

Research Methods for Human-Computer Interaction

Edited by
Paul Cairns and Anna L. Cox

 **CAMBRIDGE**
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press

The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org

Information on this title: www.cambridge.org/9780521690317

© Cambridge University Press 2008

This publication is in copyright. Subject to statutory exception and to the provisions of relevant collective licensing agreements, no reproduction of any part may take place without the written permission of Cambridge University Press.

First published 2008

Printed in the United Kingdom at the University Press, Cambridge

A catalogue record for this publication is available from the British Library

Library of Congress Cataloging-in-Publication data

Research methods for human-computer interaction / Edited by Paul Cairns and Anna L. Cox.

p. cm.

Includes bibliographical references and index.

ISBN 978-0-521-87012-2 (hardback)

I. Human-computer interaction. I. Cairns, Paul, 1971- II. Cox, Anna L., 1972- III. Title.

QA76.9.H85R45 2008

004.01'9-dc22 2008015935

ISBN 978-0-521-87012-2 hardback

ISBN 978-0-521-69031-7 paperback

Cambridge University Press has no responsibility for the persistence or accuracy of URLs for external or third-party internet websites referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

7 A qualitative approach to HCI research

ANNE ADAMS, PETER LUNT AND PAUL CAIRNS

7.1 Overview

Whilst science has a strong reliance on quantitative and experimental methods, there are many complex, socially based phenomena in HCI that cannot be easily quantified or experimentally manipulated or, for that matter, ethically researched with experiments. For example, the role of privacy in HCI is not obviously reduced to numbers and it would not be appropriate to limit a person's privacy in the name of research. In addition, technology is rapidly changing – just think of developments in mobile devices, tangible interfaces and so on – making it harder to abstract technology from the context of use if we are to study it effectively. Developments, such as mediated social networking and the dispersal of technologies in ubiquitous computing, also loosen the connection between technologies and work tasks that were the traditional cornerstone of HCI. Instead, complex interactions between technologies and ways of life are coming to the fore. Consequently, we frequently find that we do not know what the real HCI issues are before we start our research. This makes it hard, if not actually impossible, to define the variables necessary to do quantitative research (see Chapter 2).

Within HCI, there is also the recognition that the focus on tasks is not enough to design and implement an effective system. There is also a growing need to understand how usability issues are subjectively and collectively experienced and perceived by different user groups (Pace, 2004; Razavim and Iverson, 2006). This means identifying the users' emotional and social drives and perspectives; their motivations, expectations, trust, identity, social norms and so on. It also means relating these concepts to work practices, communities and organisational social structures as well as organisational, economic and political drivers. These issues are increasingly needed in the design, development and implementation of systems to be understood both in isolation and as a part of the whole.

HCI researchers are therefore turning to more qualitative methods in order to deliver the research results that HCI needs. With qualitative research, the emphasis is not on measuring and producing numbers but instead on understanding the qualities of a particular technology and how people use it in their lives, how they think about it and how they feel about it. There are many varied approaches to qualitative research within the social sciences depending on what is being studied, how it can be studied and what the goals of the research are. Within HCI, though,

grounded theory has been found to provide good insights that address well the issues raised above (Pace, 2004; Adams, Blandford and Lunt, 2005; Razavim and Iverson, 2006).

The purpose of this chapter is to give an overview of how grounded theory works as a method. Quantitative research methods adopt measuring instruments and experimental manipulations that can be repeated by any researcher (at least in principle) and every effort is made to reduce the influence of the researcher on the researched, which is regarded as a source of bias or error. In contrast, in qualitative research, where the goal is understanding rather than measuring and manipulating, the subjectivity of the researcher is an essential part of the production of an interpretation. The chapter therefore discusses how the influence of the researcher can be ameliorated through the grounded theory methodology whilst also acknowledging the subjective input of the researcher through reflexivity. The chapter also presents a case study of how grounded theory was used in practice to study people's use and understanding of computer passwords and related security.

7.2 The method

Despite the name, grounded theory is not a theory of qualitative research. Instead, it is a method of qualitative research that aims to produce new theories that are grounded in the qualitative data gathered during the research. Grounded theory was originally identified within social science as the product of close inspection and analysis of qualitative data (Glaser and Strauss, 1967). Later Strauss and Corbin (1990) used the term to refer to a data collection and analysis technique that they formulated which was no longer restricted to qualitative data. Grounded theory is, therefore, an approach to theory building that can incorporate both qualitative data sets (e.g. interviews, focus groups, observations, ethnographic studies) and quantitative data sets (e.g. questionnaires, logs, experimental). The methodology combines systematic levels of abstraction into a framework of interpretation of a phenomenon, which is iteratively verified and expanded throughout the study. 'The research findings constitute a theoretical formulation of the reality under investigation, rather than consisting of a set of numbers, or a group of loosely related themes' (Strauss and Corbin, 1990, p. 24).

A key feature of grounded theory is that it does not require a prior hypothesis for focusing the research (Strauss *et al.*, 1964). That is, the researcher may go into the research knowing that they want to find out about a particular area, such as people's perceptions of passwords (Adams, Sasse and Lunt, 1997) or how people perceive immersion in games (Brown and Cairns, 2004), but without knowing exactly what it is that they expect to find. The process of doing the research formulates the theory and therefore produces potential hypotheses for further study. A side-effect of this is that research data previously collected on the same phenomena can be used for further research.

Moreover, the theory is not developed once the data collection is complete. Instead, the theory is developed as soon as there are data to analyse, say, after the first interview. The researcher, of course, acknowledges that one interview is not likely to produce a good theory, but the initial formulation of a theory means that the researcher can gather more data with a view to validating and expanding the theory. So in an interview study, the first interview leads to a tentative theory. In the next interview, the researcher can ask questions that may specifically probe the theory so far. In particular, the researcher should explicitly probe the limits of the theory to see when it no longer holds and within what parameters it does hold. The second interview would then be analysed to modify or even reject the theory and produce a new theory. Thus, the method proceeds through cycles of data gathering, analysis and theorising. Note, in particular, that interview questions are actually adapted to investigate the developing theory and thus the initial interview may be very different from interviews later in the study. This is an important contrast to the focus on reliability through systematic repetition of observations in quantitative research.

Another particular feature of this approach is that the researcher is explicitly trying to test the limits of the theory at all times. This leads to theoretical sampling, where the researcher deliberately chooses where to collect the data next in order to test the theory to date. So as a very straightforward example, the researcher may decide that having learned something about how men experience immersion in computer games, the next interviewee should be a woman to see if her experience is in accord with the theory or whether she provides data that do not fit with the theory so far and require the emerging theory of immersion to be expanded in new ways.

The question then becomes one of when to stop. This is when the theory reaches saturation, that is, each new item of data can be fitted into the existing theory without requiring the theory to be modified. The theory at this point is considered to be complete because there are no new ideas to be accounted for. Moreover, the theory is grounded in the existing data and should fully account for them. Successful application of the methodology is, thus, assessed both in terms of the validity of the engagement with the diversity of concepts in use in the interaction with the technology and the fit between the data and the thematic interpretation that emerges in the analysis.

Strauss and Corbin (1990) suggest that grounded theory is especially useful for complex subjects or phenomena where little is yet known. The methodology's flexibility can cope with complex data and its continual cross-referencing allows for grounding of theory in the data, thus uncovering previously unknown issues. Although there is flexibility in the type of information used for grounded theory analysis, a greater emphasis is placed on theoretical sampling and contextual considerations so that later transferability of findings can be increased.

As the data are collected, they are analysed in a standard grounded theory format. Data, in whatever form, are broken down, conceptualised and put back together in new ways. To enable this to occur in a structured manner, Strauss

Table 7.1 *Example of a category broken down into properties and dimensions*

Category class	Properties (attributes)	Dimensional range (domains)
surveillance	frequency	often ... never
	scope	more ... less
	intensity	high ... low
	duration	long ... short

and Corbin (1990) have devised three major coding stages – open, axial and selective – in the analysis procedure. It must be acknowledged, however, that the lines between these forms of coding are artificial, as is the divide between data collection and analysis. This is an analytic distinction, but in practice all of these elements of grounded theory analysis intersect as the interpretation proceeds.

7.2.1 Open coding

The open coding stage involves identifying concepts in the empirical material and, as the interpretation proceeds, joining similar concepts together into categories. The coding is open because there is no pre-determined set of codes but the researcher is open to learn what these codes are as the analysis proceeds. Concepts pertaining to similar phenomena (categories) along with identifying the properties and dimensions of the said category are central to this part of the analysis.

- 1 Concepts are identified.
 - *Concepts* are conceptual labels placed on discrete happenings, events, and other instances of phenomena to name those aspects of the phenomena.
- 2 Concepts are compared to see if they pertain to a similar phenomenon (category).
 - *Categories* are where concepts are classified and grouped together under a higher order – a more abstract concept is called a category.
- 3 The properties and dimensions of the category are identified (see Table 7.1).
 - *Properties (attributes)* are characteristics pertaining to a category.
 - *Dimensions (domains)* are locations (values) of a particular property along its range.

7.2.2 Axial coding

This coding stage identifies the high-level phenomena, that is, the central ideas and events, along with the conditions and participants' strategies pertaining to those phenomena, for instance causal conditions or intervening conditions.

- 1 Key high-level phenomena are identified.
 - *Phenomena* are central ideas and/or events.
- 2 Conditions pertaining to those phenomena are identified, namely the causal condition, context of the phenomenon and any intervening conditions.
 - *Causal conditions* are events that lead to occurrence or development of a phenomenon.
 - *Context* is the specific set of properties that pertain to a phenomenon; specifically, locations pertaining to a phenomenon along a dimensional range.
 - *Intervening conditions* are the broader structural context.
- 3 Any action/interaction strategies produced in response to the phenomena are identified.
 - *Action/interactional strategies* are behaviours devised to manage, handle, carry out or respond to a phenomenon under a specific set of perceived conditions.
- 4 Any consequences from these action/interactional strategies are identified.
 - *Consequences* are outcomes or results of actions or interaction.

For example:

When I want to have (context) a personal conversation (phenomenon), I encrypt the message (strategy). I think that makes the email private (consequence).

7.2.3 Selective coding

Finally, the analysis is elaborated upon and interpreted in the selective coding stage. The core category (the central phenomenon around which all the other categories are integrated) is defined here and a conceptualisation of the descriptive narrative, set around the core category, is exposed. This whole process is iterative so that it is validated by continual comparisons with the raw data to confirm or refute conclusions. This continual validation can identify gaps in the framework that can only be filled in by further research using theoretical sampling.

- 1 The core category and a high-level storyline are defined. The storyline is set around the core category which defines the whole.
 - *Core category* is the central phenomenon around which all the other categories are integrated.
 - *Story* is a descriptive narrative about the central phenomenon of the HCI study.
 - *Storyline* is the conceptualisation of the story – the core category.
- 2 The subsidiary categories around the core category are related by means of its properties.
 - This is best done with graphical representations of the core category and subsidiary categories. The core category properties are high-level definitions.
- 3 Categories are related at the dimensional level.

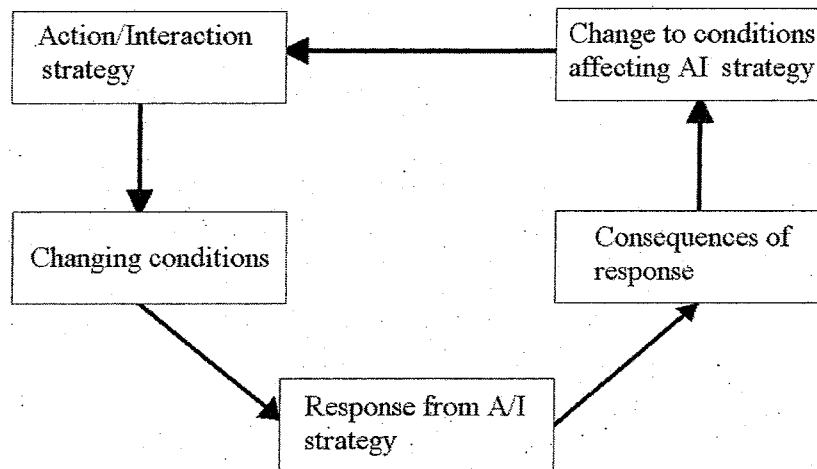


Fig 7.1 Graphical representation of a process effect chain

- This then ties up in detail, finally, all the categories into a whole HCI model/framework which is defined by the storyline and the core-category.
- 4 Relationships are validated against data.
 - The process of building the core-category and storyline is an iterative process which is validated by continual comparisons with the raw data to confirm or refute your conclusions.
 - 5 Categories which need further refinement are filled in.
 - Often, after defining some categories, gaps appear in the high-level storyline which can only be filled in by further research.

The last stage in the analysis is the integration of *process effects*, that is, factors changing over time, so that changing factors within the framework can be identified.

- 1 Define any process effects that may be occurring.
 - *Process* is the linking of action/interaction sequences over time (see Figure 7.1)

7.2.4 Performing coding

As a new grounded theorist, it is important to realise that the lines between the different levels of coding are artificial. Unfortunately end-users often jump between different levels of abstraction when they are talking. This means that data can frequently be presented at a dimensional and selective level with elements of action/interaction strategies thrown in. For example, in the humorous statement:

I find computers always break down for me when I have a lot of things to do.
So I try not to use them when I have a lot to do. Which slows everything down a bit!

the user is talking about dimensional concepts (e.g. always – sometimes, a lot – a little, slow – fast) at the same time as they are using strategies (e.g. ‘try not to use them when . . .’) and consequences (e.g. ‘slows everything down a bit’). It is useful to be able to code different levels at the same time (e.g. open and axial together) while keeping an eye on the different levels of abstraction being employed. Some researchers have found that computer-based analysis tools (e.g. ATLAS.ti, Nvivo) can help them in this codification process. Ultimately it is important to understand the complexities that are inherent in human behaviour and to ease up on yourself and your ability to codify it all. Keeping the data collection and analysis tightly interwoven, for instance conducting an interview and analysing it before the next interview, can help to support a richer, flexible and more explorative understanding of the data and the research process.

Even so, these analysis stages initially seem quite daunting and the biggest question facing a researcher new to grounded theory is: where to start? *Microcoding* is a very useful strategy suggested by Strauss and Corbin (1990). The researcher simply starts with some part of the data, possibly the first interesting part of the interview (once the ‘hello’s and ‘how are you’s are completed), and then looks at each word and tries to work out what it means. And this really does mean each word. The barrier in understanding is that of course we already naturally understand the words that people use, but are we really understanding the words as the interviewee means them? To overcome this, *asking questions* is the primary way to sensitise the researcher to the data. Consider as an example the simple quote from earlier:

When I want to have a personal conversation, I encrypt the message. I think that makes the email private.

The first word is ‘when’ and naturally we would understand this word in the context of the sentence to mean ‘on occasions or in situations where’. But now start asking questions: Which occasions? Which situations? Literally at what times of day/week/year do these occasions occur? Are these common or rare occasions? Does something prompt the occasion? The next word is ‘I’. Well that really is just the person and to ask questions on this may be too far down the road of philosophy, but the word after is ‘want’. The questions suggesting themselves here are: What would make you want a personal conversation? Is it want in the sense of deep need? Or want in a more whimsical sense? Is the wanting ever-pressing or urgent? Is the wanting provoked by other people? Or the person with whom you’ll converse? Now ‘personal’: does that mean intimate? Or just friendly? Or just not work-related? Is a conversation with a spouse personal? With a parent? A child? A friend? Would all such conversations always be personal? Could you have personal conversations with a colleague? Could they be about work? Already we have more than a dozen questions and we have only really thought briefly about three words! Some of these questions may seem trivial or overblown – surely the interviewee didn’t mean that much by these words – however, if you

go in thinking that you know what their words mean then you will struggle to go beyond your own understanding. By questioning what words mean, you open the opportunity for them to mean something else and hence for you to see something in the data that was previously closed off from you.

The data do not contain the answers (at least not in the quote here), but you are now sensitive to look for the answers and seek them in the rest of the data even if you did not explicitly ask for them. Or you could probe subsequent interviewees to find out the answers. Also, this might suggest a first concept 'conversation'; one attribute of that is how personal it is, another being when such conversations occur and a third being the motivation. Now it may be that conversation is not a dominant feature of other interviews and so this concept is replaced or superseded. Or it may be that motivation for a conversation is a separate concept in itself and this leads to links between the motivation for a conversation, the conversation itself and the use of security techniques to preserve privacy. But already, even with these three words, you could begin to formulate a (very tentative) theory based on conversations and how people determine the need for privacy and when that privacy is enough to warrant using encryption. This theory can be tested with the rest of the interview.

Of course, no one could do grounded theory by simply doing microcoding, otherwise no grounded theory study would ever have been finished! Once you are feeling sensitive to the data and alert to their potential interpretations, you can begin to read the data in large portions in an attempt to gain a bigger picture, but all the while asking questions about what you think you understand. However, if the data become challenging and hard to interpret, reverting to microcoding can be enormously helpful in refreshing your sensitivity and helping you to continue making progress.

This sort of work clearly very rapidly generates a lot of ideas that are hard to maintain in the head. This is partly why grounded theory places emphasis on documented forms of the data so that the documents can be annotated either physically with scribbles or post-its, or electronically in Word or using a specialised software package for grounded theory such as ATLAS.ti. All interviews or focus groups should be recorded and transcribed for this reason.

Annotations though may not capture the richness of some of your ideas. Thus, grounded theory also recommends *making memos*, or 'memoing'. Memos are longer than annotations and are intended to capture the thoughts of the researcher as the analysis proceeds. They do not need to be polished or well written but sufficient to help remind the researcher of their thoughts and ideas as they developed. They do not even need to relate closely to the data but may be ideas that the researcher feels could be valuable at some point. The memos then become an important tool for theorising as they allow the researcher to track the growth and development of the theory as the data accumulate and the cycles of theorising progress. They can allow the researcher to resurrect previously abandoned ideas or to avoid re-inventing old ideas in a slightly different guise.

As the analysis progresses, some of the memos will inevitably formulate the theory in terms of concepts (open coding), the links between them (axial coding) and the overall narrative of the theory (selective coding). This perhaps also indicates that though there are three types of coding, they should not occur in isolation but are strongly interwoven and may even occur at the very earliest stages of microcoding.

Even with the grounded theorist's tools of microcoding, asking questions and memoing, you may not feel sure about how to do grounded theory. This is normal. Indeed, there is a strong degree of craft skill in doing grounded theory. Do not be put off by this and do not succumb to the criticism of the more quantitative researchers who point out the inevitable bias that craft skill suggests. Doing experiments is also a craft skill! At the end of the day, to do this or any other of the methods in this book, the only way to learn how to do them properly is to try. The nice thing about grounded theory is that this learning process is an acknowledged aspect of the theorising, whereas it is entirely ignored in more positivistic approaches. This will be discussed in more detail in the critique of the method towards the end of the chapter.

7.3 Applying the method

In this section a series of study examples (Adams *et al.*, 1997; Adams and Sasse, 1999) are given for the different approaches to qualitative analysis to help clarify a series of application issues in relation to passwords and computer security. The same studies are being used in the chapter on questionnaire, interview and focus groups (Chapter 2) and so both chapters can be used to cross-reference for the whole research process.

7.3.1 Questionnaire and interview study

Authentication, and in particular passwords, plays an important role in organisational security. Security breaches and adapting security procedures (e.g. password changing regimes) have been a major organisational system issue for the past decade (Hitchings, 1995). The ever-growing costs from security breaches and reinstating forgotten passwords is a major problem within modern organisations. Chapter 2 introduced a series of password studies (Adams *et al.*, 1997; Adams and Sasse, 1999) that identified the need for a balance in password construction and implementation procedures between secure yet effective passwords. The usability, yet effectiveness of system security, is a field growing in importance. The study described in Chapter 2 and here initially sought to identify relationships between memorability and security to support users in designing memorable yet secure passwords. Later studies built on initial findings that inappropriate password procedures and organisational security practices were the major problem in modern-day security systems.

7.3.2 Method

It is interesting to highlight that the following sequence of studies concisely details some interesting differences and applicability of varying levels of analysis. Initially, a questionnaire was designed and implemented, the findings of which are presented in Chapter 2; 139 questionnaire responses were received with questions ranging from factual to open-ended questions. The findings verified some initial hypothesis that the researchers were proposing. The open-ended questions, however, identified a range of issues not previously conceptualised (e.g. password procedures such as change regimes inhibiting the memorability of passwords). These issues were noted by the respondents to be of greater importance to them than the ones previously conceptualised for the questionnaire. Because of these findings it was decided that further in-depth investigations were required.

Study 1 and thematic analysis

Initially a set of 15 in-depth interviews were conducted within a technically based organisation (Organisation A). The interviews lasted approximately 30 minutes and were used to complement the qualitative data from the questionnaires. Respondents had varying levels of password expertise, both over period and frequency of use. Participants were asked a series of semi-structured questions that covered issues of password generation and recall along with more general system and organisational factors. The interview format allowed participants to introduce new issues to the discussion that they regarded as important.

The initial analysis of the interviews and questionnaire open-ended answers took a thematic approach guided by the frequency and fundamentality of the issues raised by the users (that is, putting emphasis on those issues that occurred frequently or that were deemed of fundamental importance). This produced four factors influencing effective password usage. Problem areas for password usability were password content, multiple passwords, users' perceptions of security in the organisation and the novel concept of 'information sensitivity'.

Password content is defined here as the character content of the password reviewed in terms of its memorability and security. Initial results found that users' knowledge of secure password design was very inadequate. This leads users to create rules and judgements on password design strategies which are anything but secure. Words contained in the dictionary and names are the most vulnerable form of password. These results showed that many users do not realise this:

I mean I would have thought that if you picked something like your wife's Christian name or something then the chances of a complete stranger guessing ***** in my case were pretty remote.

It must be noted, however, that further analysis (see grounded theory analysis below) revealed that these behaviours were related to perceptions of the physical security and information sensitivity.

Many users have to remember multiple passwords, that is, they have to use different passwords for different applications and/or change password frequently because of password expiry mechanisms. A high number of passwords was found to reduce memorability and to increase insecure work practices (e.g. writing passwords down) and poor password design (e.g. using 'password' as their password):

Constantly changing passwords results in very simple choices which are easy to guess or break within seconds of using 'Cracker'.¹ Hence there is no security.

But basically because I was forced into changing it every month I had to write it down.

Many users devise their own method for beating memorability problems. One approach was to devise 'linked passwords' where passwords are linked via some common element (e.g. tom1, tom2, tom3). Such methods are devised in response to password expiry mechanisms, and by users who have a multitude of different passwords for different applications. The initial analysis identified that linked passwords were both memorable and yet had memorability problems. This inconsistency in the findings was not resolved until a full grounded theory analysis was conducted.

Initial analysis of the results revealed that users' perceptions of security levels and potential threats was a key element in motivating their work practices. Without clear feedback from the organisation, users construct their own model of security threats and importance of security. The two extracts below illustrate users' misconceptions in their perceptions of both organisational security and possible breaches:

I don't think that hacking is a problem I've had no visibility of hacking that may go on. None at all.

I think that security problems are more by word of mouth than computer problems.

The study identified that users' security behaviours often depended on their perceptions of the information sensitivity. Users identified certain systems as worthy of secure password practices, whilst others were perceived as 'not important enough'. In the absence of guidance, users concluded that confidential information about individuals (personnel files, email) was sensitive; but commercially sensitive information, such as customer records and financial data, were often not regarded as sensitive. Some users stated that they liked the classification of printed documents (e.g. Confidential, Not for Circulation) as this gave them clear feedback on what the organisation perceived as sensitive information. Although the first pass analysis identified this concept, it did not reveal complex contradictions related to differences in organisational procedures.

¹ A password dictionary checker.

Study 2 and grounded theory analysis

As detailed above, the initial findings were analysed at a thematic level. Although this approach was reasonably simplistic (for example, identifying relevant themes from the data), it helped to identify concepts and potential issues not previously identified. This analysis led the researchers to realise that there was a need for further in-depth qualitative research and analysis to explore these issues. The second stage of research sought to verify and expand on issues identified within the first set of interviews. The second study was conducted with 15 users, within a comparable organisation (a company in the construction sector). Participants from Organisation B were less experienced with technology and used it sporadically. Again, interview questions covered general security, systems and organisational issues as well as questions about password generation and recall strategies. Subsequently some of the data were analysed twice at different levels. The different types of issues uncovered reveal the strengths and weaknesses of each approach.

The analysis provided a step-by-step account of user authentication usage problems and possible intervention points. Key issues identified through research at Organisation A were substantiated and expanded upon by the research in Organisation B. This study identified two major benefits in using grounded theory as an HCI methodology:

- 1 Because of grounded theory's conceptual depth (a hierarchical analysis with cross-links) and the absence of a pre-defined theory to restrict research, the data could be tested and re-tested to identify the source of initial contradictions in the data. This means that whole data sources are not disregarded because of confounding contradictions.
- 2 Because grounded theory relies on iterative development of interview questions this allowed different perceptions to be sampled and analysed with regard to issues which did not emerge until the data was analysed. This means that valid and complex relationships can be identified in shorter time frames.

Several of the interviews show users identifying one perception of their behaviour and then later stating the opposite. Such contradictions make it hard to establish relationships between factors which influence user behaviour. In the initial thematic analysis the processes that led to these contradictions were not identified. The contradictory statements could have been caused by users being unsure of their own descriptions, or discussing complex issues which involve several factors. The application of grounded theory techniques for analysing the free-format statements on the questionnaires and the interview data identified the latter as the case. For example, the initial analysis revealed that for multiple passwords users often use a strategy of 'linked passwords' (e.g. tom1, tom2, tom3). The linked password strategy was identified by users as both improving and decreasing password memorability. Further grounded theory analysis of the data meant that this apparent contradiction was re-visited. The researchers proposed a

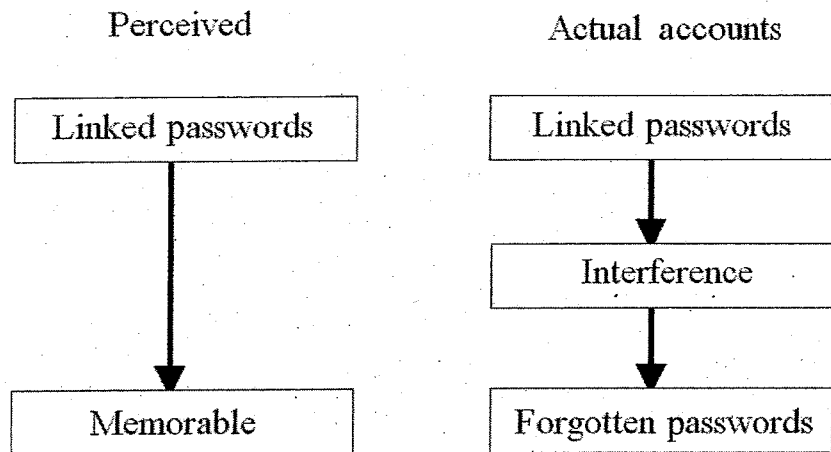


Fig 7.2 *Perceived/actual memory contradictions*

hypothesis of why the contradiction existed. It was proposed that these two sets of perceptions might be the result of individual differences. This in turn would mean that some people were better at remembering linked passwords than others. The data was re-investigated to identify to whom these perceptions were related and if there were any other traits persistent with these users. Further analysis identified that these two concepts were often related to the same person, thus discrediting the notion of individual differences. Further hypotheses were proposed and reviewed through re-analysing the data until it was noted that a key difference between these perceptions was the notion of the respondents recounting perceptions (for example, 'I think that ***** makes it more memorable') and accounts of what actually occurred (for example, 'I kept forgetting which of the passwords it was'). Frequently the perceived/actual distinctions were made by the same person without them realising that they were contradicting themselves (see Figure 7.2).

The actual poor memorability of linked passwords was identified as due to the previously identified cognitive limitation of within-list interference (Wickens, 1992). The common password element was easy to remember, but the changing element produced interference between the versions. It has been noted as similar to the problem of not being able to remember where you parked your car today but remembering where you parked it yesterday. The poor memorability of linked passwords caused users to write passwords down which in turn reduced password security levels.

Initially, analysis identified isolated concepts and user strategies, but did not identify how these could be mapped into a sequence of events with potential intervention points for changing practices and negative perceptions. Analysis of grounded theory process effects, the sequence of events leading to a concept, meant that the concepts of 'information sensitivity' and 'threats' were re-visited. User perceptions of their environment, such as the physical security around them, were found to relay assumptions and in turn incur related user strategies. For example, within organisation A, the technically biased organisation, users were

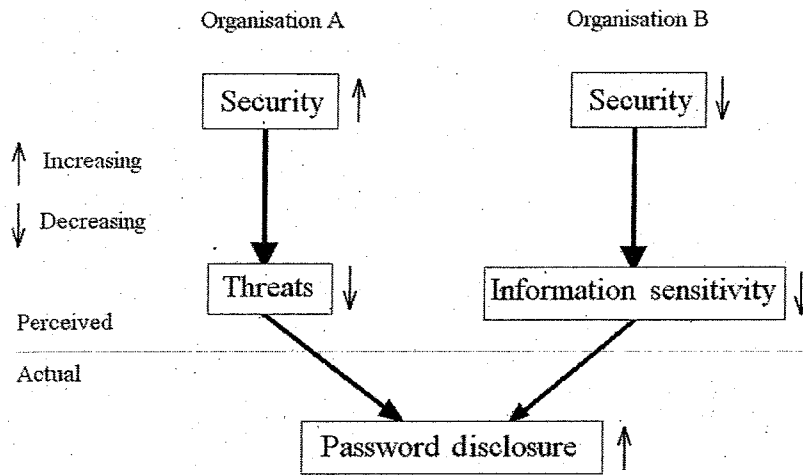


Fig 7.3 User behaviours produced by perceptions of physical security levels

identified as perceiving the organisation's general security level as high (increased). Further process effect analysis identified this as related to decreased overall perceptions of threats to the information. This was in turn found to relate to increased insecure work procedures such as password disclosure ('Well, security for getting into the site is so tight, there's no harm in writing down my password and leaving it on my desk.'). In comparison in organisation B, the company in the construction sector, users were found to perceive the organisation's general security level as low (decreased). Reviewing processes effects for these perceptions it was found that this related to decreased perceptions of how sensitive the information is. Ironically, this was also found to relate to increased insecure work procedures such as password disclosure. ('Well, if the information isn't important, why make a big fuss about keeping your password secret?') The two situations are illustrated in Figure 7.3.

The conceptual depth of these grounded theory relationships was noted when relating them to previously identified concepts. The initial thematic analysis identified a simple relationship between poor password construction and security awareness. However, further grounded theory analysis identified relationships between password construction behaviours and assumptions around physical security levels and threats.

Once a sequence of relationships has been identified it is easier to identify positive relationships and potential intervention points to counteract negative relationships. For example, in Figure 7.3 we can see that for organisation A negative behaviours were the results of perceived low threats. Increasing awareness of potential contextually relevant threats could counteract these perceptions. In comparison, within organisation B poor awareness of information sensitivity for the organisation could be increased by effective feedback from the organisation of how sensitive specific information is. This type of HCI feedback to users can provide them with guidance in adapting their security behaviours according to organisational needs. The concept of identifying behaviour-perception sequences

and potential intervention points is one of the major benefits of this approach for HCI designers.

Ultimately, these studies uncovered a complex web of variables interacting to produce users' password behaviours. Grounded theory was able to relate descriptively these variables in a way that enabled possible intervention points to be identified. In a field where there has been little previous research, the direction of the initial study could be biased by the researcher. Grounded theory enabled the research to be grounded in the data obtained so that the validity of the theories produced was increased. The structured format of grounded theory encouraged the building of a framework and theories that were grounded in the data thus improving the external validity of the research conducted.

7.4 Qualitative methods and grounded theory in HCI

HCI often needs to review complex phenomena and develop applicable frameworks for action, yet due to its short history it has not yet established an extensive knowledge base on which to base its research. Ultimately HCI research requires the in-depth nature of qualitative research to review these complex phenomena with the structure of quantitative research. It is worth briefly discussing other qualitative methods that may be useful in HCI research and what it is about grounded theory that makes it stand out.

A variety of methods of data collection under the broad rubric of qualitative methods have been applied in HCI research, including a range of observational and ethnographic methods and various forms of qualitative interviewing. In addition, a variety of approaches to analysis have been developed to complement these including thematic analysis, grounded theory, discourse analysis and conversation analysis. Such methods and approaches to analysis are not without controversy. In the past, the debate between the quantitative and qualitative paradigms has become very heated (Morgan, 1996; Sherrard, 1997; Stevenson and Cooper, 1997). Henwood and Pidgeon (1992) argue that the debate should move away from a destructive epistemological battlefield and concentrate on identifying criteria for good research in all its formats.

In the worst scenario, qualitative analysis is reduced to poorly applied 'eyeballing' of the data with 'general impressions' identified. It is hard to know what are true features of the data and what are simply things that have stood out for the particular researcher. Moreover, it is very hard to know what has been missed. This is sadly quite common in HCI research, where it seems there is a poor understanding of how to approach this type of data. Perhaps to ameliorate this, HCI qualitative data is increasingly being turned into quantitative data by means of counting terms (e.g. content analysis). Although these approaches give some useful initial descriptive data, they lack the rigour of quantitative approaches and lose the depth and richness of some qualitative analysis techniques (e.g. words out of context can be incorrectly interpreted).

More constructively, various social science methodologies have been used for some years in HCI, particularly in the field of computer-supported collaborative work (Suchman, 1987; Fafchamps, 1991). However, these studies tend to be restricted to observational, ethnographic style research, limiting their applicability as the ethnographic approach shies away from making value judgments in preference to revealing people's behaviour in a descriptive way. This makes it hard to move away from the particulars of one ethnographic study to the general situations that may be experienced by many users.

Some research has taken a more empirical approach, with methodologies such as conversational analysis (Bowers, Pycock and O'Brian, 1996; Hindus *et al.*, 1996). Discourse and conversational analysis methods sequentially break down a broader set of discourses or more specifically speech. Both seek to finely break down communication sequences, such as turn-taking. As these methods relate more to the actions of discourse and speech, they would be useful for a detailed HCI analysis of technology-mediated communications. They would struggle to be of more general use in studying technology where usually there is very little by way of a rich dialogue.

Thematic analysis, in comparison, seeks to identify patterns of experiences both of processes and attitudes to those processes. Attitudes are abstracted, catalogued and related to themes and sub-themes. This approach is often related to patterns of experience which would nicely support an analysis of many HCI interactions. However, this approach lacks a depth of analysis across different levels of abstraction and thus can be insufficient for detailed theory-building.

Henwood and Pidgeon (1992) argue that the goal of both qualitative and quantitative research paradigms is to build relevant, applicable theories. Normally, in science, theory is based on previous research, but at some point a researcher has generated this theory in an unstructured manner and, in the reporting of scientific work, this theory development stage is largely absent. In contrast, HCI can be (though it is not always) very explicit about developing the theory underlying a new design, though it is noted as being something of a craft. In a new field of exploration like HCI, there must be an increase in this unstructured approach to the discovery stage as there are fewer relevant papers to look to for assistance. Henwood and Pidgeon (1992) argue that the discovery stage is a fundamental role in the scientific process. It could be argued that it is even more fundamental within the design procedures of HCI. This suggests that the particular value of grounded theory in HCI is its structured approach to theory generation. Developing theoretically informed explanations is the most powerful way to highlight reality. Building theory implies interpreting data, for the data must be conceptualised and the concepts related to form a hypothetical rendition of reality. The rendition that results, the theory, cannot only be used to explain that reality but also to provide a framework for action within that context.

Thus, grounded theory has the potential to provide a more focused and structured approach to HCI qualitative research and to provide theories and applied models based on both qualitative and quantitative data. Indeed, its particular

approach is closer in some ways to quantitative methods and that is why it is sometimes referred to as a post-positivistic method (Stevenson and Cooper, 1997). Within HCI, grounded theory has been growing as an appropriate qualitative analysis methodology, particularly as a way of analysing usability in complex social, international settings (Adams *et al.*, 2005; Pace, 2004; Razavim and Iverson, 2006). The nature of many HCI phenomena, such as user satisfaction, engagement, privacy and trust, advocates a qualitative approach, although the requirements of the HCI knowledge base imply that a systematic quantitative approach is required. The post-positivistic grounded theory methodology potentially fulfils both of these requirements because it combines a rich, detailed analysis of qualitative material with an attempt to provide a systematic portrayal of the main concepts and themes in public discourse. Grounded theory as an HCI approach is an appropriate method for:

- building HCI theory (in research fields that are conceptually immature) which is empirically based and systematically developed
- integrating current interdisciplinary knowledge into the theory
- dealing with the complex nature of the phenomena (e.g. user perceptions, privacy, trust, technology engagement)
- providing designers with accessible and applicable guidance.

It should be noted that the use of grounded theory methodology has diversified into two approaches: the classic version supported by Glaser (1978) and the Strauss and Corbin (1998) version. It is primarily the Strauss and Corbin approach that is described here. These variations are argued by McCann and Clark (2003) as a sign that the method is maturing and developing as the domains of application widen. Nowhere is this more evident than in the field of HCI where the need for valid yet flexible research is essential.

7.5 Critique

Most qualitative approaches, not just grounded theory, are frequently criticised for being subjective. An important defence against this criticism is to point out that all methods, not just qualitative methods are open to being done poorly and that all experimenters may bias the outcomes of their research. Poorly constructed experiments and applied statistical analysis can lead to bias and subjectivity in the research process just as surely as grounded theory. It is, therefore, advisable that HCI researchers and designers applying any of the methods in this book consider the concepts of reflexivity and quality.

As mentioned in other chapters (see Chapters 2, 6 and 10) it is invaluable to reflect on your research design decisions and how they match with your analysis methods. This concept is known as reflexivity and it deals with the researchers' reflection upon the inevitable impact they have on the research they are conducting. It is through reflexivity that, as HCI researchers, we are able to interpret,

understand and improve our own research. Reflexivity compels us to investigate how we as HCI researchers interact with, influence and inform the subject of our research (Nightingale and Cromby, 1999).

Reflexivity can support us in identifying appropriate HCI methods to use and any potential research biases that may occur. This is particularly useful when designers are conducting HCI research on their own developments. The ability to reflect effectively on the limitations of a design we have developed is a difficult one to master. The desire to turn an empirical evaluation into a training session can be overwhelming when the researcher is both the developer and researcher. Carla Willig (2001) describes two different aspects of reflexivity which can help to support effective reflection on these issues: personal reflexivity and epistemological reflexivity. Personal reflexivity can help designers identify their own interests, experiences and beliefs that are helping to shape and potentially bias the research. This approach also supports a reflection of how much this research has affected and changed us both as designers and researchers. Epistemological reflexivity helps HCI researchers reflect on the research question and methodology. For example, what are the different HCI issues that could be identified through a heuristic evaluation compared to an experiment or an in-depth interview? Epistemological reflexivity supports an analysis of our assumptions upon which the research is based and the implications of those assumptions for the research and its findings.

All research methods must be defensible in order to ensure the quality of the research they produce. There are several arguments put forward to disclaim the usefulness of a grounded theory approach. It has been argued that this type of research lacks repeatability (Morgan, 1996). Repeatability is used to verify that findings can be generalised to other participants in similar situations and are not just specific to the particular study. Strauss and Corbin (1990) argue that as long as the data used are comprehensive and the interpretations made are conceptually broad, the theory developed should be abstract enough and include sufficient variation to enable its application to a variety of differing phenomena-related contexts. Thus, HCI research of technology within one context may reveal something of relevance about the technology in another related context.

The subjective elements of grounded theory have also been criticised. However, Sherrard (1997) argues that the apparent lack of opinion within science is merely the product of avoiding socially controversial issues. Many of the research projects in HCI would be difficult to approach purely experimentally either because it would be unethical or because of the complexity of the issues involved. It is also argued (Henwood and Pidgeon, 1992; Sherrard, 1997; Stevenson and Cooper, 1997) that subjectivity and bias are apparent, in varying degrees, in all research. The move, it is suggested, should therefore be to acknowledge these biases for scrutiny by professional counterparts, rather than denying that they exist. Henwood and Pidgeon (1992) suggest that all good quality research should provide documentation of the analytic process and a reflexive account of researchers' research backgrounds and perspectives. They also detail seven rules that should

be followed to increase the quality of grounded theory research. To ensure a high standard of analysis Henwood and Pidgeon's (1992) rules can provide guidance to ensure quality within qualitative analysis procedures:

- 1 A constant comparison method should be used as an internal check on validity ensuring that the framework developed retains the importance of fit to the raw data.
- 2 Multiple testing of hypotheses will result in identification of relationships that are integrated at all levels of abstraction.
- 3 Increased validity of the research can be obtained by endeavouring to increase its theoretical sensitivity using previous research comparisons.
- 4 Theoretical Sampling allows for elaboration of the model and increases the conceptual depth of the analysis.
- 5 An account of the contexts in which the studies were completed should be provided. This increases the transferability of the findings to other contexts.
- 6 Detailed documentation of the research process should be made and a sample of the process provided.
- 7 To obtain reflexivity an account of the author's attitudes and approaches to research in general should be provided.

Another criticism is that, because of the complexity in applying grounded theory appropriately, researchers' experience levels will alter the level of quality in the analysis and also the degree of subjectivity. However, the same could be said for quantitative research in which an experienced researcher would be able to identify potential confounding variables in an experimental design sooner than a less experienced researcher. Strauss and Corbin (1990) argue that a study's reliability (and some aspects of its validity) are still down to the researcher's own theoretical sensitivity, which should be encouraged to reduce bias (Glaser, 1978).

Thus, all of these criticisms, which seem initially most relevant to qualitative approaches in general and grounded theory in particular, only seem so relevant because of the explicit role of the researcher and because qualitative researchers actively acknowledge that role. In fact, though, these criticisms are true of all research methods, and all research methods would benefit from such critical scrutiny.

What cannot be disputed is the time-consuming nature of these approaches. Consider an apparently straightforward interview study. An hour-long interview can easily end up as 10 pages of type. Fifteen interviews make 150 pages that need to be coded, cross-referenced and related. In addition, the researcher will be continuously producing memos that are frequently reviewed and updated. In total, then, developing a grounded theory from even a modest study is a substantial effort. What an HCI researcher must consider, however, is the depth of knowledge they require to increase the effective design of their systems. To get an effective answer may simply require more research input.

Ultimately, through reflexivity, you should decide which alternative methods are suitable and the appropriate way to apply these methods. Latour (1987) argues

that there is basically little difference between the two paradigms, quantitative and qualitative methods, as both endeavour to arrange and rearrange the intricacies of raw data. Bryman (1988) additionally suggests that the distinction between these two approaches is purely technical, so that the choice between them relies on their suitability in answering particular research questions. It is suggested that a valuable approach towards strengthening the quality of research is to use a principled combination of methods (Strauss *et al.*, 1964; Henwood and Pidgeon, 1992). It should be acknowledged by advocates of qualitative approaches that there is a lot to be learned from the quantitative paradigm just as there are lots of critical issues addressed by the qualitative approach. This therefore highlights the value of a methodology, such as grounded theory, that seeks to and can encompass both paradigms.