User-Centered Design of Preference Elicitation Interfaces for Decision Support

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Abstract. A crucial aspect for the success of systems that provide decision or negotiation support is a good model of their user's preferences. Psychology research has shown that people often do not have well-defined preferences. Instead they construct them during the elicitation process. This implies that the interaction between the system and a user can greatly influence the quality of the preference information and the user's acceptance of the results provided by the system. In this paper we describe a user-centered approach to design preference elicitation interfaces. First, we extracted a number of criteria for successful design of preferences elicitation interfaces from literature and current systems designs. Second we constructed four new intermediate designs that are compositional with respect to different criteria and, furthermore correspond to different thinking styles of the user. Last, we offer first insights from an initial formative evaluation of our designs.

Keywords: Preference Elicitation, Prototypes, User-Centered Design, Evaluation.

1 Introduction

Knowing what a user likes and dislikes, i.e., his preferences, is important for intelligent systems in many domains. A user's preferences are part of an accurate user model, which is needed to create system responses that are adapted to the user, e.g. his learning style in an eLearning system, and for the creation of personalized content. We focus our work on preference elicitation for decision or negotiation support systems. These systems are similiar to Recommender Systems which support people to find right products and services online. Decision support systems, however, focus more on the decision process itself. This includes helping the user to discover and enter their preferences, understand the link between preferences and decision outcomes and analyzing the steps taken in the process. Particularly in negotiation support, the quality of the outcome depends to a large extent on the quality of the preparation of the negotiators and their interaction. Both preparation and interaction should focus on discovering the preferences of both parties [15]. Often decision support systems are used in difficult and important decision situations, that have serious consequences, e.g. in health care [18].

Existing interfaces aiming at eliciting preferences from users range from systems that explicitly ask their users to fill in a long list of values for all the attributes of a certain

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product to systems that implicitly learn preferences from the user's ratings and comparison to other users of the system [28]. Both extremes are not likely to be successful if we want the user to stay engaged with the system and trust the system's advice. First of all it is not sensible to ask a large number of elicitation questions that are cognitively demanding to the user. Using implicit techniques to get a preference model on the other hand bears the danger that the elicited model is not accurate [5]. This might lead to the problem that the users cannot comprehend the advice from the system.

Recently, researchers in the AI [5] and HCI [27] communities have already pointed towards the constructive nature of human preferences and the implications for intelligent systems. Preference models based on economists' views of stable and known preferences might not always be accurate since people do not possess stable preferences that reside in their heads. Often they construct their preferences during the elicitation process. Therefore, it is important to design that process carefully, so that the user is able to construct an accurate model. We believe that a major factor in the process is the interaction between the system and its user via a preference elicitation interface. Therefore, in order to create more successful systems that can elicit accurate preferences we have to focus on the design of the user interface. Even the best underlying algorithms and reasoning frameworks do not give successful results if the user has problems interpreting information presented by the system and entering his preferences [25].

Our goal is to design interfaces that help users build their own preference profile in a way that is intuitive and comprehensible to them. To achieve that goal we set up a list of criteria for the design of such interfaces extracted from social sciences, psychology and HCI literature on human preferences. Next, we created a number of interface elements addressing the different criteria and combined them into four first prototypes. They also take into account people's different styles of perceiving and processing information. Last, we evaluated the different interface elements with people using the prototypes and held a creative session where the same participants combined the elements to new interfaces. The data collected in the evaluations informed our further design process.

2 Related Work

People's preferences have been the interest of researchers in many fields including psychology, behavioral science, consumer research, e-commerce, intelligent (interactive) systems, as well as decision support. We do not aim to give a complete overview of the work in all these fields, but focus on topics relevant for designing user interfaces for preference elicitation for intelligent systems. Many algorithms and interaction techniques have been proposed in current systems to elicit and model the users' preferences. Before giving an overview of the state-of-the art systems, we would like to give the reader insights into how people construct their preferences, since this is the process we want to support the user in with adequate interfaces. Last, we will give a short introduction into Participatory Design, since it is relevant for our evaluations and creative design sessions described later on.

2.1 Constructive View on Preferences

Carenini and Poole [5] describe a conceptual shift for classical decision theory towards constructive preferences [24] and the implications for AI research. Opposing the prevailing economist view of rational and stable preferences, see e.g. [10], psychology studies have confirmed that preferences are not stable but constructive. This means that people do not have well-defined preferences in most situations but rather construct them when necessary, i.e., in the decision making context. This allows people to re-construct their preferences whenever they get new information that is important for the decision. There are different views on how people construct their preferences.

Simon and colleagues [32], for instance, found in their experiments that while people processed the decision task, their preferences of attributes in the option that was chosen increased whereas those for attributes of rejected options decreased. Similar effects have been found in negotiation settings reported by [8]. This is in line with one of the meta-goals named by Bettman and Luce [1], i.e. trying to maximize the ease of justifying a decision. Another aspect of constructing preferences has been brought forward by Fischer et al. [14] focusing on the goals of the decision task in relation to a so-called prominence effect. This effect occurs when people prefer an alternative that is superior only on the most important attribute. They confirmed in three studies that the prominent attribute will be more heavily weighted when the goal was making a choice between alternatives than when the goal was to arrive at a matching value. Johnson and colleagues [18] found anchoring effects and effects that occur when complicated information is presented in the choice task. They conclude that different ways to measure preferences can lead to different results, which is not the intention of eliciting preferences. To help people to construct their preferences in health care scenarios, the authors suggest presenting defaults choices that have led to the best outcome for most patients and presenting information in a way that helps the patient to understand the outcomes of each choice. Another view is the so-called PAM (preferences-as-memory) framework [36], which assumes that "decisions (or valuation judgments) are made by retrieving relevant knowledge (attitudes, attributes, previous preferences, episodes, or events) from memory in order to determine the best (or a good) action."

Consumer research looked at the interplay between affect and cognition on decision making [31]. They investigated the influence of available processing resources when confronted with a decision task. In cases where people have only few resources available affective reactions tend to have a greater impact on choice, whereas with high availability of resources cognitions related to the consequences of the choice are more dominant. This finding can be influenced by personality and by the representation of the choice alternatives.

In conclusion, we can record that there are many factors influencing preference construction and elicitation. To avoid unwanted effects we have to think carefully about the way we pose a preference elicitation task to the users.

2.2 Preference Elicitation - Current Systems

Chen and Pu [7] provide an overview of existing systems that elicit user preferences. They mention techniques commonly used, e.g. knowledge-based find-me techniques

[2], example critiquing and tweaking [11,29], active decisions and clustering or collaborative filtering [28]. Collaborative filtering and clustering techniques are used mainly to create profiles for new users of recommender systems based on clusters of existing users and similarity. For an overview see [28]. There are also hybrid systems combining different approaches [3]. In knowledge-based systems, preferences are elicited by example-similarity; the user rates a given item and requests similar items. Tweaking can be used to limit the similar items to only those satisfying the tweak. In example-critiquing approaches [29] the user is presented with a set of candidates (e.g. products) that can be critiqued. The user can either choose one of them or critique some of their attributes. An interesting example-critiquing interface is the Apt Decision Agent [29]. In this system people initially provide a small number of criteria for an apartment. Based on those they get a number of sample apartments. They can react to any attributes of any apartment. Interesting here is that the preference feedback by the user gets more and more detailed during the interaction. At the same time the user is not forced to go into more detail, but is free to give only the feedback the user wants to give.

Not all techniques mentioned are relevant for decision support systems due to a lack of user-involvement. The user will be less likely to trust the advice by the system, if the system has created a user profile implicitly. A majority of the literature presenting these systems focuses on technical implementations rather than the user. Therefore, it is not always clear how the interface designs support the constructive nature of human preferences. Lately, some researchers have acknowledged this gap and made attempts to set up guidelines for user-involved preferences [23,27].

2.3 Participatory Design

Participatory design (PD) is a design approach where the user is involved not only as an experimental subject or someone to be consulted but as an active member of the design team [9]. PD can be seen as a form of user-centered design (UCD). For a more detailed description of the relation between PD and UCD see Caroll [6]. PD originated in Scandinavia, in the 1980s and has since then been growing rapidly in terms of numbers of practices, extent of theoretical development, numbers of practitioners etc. [21]. To give practitioners guidance in which techniques are best applicable in which circumstances Muller and colleagues provide taxonomy of PD practices. It is based on the dimensions of point of time in the design cycle and who is participating with whom (designers in user's world or vice versa). In addition, they give an indication of optimal group size for every PD technique. Techniques range from ethnographic methods and contextual inquiry [17] to various forms of cooperative prototyping, e.g. paper prototyping [22] and evaluation. One interesting PD technique, that inspired our approach, is PICTIVE [20], which makes use of low-tech objects of system functionality (plastic icons, post-its, colored pens etc.) which are used in a brainstorming session to express the participant's ideas.

3 Design Criteria for Preference Elicitation

From the related literature presented above the following design criteria are derived, which appear to be influential to the success of a preference elicitation interface.

(*1*) *Support of human process of constructing preferences*

A major outcome from the studies presented in the related work section is that people do not possess stable preferences, but construct their preferences when confronted with a decision task. This construction process is highly influenced by the decision context and the way the preference questions are posed. The work of [27] provides a number of more detailed guidelines addressing this criterion:

(*1.1*) *show decision context, that also allows people to see the consequences of their decisions.*
(*1.2*) *provide examples that can be critiqued by the users to refine their preferences.*
(*1.3*) *give immediate visual feedback.*

(*2*) *Affective feedback*

The role of affect in preference construction was explored in consumer research. As described above, there is an interplay between cognition in affect when people construct their preferences. Therefore, combining cognitive (e.g. choosing from a list of values) and affective (e.g. emoticons) elements in an interface might lead to more insights into the user's preferences.

(*3*) *Value-Focused Preferences*

In opposition to the traditional approach of alternative-focused thinking, Keeney proposed [19] value-focused thinking. In this approach the decision-maker should focus on fundamental values that are relevant for a decision before identifying possible decision alternatives and assessing their desirability. Generally, values are seen as more stable than preferences over attributes [30]. This idea has been used in a small number of preference elicitation interfaces, e.g. Personal Choice Point, a financial aid system showing consequences of a decision in terms of lifestyles [12] and Teaching Salesman [34], a product recommender focusing on needs and features.

(*4*) *Transparency*

A major aspect influencing the success of decision support systems is the user's trust in the system [26]. System transparency is one aspect that can enhance the user's trust [33]. Take a recommender system that implicitly learns your preferences and then recommends a product to you. Often you wonder 'why this product'? You do not understand the relation between the product and your preferences since you do not know the preference profile the system created. Furthermore, you did not get the chance to construct your preferences in the first place. If the recommendation was a movie, you might watch it anyway. However, if the system gave you advice on buying a house you might be more reluctant. To avoid this situation it is important that the system is transparent for the user, i.e. the user knows what the system is doing, why it asks certain elicitation questions and how the current profile looks.

(*5*) *User-System Interaction/Collaboration*

For a long time already designing user interfaces is not only about graphical designs but much more about designing the interaction between the system and the user. For decision support it is important that the user and the system collaborate in establishing a good user profile. We define three criteria for the interaction:

(*5.1*) *Natural Interaction*

Natural interaction refers to the usual way in which the users act in the physical world [35] applied to computer systems. People use gestures, expressions, speech and movement to communicate.

(*5.2*) *Real World Metaphors*

Part of designing the interaction with a system as natural as possible is using real-world metaphors. Users know them and can relate to them easily, e.g. the trashcan on the windows desktop. In the physical world preferences of people show by what people say, their emotional reaction to something or the way they order things or actions.

(*5.3*) *Mixed-Initiative*

An aspect often studied with regard to user-system interaction is the level of initiative. For collaborative problem solving (e.g. constructing a preference profile) between user and system mixed-initiative is a popular approach [13].

4 User-Centered Prototype Design

As part of our design of a novel negotiation support system we are in the process of designing prototypes for the preference elicitation interface. Our domain is job contract negotiations. Given the set of design criteria in the previous section we selected appropriate existing interface elements (e.g. ValueCharts [4], a virtual job agent) and created new ones (e.g. job offer clusters, post-it notes with preference information). Next, we combined these elements into four interfaces. There are, of course, many combinations of elements possible, which would lead to an exponential number of prototypes. Instead of creating this high number of prototypes we combined the elements in a way that each prototype differs in the way the system interacts with the user. Each way of interaction supports a different thinking style based on the theory by Gregorc [16]. By this we can create meaningful combinations, each supporting a different user group. In the evaluations we did not try to find the best prototype to choose and develop further, but rather evaluate the different design elements used. In the following creative session we then gave the participants the chance to combine them in different ways that they preferred and found more usable. We implemented the designs as hi-fi prototypes because this was the best way to ensure that the users get a feeling for the interaction with the system. In the following we describe the four prototypical interfaces highlighting the interface elements used (*italic font*).

4.1 Conversation: Abstract-Random Style

This prototype (Figure 1) focuses mainly on design criterion 5 and in particular the natural interaction (5.1) between the user and the system employing mixed-initiative (5.3). A natural way of building a preference model is being questioned by an expert, who can understand what you want by asking the right questions. In real life this could be a job agent. Since this is a known and intuitive way for people to express their preferences we designed a very simple interface based on a conversation with a *virtual agent*. Another design criterion used in this prototype is criterion 4. We tried to reach transparency of the system by two means: the affective state of the agent and the "thoughts" of the agent regarding the user's preferences. In the first simple version there are three states of the agent implemented, speaking with positive expression, thinking and confused. The second feature is a *thought bubble* above the agent's head. In the beginning of the conversation it is empty. It gets filled with tags (forming a *tag cloud*) whenever the agent could retrieve an interest or issue from the chat that seems to be important to the user. To ensure natural interaction during the evaluation sessions the prototype was implemented as a client-server application for a Wizard-of-Oz testing, i.e. the role of the agent was taken by a real person.

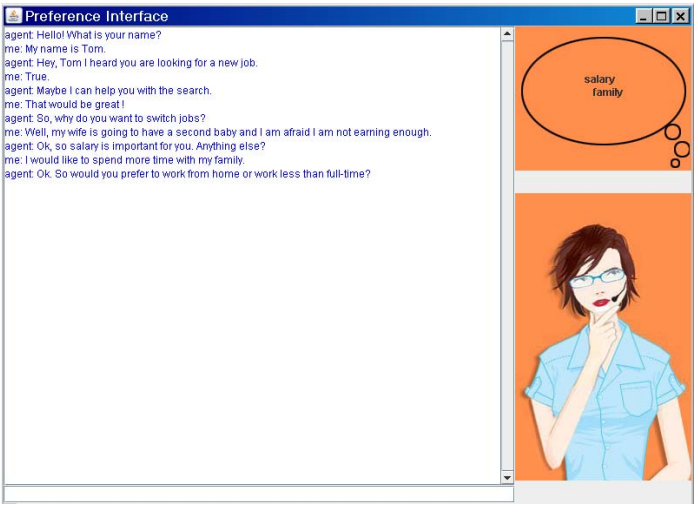

Fig. 1. User interface for conversation with intelligent agent

4.2 Post-its: Concrete-Random Style

This prototype uses different design elements based on criteria 1, in particular 1.1 and 1.3, and 5.2. The focus lies on supporting the constructive nature of human preferences (1). Two things inspired the interface shown in Figure 2. First, preferences are rather unstructured to begin with. They are not necessarily linked to each other. Second, preferences change dependent on the context.

We used *post-it notes* as a real-world metaphor (5.2). The interface allows dragging as many post-it notes onto the so-called preference view as the users want. They can then write the important issues on the notes, add a value and specify whether they like, want, dislike or do not want these issues. At any time they can remove, add or drag around the post-its to structure their profile. More important issues can be dragged further up and less important ones down.

At the same time we provide the users with the needed context (1.1) to make their choices of how to structure the notes. The context is a number of job offers in the *outcome view* that get arranged into *clusters* according to good fit to the current preference profile. This could be done in real-time while the user is interacting with the notes to give immediate visual feedback (1.3). For simplicity reasons the arrangement takes place after pressing the "update offers" button. In the evaluation we discussed both options.

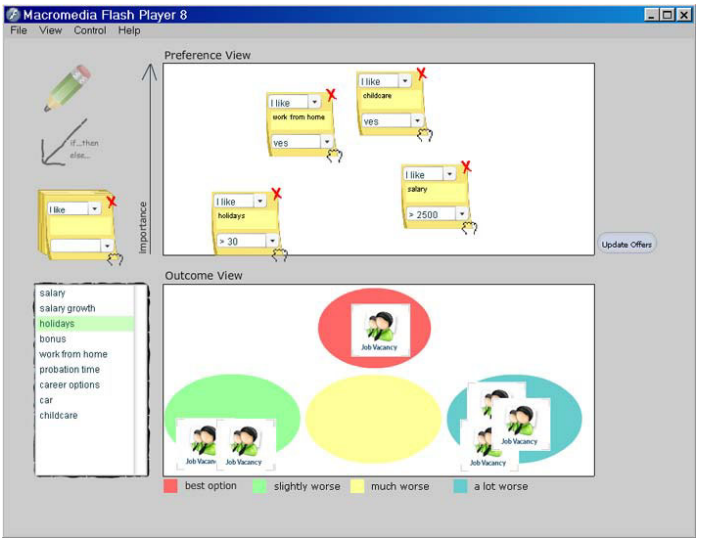

Fig. 2. Visual construction of preference profile

4.3 Comparison: Abstract-Sequential Style

This prototype (Figure 3) employs criteria 1.1 and 1.3 as well as 3. Based on the value-focused thinking approach (3) the user chooses from a list of *interest profiles*: family-oriented, money-oriented, career-oriented, or self-fulfillment. We chose these profiles because they represent life goals that are linked closely to jobs. In a real system this needs to be scientifically proven. In order to help people choose a profile we added a visual stimulus to each profile. We chose a moodboard-like collection of images as often used in advertising to convey a certain feeling or style. Each moodboard consists of a collection of images that represent the particular profile at a glance. The selection of images aimed at giving a diverse view of the profile (e.g. career profile: doctor, model, business man etc.) in order to avoid that users focus too much on a particular image. In

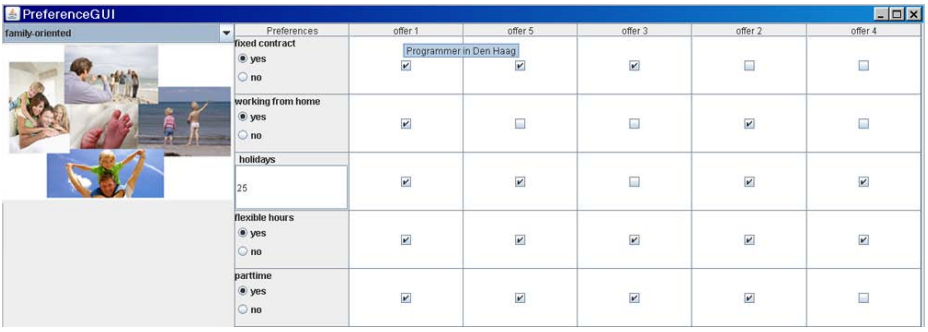

Fig. 3. Choosing and adjusting a default profile

the second step, the user received a filled-in list of preferences that fit the chosen profile. To give the user context to understand their preferences and refine the preselected ones we also present a list of job offers (1.1).

The data is presented in form of a *decision matrix* similar to the ones often used on product comparison websites. Both the preferences and the offers are ordered by importance, from top to bottom and left to right respectively. By hovering over the job offer with the mouse the user gets a description of the jobs. Since we are not expecting that people fit perfectly into a profile the users have the chance to adjust the preference values as well as the ordering. As soon as they enter a new value or drag and drop the rows around the job offers get ordered based on the new input to give visual feedback of the consequences (1.3). We use a lexicographic ordering. During the evaluations we also discussed the possibility for the user to drag the job offers, which will result in adapted preferences.

4.4 Stepwise: Concrete-Sequential Style

Our fourth prototype addresses criteria 1, 2, 3 and 4. The interaction is similar to the APT Decision agent [29] following three steps: (a) letting the user give only a small number of preferences, (b) then receiving a list of offers to compare and (c) giving feedback to attributes that appear in the offers. We adapted this approach and ask the users in the first stage about their three most important interests (e.g. work-life balance or professional development) instead of negotiable issues. By that we follow the value-focused thinking approach [19] (3). After choosing the interests the user enters the interface depicted in Figure 4. The interface aims at helping the user explore several job offers (1.1) with regard to the user's interests and by that construct his preference profile. To compare the offers we used *ValueCharts*, developed by Carenini and Loyd [4]. The user can adjust the (initially equal) importance of the interests. He receives immediate visual feedback (1.3) on how well the job offers match his interests, while adjusting the importance by growing or shrinking of the job offer bars. By double clicking on an interest the job offers get ordered according to good fit. The interface also offers the possibility to critique any attribute of a job offer (1.2). Once the user chooses to look at a job offer in more detail the table on the right gets filled with all values for existing attributes in the job offer. The users are free to give *affective feedback* (2) on any

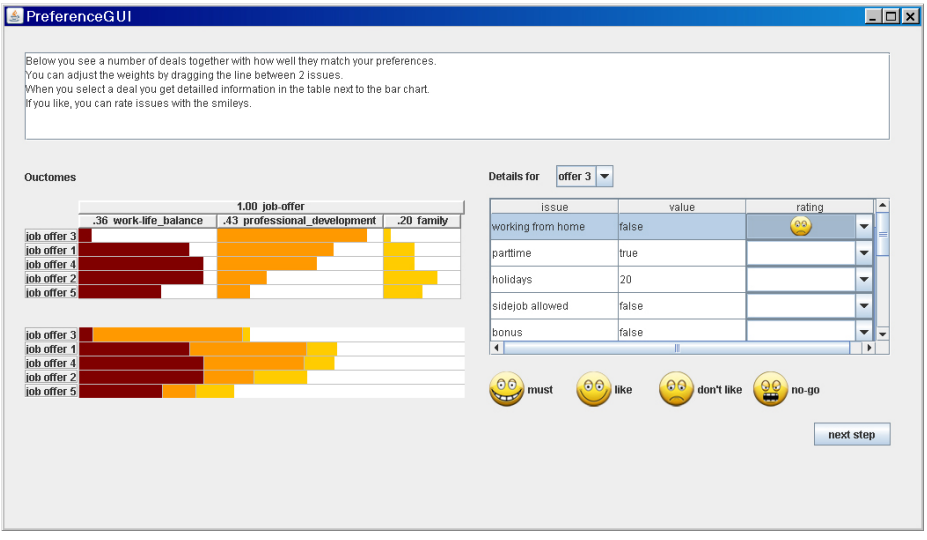

Fig. 4. Preference elicitation using ValueCharts and affective feedback

issue-value pair they want, but are not forced to rate all of them. We included "musts" and "no-goes" as hard constraints in the system, i.e. a job that does not comply with either will not be an option to the users. When the user is done exploring his options, the interface reveals an overview over elicited preference profile, which supports the transparency of the system (4).

5 Formative Evaluation

As a first step in our iterative cycle of designing new preference elicitation interfaces we conducted eight evaluation sessions with one participant at a time and one creative session with all eight participants. In the individual sessions the participants had the chance to interact with all four prototypes and give verbal feedback.

5.1 Individual Sessions

Participants. We included 5 male and 3 female participants. The participants were people with different backgrounds, i.e. computer science, artificial intelligence, agent technology, affective computing, design, linguistic and visual perception. We intended to have a mixture of people with diverse backgrounds in order to get different views on the interfaces.

Procedure. The sessions were carried out in a lab setting. The participants were first briefed about the background of the evaluation and the intention. We emphasized that we would like to receive constructive feedback on the different elements of the prototypes that we can feed back into the design process rather than focusing on usability

issues. After the briefing we provided the participants with the scenario described in the following subsection. We chose using a scenario rather than the participants' real job preferences for two reasons. The first is of practical nature: Since our interfaces are limited regarding their domain knowledge, we wanted to make sure that the issues and interests people want to express preferences over were available in the system. The second reason was trying to get participants to use the interfaces in a very similar way to be able to compare the feedback. The participants then interacted with each of the four prototypes for about 10 minutes on average. The order of prototypes was changed per participant. Their task was to fill in preferences about jobs that would fit the person described in the scenario. During the interaction the participants were asked to think aloud. The actions and the voices of the participants were recorded by the help of the Camtasia Studio software (http://www.techsmith.com/camtasia.asp). Each prototype saved the preferences to a log file. The person leading the evaluation intervened whenever participants seemed to be lost, asked for help or forgot to think aloud. Often the evaluator and the participant already got into discussions about new ideas and problems with the interfaces during the interaction. After the interaction with the prototypes we conducted an informal interview to get a grasp of the user's experiences, constructive critique and new ideas. We used printed screenshots of each interface to remind the participant what they looked like. Together with the evaluator new ideas were developed and discussed and drawn onto the printed screenshots.

Scenario. "Bob, a 35 year old programmer with some experience in consulting and project management, is searching for a new job. He and his wife recently moved into a new house because they are going to have a baby soon. It will be their second child- their daughter is 5 years old. Bob likes to spend time with his family. He enjoys playing with his daughter and is excited about the new baby. Generally, he is a very social person, involved in many activities besides his work that he values highly. Having luxury is not one of his concerns. However, in the current situation regarding the new house and baby, it is important for him to earn a decent salary and to have a secure job. In his current job he earns about 2850 EUR (before taxes) monthly. He thinks it is okay for a programmer, but since the working hours are long and overtime is unpaid he wants to change jobs."

Wizard of Oz set-up. The prototype based on a conversational approach was implemented for a Wizard of Oz testing. Instead of implementing an intelligent agent that could interact with the user we developed a client-server chat application. The participants in our evaluation used a Java client which included a chat window, a virtual agent and a thought bubble above the agent's head (Figure 1). The wizard was sitting in a different room and was thus not visible to the participant. He received an SMS from the evaluator about 3 minutes before the chat started in order to get ready. The connection between the server and client applications was made before the evaluation session started. Within the server application used by the wizard, he could reply in text form, change the agent's state between talking, confused or thinking, and put in tags that appeared in the thought bubble on the user side. The participant initiated the conversation by talking to the agent. The wizard followed a script while talking to the participant.

The script included greeting and ending of the conversation as well as a number of questions that he could pose fitting the scenario. He also had a number of tags that he could use. However, since the user input could be arbitrary the wizard was free to adapt to the conversation.

5.2 Collaboration Session

After the individual sessions we held a creative session with all eight participants. Goal of this session was to create new ideas for preference elicitation interfaces. The session consisted of two parts, a group discussion and participatory design session aimed at creating new paper prototypes.

Fig. 5. Interface Elements for Creative Session

Material. We created paper versions of all interface elements we had used in the four hi-fi prototypes (Figure 5), e.g. the virtual agent, the post-its, the value charts or the tag cloud, as well as standard interface elements such as text fields, check boxes, sliders, comboboxes, etc. Additionally, we had a number of blank papers, pens and scissors to give the participants the chance to create their own interface elements. These materials were used by the participants in the second part of the session to design their own preference elicitation interfaces.

Procedure. After a short introduction to the meeting including a reminder of all four interfaces and the agenda, we started a general discussion about the interface elements. The discussion took part with the whole group and took about 20 minutes. After that we split all participants into two groups of four participants each. Each group was provided with the same set of materials described above and instructed to use the material to create their own version of a preference elicitation interface. They were encouraged not only to combine the elements existing in the four presented prototypes but also create new ones. This part of the creative session was planned for about 30 minutes. However, since both groups were not done within that timeframe, the session went longer (ca. 1 hour). The creative session was concluded with a presentation of the two groups' results to each other. During the presentation new discussions arose about design decisions.

6 Informing the Design Process

We gained detailed feedback on the four prototypes as well as new ideas, including tips and new combinations of the prototypes' elements. We will use this data to inspire our further design process. Therefore, the analysis was focused on extracting ideas instead of drawing general conclusions about the four different prototypes. In order to extract ideas we annotated the recordings from the individual sessions using NVivo (www.qsrinternational.com). Based on the annotations we created a table with feedback on each prototype per participant. In addition, we made a list of observations of how users used the prototypes and a list of new ideas that were discussed in the individual and the collaborative session. In the following we will give a detailed account of the feedback we got per prototype element. We will combine data coming from the individual sessions and the group discussion, because the same issues were discussed in both settings. Finally, we will describe the new designs that came out of the creative session.

6.1 Feedback from Individual and Collaborative Sessions

Virtual agent (Conversation prototype). From observation we can say that the conversational prototype with the virtual agent was engaging and straight forward. The opinions of whether it is a useful interface for eliciting preferences, however, were rather diverse. Whereas some participants doubted mostly the feasibility, others thought of it as a natural way to enter preferences. Main critique points were that it was generally too slow in getting to a complete preference profile, it is rather vague, the profile that is saved by the system is not clear and it does not offer any comparison of job offers. Positive points mentioned were the ease of use, the fact that it is open, that the user does not need to work within the programs constraints and that it is easier than giving each issue a number. A few times the idea was mentioned that this could be a nice interface for eliciting underlying interests from the participants. Another point mentioned often was that the success of this kind of interface depends on how good the agent is and how much the user can trust her.

Tag Cloud/ Thought bubble (Conversation prototype). Most participants, regardless of positive or negative attitude towards the complete interface, liked the tag cloud because it gave them a hint of what the system was "thinking".

Post-it notes (Post-its prototype). The post-it notes were discussed both in the individual and collaborative sessions. The majority of participants had a positive attitude towards them. Only one participant thought it was too difficult to operate and another said there were too many hidden things. From the other participants we got a lot of feedback regarding improvements of this prototype. Besides smaller usability issues like the way you drag the post-it notes on the preference view or that the "best"-cluster should not be red, we received feedback about the visualizations and ideas for combinations with other interfaces. Most participants agreed that the process of dragging the post-it notes and filling them takes quite long. Therefore they suggested that this interface could be combined with a profile selection, either with pictures or a short chat. In the

next step the relevant preferences for the chosen profile could already be in place. The user just needs to 'fine-tune' them. One idea for fine-tuning was using scenarios, i.e., job offers that people have to decide between. This is similar to the example critique approach mentioned in the related work section. An easier way to represent the post-its would be on a horizontal line, where the more important preferences would be further right. The line could be colored with a gradient from red to green, indicating the importance from low to high. The colors would help people to judge the importance better than in the current version. Equally important preferences could be stacked onto each other. The outcome view could be enhanced, e.g., by aligning the offers in a diagonal line from bottom left to top right, whereas the best option would be on the top right.

Outcome view/ clusters of offers (Post-its prototype). Participants generally liked seeing and exploring the offers in the outcome view. One participant in the individual sessions mentioned the importance of the "tie between what you are doing (preferences) and the consequences (job offers)". This was also an aspect that most participants agreed on in the group discussion. Many ideas arose to improve the interaction. One participant had the idea that when you mark one preference it should be highlighted in the outcome view how well the offers fit regarding just that preference. Generally, participants agreed that the offers should be dragable and trigger an update in the issue preferences. Several participants mentioned that when the user wants to drag a worse offer to a better cluster the user needs to give a reason to the system why he likes this offer. In turn the user should also have the possibility to ask the system why a particular job offer scores badly with the current preferences. One participant suggested the possibility to zoom into the cluster view and see more details the further you zoom in. Furthermore, the offers themselves could be colored according to how well they match the preferences.

Interest Profiling (Comparison prototype). In general, participants liked the idea of choosing a profile. However, most had trouble deciding on one profile that fits them best. Different ideas were mentioned to overcome the problem, e.g., allowing combinations of profiles, using a chat to understand which profile the user fits in or already showing the default preferences of each profile. In addition, after choosing a profile the user should still have the chance to remove and add issues from the pool of all issues. This was also an element discussed a lot with the whole group of participants. It was discussed to give people the choice of choosing a default or starting with an empty profile. In order to choose a profile different ways were mentioned, e.g. using a set of questions or pictures. An idea that appealed to a number of participants was the combined use of pictures and sliders for each profile. The users can select with the slider how important each profile is to them. This solves the problem of fitting into exactly one profile.

Decision matrix (Comparison prototype). One participant liked the matrix with preferences and job offers, because it reminded her of the product comparison websites online. The other participants had a negative attitude towards the matrix. One main critique point of the interface was the visualization. Most participants had trouble understanding that issues and jobs were ordered and that it was possible to drag them around to adjust

the preferences. One user said that the table gives a static impression. Instead we could show the rows as free-floating bars or the selected row could be overlaying the other ones to make it clear that they are not fixed. Another option would be to use arrows behind each row indicating that it can be moved up or down. Another point mentioned was that most of the interface is occupied by the checkmarks and not by the preferences, although the latter are what it is all about. One participant mentioned that the user should maybe have the chance to select a couple of offers and compare them in detail instead of all five offers.

ValueChart (Stepwise prototype). The ValueChart got a lot of positive feedback and was also a major discussion point in the group session. People needed a first period of understanding how to operate it. Most participants found it appealing since it gives an overview of how the job offers fit the profile but without losing the detailed information of how well each interest/issue scores in an offer. This is something that is, e.g. not visible in the clustering (outcome view in constructive prototype). Participants particularly liked the immediate visual feedback while interacting with them. One participant had the idea to use the chart for profile selection. Another idea was to attach ValueCharts to the job offers in the constructive prototype to enhance the visual feedback of how good a job is. A major critique point of the whole interface was that there is no link between the ValueChart on the left and the table with issue ratings on the right side. Almost all participants were expecting that when you rate the issues it will have an effect on the bars in the ValueChart. One participant mentioned that if there is no connection there should be a clearer distinction, e.g., between your life goals (ValueChart) and your current job preference (table).

Affective feedback (Stepwise prototype). A problem that occurred with the affective feedback was that the must-have smiley was not interpreted as a hard constraint but rather for something that is liked a lot but not a must. One participant suggested using smileys with a continuous scale with clear extremes instead of static ones. This could help avoiding misunderstandings of the static smileys.

Summary (Stepwise prototype). Another element that was liked was the summary of preferences in the last step. However, it was also mentioned that this summary should already appear while you are adjusting your preferences and that it needs more interactivity (dragging issues into different categories, adding new ones, etc.). This element could, generally, be combined with any other prototype to give the users a clear picture of their preferences.

6.2 Overall Feedback

From the individual evaluations we could discover a tendency towards the post-it notes interface but combined with other approaches, e.g. having pre-set default profiles. Other ideas that came up besides the ones mentioned above were: including standards in the interface, e.g. the typical number of holidays based on the user's age or typical salary for a certain position; and giving people the option to choose only a few job offers that they want to compare (instead of a fixed number). In general, it seemed that the participants

were exploring the options and the link between their preferences and job offers a lot. In the group discussion most participants generally agreed, that the visual and real time feedback is important for to get an understanding of their preference adjustments and the consequences. They played around to figure out how the job offers' order changed when they adjusted their preferences. Some even emphasized that they wanted to be in control of the process. One participant aptly formulated that "it is better when you feel involved in the process. If it is your own creation you feel more attracted than when the computer says: 'this is your profile'".

6.3 New Interfaces

After the discussion we split the participants into two groups of four people to each design their version of a preference elicitation interface. The results are depicted in figure 6. Group 1 designed an interface consisting of three parts (views). In the upper left is a profile selection. Each of the four profiles is presented with an image. The user can give both an affective rating with a smiley as well as an importance rating with a slider for each profile. The lower left part of the interfaces shows based on the profile input a small number of filled-in preferences in form of an ordered list. The user can add new ones (presented by the post-it in figure 6) or manipulate the existing ones. At the same time the user gets an outcome view on the right side of the interface which shows a number of offers including a full description of all issues. To each job offer a ValueChart is attached consisting of two rows. The first shows the fit of the different profiles for the offer and the second one the fit of a number of issues that can be selected by the user in the preference view. In turn the user can also directly drag an interesting issue from a job offer to the preference list on the left. The idea of the group was that all three views are connected and manipulation of one affects the other two. In addition, each view can be minimized or maximized (lines in the upper right corners of each view in figure 6). Some users might prefer not to see all views at the same time and should be able to choose.

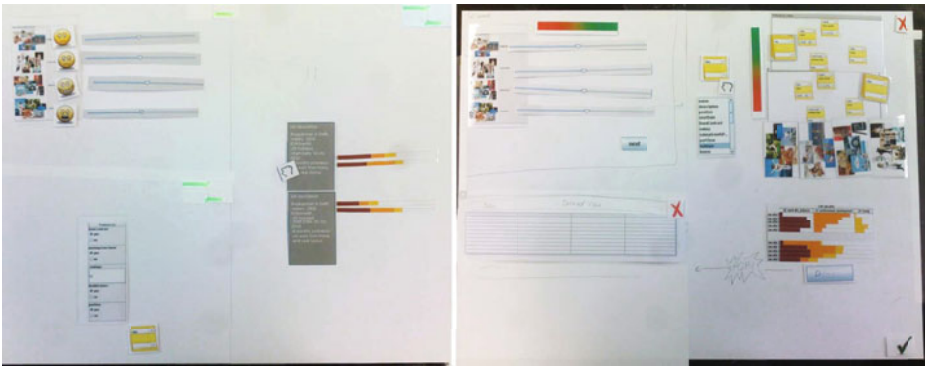

Fig. 6. Design proposal group 2 (left) and group 1 (right)

Group 2 decided to start the process with a so-called profiles wizard, a separate screen where the user decides on a profile that fits him. Pictures help to visualize the four profiles and the importance of each profile to the user is put in by positioning a slider. A colored bar from red to green helps the user, red indicated low importance, green high. Once the user clicks a 'next' button the screen is closed and the user gets to a new screen. This one is split into two parts similar to the constructive prototype. In the top half the user already gets a number of post-it notes with preferences. These are arranged in a 2D space according to importance on the y-axis and the four profiles on the x-axis. The user can still adjust the preferences by changing the values, adding or removing issues. The bottom part of the interface contains a visualization of how good five job offers score according to the current preferences using a ValueChart. The job offers are only described in short summary here. By selecting one and clicking the 'detail' button the user can get a table (pop-up) that shows all issues and values of the selected offer. The users can interact with the preferences and job offers, as they wish, and the respectively other view gets adjusted automatically.

6.4 Design Implications Leading to Current Work

This first formative evaluation provided us with insights into how people would like to enter their preferences, what they find important and which elements support the process. Regardless of the interface elements used, an important aspect for people was to understand and explore the link between the preference input and the order or fit of job offers. An element that the participants found highly useful for this exploration were the ValueCharts, because they give immediate visual feedback while keeping details about the selected interests/issues. Another well-liked element supporting the construction of preferences was the post-it note. Furthermore, using default profiles was anticipated

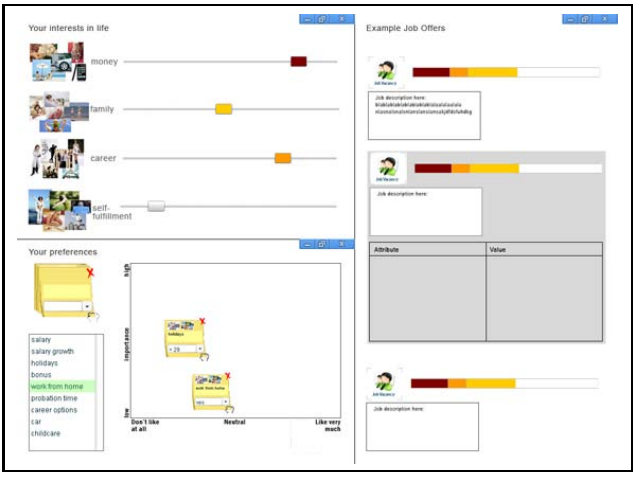

Fig. 7. Design for Preference Elicitation Interface for NSS Prototype

since it gets the elicitation process started more easily. Based on a given profile a number of common preferences can already be displayed. Carefulness needs to applied with designing the interface in this case. Most people had trouble fitting themselves into one of the four given profiles.

Based on these findings and the created interface proposals (Figure 6) we designed a preference elicitation interface for our first prototype of a novel NSS (Figure 7). We picked up the idea of having three panels: (1) one where people can specify their interests, (2) one for entering preferences using the post-it notes and (3) one for showing job offers with ValueCharts indicating how they fit the interests. Each panel can be minimized if not needed. We are currently in the process of defining the concrete interaction between the three views, i.e. how changes in one view affect the other two. As a follow up we will test the interface in the context of our NSS prototype with real users in a preparation for a negotiation.

7 Conclusion and Future Work

We presented the first stages of our approach to designing new preference elicitation interfaces for decision/negotiation support systems. Unlike many existing systems we put the focus on how to involve the user in the process of constructing his preference profile. Our scientific contribution is a number of design criteria based on the literature about human preferences and a number of design elements combined to four new interfaces. Our user-centered design process involving users actively in designing new interfaces provided insights into how people perceive the interface elements and envision complete interfaces. We noticed that participants in the creative session focused only on existing elements although we encouraged them to create their own new ones. Therefore, having separate creative sessions with other potential users that have not seen the prototypes could help more to facilitate creation and inclusion of new elements for preference elicitation.

Our work on evaluating, combining and improving the interfaces in an iterative way is still in progress. Therefore, we cannot give any generalizations on which interface would work the best. Certainly this is also dependent on the characteristics (e.g. thinking styles) of the user and the goal of the system. However, we believe, the work we have done so far, offers a new view on designing preference elicitation interfaces focusing more on the users and their cognitive abilities. We hope to be able to motivate researchers from diverse fields dealing with preferences to put more focus on the constructive nature of human preferences and acknowledge the importance of well-designed interfaces supporting the users in that process. Our work can be seen as a starting point for further research in the following directions: (a) the influence of initiative between the user and the system, (b) how to achieve system transparency (e.g. by the system's explanation based on reasoning with the preferences), (c) intelligent interaction between the user and a virtual agent eliciting preferences, or (d) the influence of different thinking styles of people on the accuracy of the elicited preference profile.

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