to assume that many users' utility functions are nonlinear, this reduces the usefulness of the overall value. Another, similar problem is that there might be a lack of independence between the attributes. A high positive correlation between two attributes that are both rated as being important leads to the possibility of over-representing their joint importance because the overall value is not corrected for cue redundancy. Moreover, a decision maker might regard a certain combination of two attributes as being better or worse than their weighted sum (Hill and King, 1989, Garcia-Retamero et al., 2007).

However, we again want to point out that when we created ICA, one of our main goals was to design a highly comprehensible and transparent application. A manager who makes risky decisions where mistakes are costly may prefer a more complex and highly accurate decision aid, but the average consumer who buys a comparatively cheap product is probably not willing to invest the time that is needed for the execution of more sophisticated preference elicitation techniques. Moreover, there is evidence that even for professional users of decision support systems, training and experience is necessary to provide complete and consistent responses (Tversky, 1974).

In sum, ICA is a new decision aid, which (1) incorporates ideas and insight from various fields of behavioral and prescriptive research, (2) is based on current best practice (e.g., the method of pre-selecting alternatives), and (3) adds functionality above that (e.g., the method of comparing pre-selected alternatives). The price for this increase in functionality is a decrease in the ease of use. The question now arises: are people willing and able to exploit this increased functionality, and does the use of ICA result in a perceived facilitation of the process of choosing? We tried to answer this question empirically with a study, which is described briefly in the following section.

## AN INITIAL TEST OF THE INTERACTIVE CHOICE AID

To see how our new decision aid compares to other choice aids regarding perceived utility and user satisfaction, we tested it against two other (control) applications, which were adaptations of decision aids implemented in real world consumer websites. The three decision aids that we compared varied with respect to their functionality in terms of the number and type of tools they featured to facilitate choosing (in other words, the degree to which users could influence which product information was displayed and how). The first application featured a tool for eliminating alternatives based on desirable attribute values such as price (Low degree of Functionality, *LowF*), the second one included tools for eliminations and side-by-side comparisons of alternatives in a simple attributes-by-alternatives matrix (Medium degree of Functionality, *MedF*), and the third application, our prototype of ICA, offered tools for eliminations, side-by-side comparisons, and resolving tradeoffs (High degree of Functionality, *HighF*). Note, however, that this was not an explicit test of different levels of functionality but rather a general study of usability and user acceptance.

### Method

Because all three applications we compared were in different stages of their product life-cycles, we reengineered the functionality of the two web-applications to make their user interfaces similar to that of ICA by transferring them to a spreadsheet environment (Microsoft® Excel® 2004 for Mac, version 11.5.3). As a consequence, general visual appearance and basic functionality were held constant across all three applications. Although they were not real websites, the applications came very close in terms of look and feel to the specification for most functional demands (but not all, such as the interactive comparison matrix in Phase 2 of ICA). For non-functional features, in contrast, the gap between ideal and the current implementation was larger. Given the early stage of development of ICA, we decided that the current prototype was most appropriate for the present purpose.

Twenty-four participants (10 female and 14 male; mean age 24.7 years) were randomly assigned to one of the two conditions of the between-participants variable product category (i.e., mobile phones or digital cameras). The degree of functionality (i.e., low, medium, or high functionality) was manipulated within participants. The order of these three conditions was counterbalanced. Each choice was made from a set of 30 products, which was different for each participant and each application, and which was drawn randomly from a larger set of 45 products. Participants were informed that the goal of the present research was to create a website that actively aids the decision maker during the process of choosing. In addition, they were told that we implemented three versions of such a website, which they would now evaluate. We provided no further information regarding the applications or the research question.

After the participants had made a choice with all three applications, they completed a comparison questionnaire that contained five dimensions: understandability, ease of use, ease of elimination of alternatives, ease of comparison of alternatives, and choice confidence. To indicate how well the applications fared in comparison to each other on these dimensions, participants were asked to locate each of them on a 78 millimeter long line ranging from "low" (on the left) to "high" (on the right). This was followed by a semi-structured interview, which aimed to give the participants room to express their thoughts about the new decision aid.[10]

## Results

### *Comparison Questionnaire*

To obtain the values for the analyses, the positions of the three points on each line were measured in millimeters, starting from the left end of the line (i.e., low). The values so obtained ranged from 1 to 78 mm. Note that 18 participants (75%) used the comparison phase in MedF and 16 (67%) in HighF, but only 11 participants (46%) used it in both.

The average overall rating (AR) was calculated for each application across all five dimensions. Overall, participants preferred MedF (AR = 232) overHighF (AR = 220) and LowF (AR = 197). When looking at the two product categories separately, the same picture was found for the mobile phones (ARs = 267, 229, and 200, respectively), but a preference for HighF (AR = 211) over MedF (AR = 198) and LowF (AR = 193) in the digital cameras condition.

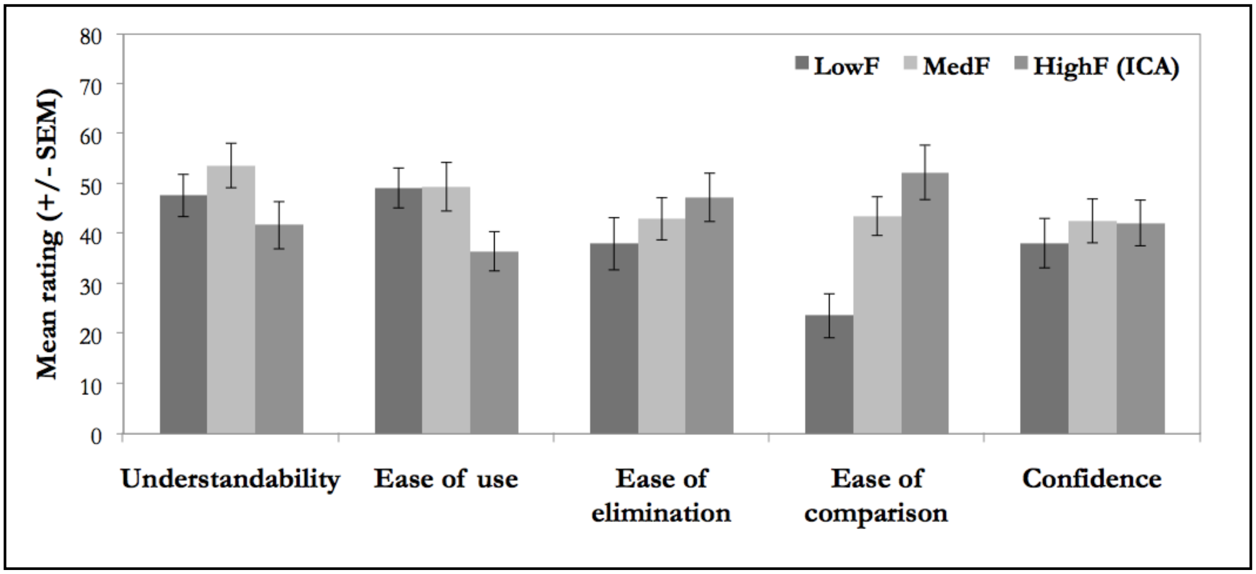


**Figure 4: Mean ratings of the three applications (low, median, and high functionality) on each of five dimensions**

A mixed design MANOVA was used to test whether the differences between the three applications were significant. The MANOVA included the within-participants variable of application type (LowF, MedF, and HighF), the between-participants variable of product category (mobile phones and digital cameras), and the five dependent variables (understandability, ease of use, ease of elimination, ease of comparison, and choice confidence). The means (and SEMs) are shown in Figure 4. There was a significant overall effect of application type across all dependent variables ($F(10, 13) = 5.87$, $p = .002$). Neither the effect of product category ($F(5, 18) = 0.71$, $p = .62$) nor the interaction of the two independent variables ($F(10, 13) = 1.44$, $p = .27$) was significant.

The significant overall MANOVA was investigated further with five within-participant ANOVAs that each only included t he variable of application type. These showed that there was an overall effect of application type on ease of use ($F(2, 44) = 3.35$, $p = .04$, MSe = 391.3) and on ease of comparison ($F(2, 44) = 7.83$, $p = .001$, MSe = 663.5), but not on th e other three dependent variables (all p's > .10). Further analyses were performed on the two dependent variables on which there was a significant overall effect using unprotected t-tests to compare HighF to MedF and HighF to LowF. H ighF was rated as significantly less easy to use than LowF ($t(23) = 2.13$, $p = .04$), which was a medium effect size ($d = 0.44$), but only marginally less easy to use thanMedF ($t(23) = 1.84$, $p = .08$), a small to medium effect size (d = 0.3 7). For ease of comparison, HighF was rated as significantly better than LowF($t(23) = 3.54$, $p = .002$), a reasonably la rge effect size ($d = 0.72$), and better than MedF, but not significantly so ($t(23) = 1.05$, $p = .30$), which was a very small effect size ($d = 0.21$). The order of the means for each application type on the ease of use and ease of comparison m easures does not change when looking at only the 11 participants who used the comparison features in MedF and Hi ghF.

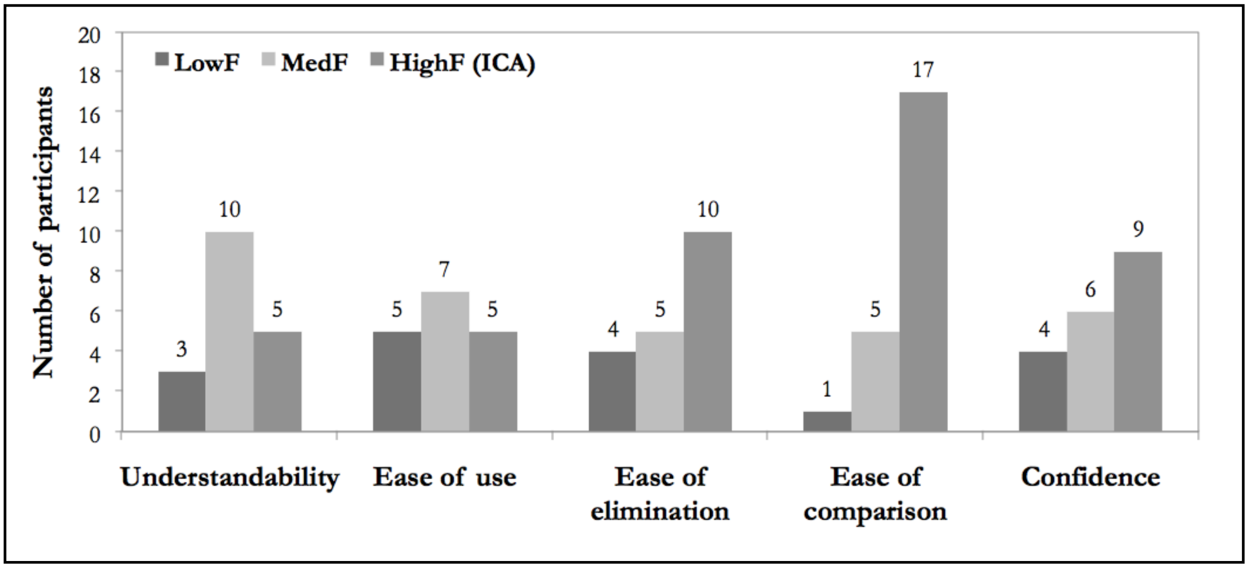


**Figure 5: Number of times each application received the highest rating**

In a subsequent analysis we counted the number of times each application received the highest rating (ignoring ties) to see which fared best on each dimension and for each participant. As can be seen in Figure 5, most participants rated MedF to be the most understandable and the most easy to use, but preferred HighF regarding the ease of elimination, the ease of comparison and the confidence in their choice. These differences are only significant for ease of comparison ($\chi^2$ (2, n = 24) = 18.1, p < .001). MedF received the highest overall rating from 11 of 24 participants (4 6%), 9 (37%) to HighF, and 4 (17%) to LowF. These differences are not significant ($\chi^2$ (2, n = 24) = 3.25, p = .197), even when MedF and HighF are combined ($\chi^2$ (1, n = 24) = 3, p = .08). From the 11 participants who used the comparison feature in both applications, six (54%) gave the highest ratings to MedF and five (46%) to HighF. In this subset, no participant rated LowF best.

### *Semi-structured Interview*

The semi-structured interview revealed that all 24 participants thought that ICA (HighF) helped them to make choices the way they like to make them and most (92%) would use it if it existed as a real website. Moreover, participants saw potential applications for a great variety of product domains (mostly consumer electronics), and they reported that they would recommend this decision tool to others. Finally, the possibility of adding self-selected attributes to the list was welcomed by 74% of the participants (17 of 23) and 80% (12 of 15) would find it helpful to have relative attribute values in addition to absolute ones.

## DISCUSSION

The results can be summarized as follows. A significant difference could only be found for two of the five dimensions: The Interactive Choice Aid (ICA, i.e., HighF) was rated significantly less easy to use than the low functionality application (LowF), and marginally less so than the medium functionality application (MedF). On the other hand, ICA received significantly better ratings than LowF on ease of comparison of alternatives. The non-significant differences show no clear pattern, except that LowF was the least preferred overall. For the medium functionality application (MedF) and ICA, however, it depends on the dimension on which they are compared. MedF was rated better than ICA on understandability and ease of use. ICA, in contrast, was rated best on ease of elimination and ease of comparison of alternatives. The difference on the fifth dimension, confidence in the choice, was very small. Although not many results are significant, some insights can still be gained from the present data, and there is evidence that several of our goals upon creating ICA were achieved.

First, the tools provided for elimination (ICA's Phase 1) and for in-depth comparison (ICA's Phase 2) facilitated choice among the consumer products. Second, all participants stated that the interface helped them to choose the way they like to choose and only one said that the decision aid altered his habitual way of choosing. Therefore, the objective to create a decision aid that aims to assist people in their natural way of making a choice was accomplished. Third, the vast majority of the participants stated that they would find it helpful to have relative values in addition to the absolute ones. This seemed to be a desired feature, and the fact that it was not used is very likely due to participants' lack of awareness of this feature. Fourth, the mean number of attributes that were selected for the comparison of alternatives (i.e., 7) was very similar to what was found in two other experiments in which the number of attributes that participants used for their choices was counted (i.e., 6 and 7, respectively, Reisen et al., 2008). This evidence further supports the assumption that people base their choice on only a subset of the available information (cf. Jacoby et al., 1977) and hence demonstrates that ICA's feature giving users the ability to decide which attributes to include in the comparison matrix corresponds to users' natural decision making processes. This is also congruent with findings of Ariely (2000), who discovered that people preferred to have a higher level of control while interacting with machines and software, which, in turn, increases trust, satisfaction, and the perception of usefulness (see also McNee et al., 2003; Pereira, 2000; Wang, 2005). Fifth and finally, during the interview, almost all participants stated that they would use ICA if it were a real website. They felt that once they understood how the software works, its features could be very helpful to facilitate the process of choosing.

On the negative side, however, the use of ICA was rather cumbersome due to its suboptimal usability, which might have overshadowed the positive effects of the new tools (cf. Ariely, 2000; Peintner et al., 2008). This might also be responsible for the small difference in the ratings. Interestingly, the sliders turned out to be the major usability problem of the pre-selection phase. Even though they are implemented in a very similar form on some real-world consumer websites (e.g., www.de.o2.com), the participants had little appreciation for them. Some participants suggested replacement of the sliders with pull-down menus allowing the user to choose one of several intervals (e.g., a price between €100 and €150) or the provision of two separate boxes allowing users to specify the upper and lower limits of their acceptance intervals. Moreover, the large number of sliders and check boxes caused confusion because the interface was judged to present too much information. Therefore, it could be beneficial to display elimination options for only some attributes (as in MedF); users who want to base their elimination on more or other attributes could access these via a "more" button or something similar. A more advanced version could also establish which attributes are shown at the outset based on the behavior of past customers.

A related problem was that many participants tended to set thresholds that were too severe, which often resulted in an elimination of all alternatives. This could be avoided in part by interpreting the thresholds in a less strict way, in the sense of just-noticeable differences (e.g., Reisen et al., 2008). In other words, alternatives with an attribute value very close to the threshold set by the user (e.g., within 10%) would be saved from elimination. Note that this practice corresponds to modeling the user's representation of the alternatives as pursued in fuzzy set theory (Zadeh, 1965). To overcome the problem of winnowed-out winners (Edwards and Fasolo, 2001), additional alternatives that are similar to the ones currently being compared but that were eliminated in the first phase could be proposed in the comparison phase.

Although it is very likely that the above suggestions would improve the current prototype of ICA, given the observed problems, it is probably worthwhile to more drastically re-conceptualize the pre-selection phase. For example, a first pre-selection could be done by asking the users what they need the product for (e.g., a manager who needs smart phone functions such as mobile internet and push e-mail) or in which category of users they would place themselves. The software would then propose a reduced choice set with products that are typical for the respective need or user category.

## CONCLUSIONS

The current implementation of the Interactive Choice Aid assists the natural process of choosing by providing functionality that facilitates the execution of complex tasks. In particular, the comparison feature is a novel and promising development. ICA integrates both considerations from prescriptive decision theory (i.e., how a rational decision maker should choose) as well as insights from descriptive decision research, best practice, and practical considerations.

The initial test of the new choice aid afforded some promising results, and the generally encouraging comments of our participants warrant a more thorough development of ICA through explicit tests of several of its features. The study showed that the tools for eliminating undesirable products and making in-depth comparisons of alternatives fulfilled the specification. Even though the overall functionality was rated as helpful, more attention has to be devoted to non-functional requirements (e.g., understandability and ease of use). Given that many of today's purchases are made on the internet, further developments of ICA are not only of interest to researchers but also to retailers and, in particular, to customers who have to find their way through a plethora of similar products without the help of a sales assistant. In a more developed version, the Interactive Choice Aid might be implemented in productive environments, such as shopping websites or on websites that provide guidance to the customer by, for example, featuring reviews and buying guides (e.g., www.consumerreports.org).

Häubl and Murray (2006) conclude that "[w]ell-designed electronic product recommendation agents can and should play a more prominent role in improving the overall value of online shopping" (p. 12). We agree, but we also want to point out that to be accepted and used by a multitude of consumers, a decision aid needs to have benefits that outweigh the perceived costs (cf. Peintner et al., 2008). To achieve this, on one hand, it has to be simple, transparent, and easy to use, while on the other hand it has to provide functionality that is relevant, and offer a high degree of interactivity and user control. We believe that the Interactive Choice Aid, by building on consumers' natural way of choosing and simultaneously structuring their decision processes, strikes a balance between simplicity and functionality. ICA can thus be seen as a promising step in the development of decision aids.

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[1] www.internetworldstats.com/stats.htm, accessed in 2009

[2] Recommendation agents are sometimes also referred to as *recommender systems* (Adomavicius& Tuzhilin2005) or as *electronic sales assistants* (Miles, Howes, & Davies, 2000).

[3]The analytical hierarchy process (AHP) is used as a principal component in many (commercial) decision support systems (e.g., *Expert Choice* [www.expertchoice.com], *Decision Lens* [www.decisionlens.com], and *Decision Simplifier* [www.decisionduck.com]).

[4]The trustworthiness of a decision aid as experienced by the user is an important issue in this context, but a discussion of this topic would be beyond the scope of this article. We refer the reader to the following publications: Häubl and Murray (2006), Komiak and Benbasat (2006; 2008), Senecal and Nantel (2004), Wang and Benbasat (2007; 2008), and Xiao and Benbasat (2007).

[5]Displaying the pictures of the products in addition to the product name without any action required from the users was intended but technically not feasible for the prototype used.

[6]In a more mature version of ICA this will be a drag and drop function and no typing will be required.

[7]The attribute weights are determined in the following way: For a particular product category, the matrix has *n* lines – as many as there are attributes. If the user places an attribute in the uppermost line, this attribute receives a weight of *n*. If an attribute is placed directly below this first line, it receives a weight of *n*-1, and so on. It is currently not possible to assign equal weights to two or more attributes. However, this limitation is due to technical constraints of the present prototype and will not be present in upcoming versions.

[8]Due to the fact that no data on past customers was available in the mobile phone condition, we used the seven attributes that were used most often by participants in a previous study (Reisen et al., 2008). These attributes were: price, size, weight, stand-by time, talk time, camera, and music player. In the digital cameras condition, we selected attributes that were prominent on many shopping website: price, resolution, optical zoom, digital zoom, display size, video resolution, and size.

[9]The feature described here has disappeared in the meantime.

[10]Questions were prepared for the semi-structured interview to serve as a guideline. However, the experimenter could freely choose the questions he asked. For each application, participants also filled out a usability questionnaire, which did not result in any interpretable data and which is thus omitted from the present pages (for details, see Reisen, 2009).

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