Differences and Changes in Preferences Regarding Personalized Systems: A User-Centred Design Perspective

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Abstract. We introduce a tentative overview of the factors that can lead to differences and changes in users' preferences concerning user-adaptive systems. We then discuss how current methods in user-centred design could be deployed or adapted to develop personalized systems that better take into account the different preferences of their users, especially concerning the adaptive aspects of the systems, both in the short and long term.

1 Introduction

Personalized Systems (PS) can be defined as interactive artifacts that present a combination of adaptive and adaptable techniques [9][17]. They are systems that "… can alter aspects of their structure, functionality or interface on the basis of a user model generated from implicit and / or explicit user input, in order to accommodate the differing needs of individuals or groups of users and the changing needs of users over time" [1]. The design and evaluation of this type of system can be particularly challenging due to the complexity of generating user models that are rich and flexible enough to do justice to the various needs and preferences of different users, as well as their changes over time. Also, defining adequate methods to evaluate PSs has been recognized in previous studies [8][14][19] to be no trivial task.

In this paper we will propose a theoretical framework which provides a new perspective for the User-Centered Design (UCD) of interactive systems (and PSs in particular), by putting users' preferences in the spotlight, bringing to light some important aspects concerning their differences and change over time that have traditionally received little attention. Our focus will not be primarily on how an adaptive system can recognize and adapt to differences and changes in users' preferences, although this is a valid and commonly studied issue in the area of PS design. Instead, it will be on the analysis of how the new perspective provided can improve the way in which UCD of PS is carried out.

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In particular, the framework provides a tentative overview of factors that help to explain differences in users' preferences and offer some hypotheses about how each factor changes over time, including the rationale underlying each hypothesis. After a brief presentation of the framework in Section 2, we will analyse in Section 3 how designers could apply it to improve the design and evaluation of PS, and which adaptations of the typical UCD methodologies should be made to fully exploit the power of the new perspective presented.

2. A Framework for Understanding and Predicting Preferences

When looking at any particular system or study, we may seem to be able to explain the observed preference differences and changes in terms of one or two fairly obvious factors, such as the users' level of experience or their personality traits. But when we look at a broader range of experience with user-adaptive systems, we see that there is a great variety of factors that can influence user's preferences; a focus on any subset is likely to lead to inaccurate conclusions.

In the framework presented in Table 1 two categories of factors are distinguished that can help to explain differences in users' preferences: *Users' needs and the System's properties*. For concreteness, we will explain the table with reference to two related examples of user-adaptivity: (a) the early profile-based personalized search introduced for a few months in 2005 in Google's "Lab" (see Figure 1); and (b) the now familiar history-based personalized search that is turned on by default in Google's search engine (with which the reader is assumed to be familiar).

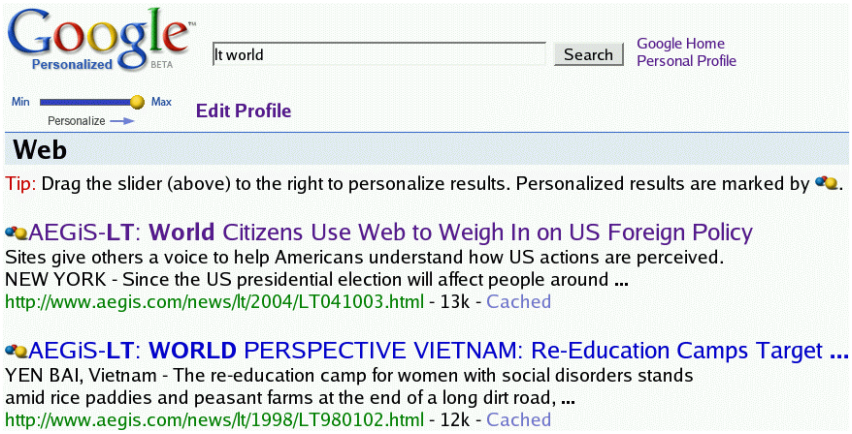

Fig. 1. Screenshot of the experimental, profile-based version of Google's personalized search that was used in Google's "Lab" in 2005. (By moving the slider in the upper left, the user could change the degree to which the search results were reranked on the basis of a previously specified interest profile. The reordering was visualized with an animation.)

Table 1. Overview of the factors that can lead to differences and changes in users' preferences concerning user-adaptive systems. (Symbols like "+++" indicate roughly, on a scale from "()" to "+++", the amount of attention that the factor has attracted so far in the literature.)

Factor	Systematic evolution	Reason(s) for evolution
Users' needs		
Needs relevant to success at task performance:		
+++ Tasks to be performed	++ May expand in scope and increase in complexity	Experience with system makes additional tasks manageable
+++ Skills	+++ Will usually increase	Use of system provides relevant practice
+++ Typical usage contexts	++ May expand	Experience with system makes additional contexts manageable
++ Usability priorities	++ May shift away from learnability and become more realistic	Experience diminishes importance of learnability and reveals which priorities are most important
Other needs:		
++ Aesthetic preferences, values, and attitudes (e.g., culturally determined)	+ May shift in favor of system	Habituation to system
++ Relevant personality traits	+ No systematic tendency	Traits are generally stable; any change can be favorable or unfavorable
+ Habits formed with other systems	+ May decline in influence	Experience leads to formation of new habits more favorable to system
+ Desire for novelty	+ Should favor system less, if system was initially novel	What was initially novel does not remain novel
The system's properties		
Variable aspects of the system:		
+++ Aspects dependent on adaptation to and customization by user	+++ May (but may not) make system more suitable for each user	Customization and adaptation have this purpose, but success depends on various factors
+++ Aspects dependent on particular versions of the system	+++ Can become more or less favorable	The system itself tends to improve, but the match with user's knowledge and habits may decline, at least temporarily
Incidental aspects of the system:		
+ Features (e.g., functional limitations) incidentally associated with the adaptive system that evoke different responses in users	+ No systematic tendency	These features can take many different forms, making systematic prediction difficult

2.1 Users' needs

Generally speaking, the most obvious explanation for differences in users' preferences consists in differences in the users' relevant needs. Some of these are directly related to the users' success at performing tasks with the system.
For example, the profile-based search might be expected to work relatively well for, and therefore to be relatively preferred by:
– people with no specific information need who are just looking for information that corresponds to the general interests expressed in their profile (*Tasks to be performed*);
– people who are not very good at expressing their interests with query keywords (*Skills*);
– people who attach high value to being able to understand and control the system's adaptation (*Usability priorities*).
By contrast, the history-based search would be expected to be relatively preferred by users who often search for the same specific pages, who do not want to devote any attention to the matter of personalization, and who do not mind having their search histories stored on Google's computers.
When considering such factors, we can see some predictable changes: A novice web searcher who initially likes the profile-based search may acquire skill in formulating more precise queries and begin performing more ambitious search tasks— changes which, according to our table, may diminish their preference for the profile-based search.
Other types of users' needs are less closely related to performance of specific tasks, that is why they have been generally given less attention in previous design and evaluation studies. For example, the profile-based search, with its colorful icons and appealing animation, should appeal to people who like this type of interface or who more generally enjoy interacting with novel interfaces. But people who are accustomed to leaving search results in the order in which they are received from the search engine may never get used to the sort of active manipulation that is presupposed by the profile-based search (even though this manipulation does not require any particular skill). Here again, some changes may be expected: The unfamiliarity and novelty of the profile-based interface can wear off, for better or for worse; and over time the user may become so accustomed to moving the slider on the profile-based search that they would be frustrated if deprived of the opportunity to do so.

2.2 The system's properties

At first, it might be thought that the properties of the system itself cannot lead to differences or changes in preferences, since the system stays the same for all users. But especially user-adaptive systems are designed to adapt to—and/or be customized by— the user. So at any given moment, different users are likely to be working with variants of the system that are differently well-adapted to them, which in turn can lead to different preferences. For example, User A may be happier with the history-based search then User B simply because User A's web history currently captures A's interests better than User B's history captures B's interests.

Since adaptation and customization are supposed to make the system better for each user over time, the default expectation would be increased acceptance by users over time, providing that they use the system long enough to benefit from the adaptation or customization. But the time course of such changes can be very different for different adaptation techniques: With the history-based personalized search, there tends to be a gradual improvement over time, in addition to possible short-term benefits; with the profile-based search, the benefits may actually be greatest early on and decline over time as the user's initially specified interest profile falls out of date.

There are also a number of interesting aspects of the *process* of preference formation and evolution affecting differences and changes in preferences (they are not addressed here due to lack of space). As an example, even if adaptation is in principle able to bring great benefits for a given user, that user may never notice the fact for different reasons or events related to initial interaction with the system [19].

3 Designing Personalized Systems From the New Perspective

We turn now to consider how the framework presented above could be applied during the design and evaluation of PS, how it could help designers to choose, and adapt when necessary, methods from the vast repertoire of UCD [7][13] to take into account differences and changes in user preferences for these systems. We will address first the research questions raised by the framework with respect to system design (in the phases of user requirements analysis and early design) followed by those more concerned with PS assessment (in the phases of iterative testing and summative evaluation).

3.1 Requirements analysis

How can we help designers to acquire information about users' needs that are not commonly considered in requirements analysis?

If the to-be-designed PS is likely to include some highly novel elements and adaptation mechanisms, there should be a way of determining whether novelty is considered desirable or undesirable by the various subgroups of potential users. Similarly, designers should not overlook the investigation of users' aesthetic preferences, values and attitudes, as well as the relevance of personality traits and previously formed habits when conducting a PS requirements analysis.

Interviews and questionnaires are commonly used methods to investigate user preferences and needs when interacting with PS [18], as well as scenarios, storyboards and focus groups, which are well suited to shed light on this type of needs. Preference elicitation materials used in the requirements analysis should be designed in such a way to allow users to express their own meanings and interpretations about the type of personalization proposed or looked for, so that designers can achieve a more reliable and comprehensive understanding of the personalization value space [10] for a system, which is not just based on needs or preferences regarding tasks to be performed.

How can we add a temporal dimension to the characterization of user needs?
A first method would consist in directly questioning users about changes in the factors that can lead to preference evolution (e.g., to what extent do the habits formed with other systems are persisting once they have started using the new PS?).
Repetitive measurements based on questioning and user observations could also be useful to detect change when it occurs, as well as to design an adaptation mechanism that can sense and properly respond to it.
As an example, in mobile or ubiquitous systems design, experience sampling techniques are often deployed for questioning users even before having developed a prototype of the new system. Experience sampling is a method used in flow research [12] which consists in signaling participants during their daily lives, to collect assessments of their experiences in natural settings, in real-time (or close to the occurrence of the experience being reported), and on repeated time occasions. Reports can be made in response to a random signal (e.g., emitted by a pager or PDA), at pre-determined times during the day (e.g., daily diary) or following particular events (e.g., interaction with another person or a digital system). This method would be particularly suitable to apply when the type of questions to pose are multiple-choice questions, true–false questions, text auto-completion, numerical ratings (e.g., Likert scales) and it is important to ask them when the user is immersed in the relevant usage context (e.g., [11] found that paper-based surveys are not reliable methods for measuring privacy concerns regarding context-aware services, while experience sampling questionnaires are more effective). Also, in [4] mobile questionnaires were augmented with Web-based diaries to gather qualitative accounts of user preferences and reasons for users' previous in situ choices and ratings. Real time data collection of user preferences would allow researchers to conduct preliminary data analyses almost immediately, send new questions or adapt questionnaires dynamically, and to prepare targeted ex situ inquiries (e.g., individualized interviews). Effective summary reports and visualizations of users' answers stored in the database can then be generated to better appreciate the relevant evolution of their preferences and needs that have been collected during the requirements analysis.

3.2 Early design

How can designers be helped to take into account the less well-understood types of user needs in the conceptual design?
The results of requirements analyses inspired by our framework are likely to yield additional requirements that should be borne in mind during the following stages of design and testing, which should also be planned in such a way to assess the extent to which these requirements are fulfilled.
A complementary strategy is to approach the conceptual design phase by keeping in mind how unlikely it is to understand completely what will happen in real use, no matter how good the previous phase has been conducted. That is why a PS conceptual design should be based on the principles of openness and flexibility, allowing the new system to be used also in unexpected ways, as a consequence of users' appropriation [5]. A relevant guideline to follow would be to make key aspects of the

personalization features developed and their effects as visible as possible to the user, to support an easier appreciation of the added value they provide if compared to nonpersonalized versions of the system. Designers should try to make as explicit and clear as possible the intentions behind the personalization features implemented (more than trying to explain to the user the complexity of the adaptation mechanism developed), so as to enable users to provide more informed feedback about their usefulness in practice; this could form also a more reliable base for making future decisions regarding refinements or, if required, re-examination of the adaptation provided.

How can the initial design take into account the expected evolution of needs?
Since both the environments in which a PS is used and the preferences of its users are likely to change over time, design should take into account the expected evolution of these requirements and find out adequate solutions to accommodate them.
Contextual design inquiries [2] have often been used to understand and follow how different situational factors and evolving user needs affect interaction with a system, by directly observing users in their natural settings and activities. A main issue relevant to PS design is that often if you optimise for one task you typically make others more difficult to perform [5]. Also, it is very difficult to define precisely tasks or activities that are performed in natural settings so that their description during initial design is often incomplete and approximate, and it typically ignores exceptions. A relevant heuristic to follow in most cases would be to design PSs that provide the necessary functions so that the user can perform a certain activity in different ways (according to their different preferences over time). Of course a PS should try to provide fast paths to optimize the performance of repetitive tasks, but this objective should not be the designers' only concern. Also, a PS focusing mainly on supporting task execution efficiency might encourage passive user behavior, thus exposing users to the risk of getting stuck in a local optimum, and preventing them from a more active exploration of the potential benefits that the adaptation features could provide in different situations.

How can the initial design take into account the expected characteristics of the process of preference formation?
During the early design phases of a PS, designers should try to involve users who have different overall approaches to preference formation. There are factors related to motivation, attractiveness, emotions and cultural background that need to be taken into account to understand the process of preference formation (e.g., some users may need more pleasurable experiences of interaction with the system to develop fidelization and start to appreciate the added value provided by personalization). Since in PS design affective and cultural dimensions of preferences have received less attention than cognitive factors, methods such as participatory design and cultural probes could be effectively applied to collect more detailed accounts on these dimensions (e.g., users' aesthetic preferences and cultural concerns [6])
A main issue to consider would also be how to best support user transition from novice to more expert interaction with the PS. Since online support or documentation is often disregarded by both users and interface designers, a better strategy might be to encourage end users to contribute material for these sections in the form of sharing

favourite tips and tricks about interesting experiences of PS usage, that could be useful to other (e.g., less experienced) users as well. These forms of mutual support or word of mouth could foster the formation of more accurate and realistic judgements about the system, as a result of knowledge sharing within a community of practice or informational cascades [3].

3.3 Iterative testing

How can we make it possible to take into account the full range of users' preferences in iterative testing?
The focus on predicting preference evolution is expected to provide a number of hypotheses that can be tested to some extent during formative evaluation. The different personalization techniques designed can be presented to study participants (e.g., by means of wizard-of-oz or prototyping methods [8][20][15]) asking for their comments, ratings or rankings to define which are the least or most favored ones according to the type of interaction experienced. Designers should define precise ways of measuring the direct experienced value for users when interacting with the variable components of the system developed (e.g., the alternatives offered in option setting). This could enable them to better understand and take into account which are different situated preferences of the target users and to refine the design and presentation of the system's options in such a way to get each user into the best possible system configuration, according to specific preference and usage conditions.

How can we test hypotheses about longer-term preference evolution within the type of short-term study that is typical of iterative testing?
For the study of changes in user preferences over time, wizard-of-oz methods should be adapted by taking care of providing participants with longitudinal scenarios regarding fictional characters' tasks and preferences for the PS, so as to provoke more reasoning and comments from users about the dynamics of preference formation and change. Another suggestion would be to combine these methods with a temporal compression strategy (comparable to a technique used to test the stability of an object by repeated placement of a heavy weight on it every few seconds for several hours, so as to simulate the type of stress which would occur in several years of normal use). This would allow designers to get comments and feedback from users that have already acquired high levels of familiarity with the adaptation mechanism under study, without having to wait until this level of familiarity has been spontaneously acquired.
Other possible methods would be adapted versions of expert-based assessments (also called discount techniques). Once an adequate corpus of empirical knowledge on user preferences for PS is available, new heuristics and guidelines representing this knowledge should be developed to support experts' assessments (e.g., by using a preference-oriented version of heuristics for Heuristic Evaluation [16]).
Another form of innovation would consist in adapting the type of questions used by experts when performing Cognitive or Heuristics Walkthrough of PS, to better focus their inspections on anticipating differences and changes in user preferences. There are important aspects of preference formation and expression (e.g., deciding which

option to choose among the ones available for customizing an interface) that cannot be assimilated to the mere acquisition of procedures for executing tasks (which are typically assessed by employing usability criteria). More relevant questions to ask in assessing user preferences for a PS would be '*can the user understand the customization options available, their consequences, the intentions behind the adaptation features implemented?*', instead of '*can the user easily notice and perform the correct action available?*'. Although addressing preference evolution could raise the complexity of conducting expert-based evaluations, tuning the inspections on the special topic of user preferences and on the most critical components of an adaptive system should make this task rather manageable by experts.

3.4 Summative evaluation

Where longer-term summative studies are feasible, how can we support their design?
When feasible, large-scale, longitudinal studies of user preferences combining the collection of qualitative data (e.g., based on ethnographic, contextual or participatory approaches) as well as quantitative data (including logs) should be carried out. We expect that the framework provided will offer conceptual support in the design of these studies and will get the opportunity of being further refined and extended by the empirical evidence gradually accumulated by researchers.
A major outcome of the framework would be that of raising designers' awareness about the value of understanding user preferences for PS and their change, as they constitute important aspects for explaining both the adoption and appropriation processes regarding a PS. The guidance provided by the framework is also in terms of facilitating a more systematic analysis of previous studies on user preferences and an easier definition, as well as investigation, of future research questions. By adopting a preference-oriented perspective throughout the whole UCD of PS, the set up of longitudinal evaluations should become for designers more essential and (hopefully) less demanding to carry out.

4 Concluding Remarks

With this brief presentation of a new theoretical perspective, we hope to make readers aware of the many interrelated factors that can determine the ultimate acceptance of PS, just as strongly as the inherent intelligence of the systems themselves.
The application of our framework to the UCD of PS is likely to shed light on how to remove current obstacles in the adoption of these systems by their users, and to inspire new design solutions supporting a better evolution of user-system interaction in the long term.

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