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Choices and Decisions of Computer Users

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Contents

1 Introduction

1.1 Concepts and Goals

Computer users are constantly making small choices and larger decisions about how to use their computing technology, such as these:

- Which of the available photo management apps shall I use on my smartphone?
- Shall I dictate this email message using speech recognition or tap in the text with a stylus?
- How should I configure my privacy settings?

This chapter focuses on cases, like these, where a user can choose among two or more *options*, none of which is correct or incorrect but one of which can be *preferred* to the others. The term *preferential choice* will be used to distinguish this situation from *nonpreferential* choices that concern the correct way to operate a system, such as "Which of these unfamiliar icons do I have to click on to send off my email message?"

We will use the terms *choice* and *decision*, together and in alternation, to do justice to the variety of forms that the processes in question can take. *Decision* suggests a thorough, effortful process, while *choice* suggests a quick selection that may be based, for example, on habit. Both types of process occur in computer users, often with regard to the same set of options.

These are the goals of this chapter:

1. Bring preferential choices and decisions of computer users into the foreground as a topic in human-computer interaction (HCI).
2. Provide access to the relevant psychological and HCI literature by summarizing key concepts and results and listing references.
3. Provide a framework for thinking about how to help computer users make better preferential choices and decisions.

1.2 Relationships to Other HCI-Related Research

Figure 1 visualizes the relationships between these goals and the goals of three other broad types of research that fall within or overlap with the HCI field.

1.2.1 Interaction Design Guidelines and Principles; Help and Training

Much of what is known about how to design interactive systems and their associated help and training material can be seen as concerning ways of helping users to make the right choices: to click on the right icon or web link, select the correct command from a menu, or identify the part of the system that will provide the needed functionality. Interaction designers have become skilled at helping users to make these choices well, for example by designing effective visual displays, making the user's options clearly identifiable and understandable, providing informative feedback on the user's actions, and making the actions reversible in case they don't yield a satisfactory result (see, e.g., J. Johnson, 2010, for a collection of well-known sets of user interface design guidelines). Similarly, those who develop online help and training programs have worked out a rich set of best practices for instructing and advising users about the choices that they need to make. Most of the content of help and training concerns the general question of how to operate the system in question, but some of it explicitly addresses preferential choices, such as when to use each of two available methods

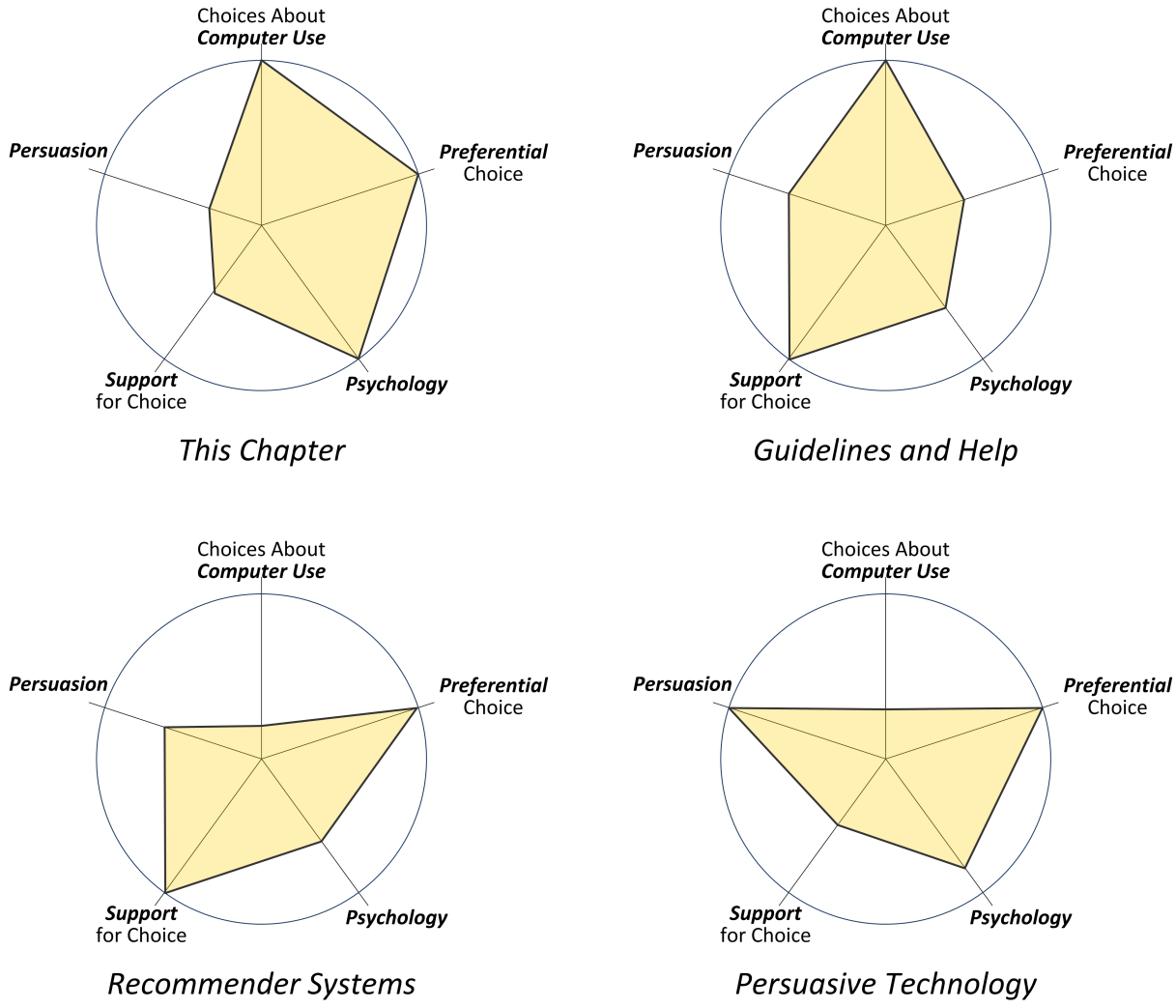

Figure 1: Visualization of the relationships between the focus of this chapter and three HCI-related areas of research.

for accomplishing a particular goal or what type of configuration is best under what circumstances (e.g., "This setting is recommended if you often work off-line").

Guidelines and design principles are rarely tailored explicitly to supporting preferential choices and decisions, and the related research hardly ever refers to the psychological literature on these topics that is covered in this chapter.

1.2.2 Recommender Systems

A focus on preferential choice and decisions is found, by contrast, in research on recommender systems (see, e.g., Jannach, Zanker, Felfernig, & Friedrich, 2011; Ricci, Rokach, Shapira, & Kantor, 2010) which aim to support and influence users' choices concerning products to buy, documents to read, and a variety of other types of item. As Figure 1 shows, recommender systems almost always support decisions that are not about the use of computing technology as such. The work in this area tends to be based to some extent on knowledge about psychological processes involved in preferential choice, but the main focus of attention is on accurately predicting what items will satisfy a user, rather than on understanding and influencing the user's decision making processes.

1.2.3 Persuasive Technology

Yet another line of research (see, e.g., Fogg, 2003; Fogg, Cueller, & Danielson, 2008) differs from the previous paradigm mainly in its emphasis on motivating and persuading people to do some particular thing (e.g., save energy) which either that person or someone else has decided is best for the person in question. This line of research has yielded a wealth of ideas about how computing technology can be deployed to influence people's beliefs and behavior. But only a few of the choices and behaviors targeted for persuasion (e.g., none of the 12 "domains for persuasive technology" listed in Table 7.1 of Fogg et al., 2008) concern computer

use as such.

As Figure 1 indicates, this chapter will not go into much depth on the question of how to support and influence preferential choices concerning computer use. Instead, by foregrounding this class of choices and by providing an introduction to the large areas of relevant psychological literature, it aims to encourage and support increased attention to this topic.[1] Systematic efforts to support choices and decisions of this type should be able to benefit greatly from appropriately adapted knowledge transferred from the other three areas of research, notwithstanding the various differences visualized in Figure 1.

1.3 Preview of Aspects of Preferential Choice and Decision Making

Figure 1 reflects the fact that psychological research about how people make preferential choices and decisions has received limited attention in HCI so far.[2] One reason may be the fact that there is no single relevant theory in psychology that could be straightforwardly adapted to the needs of the HCI field. Though dozens of books and hundreds of articles from relevant psychological research exist, they come from several research traditions that only partly overlap and refer to each other. The discussion in this chapter will draw from these areas: judgment and decision making (see, e.g., Hastie & Dawes, 2010; Koehler & Harvey, 2004; Lichtenstein & Slovic, 2006; Schneider & Shanteau, 2003; Newell, Lagnado, & Shanks, 2007; Weber & Johnson, 2009); naturalistic decision making (Klein, 1998), the Reasoned Action approach (Fishbein & Ajzen, 2010), research on habitual behavior (Wood & Neal, 2007), behavioral economics (Ariely, 2008; Iyengar, 2010; Thaler & Sunstein, 2008), and research on self-control (Rachlin, 2000) and on compliance tactics (Cialdini, 2007).

As a way of providing a reasonably coherent overview despite the differences among these research traditions and their terminologies, Table 1 lists the aspects of choice and decision processes that will be covered in turn in this chapter, formulating each one in terms of one or more "questions" that a computer user might conceivably "ask" him- or herself while considering a choice or decision. Though in some cases such questions may be consciously asked and addressed by a computer user, the processing represented in the table by a question often occurs without any verbal formulation or conscious deliberation—whatever particular definition of the elusive concept of *consciousness* one may prefer to use (see, e.g., Wilson, 2002).

With any given choice or decision for a particular person, in general only some subset of these considerations will be relevant, and the table is not intended to convey a particular temporal order of processing: Because of the variety of forms that preferential choices and decisions can take, it would not be realistic to try to formulate a causal model or a process model, for example in the form of a flowchart, though models of this sort are often found useful for particular types of choice or decision making situation (see, e.g., Wickens & Hollands, 2000, chap. 7; Fishbein & Ajzen, 2010; Klein, 1998, chap. 3).

Table 3: The four main variables in the UTAUT model and typical questionnaire items used to measure them.
(Based on parts of Figure 3 and Tables 9–12 of Venkatesh et al., 2003.)

Performance Expectancy
- Using the system in my job would enable me to accomplish tasks more quickly.
- Using the system would improve my job performance.
- Using the system would make it easier to do my job.
- ...

Effort Expectancy
- Learning to operate the system would be easy for me.
- My interaction with the system would be clear and understandable.
- I would find the system to be flexible to interact with.
- ...

Social Influence
- People who influence my behavior think that I should use the system.
- People who are important to me think that I should use the system.
- ...

Facilitating Conditions
- I have control over using the system.
- I have the resources necessary to use the system.
- I have the knowledge necessary to use the system.
- The system is not compatible with other systems I use.
- ...

2 General Preferential Choice Problems

Though opportunities to make preferential choices and decisions crop up constantly with just about every type of interactive system, there are three generic classes of choice that are worth distinguishing, because of their frequency of occurrence and because they have attracted a fair amount of attention in HCI research. Table 2 introduces them to facilitate reference to them at various points later in the chapter.

[1] A first step toward a systematic approach to supporting preferential choice on the basis of the conceptual framework of this chapter is offered by Jameson et al. (2011).

[2] Two thorough book-length syntheses of cognitive psychology research for HCI (Gardiner & Christie, 1987; J. Johnson, 2010) include hardly any references to the sort of psychology literature cited in this chapter.

Table 1: Preview of the aspects of preferential choice and decision making discussed in this chapter.

Topic	Questions That a Decision Maker May Consider
Focusing on Goals and Values	What is a good decision making process for this situation? What are my relevant goals and values?
Situation Assessment and Option Identification	What's going on in this situation? What are my options?
Anticipation of Consequences	What would the consequences be if I chose this option? How desirable would they be?
Intertemporal Choice	How should I value consequences that will not occur until some time in the future? How should I deal with a sequence of repetitions of basically the same choice?
Reuse of Previous Choices	What did I choose the last time I had a choice like this?
Social Influence	What do other people choose in this situation? What do they want or expect me to choose?
Learning From Experience	What can I learn from the results of the choice that I have made?

Table 2: Three general types of preferential choice that have been studied in HCI.

Generic Choice Problem	Selected Research Issues
Decision about whether to use a given system	What variables influence people's decisions about whether to use a given system if it is made available to them (usually: within an organization)? What are the causal relationships among these variables? How can these variables be measured?
Choice of a method from a set of alternative methods	When more than one method is available for a particular subtask, how do users decide which one to use? Why do even experienced users sometimes persist in using inefficient methods?
Configuration decision	How do people decide whether and when to configure an application? What difficulties do they encounter when making configuration choices?

2.1 Decision About Whether to Use a Given System

One type of decision that a person can make with regard to computer use is that of whether to use a given system at all. The most extensive line of research that has looked into this question is research on *technology acceptance*. A good entry point to this literature is the influential article by Venkatesh et al. (2003), which presented the Unified Theory of Acceptance and Use of Technology (UTAUT), a model that integrates eight previously developed models, including the especially widely studied *Technology Acceptance Model* (TAM; see, e.g., Venkatesh & Davis, 2000). These models in turn drew their inspiration from more general theories from social psychology and sociology, such as the precursors of the recently formulated *reasoned action approach* of Fishbein and Ajzen (2010).

Table 3 gives an impression of the basic nature of the models in this area by depicting the four main variables in the UTAUT model that influence intention to use a given system

and actual use of the system, along with examples of questionnaire items typical of those used to measure these variables. The model also includes claims about several variables that moderate the influence of these main variables: *gender*, *age*, *experience*, and *voluntariness of use*.

Though some of these questions are reminiscent of questions from usability scales such as SUS (System Usability Scale, Brooke, 1996), the overall goal of the model and the associated measuring instruments is not to assess usability but rather to predict whether potential users (typically, employees in a given company) will actually use a given system (e.g., a new videoconferencing system) if it is made available to them. Note that most of the questions related to the variables *Social Influence* and *Facilitating Conditions* concern considerations other than usability.

Researchers and practitioners in the HCI field usually want to go beyond *predicting* whether people in a given target group will use a given (type of) system, to attempt to improve the system (and/or related resources) to increase the likelihood that the system will be used and the success of its use. Still, the large amount of information collected in the technology acceptance area about variables related to choices about system use and about ways of measuring these variables can help to stimulate and structure thinking about this class of choices. Researchers in this area regularly introduce new variables and new perspectives that shed light on different aspects of acceptance decisions (see, e.g., Bagozzi, 2007; Loraas & Diaz, 2009).

2.2 Choice of a Method

In all but the simplest interactive systems, there is often more than one method available for achieving a given goal. Whenever the user can choose freely between two or more methods, the choice is preferential. Card, Moran, and Newell introduced in their GOMS model (Goals, Operators, Methods, and Selection Rules; described most completely in Card, Moran, & Newell, 1983; see also Kieras, 2008) a notation for such cases: The two or more available methods are described as part of the model for a given task, and it is assumed that each user has learned a *selection rule* for making the choice (e.g., "Use the mouse instead of the cursor keys if the target is more than a couple of inches away on the screen"); this assumption is plausible given that the GOMS model assumes that users have considerable experience with the system and the tasks in question.

In the intervening years, some research has looked at the ways in which users learn selection rules on the basis of experience with the methods in question (see, e.g., Gray & Boehm-Davis, 2000) and at the considerations that users take into account when choosing among methods (see, e.g., Young & MacLean, 1988; Jameson & Klöckner, 2005), while other researchers have investigated situations in which users systematically fail to use suitable methods that are available to them (Carroll & Rosson, 1987; Bhavnani & John, 2000; Bhavnani, Peck, & Reif, 2008; Charman & Howes, 2003).

2.3 Configuration Decision

A usually more complicated type of choice that users can make concerns whether, when, and how to configure an application to suit their own tastes and needs. Over the years, researchers have repeatedly found this type of problem to be challenging for most users (see, e.g., Mackay, 1991; McGrenere, Baecker, & Booth, 2007), and it has attracted increased attention in recent years because of the practically important problem of configuring privacy settings in social network platforms (see, e.g., Iachello & Hong, 2007).

3 Focusing on Goals and Values

The first of the general considerations listed in Table 1 concerns the basic values that a chooser will be guided by when making a choice. Although computer users often do not think explicitly about these values, interaction designers ought to be aware of them when considering how to support good choices; and calling these issues to the user's attention may be an effective tactic.

3.1 What Constitutes a Good Choice or Decision?

The most fundamental question is that of what constitutes a good choice in the first place. Before considering what choosers think about this issue, we should take note of a shift in the thinking of scientists who have studied decision making. Traditional notions of what constitutes a good decision are that a decider should (a) apply a decision procedure that is normatively justifiable (e.g., consistent with the laws and principles of logic, probability, and expected utility) and (b) choose the action that will maximize desirable (and minimize undesirable) outcomes under idealized conditions(see, e.g., Gigerenzer & Todd, 1999, chap. 1; Gigerenzer, 2007, chap. 5). More recently, researchers have become impressed by the extent to which animals and humans can function quite effectively by using decision procedures that are justifiable only in the sense that they work well in the environment in which they are applied and make good use of the decider's limited time and cognitive resources. For example, a web searcher's strategy of clicking on the first link on the search result page that looks reasonably relevant would be hard to justify in terms of a normatively optimal general strategy; but if the user's previous experience with the search engine in question has shown that the first reasonably relevant-looking link is almost always the best one, this strategy can be considered *ecologically rational* for that search engine. The same point can apply to the decision rule of always buying your smartphone applications from your favorite vendor or always accepting the default configuration when installing new software. In cases where the choices of a computer user make sense only given particular assumptions about the structure of the environment, the best way to help the user make good choices may be to ensure that the environment satisfies these assumptions.

Researchers have also investigated the question of what constitutes a good decision process from the point of view of the decision maker (see, e.g., Bettman, Luce, & Payne, 1998; Hastie, 2001; Yates, Veinott, & Patalano, 2003). Although specific answers to this question vary, the following statements are widely accepted:

1. Choosers want their decision to yield a good outcome.
   This point isn't as straightforward as it may seem, because what counts as a good outcome depends in turn on a variety of factors, as we will see.
2. Choosers don't want to invest time and effort in the decision making process itself that is out of proportion to the resulting benefits.
   For example, when installing a new application, a user who is asked which specific components should be installed may choose the option "Everything" simply to save the time of deciding about the individual components, since the possible benefits of choosing any other option (e.g., saving a few megabytes of hard disk space) do not seem to justify the investment of even a few seconds of decision time.
3. Choosers prefer to avoid unpleasant thoughts.
   Some ways of thinking about a decision can involve distressing thoughts, as when a driver faces a choice between (a) ignoring an incoming text message from his boss and (b) driving less safely for a while in order to respond to the message. A user may be motivated to think about the decision in a way that avoids such thoughts (e.g., by convincing himself that he can respond to the boss's message without taking the slightest risk).
4. Choosers often want to be able to justify the decision that they have made to other persons—or to themselves.
   Justifiability is often simply a necessary condition for being able to implement a decision (cf. Lerner & Tetlock, 2003). For example, even if a business person would really like to buy an iPhone for professional use, they may choose a Blackberry instead because they think that this choice is more likely to be approved by their company's purchasing department. But even just the desire to convince another person or oneself that a decision was sound can cause people to look for justifiable decisions (see, e.g., Shafir, Simonson, & Tversky, 1993).
   Consequently, one way of supporting preferential choice is to make it easy for the user to come up with a satisfying justification of whatever option is best for him, for example, by supplying a justification explicitly (as is done by many recommender systems; see Tintarev & Masthoff, 2010) or by structuring the situation in such a way that a justification is easy to derive.

3.2 Current Goals and Values

One characteristic of preferential choice is its dependence on the particular goals that the chooser is currently focusing on (see, e.g., Schneider & Barnes, 2003). To a certain extent, this dependence is obviously necessary and appropriate: Your choice of an application to prepare a text document with should depend on whether you want it to be beautifully formatted or whether you just want to get it finished as quickly as possible. But the dependence on current goals can also lead to some curious phenomena: Both anecdotal evidence and some research (e.g., Iachello & Hong, 2007, sect. 3.3.2; Mackay, 1991) concerning configuration decisions tell us that users often accept the default configuration of a system until some negative event (e.g., a privacy violation or a need to repeat a given tedious operation multiple times) prompts them to change the configuration. A normatively more rational way of deciding when and what to configure would involve something like estimating the total (discounted) benefit of the improved configuration over an extended period of system use. By contrast, reactive configuration can be seen as a response to the goal of preventing the specific negative thing that just happened from ever happening again. Whether this configuration action is really a good idea in the long run will depend on how well the short-term goal happens to coincide with the user's larger pattern of goals and use situations. Mackay (1991) and Iachello and Hong (2007) offer perceptive discussions of strategies for dealing with this type of discrepancy.

Keeney (1992) discusses in great depth the importance of ensuring that decisions depend on the decision maker's true values rather than on temporarily salient considerations such as those that are suggested by the set of options that are immediately available. Although interaction designers rarely, if ever, have an opportunity to support their users with in-depth decision analysis, calling the user's attention to important goals and values on a much smaller scale does represent a promising way of supporting preferential choice. Two experiments by Mandel and Johnson (2002) demonstrate clearly how a goal or value (e.g., "safety" or "economy" for a prospective car buyer) can be activated by a change in interface design (here: the colored background of the web pages of an e-commerce site), mostly without awareness on the part of the user.

4 Situation Assessment and Option Identification

In order to be able to make a choice or decision, the chooser must normally in some sense be aware of the fact that a choice is available—though in extreme cases the awareness can be minimal, as when the choice is made out of habit or when it involves accepting the status quo or default option by doing nothing.

In experimental laboratory studies, the way in which the chooser perceives or *frames* the choice problem is largely under the control of the experimenter. Some well-known and striking results concern the effects on choice of the way in which the problem is framed. For example, people tend to be influenced strongly by whether options are described in terms of people being "saved" vs. people "dying", even when

the situations described in these terms are objectively identical (see, e.g., Hastie & Dawes, 2010, sect. 12.2). An important part of one of the dominant theories of judgment and decision making, *prospect theory* (originally presented by Kahneman & Tversky, 1979), concerns the process of *editing* the initial representation of a choice problem to arrive at the chooser's own representation; but choosers often stick with the initial representation.

Like laboratory experimenters, interaction designers often have control over the way in which a choice is presented to the user. For example, users who purchase a software product are often offered an option like "Check this box to receive news about updates and special offers", which a user may mentally edit into a representation like "Check this box to get even more spam".

When decision making occurs outside the laboratory, the presentation of the choice problem is often less clear-cut; understanding the situation and identifying the available options can be a complex process (often called *situation assessment*) that calls for considerable expertise. This process has been extensively studied within the research paradigm of *naturalistic decision making* (see, e.g., Klein, 1998, 2008; Maule, 2010). This type of decision making is typified by the situation of a fire brigade arriving at the scene of a burning building: The problem situation is changing rapidly over time, even as the decision makers think about how to deal with the fire; there is considerable stress because of the high stakes and because of environmental factors such as noise and heat; and on the positive side, the decision makers typically possess considerable experience in dealing with such situations, which makes it unnecessary for them to analyze the problem from first principles. Some key results of this research will be summarized below in Section 7.1. For now, the main point is that recognizing the need for a choice and identifying or generating one or more options is sometimes the most important and challenging aspect of a decision problem.

An implication for interaction design is that we should look out for situations in which recognizing and interpreting a decision situation may be unnecessarily or unduly challenging for at least some users. For example, a sophisticated user who installs a new web browser is likely to recognize the need to choose security and privacy settings that are well adapted to the context in which the browser will be used; a less sophisticated user is likely to accept the default settings, perhaps without even being aware that a choice exists.

In fact, the widespread tendency of people to overlook or ignore choice opportunities and accept the default represents a major way in which *choice architects* (to use the suggestive term of Thaler & Sunstein, 2008), including interaction designers, can influence choices. Widely discussed controversies concerning computer use include the bundling of software with the WINDOWS operating system (which offers new users a convenient default option for many application choices that they would otherwise have to make) and the default privacy options for social network platforms like FACEBOOK. Outside of the arena of computer use, one of the primary and most successful tactics of interventions based on behavioral economics (such as the *libertarian paternalism* of Thaler & Sunstein, 2008) is to provide a default option which is thought to be in the best interest of the people making the choice in question or of society as a whole (e.g., laws that state that every person can be viewed as an organ donor unless they have specified otherwise; see E. J. Johnson & Goldstein, 2003).

5 Anticipation of Consequences

The most dominant traditional view of decision-making is a *consequentialist* one (Hastie, 2001, pp. 663–664): that of a person who anticipates the (perhaps uncertain) consequences of choosing each of the available options and bases the decision on an evaluation of those consequences. As Table 1 indicates, there are other considerations that can affect a decision, and choosers often don't anticipate consequences at all.

Still, computer users do sometimes anticipate the possible consequences of their choices, and one question is that of what sorts of consequence they consider. If users were concerned only about traditional usability criteria, they might make their decisions solely on the basis of consequences like those covered by UTAUT's *performance expectancy* and *effort expectancy* variables (Table 3). The growing interest in recent years in a broader view of user experience (see, e.g., Law, Roto, Hassenzahl, Vermeeren, & Kort, 2009; Kuniavsky, 2010) can be viewed as an awareness of a wider range of types of consequence that can influence users' evaluations of systems and possible actions.

5.1 Anticipating Experience

But how accurately can computer users anticipate the consequences of options? Even just anticipating the enjoyableness of an experience that has been described to you (e.g., using an allegedly delightful photo management app on a smartphone) is not as straightforward as it would intuitively seem. Trying the experience out briefly (e.g., with a demo version of the app) is not always a reliable test, partly because of people's tendency to adapt their tastes and expectations on the basis of new experience (see, e.g., Wilson, 2002, chap. 7). And if a user's initial expectation is (erroneously) that an experience will not be positive, he or she may refrain from trying it out in the first place.

A straightforward effort of designers to support the anticipation of the experience of performing an action is found in promises such as "Filling in our customer satisfaction questionnaire will take just 2 minutes of your time" or "Configuring the application is quick and easy". But this method presupposes that the user is likely to believe claims like these. An alternative approach is to consider nonverbal ways of previewing the consequences of an action. This general strategy

has been explored extensively in the area of persuasive technology (see, e.g., Fogg, 2003, chap. 4), as with the BABY THINK IT OVER infant simulator, which helps teen-aged girls anticipate realistically what it is like to take care of a baby. Some further work will probably be required before this strategy can be applied widely to (a) decisions concerning computer use and (b) decisions where it is not a priori clear which option is best for the chooser—that is, where the chooser must really *choose*, as opposed to being persuaded (cf. Figure 1).

5.2 Anticipating the Consequences of Configuration Choices

One challenge for users in connection with the configuration of applications(Mackay, 1991; Iachello & Hong, 2007) is that the consequences of configuration actions tend to be hard to anticipate. First, there is the question of how time-consuming, tedious, and risky the configuration actions themselves will be. Then there is the fact that the consequences of a configuration decision are often not immediately visible; they consist in changes to the computing environment that will have consequences in the future which will in turn depend on actions of the user (and perhaps other persons) and on other configuration settings.

Gabrielli and Jameson (2009), applying an adapted heuristic walkthrough to parts of four widely used applications, found that about three-quarters of the formulations used to describe configuration options (e.g., "Accept cookies from third parties") did not appear to convey to a typical user a clear idea of the meaning of an option, the consequences of choosing it, or the overall desirability of choosing it. The proportion of problematic cases diminished to about one-half if the help texts explaining the options were taken into account.

6 Intertemporal Choice

6.1 Time Discounting

Humans and animals alike tend to prefer a benefit that will come soon to an equal benefit that will occur later in time. That is, they *discount* future benefits. For example, a member of an online community may be more willing to make a contribution if it appears on a web page immediately, so that its positive consequences (which can take various forms) occur without delay. As is the case with monetary investments, there are various good reasons to discount temporally distant benefits (including uncertainty about whether they will actually come about). A straightforward design implication is that, to encourage a user to choose a particular option, you can try to arrange for its benefits to come sooner rather than later. This strategy was applied by McDowell et al. (2003) to encourage nontechnical users to annotate HTML data for semantic web services.

But there are some more subtle aspects of time discounting

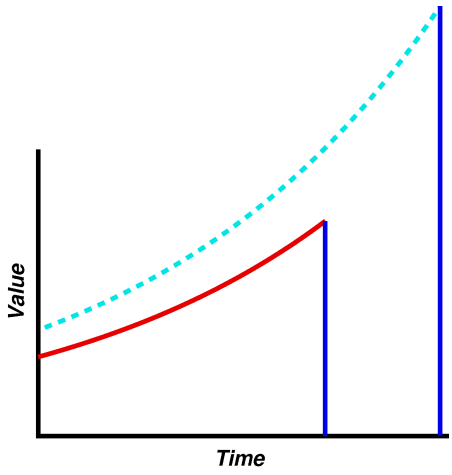

Figure 2: Exponential time discount functions for a "smaller-sooner" and a "larger-later" benefit.

(Each of the vertical line segments on the right represents the value of a benefit at the point in time at which it occurs. Each curve represents the discounted value of the anticipated benefit at an earlier point in time.)

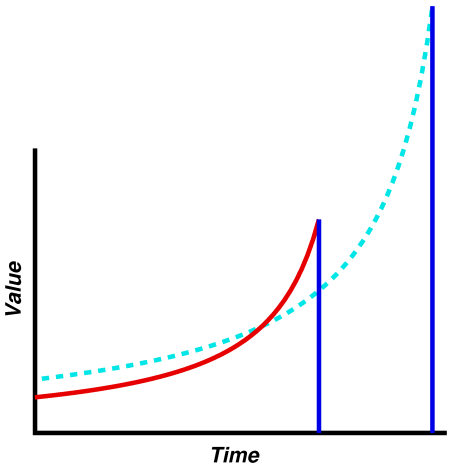

Figure 3: Hyperbolic time discount functions that cross.

(Compare with Figure 2. The the larger-later benefit is preferred until shortly before the time at which the smaller-sooner benefit will occur.)

that deserve attention.[3] These can be illustrated with reference to the frequent situation in which a person can choose between (a) an option that will bring a small benefit soon and (b) another option that will yield a larger benefit at a later time. If people's discount curves were exponential—as is the case with typical discount rates for financial investments and in early normative models of time discounting (see, e.g., Read, 2004)—then people would always show *time consistency* in their preference between the smaller-sooner and the larger-later option: If, when asked on Monday, you prefer

[3] Useful collections of articles on phenomena that arise when choices and/or their consequences are distributed over time have been edited by Loewenstein and Elster (1992) and by Loewenstein, Read, and Baumeister (2003).

a larger benefit on Saturday afternoon to a smaller benefit on Friday afternoon, then you will express the same preference on Friday morning. As is illustrated in Figure 2, the discounting curves in question never cross.

Many studies with humans and animals have shown, however, that discounting curves are better described by a hyperbolic function (Figure 3) than by an exponential one. One implication of the mathematical form of a hyperbolic function (see, e.g., Read, 2004) is that the curves in a problem like the one we are considering can cross. Concretely, in our example, when Friday morning arrives and the small benefit could be obtained almost immediately, the chooser may change his mind and opt for the smaller benefit after all. This particular type of *preference reversal* has been documented countless times in studies with animals (e.g., pigeons) and humans (see, e.g., Rachlin, 2000, chap. 2), and it corresponds to our everyday experience that benefits which are tangibly near can loom disproportionately large.

Often, people are aware of the danger of such a last-minute preference reversal and are willing to avoid it by *committing* themselves at an early point in time to the option with the larger-later benefit (Rachlin, 2000, chap. 3). One strategy is to eliminate the option with the smaller-sooner benefit (e.g., by permanently discontinuing membership in an online community that offers immediate but trivial rewards). A softer commitment mechanism involves arranging for a punishment or other disadvantage to be associated with the smaller-sooner option (e.g., throwing away your password for the online community in question, though you know you can always get a new one with some effort). A drawback of the softer mechanisms is that people may still succumb to the temptation of the smaller-sooner benefit and willingly accept the associated punishment, in which case they are worse off than they would have been without the commitment.

One very general strategy for helping users to make better choices is to make available suitable commitment mechanisms. Many of the strategies applied within the paradigm of persuasive technology can be seen as ways of helping people to stick to a commitment that they have made (e.g., to exercise regularly). Where the choices in question concern computer use (which is normally not the case in the persuasive technology paradigm), there are additional forms of commitment mechanism available, because the decision environment is more under the control of the designer and the user. For example, mechanisms that are commonly used to make it impossible for children to visit certain websites or to use certain applications can also be used as self-control mechanisms that people can willingly apply to themselves.

6.2 Choice Bracketing

The choice between a smaller-sooner and a larger-later benefit is actually quite straightforward compared with many situations that arise when options and their consequences are distributed over time. One key concept is that of *choice bracketing* (Read, Loewenstein, & Rabin, 1999). Although the concept is actually more general, we will discuss only *temporal bracketing*, which is illustrated graphically in Figure 4.

The issue arises when a chooser confronts a sequence of similar choices—for example, which of two alternative keyboards to employ to enter text on a smartphone: the traditional QWERTY keyboard or an unfamiliar keyboard that has been optimized for one-handed text input. Conceivably, a user could make this choice separately every time it arises, which would be an example of *narrow bracketing*. If instead the user opts for *broad bracketing*, she will think in terms of a general policy, such as the choice between: (a) "Always use the QWERTY keyboard"; (b) "Always use the alternative keyboard"; or (c) "Use the alternative keyboard when you have a lot of text to enter." Research has brought to light a number of typical advantages of broad bracketing, most of which are illustrated by this example.

One benefit is that a sequence of choices can have important properties that the chooser cannot see when contemplating the individual choices. For example, if the user consistently employs the alternative keyboard, she will initially enter text more slowly and with greater mental effort than with the QWERTY keyboard; but if she persists long enough the alternative keyboard will eventually become easier and faster to use than the QWERTY keyboard. Similarly, the user's tastes can change: She will probably find the appearance of the alternative keyboard less strange and distracting.

Another emergent property of a sequence of choices is the amount of variety associated with it: A user might prefer to alternate between the use of a trackball and the use of a mouse in order to avoid one-sided use of her hand and arm muscles.

Situations where broad bracketing is possible may also involve time discounting: The user in our example might opt for narrow bracketing because she heavily discounts the long-term benefits of using the alternative keyboard. But the issues just discussed cannot all be reduced to time discounting. Rachlin (2000) uses the terms *complex ambivalence* and *simple ambivalence*, respectively, to distinguish the two cases.

Designers of interactive systems have many opportunities to encourage broad bracketing in cases where doing so seems conducive to good decision making. For example, instead of making two different virtual keyboards readily available at all times, the designer can make the choice of keyboard a configuration option—perhaps one that is difficult to change—so as to encourage the user to take a broader view. Conveying a realistic idea of the consequences associated with broadly bracketed options is more of a challenge, because by definition these consequences cannot be experienced immediately. In particular, the general strategy of trying something out to see if you like it is relatively hard to apply in cases where broad bracketing is appropriate.

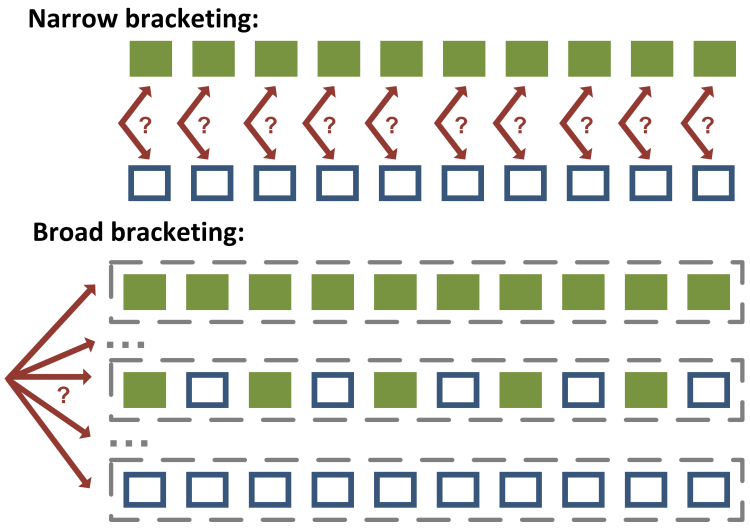

Figure 4: Visualization of the distinction between narrow and broad *temporal bracketing*.

7 Reuse of Previous Choices

Sections 5 and 6 have shown that making choices on the basis of anticipated consequences can be an effortful and error-prone process. These considerations help to explain why choosers often apply a simpler general strategy: Choose the same option that you chose the last time you were in this situation, maybe adapting it a bit. Several complementary lines of psychological research help to understand how and why choices are often repeated.

7.1 Recognition-Primed Decision Making

The concept of *recognition-primed decision making* was developed by Klein and collaborators in the context of their studies of naturalistic decision making (introduced in Section 4).

On the basis of previous research on decision making, most of it in the laboratory, Klein expected that decision makers such as fireground commanders would typically consider two possible courses of action before deciding which one to execute. They were surprised to find that usually the "decision makers" seemed not to be making decisions at all: Most often, they would evaluate the situation confronting them, remember a course of action that they had previously applied in one or more similar situations, and proceed to implement that action. As Table 4 indicates, a somewhat more complex variant of this basic procedure was observed in cases where a contemplated action was not obviously appropriate: The decision maker would anticipate the consequences of the action by a process called *mental simulation* and if necessary modify it until the mental simulation produced a satisfactory result. In a small fraction of cases, the decision makers really did find it necessary to consider (and perhaps modify) two or more alternative options before arriving at a satisfactory course of action.

Some of the characteristics that make recognition-primed decision making ecologically rational are: (a) the decision maker has a great deal of experience with previous similar situations; and (b) there is no time available for exhaustive generation and comparison of the alternative options.

These two conditions often apply to computer users as well, though the time pressure is usually not due to a dynamically changing emergency situation but rather to a need to proceed briskly with the activities that really interest the user.

7.2 Coherent Arbitrariness

A different line of research that revealed a striking tendency of people to repeat previous choices was conducted by Ariely (see, e.g., Ariely, Loewenstein, & Prelec, 2003; Ariely, 2008, chap. 2).[4] In one typical experiment, Ariely asked study participants to state how much money they would want to be paid to endure unfamiliar unpleasant sounds of various durations. This choice problem was used because a participant's choice was bound to be largely arbitrary: Since people have no previous experience in paying money to avoid unpleasant sounds of this sort, there is no a priori notion of what a reasonable amount might be. And indeed, it was found that participants differed in the amounts they required and that their requirements could be influenced strongly by the manipulation of asking them about a particular price at the beginning ("Would you be willing to endure this sound for $.10 / for $.50?").[5] But despite this arbitrariness, the participants' payment requirements were *co-*

[4] Paradoxically, Ariely introduced the term *coherent arbitrariness* in the first publication and switched to *arbitrary coherence* in the 2008 book.

[5] The provision of an *anchor* in this way is a frequent experimental method for influencing a judgment. Epley (2004) discusses the psychological mechanisms that underlie anchoring effects.

Table 4: Three forms of recognition-primed decision making.
(Summarized on the basis of Klein, 1998, chap. 3.)

Straightforwardly retrieve an action

Experience the situation.

Recognize it and identify a typical action for that situation.

Implement that action.

Retrieve, evaluate, and modify an action

Experience the situation.

Recognize it and identify a typical action for that situation.

Evaluate that action via mental simulation.

Until it seems likely to work in its familiar form, modify it and evaluate it again.

When satisfied, implement it.

Make sense of the situation and consider more than one action

Experience the situation.

Try to make sense of the situation until you have identified it as matching a familiar pattern.

Generate one or more plausible actions for this type of situation.

Evaluate each action via mental simulation, modifying it if necessary, until you have found one that seems likely to work.

Implement the selected action.

herent: If one of them required a given amount of money to endure 10 seconds of a sound, they would require predictably larger amounts to endure 30 seconds or 60 seconds of the same sound. Evidently, participants were inclined to state their requirements in a way that was consistent with whatever requirement they had specified initially. The impact of the manipulation of the initial level could still be detected even after participants had received a good deal of relevant new information (e.g., information about the requirements of other participants).

One way of viewing coherent arbitrariness is as a result of reusing previous choices so as not to bother having to make the same choice over again. But it can also be seen as a reflection of people's desire to exhibit a consistent pattern of choices (see, e.g., Cialdini, 2007, for a discussion of the ways in which *compliance professionals* such as salespersons exploit this tendency).

7.3 Choices Based on Habit

The most familiar way in which people repeat previous choices is when they act out of habit. The topic of habits is one of the oldest in psychology, but it continues to be an active area of research, bringing forth new theoretical perspectives, many of which now make use of neuropsychological concepts and research methods (see, e.g., Fu & Anderson, 2006; Bayley, Frascino, & Squire, 2005). For HCI researchers, a useful current synthesis is found in an article by Wood and Neal (2007), who characterize habits as follows: "Habits are learned dispositions to repeat past responses. They are triggered by features of the context that have covaried frequently with past performance, including performance locations, preceding actions in a sequence, and particular people. Contexts activate habitual responses directly, without the mediation of goal states." (p. 813).

Though the ability to be triggered independently of any particular goal is a characteristic feature, habits can also interact with goals in various ways (Table 5), which are of particular interest to interaction designers who wish to take into account—or influence—habit-based behavior. The ways in which goals control habits are relevant to attempts to help users form appropriate habits or to leverage habits that they already have. The ways in which habits can conflict with goals are relevant, for example, to attempts to induce users not to act in accordance with an existing habit.

7.4 The Role of Skill Acquisition

Yet another reason why people often repeat previously made choices was already mentioned in the discussion of choice bracketing: Suppose a user can choose between two ways (*A* and *B*) of performing a particular task, both of which seem about equally desirable at first (e.g., two different search engines for executing a web search; two alternative websites for downloading software; using the touch-pad or the isometric joystick on a new laptop). Even if the user's initial choice of *A* is essentially arbitrary, after executing *A* the user will have become a bit more skilled at using *A*. So the next time basically the same choice comes up, *A* should in principle be more attractive in terms of the user's skill at executing it. The user who engages in broad bracketing can anticipate this skill acquisition and take it into account when making the initial decision. But even a user who does not think that far ahead may notice the additional advantage of *A* after having chosen it at least once.

7.5 Example From Research on Method Selection

The importance of reusing previous choices was discussed in an influential article by Carroll and Rosson (1987) on the problem of method selection (Table 2). The authors began with the observation that computer users often persist in employing a relatively inefficient method to perform a given task even when they have more efficient methods available. One of the two explanations that the authors offered was *assimilation bias*: The authors noted that, if users can immediately think of an adequate method for performing a given task, they may use that method instead of taking the trouble to search for a better method. Assimilation bias is consistent with all four of the forms of repetition of previous choices

Table 5: Forms of interaction between goals and habits *(formulated on the basis of Figure 1 of Wood & Neal, 2007)*..

Relationship Between Goals and Habits	Example
1. Goals control habits	
A person may intentionally form a habit.	"I'll back up my computer every evening just before leaving the office, so as to get into the habit of backing it up once a day ...."
A person's goal−directed behavior may lead to the formation of a habit, without the person having any such intention.	"I decided on several days in a row to start my day by checking Facebook messages; and it became a bad habit."
2. Habits give rise to (inferences about) goals	
A person can observe their own habitual behavior and make inferences about their own goals.	"I guess I assign high priority to good spelling and grammar: I always check the language of every email message carefully before sending it off."
These inferences can in turn give rise to new goals.	"... So I guess I should spend more time proofreading my scientific articles before submitting them."
3. Habits can conflict with goals	
A person is sometimes aware that some habitual behavior of theirs conflicts with a goal that they have.	"I really have more important things to do at the beginning of each day than checking my Facebook messages."
But this awareness is not in itself enough to overcome the habitual behavior; two strategies are often successful:	
A. Actively and effortfully resist performing the undesired habitual response.	"I'm going to ignore the Facebook notification that just arrived!"
B. Change the situation so that you are no longer exposed to the cues that trigger the behavior.	Disable automatic notification about incoming Facebook messages; disable your entire Facebook account.

discussed earlier in Sections 7.1–7.4.[6]

7.6 Concluding Remarks on the Reuse of Past Choices

This section has shown that there are several different ways in which what a person chooses now can influence what they will choose in the future: Today's action can serve tomorrow as an example of a successful action or as a precedent; it can strengthen a habit or increase a person's skill. A negative implication is that an inappropriate choice can have more serious negative effects in the future than one would intuitively expect. The positive side is that, by supporting or influencing the user's actions in the short term, an interaction designer can increase the likelihood of appropriate choices in the longer term as well.

[6]The second explanation offered by Carroll and Rosson (1987), a *production bias*, can be seen as another example of the role of the user's current goal: The goal of getting the current job done is usually more important than the goal of increasing skill at using the system.

8 Social Influence

Another important general alternative (or complement) to consequentialist decision making is to be guided by the social context—specifically the examples, norms, and expectations established by other people and the advice that they explicitly give.[7] For example, a person who has acquired a new computer for home use may consider at length what applications to install, what privacy and security settings to choose, and how to communicate with friends. When the same person works at the office, many of these decisions are likely to be influenced by written or unwritten rules, conventions, or social examples.

March (1994) offers a deep discussion of the view of decision making as *rule following*, which he contrasts with consequentialist decision making. In a similar vein, many authors in the HCI field have emphasized the importance of social and organizational context in influencing users' behavior (see, e.g., Button, 2003). The point of view taken in this chapter is that social context accounts for some of the many considerations that are involved in decision making by an individual. In particular, a carefully selected presentation of aspects of the social context to an individual user can support or influence that user's choices.

The fact that the social environment often exerts a powerful influence on people's choices and decisions is known from everyday experience, and the mechanisms of social influence have been analyzed thoroughly in theories from social psychology and sociology. The diverse perspectives are associated with different concepts and terminology (cf. Fishbein & Ajzen, 2010, chap. 4). The summary in Table 6 summarizes some commonly accepted ideas in everyday terms.

Note that, except for the final one, all of these considerations have something to do with consequences, either social or nonsocial. But when making a specific choice, a person may simply follow the general pattern of conforming to examples and expectations, without wondering about any associated consequences.

When it comes to interaction design and providing information to users, one general strategy is to provide users with more accurate or useful information about social examples and norms. The widely employed paradigm of *collaborative filtering* for recommender systems (Jannach et al., 2011; Ricci et al., 2010) can be seen as providing information about choices that like-minded people have made. Most straightforwardly, this type of information serves the first function listed in Table 6. One of the relatively few applications of collaborative filtering to the support of choices about computer use, for the recommendation of commands, was presented recently by Li, Matejka, Grossman, Konstan, and Fitzmaurice (2011), discussed in chap. 19 of this handbook.

The provision of extensive information about choices of other users is a typical feature of Web 2.0. Many online communities provide explicit information about the contribution behavior of their members, which can influence the contribution behavior of other members in several of the ways listed in Table 6.

These practices suggest that social information could be leveraged more extensively for the support of preferential choices and decisions about computer use—for example to follow-up belatedly on the observation made by Mackay (1991) on the basis of her study of customization that "users want information about their own use and that of other people with similar job responsibilities and attitudes [on] which they can base their customization decisions" (p. 159).

9 Learning From Experience

Especially when we consider sequences of similar choices that are made repeatedly, which is a typical HCI case, it becomes clear that an important aspect of choice and decision processes is what happens *after* the user has selected an option and experienced (to some extent) the consequences of a choice (see, e.g., Newell et al., 2007). Aspects of learning have already been mentioned at various points in Section 7.

The model of action introduced by Norman (1986), which is well-known in the HCI field, is worth bearing in mind in this context, even though it was not specifically intended to illuminate processes of preferential choice. In his discussion of the *gulf of evaluation*, Norman distinguishes the phases of perceiving, interpreting, and evaluating the results of an action. Each of these phases can be seen as a way in which a chooser may have difficulty in learning from experience in making a certain type of choice. For example, a person who has acted on a decision to contribute one paragraph to a WIKIPEDIA article will probably never know how many people have read the paragraph or how much they benefited from it. The author may well notice the changes that other WIKIPEDIA contributors make to the paragraph, but he may interpret them unrealistically and thereby arrive at an inappropriate evaluation of his original decision to contribute the paragraph.

Another example comes from the area of research on method selection: Bhavnani and John (2000) studied in depth expert users of computer-aided design systems who persisted in using inefficient methods: Among other things, they tended not to take advantage of the opportunity that their systems offered to perform an operation on multiple objects at one

[7] Many choices are made by a group of people rather than by an individual, as when a group of collaborating authors decides what text processing system to use to prepare their joint article. Group decision making in general involves some processes, such as interpersonal negotiation of compromises in cases of conflict of interest, which are not found in individual decision making (see, e.g., Kameda, Tindale, & Davis, 2003, and Sorkin, Luan, & Itzkowitz, 2004, for general treatments of group decision making; and Jameson & Smyth, 2007, for a discussion of the special characteristics of recommender systems that make recommendations to groups). Although group decision making about computer use appears to be growing in importance with the increasing interconnectedness of computer users, the topic is omitted from this chapter for reasons of space.

Table 6: Reasons why people can be influenced by social examples, expectations, and norms.

Reason to Choose in Accordance With Social Influence	Example: Using the Company's Social Network
If others set an example (without necessarily expecting you to follow it):	
Their experience is a useful source of information.	"If these coworkers have acquired experience with this social network and are still using it, their experience must have been positive."
You want to enjoy practical benefits of conformity.	"There will be direct practical benefits to being in the same network as my coworkers, such as being able to exchange information with them conveniently."
You want to feel that you belong to their group.	"If I use the social network, I will feel more like a typical employee of this company."
If others expect you to make a particular choice:	
They can reward or punish you.	"If I don't use it, I may be subject to disapproval or even concrete disadvantages."
They have a legitimate reason for their expectation.	"The managers in my company have a right to expect me to do things like this."

time. For example, when they needed to create three identical objects, they would draw them separately, instead of drawing one object and making two copies of it. One of the authors' explanations for the persistent use of inefficient methods concerned the fact that the users did not obtain clear feedback that revealed the inefficiency: The quality of the resulting drawings was in general identical, and the difference in execution times was not easy to notice from experience, especially if the users never tried the more efficient method in the first place. In view of this and other obstacles to spontaneous learning of the more efficient procedures, Bhavnani and his collaborators concluded that explicit training was required (see, e.g., Bhavnani et al., 2008).

By contrast, Gray and Boehm-Davis (2000) showed that, under more favorable learning conditions, users can sometimes take into account a difference between alternative *microstrategies* that involves only milliseconds of execution time. It can be seen, then, that the exact nature of the feedback that users receive about their choices can be crucial in determining whether preferential choices will improve on the basis of experience.

A recent trend in laboratory research on judgment and decision making (see, e.g., Rakow & Newell, 2010) is to study *experienced-based choice*, where a person's choices about typical experimental problems such as pairs of gambles are based on concrete experience with the problems in question rather than on descriptions of the problems. For example, instead of being told that Option *A* offers a 10% chance of winning $12 while Option *B* guarantees a win of $1, a participant is allowed to click repeatedly on two buttons corresponding to the two options and observe the resulting rewards. An important issue in this sort of situation is the tension between *exploration* and *exploitation*: In order to learn efficiently which of the two options is preferable, a chooser should in principle systematically "explore" both of them, trying them out until it is clear which one is better—a process that may take some time, as in the example just given. But in practice, once a chooser has the impression, say, that Option *B* is better, there is a temptation to "exploit" this insight by consistently choosing *B*. The *production bias* observed by Carroll and Rosson (1987) can be interpreted in part as a result of users assigning higher priority to exploitation than to exploration.

Another typical obstacle is the difficulty of learning from one's own everyday experience very low probabilities such as those of a major hard disk failure, identity theft due to inadequate security measures, or an accident due to texting

while driving.

As was mentioned in connection with choice bracketing (Section 6.2), one obstacle with broad bracketing is that it can be difficult for the chooser to learn from experience which of the broadly bracketed options yields the best results.

In cases like these, in which individual learning from experience faces serious obstacles, sources of guidance such as norms, policies, and the behavior of similar other persons play an especially important role. These cases also offer opportunities for interaction designers to improve choice and decision making noticeably by identifying the learning difficulty and taking steps to compensate for it.

10 Concluding Remarks

Readers who follow up on the references given in this chapter will discover many additional theoretical concepts, empirical results, and suggestive examples, including many on aspects of choice and decision making that could not be discussed in this chapter for reasons of space.[8] This literature can serve as a rich source of ideas about new ways to apply the HCI knowledge that is documented so thoroughly in the other chapters of this handbook.

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[8] For example, the collections edited by Koehler and Harvey (2004) and by Lichtenstein and Slovic (2006) include articles about the influence on decision making of affect and of culture.

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