Curiosity, Creativity, and Surprise as Analytic Tools: Grounded Theory Method

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In memory of Susan Leigh Star (1954–2010), whose insights and humanity helped many of us to find our ways, individually and collectively.

Introduction: Why Use Grounded Theory Method?

Grounded theory method (GTM) is increasingly used in HCI and CSCW research (Fig. 1). GTM offers a rigorous way to explore a domain, with an emphasis on discovering new insights, testing those insights, and building partial understandings into a broader theory of the domain. The strength of the method—as a full method—is the ability to make sense of diverse phenomena, to construct an account of those phenomena that is strongly based in the data ("grounded" in the data), to develop that account through an iterative and principled series of challenges and modifications, and to communicate the end result to others in a way that is convincing and valuable to their own research and understanding. GTM is particularly appropriate for making sense of a domain without a dominant theory. It is *not* concerned with testing existing theories. Rather, GTM is concerned with the *creation* of theory, and with the rigorous and even ruthless examination of that new theory.

Grounded Theory Method is exactly that—a *method*, or rather, a family of methods (Babchuk, 2010)—for the development of theory. GTM makes explicit use of the capabilities that nearly all human share, to be curious about the world, to understand the world, and to communicate that understanding to others. GTM adds to these lay human capabilities a rigorous, scientific set of ways of inquiring, ways of thinking, and ways of knowing that can add power and explanatory strength to HCI and CSCW research.

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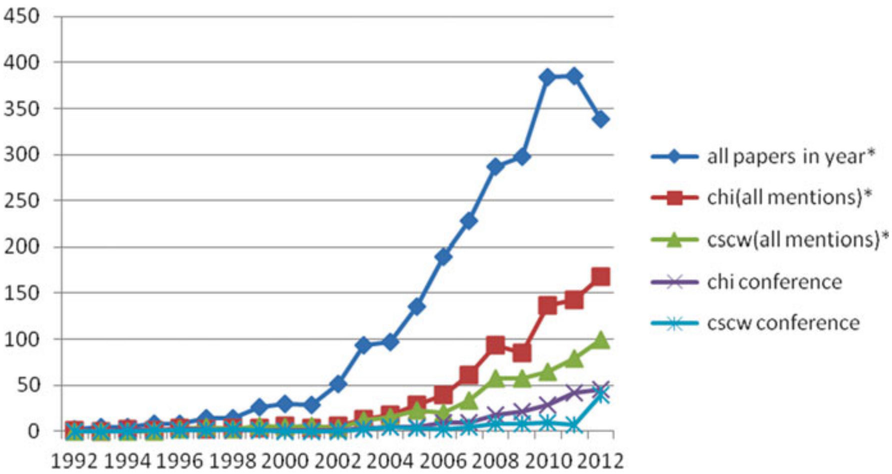

Fig. 1 Papers in the ACM Digital Library that mention "grounded theory." The line labeled "all" is for all references to "grounded theory" in each year. The line labeled "chi" shows papers that mentioned both "grounded theory" and "chi." The line labeled "cscw" shows papers that mentioned both "grounded theory" and "cscw." The remaining two lines are grounded theory papers in the CHI or CSCW *Conference Proceedings* (including *Extended Abstracts*). Figures for 2012 (*asterisk*) are estimates, based on entries from January to September

GTM has been used to study diverse phenomena that pertain or contribute to HCI and CSCW studies. Matavire and Brown (2008) surveyed the use of GTM in information systems research; (Riitta, Urquhart, & Iivari, 2009; Riitta & Newman, 2011) used GTM to understand information systems project management (*see* also Seidel & Recker, 2009, for a grounded theory study of business process management). Adolph, Hall and Kruchten (2008) applied GTM to understand software development. More specifically, Hoda (2011) used GTM to develop an account of agile software teams. In a contrastive pairing, Macrì, Tagliaventi and Bertolotti (2002) conducted a grounded theory study of resistance to change in organizations, and Pauleen and Yoong (2004) studied innovation in organizations. Locke (2001) focused on management studies.

Within HCI and CSCW, various forms of GTM have been used to study phenomena such as boundary objects and infrastructures (1985, 1999, 2002; Star & Griesemer, 1989), appropriation (Kim & Lee, 2012), decision-making (Lopes, 2010), personas (Faily & Flechals, 2011), HCI education (Cennamo et al., 2011), social media (Blythe & Cairns, 2009; Thom-Santelli, Muller, & Millen, 2008), and the use of classifications in organizations (Bowker & Star, 1999). Among domains that can be addressed via information and computing technologies, GTM was used in studies of diverse populations ranging from homeless people (Eyrich-Garg, 2011) to seniors (Sayago & Blat, 2009; Vines et al., 2012) to parents (Rode, 2009) to families in various configurations (Odom, Zimmerman, & Forlizzi, 2010; Yardi & Bruckman, 2012) to the founders of ventures (Ambos and Birkinshaw (2010). GTM has also been invoked in studies that focused primarily on technologies (Chetty et al., 2011; Faste & Lin, 2012; Kim, Hong, & Magerko, 2010) and on the social attributes of technologies (Kjeldskov & Paay, 2005; Lewis & Lewis, 2012; Mathiasen & Bødker, 2011; Paay, Kjeldskov, Howard, & Dave, 2009; Rode, 2009; Wyche, Smyth, Chetty, Aoki, & Grinter, 2010; Yardi & Bruckman, 2012).

However, the development of GTM has been complex and even schismatic. After the initial *Discovery of Grounded Theory* (Glaser & Strauss, 1967), two major orientations to grounded theory diverged from one another (Babchuk, 2010; Kelle, 2005, 2007), followed by a "second generation" of grounded theorists who creatively extended and recombined one or both of the major orientations (Morse et al., 2009) and further offshoots as well (Matavire & Brown, 2008), described in more detail later. Also, the application of GTM in HCI and CSCW has been uneven (see Furniss, Blandford, & Curson, 2011, for a recent discussion). Some researchers adopt the concept of grounded theory as a full methodology (e.g., Star, 1999, 2007). Other researchers make selective use of a subset of GT practices (e.g., Paay et al., 2009; Thom-Santelli et al., 2008). Yet other researchers invoke GTM as a kind of signal to indicate an extended qualitative data analysis. Taken together, these problems have led to a blurring of the definition and the practices of GTM in HCI and CSCW research. It is difficult to know what a reference to "grounded theory" means in CSCW and HCI, and it is correspondingly difficult to assess the quality and rigor of grounded theory reports.

This chapter attempts to address some of these problems. Because the theme of this volume is "ways of knowing," I use the grounded theory approach of *abductive inference* as a core distinguishing contribution of GTM to HCI and CSCW, and as the central organizing principle of this chapter. As with many papers on GTM, my excerpting from the literature is necessarily personal; I provide citations to different perspectives as well.

Grounded Theory Method as a Way of Knowing

Ground Theory Method is concerned with *knowing* as a human endeavor, using the unique capabilities of humans as active inquirers who construct their interpretations of the world and its phenomena (Charmaz, 2006; Gasson, 2003; Lincoln & Guba, 2000). In this way, GTM differs from many conventional "objective" approaches to HCI, which often define their methods as a series of procedural steps that should result in a replicable outcome regardless of the identity of the researcher(s) involved (e.g., Popper, 1968). Grounded theory recognizes that human researchers are curious and active agents, who are constantly thinking about their research questions, and who can make, modify and strengthen their research questions as they learn more. The procedural steps of conventional approaches are replaced with a different logic of inquiry derived generally from the philosophy of pragmatism (Peirce, 1903), with its own standards of rigor.

Conventional approaches advise a linear sequence of actions in which the researcher (1) defines a theoretical question, (2) collects data, (3) analyzes the data, and (4) interprets the analysis to answer the theoretical question. Grounded theory makes a virtue of our human inclination to ask "what's going on here" long before we have completed our data collection (Charmaz, 2006; Gasson, 2003). Instead of waiting to theorize until all the data are collected, GTM provides ways of thinking that depend crucially on the iterative development of interpretation and theory, using principles of *constant comparison* of data-with-data, and data-with-theory (Charmaz, 2006; Corbin & Strauss, 2008; Glaser & Strauss, 1967; Kelle, 2007; Urquhart & Fernández, 2006). Data collection is guided by the iteratively developing theory, usually in ways that involve challenging that theory through additional data samples that are chosen to test the theory at its weakest points (e.g., Awbrey & Awbrey, 1995). For example, we might ask, "is this finding universal, or does it occur only among a subset of the population?" or, using a more targeted strategy, "what *other* situations are crucially different, such that we should we *not* be able to replicate this finding in those situations?" A theory that survives this process is likely to be broad and robust, and is therefore likely to provide explanatory value and power to the researcher and the field.

Abductive Inference and Surprise

According to many GTM researchers, the core concept of GTM is a way of reasoning that is distinct among most other methods in HCI and CSCW. *Abductive inference* is a "logic of discovery" (Paavola, 2012) concerned with finding new interpretations (theories) for data that do not fit old ideas (Reichertz, 2007; Shannak & Aldhmour, 2009). As such, it is neither inductive nor deductive, although some theorists claim that it incorporates both of these inferential operations (e.g., Haig, 1995). The logic of abduction is to find a surprising phenomenon, and then to try to explain it. Haig (2005) describes the process as follows:

> [S]ome observations (phenomena) are encountered which are surprising because they do not follow from any accepted hypothesis; we come to notice that those observations (phenomena) would follow as a matter of course from the truth of a new hypothesis in conjunction with accepted auxiliary claims; we therefore conclude that the new hypothesis is plausible and thus deserves to be seriously entertained and further investigated. (Parentheses in original)

The new idea is a "hypothesis on probation" (Gold, Walton, Cureton, & Anderson, 2011), and must be rigorously tested. GTM provides disciplined ways of "managing" one or more "hypotheses on probation," and of testing them in ways that make the hypothesis stronger, more internally consistent, and broadly applicable.

Most grounded theorists trace the concept of abduction to Pierce's philosophy of pragmatism (Peirce, 1903): "Deduction proves that something must be; Induction shows that something actually is operative; Abduction… suggests that something may be."[1] But how can we move from the tentative position of "may be" to a stance of greater confidence? Quoting from Peirce, Reichertz (2010) summarizes: "One may [achieve] a discovery of this sort as a result of an intellectual process and, if this

[1] For more discussion of pragmatism, see Hayes' chapter on Action Research in this volume.

happens, it takes place ‘like lightning,’ and the thought process ‘is very little hampered by logical rules.’” While intriguing, Peirce‘s theorizing would seem to make for poor science. The *method* aspects of Grounded Theory Method are designed to resolve these problems in detail.

What Grounded Theory Is and Is Not

Grounded theory is not a theory!—at least, not in the conventional sense of theory, such as Activity Theory (Nardi, 1996) or Structuration Theory (Orlikowski, 1992). Grounded theory is a family of methods (Babchuk, 2010)—hence, the more accurate term of Grounded Theory Method (Charmaz, 2006). The methods are used to *construct* theories of particular phenomena or domains that are “grounded” in the data. In this way, GTM puts its emphasis on data, and on thinking about the data. The methods of GTM help researchers to describe data, to build increasingly powerful abstractions based on the data, and to collect additional data that can provide the most effective tests of those abstractions.

Grounded Theory as Method

History and Sources of Grounded Theory

Grounded Theory began as a “discovery” of two sociologists (Glaser & Strauss, 1967) who had enjoyed a fruitful collaboration (Glaser & Strauss, 1965, 1968; Strauss & Glaser, 1970), but who eventually disagreed with one another, sometimes profoundly (Corbin & Strauss, 2008; Glaser, 1978, 1992; Strauss, 1993). The core of their shared insights was a rejection of the positivist sociology that was dominant in the US in the 1960s (Star, 2007) and the development of an approach that emphasized the gradual development of new theories based on continual reference (“constant comparison”) to data. They rejected the conventional approaches that begin with a theory, collect data in a uniform manner, and then test that theory. Instead, they pioneered methods for making sense of data through iterative coding and theorizing, in which theory guided codes and codes guided theory, and in which the theory was understood to be under constant development.[2] A direct consequence of the focus of theory and ongoing development was the requirement to reshape the inquiry based on the developing theory (see “theoretical sampling,” below).

The disagreement between Glaser and Strauss has been discussed by many grounded theory researchers (Bryant & Charmaz, 2007; Charmaz, 2006, 2008; Locke, 2001; Morse et al., 2009), including an HCI-oriented account (Muller & Kogan, 2012).

[2] This approach is similar to HCI ideas of iterative design, and the quick, in-process evaluations of designs through formative evaluation (Nielsen, 1992). GTM adds methodological rigor and the coordinated development of both data and theory.

Strauss focused on a set of methods for conducting grounded theory research. Consistent with the themes of ongoing development and discovery, Strauss made significant modifications to his treatment, sometimes discarding entire "paradigms" in favor of more open procedures (Corbin & Strauss, 2008). Glaser disagreed with many of the specific methodologies, which he considered to be "forcing" the data into preexisting structures (e.g., Glaser, 1992), with a potential loss of the ability ("sensitivity") to discern and create new theories (e.g., Glaser, 1978). Students of the two founders developed their own practices and their own philosophical orientations. Today, grounded theory spans multiple positions, from quasi-positivist (e.g., Corbin & Strauss, 2008) to constructivist (e.g., Charmaz, 2006) to explicitly postmodern (e.g., Clarke, 2005). In what follows, I focus more on the Strauss and Charmaz approaches, because they offer relatively clear guidance for HCI and CSCW. I encourage interested readers to consult many of the other sources, because of the strongly personal and personalized nature of much of grounded theory methods. GTM methods are *ways of knowing*; each GTM practitioner will need to make choices about the best (sub) methods through which she or he perceives and knows.

Major Resources for Grounded Theory

As mentioned above, the founding text of grounded theory was the book about its "discovery" by Glaser and Strauss (1967). Strauss's work proceeded through a methodological evolution, sometimes informally referred to as "the cookbook"; the most recent version appeared as Corbin and Strauss (2008). Glaser published a series of theoretical evolutions, with a diminished focus on methods; Glaser (1998) is a good summary.

Students of the founders developed their own approaches. One group of students described themselves as "the second generation," and published a summary of their approaches in Morse et al. (2009). Several of them also published influential versions of grounded theory research methods, such as the constructivist methodology of Charmaz (2006), the postmodern and cartographic approach of Clarke (2005), and the more pragmatic, business-applied version of Locke (2001). Like any field of committed scholars, grounded theory has needed its own handbook to pursue diverse specialized topics. An influential handbook has appeared in the Sage series by Bryant and Charmaz (2007).

Grounded Theory Practices

The Abstraction of the New: Codes, Coding, and Categories

Grounded theory begins not with theory, but with data. Data are connected to thinking, and to theorizing, through a formal vocabulary known as *codes* (Holton, 2007), as shown by lozenge shapes in the left side of Fig. 2. Star (2007) wrote, "A code sets

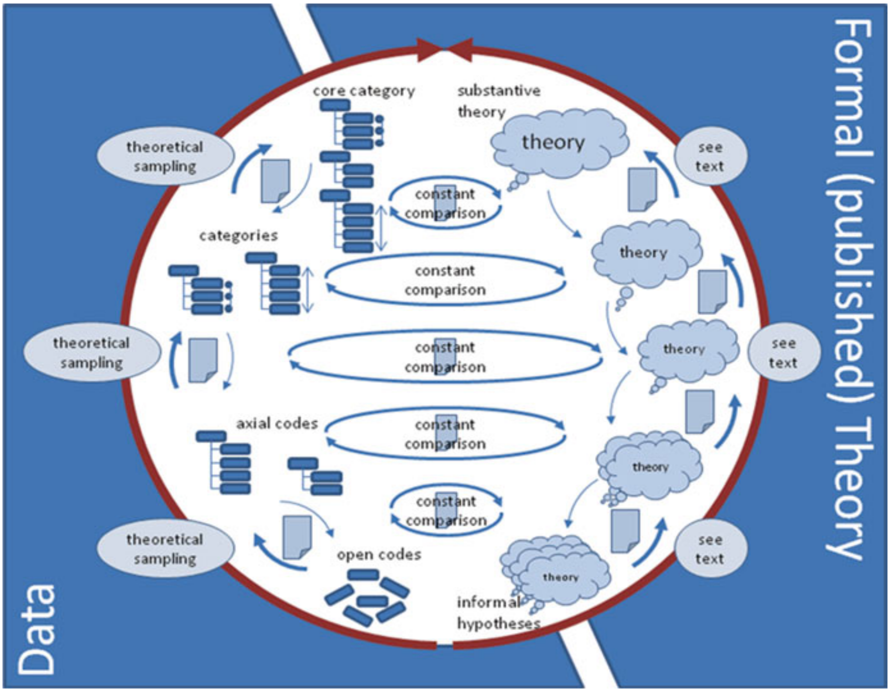

Fig. 2 A sketch of the major components of GTM practices

up a relationship with your data, and with your respondents [Codes are] a matter of both attachment and separation […] Codes allow us to know about the field we study, and yet carry the abstraction of the new." Writing descriptions that are both accurately detailed and powerfully abstract is challenging. A code is a descriptor of some aspect of a particular situation (a site, informant or group of informants, episode, conversational turn, action, etc.). When codes are reused across more diverse situations, they gain explanatory power. Each situation becomes a test of the power of the codes to explain an increasing rich set of data. Codes are initially descriptive and tied to particular aspects of the data. Over time, the researcher(s) develop more abstract codes, which become one instantiation of the developing theory as shown by the thought-bubbles on the right side of Fig. 2. GTM provides guidance about how this happens, how to assess the resulting set of codes (see "Research Quality and Rigor," below), and how to record the emerging theory through informal documents called "memos" (the paper icons in the central column of Fig. 2).[3] Several influential accounts of GTM converge on a four-level schema to help to meet the challenge of how to get started in coding (Charmaz, 2006; Corbin & Strauss, 2008;

[3] Note that there is controversy among GTM researchers about the appropriate time to consult Formal Theory (i.e., the research literature). See "Creativity and Imagination," below.

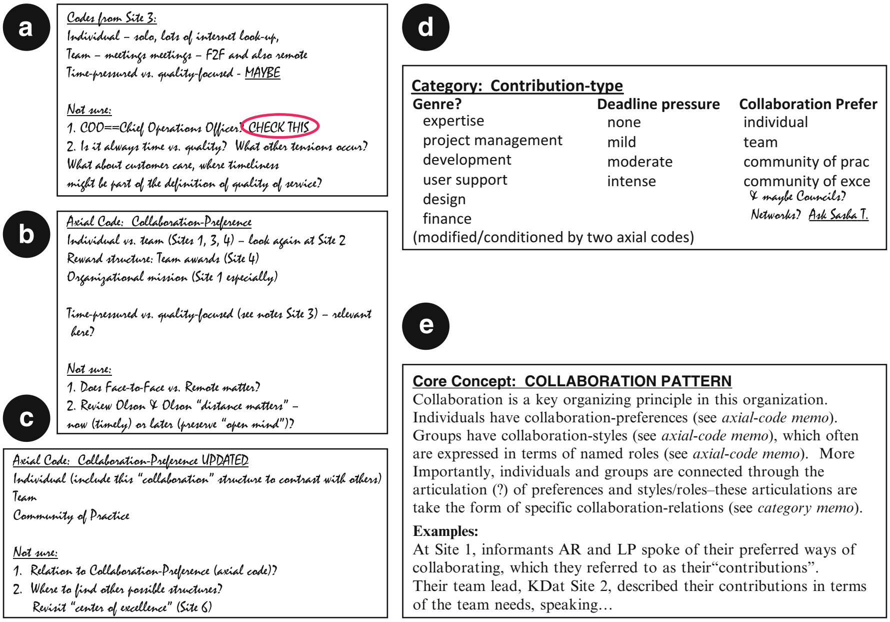

Fig. 3 Examples of memos in GTM

Dick, 2005; Star, 2007): open coding, axial coding, selective coding, and the designation of the core concept.

Open coding is the phrase used for the initial description of a situation. An open code is a kind of label placed on a phenomenon. Open codes are "open" in the sense that they are "open minded" (not governed by formal prior knowledge) and also in the sense that they are relatively unconstrained.

Suppose that we want to understand work practices in organizations. We might begin by interviewing people about their work. In this particular case, a "situation" is a person, and we are coding attributes of the person's job, tasks, and responsibilities.[4] Possible codes might include "individual" or "team," or "time-pressured," or "quality-focused." Some codes turn out to be useful in more than one situation, while others, which are mentioned by only a single informant, turn out to have little generality. Codes should be recorded in brief, informal researchers "memos" (see below). At this stage, the memo would be likely to contain a list of codes, the informal rules or heuristics for applying those codes to the data, and the beginnings of a list of reasons to doubt that the codes are complete descriptions of the data (Fig. 3a).

Axial coding is the first of several practices to organize the open codes into broader abstractions or more generalized meanings—a continuing integration of one's understandings, moving from *describing* to *knowing*. Axial codes are

[4] In other cases, the "situation" could be a group, or an organization, or a document, or a conversation.

collections of related open codes. It is tempting to say that axial codes are built up from the component open codes in a bottom-up way, and that's partially true. For example, the open codes of "individual" and "team" may suggest an axial code of "collaboration-preference." That might seem like a nice research outcome, and we should record it in another informal memo, describing the axial code and its component open codes—perhaps with back-references to the memo(s) created in the preceding paragraph (Fig. 3b).

The concept of collaboration-preference might provide a good basis for writing a paper. However, an axial code may also be used to interrogate the open codes, leading to more data collection and more open coding. Suppose, in the example of the axial code for collaboration-preference, we might have heard references to other configurations of work, such as communities of practice, or less structured networks. If we have already accepted the axial code as "individual-or-group," then these other configurations of work would come as a surprise. If we were guided by a hypothesis-testing approach, we might try to force a community of practice into the "team" category. Because we are using GTM, we can instead interrogate our initial theory and its axial code of collaboration-preference, to see how it can be expanded and strengthened based on the tentative evidence of communities of practice.

This way of thinking may lead to a search beyond the current sample of informants, for people who work in those other configurations, such as communities of practice (see "theoretical sampling," below). If we find people who work in those configurations, then the axial code must be broadened, and has thus become stronger and more generalizable: The axial code now organizes more cases, and (crucially) it *sets each case in relation to other cases along a common frame of reference*—that is, each case has a unitary description (the open code), and those unitary descriptions make more sense because they can be thought about in relation to other unitary descriptions (other open codes). The axial code sets these open codes into that relationship, which should be recorded in another informal memo. Like the preceding memo, this new document could be quite short, describing the axial codes, their constituent open codes, and the emergent concepts that are related to this new cluster of labels (Fig. 3c).

Categories begin to emerge as we focus our attention and insight upon certain axial codes. A category is a well-understood set of attributes of known relation to one another. A simple example might be "contribution type" (as a component of collaboration-preference). Continued interviews may show that the informants typically make contributions such as "expertise," "project management," "development," or "user support." If we become convinced that these four types of contributions are sufficient to describe all (or most) cases, then these terms become properties of the category of contribution-type. Another example might be "deadline-pressure," which might be summarized as "none," "mild," "moderate," or "intense." As these clarifications occur, they too should be recorded in another informal memo. This memo might be longer than the previous ones, because it would detail the category and the several axial codes that contribute to it (Fig. 3d).

More radically, we might recall that some informants seemed to refer to different kinds of roles, with different collaboration attributes, in different working groups. Further interviews confirm that this phenomenon is widespread. However, the pattern of *multiple* collaboration attributes for the same person, could not occur if each person had a single, *personal* collaboration-preference. This is a key moment in abductive inference, because we have to think of a new informal theory to make sense of this insight. Is the collaboration-preference really an attribute of the person? This thinking suggests additional questions, and those questions might lead us both to find new informants, and also to return to previous informants to get answers to those additional questions. In some cases, we could return to a set of interview transcripts, or documents, and use our new understanding to ask new questions of these "old" data. As we find that some people participate in *different* collaboration-patterns, then the attribute of collaboration-preference has moved away from the *person* and has become instead a characterization of each collaborative *group*, such as the collaboration personas of Matthews, Whittaker, Moran, and Yuen (2011). It might be appropriate to rename the axial code at this point, to make its group-basis clearer—perhaps "collaboration-style." The evolving theory has become much stronger, because we have a new understanding of *what entity* is properly described by the collaboration-style. Another memo is needed to record this new understanding. As in the preceding paragraph, we may find that the memos are getting longer, comprising lists of open and axial codes, but also greater depth and integration of the emergent theory.

The collaboration attribute now appears to be a defining aspect of each group. That's an interesting new theory, but we need to test it further. In GTM, we usually test a theory at its weakest point. We might therefore ask if all of the members of each group have the *same* kind of relationship to the group. And indeed, we learn that some people serve as core members of a group, while other people serve as more peripheral members (e.g., subject-matter experts, who are called upon from time to time for specific types of expertise)—another surprise. On this basis, the "collaboration-style" theory appears to be insufficient, because it proposed that the group had a single collaboration-pattern. How can the theory be broadened and deepened, to accommodate these new insights from the data?

We could hypothesize another kind of theoretical "relocation" of the characteristic of collaboration-style. First, we thought that collaboration-preference was a characteristic of a *person*. Then we thought that collaboration-style was a characteristic of a *group*. Through a series of surprises, we realized that neither of those theories was capable of describing the richness of the data. Now we hypothesize that the collaboration attribute is a characteristic not of a person nor of a group, but rather of the *relationship* of a person to a group. Perhaps now we should use the phrase "collaboration-relation," and we should document this subtle but important distinction in another memo. This new memo describes not only the new configuration of codes, but also the theoretical concepts that led to that reconfiguration (Fig. 3e). The developing theory has changed again, and has become more powerful, and capable of describing a broader set of phenomena. Further interviews and observations present no further surprises: The theory appears to explain all of the data, and this phase of theory development is complete.

Additional work could be done to expand the theory beyond this situation or to test the theory in more detail. For example, are there certain *types of groups* that have a set of characteristic collaboration-relations (Matthews et al., 2011) that link people to each group? Or it might be useful to determine if certain job titles have a set of characteristic collaboration-styles that link people in that job title to other people (through groups). And it might be helpful to see if certain people tend to have a single, predominant collaboration-relation with their groups.

A further test of the theory could be done via a social network analysis, and some of the hypotheses could have been evaluated through such a network analysis (see Chapter on Social Network Analysis in this volume). Alternatively, we could have been using a statistical summary of individuals and their group memberships all along, to help us find appropriate next people for interviews (e.g., as we did, in a more primitive fashion, in Muller, Millen, & Feinberg, 2009; Thom-Santelli et al., 2008). This is to say, while GTM is most commonly used for qualitative data, it can also be used for a quantitative exploration, and both qualitative and quantitative methods may be used together.

The *core concept* emerges through this kind of intense comparison of data to data, and data to emerging theory (some grounded theorists make reference to *selective coding*, which is approximately the choice of the core concept). Could it be that we are thinking about a complex set of inter-related axial codes? We are currently thinking about collaboration-relations as describing the links between people and groups. But we earlier thought about collaboration-preferences of individuals, and *perhaps that concept is still useful* to us. Also, we earlier thought about the collaboration-styles of groups, and *perhaps that concept is also useful* to us. The general concept of collaboration-pattern appears to apply, in *different but related ways*, to persons, groups, and the relationships among them. This three-way analysis of collaboration-pattern is becoming a powerful and generalizable theory. At this point, we can retrieve the two memos describing collaboration-preference and collaboration-style, and combine them with the more recent memo on collaboration-relations. With those source materials in hand, we can write a longer, more integrative memo about the core concept of collaboration-patterns, making use of each of the three preceding memos. This new memo is likely to be the basis of the results and/or discussion section of our report of this research. We should record other ideas in other memos, and save them for later. The core concept that we have chosen now will be the basis for one report of the work. We may want to revisit the data and our memos later, for additional insights, and perhaps additional papers.

Substantive Theory

Glaser (1978) proposed the heuristic question, "What is this data a study of?" (Charmaz, 2006, might rephrase this as "what story do I want to tell about the data?"). In this example, the answer is becoming:

> The data are a study about a broad concept of collaboration-patterns, which are manifested in individuals as a subset of attributes that we've called collaboration-preferences, in groups as a related subset of attributes that we've called collaboration-styles, and in connections between groups and individuals as collaboration-relations.

This has become a powerful theory *based in the data*, and we may now be ready to begin to write a report of what we have concluded. The report will be centered on the *core concept* of collaboration-pattern, and will make use of the *categories* of collaboration-preference, collaboration-style, and collaboration-relation. Each of these categories has multiple *axial codes* which organize the original *open-coded* data. Our intense thinking, sampling, and theorizing about the core concept has resulted in what grounded theorists call a *substantive theory*—that is, a well-developed, well-integrated set of internally consistent concepts that provide a thorough description of the data. The work is not over. The next step, in beginning to write the report, is to relate this substantive theory to previously published or "formal" theories in the research literature (see "Case Studies of Grounded Theory Method in HCI and CSCW," below).

From the perspective of this book, we have used the powerful methods of grounded theory to shape our *knowing* about this domain, through a disciplined series of movements up and down a scale of abstraction. Initially, all we knew were the data. Keeping an open mind, we looked for regularities in the data (repeating phenomena, repeating patterns), and we began to hypothesize how those phenomena and relations could be related to one another. We tried various informal theories, and for each theory we immediately returned to the data, asking more questions, *testing* the theory to see if it was an adequate description. The goal of GTM at this point is to find out *what's wrong with the developing theory*, so that we can replace weak parts with stronger conceptions. Our testing led to these kinds of desirable failures, and ultimately to a much stronger, much more generalized theory. Now we *know* more about our domain, and we know it because we based and tested each of our theoretical developments on the data. The theory is *grounded* in the data.

Grounded theory researchers would describe this journey in different ways. Glaser held that the theory *emerged* from the data (1992), and that a principal task of the research is to cultivate sufficient *theoretical sensitivity* to be able to discern the theory in the data (1978). Corbin and Strauss also focused on finding patterns that were present in the data, using well-defined procedures and coding practices to find the right data, and to describe the phenomena in those data (2008). In retrospect, both of these approaches seem to reflect the objectivism of the times. *Knowing* takes place through discovery—grounded in the data.

By contrast, Charmaz (2006) and Clarke (2005) emphasize the researcher as an active interpreter of the description and the developing theory. In their postmodern approach, theory is constructed (not discovered), and the researcher is accountable both for the theory that she/he creates, and for the path through which she/he arrived at that theory (Charmaz, 2006, 2008; see Dourish's chapter on Ethnography in this volume for a similar movement toward accountability in ethnography). Clarke particularizes the role and responsibility of the researcher, asking *whose voice is not being heard* (*and why*)? *Whose silence is significant* (*and why*)? From the perspective of this volume, *knowing* in these postmodern accounts of GTM is an active process of construction, and takes place through cognitive and/or social acts of interpretation, conceptualization, hypothesis-creation and testing, and construction of theory—grounded in the data.

Creativity and Imagination: Memos

GTM describes a series of rigorous steps through which theory development occurs incrementally. In that spirit, most grounded theory researchers advocate an iterative series of documents (memos) that record the development of our understandings, including descriptions of codes and their meanings, thoughts about what might be going on, descriptions of how data fit (or do *not* fit) the developing theory, strategies for new samples, and so on. Corbin and Strauss write, "[Memos] force the analyst to work with ideas instead of just raw data. Also, they enable analysts to use creativity and imagination, often stimulating new insights into data." Charmaz (2006) agrees: "Memo-writing constitutes a crucial method in grounded theory because it prompts you to analyze your data and codes early in the research process […] [N]ote where you are on firm ground, and where you are making conjectures. Then go back to the field to check your conjectures." Memo-writing is an essential component of the *knowing* that occurs during GTM: "[M]emos… grow in complexity, density, clarity, and accuracy as the research progresses… They… are just as important to the research process as data gathering itself" (Corbin & Strauss, 2008).

Advice about the practices of memo-writing practices varies widely. At perhaps one extreme of brevity is Dick (2005), who recommends that a grounded theory researcher carry file cards in a pocket, so that she/he can record one of *several* memos on *each* file card. Corbin and Strauss (2008) provide examples of memos that range from a single paragraph to a page or more. Charmaz's examples include single paragraphs and well-structured essays, the latter including headers and subheaders within a single memo (2006). As theory-development progresses, memos may take on greater structure, such as the essays in Charmaz's account (2006), causal diagrams (e.g., Corbin & Strauss, 2008), formal tables that lay out each category with its component codes (Muller & Kogan, 2012), and a cartographic technique called *situational maps* (Clarke, 2005), as shown in Fig. 4. Each researcher, and each research team, will probably need to experiment to find the form or forms that suit their work.

The important point is that memo-writing is a way for the researcher to construct her/his knowledge, and to put that evidence of *knowing* into a concrete form. Activity theorists might say that, through memos, the act of knowing is externalized or crystallized (e.g., Nardi, 1996). To coin a phrase, memos are a crucial step in *making the knowing known*—to oneself and others. Memos help us to remember old ideas that we thought were not relevant (as in the examples about collaboration-preference and collaboration-style, above). Memos are the expression of theory, and guide data collection, as well as being useful in writing reports of a GTM research project.

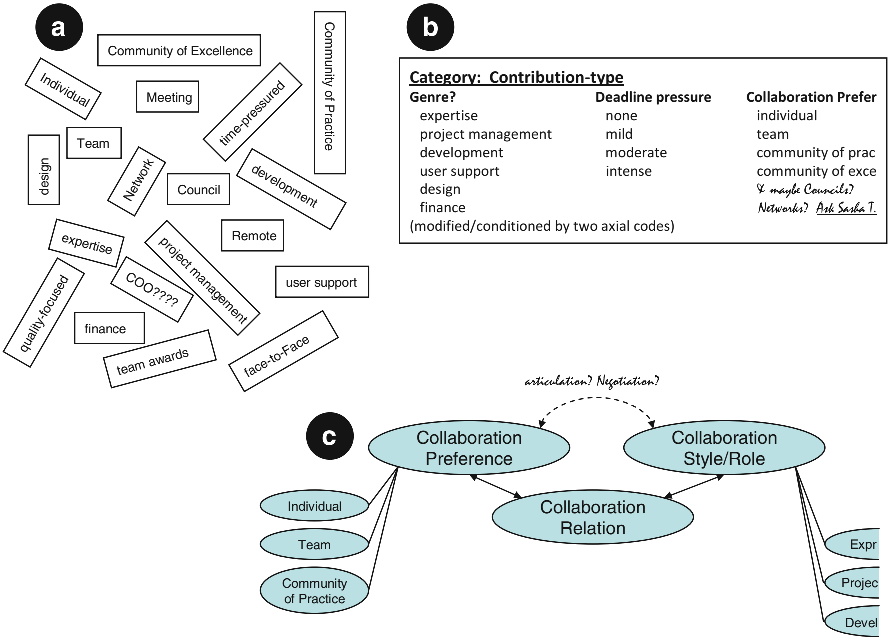

Fig. 4 The scenario in this chapter, represented according to Clarke's situational maps. (**a**) "Messy" situation map. (**b**) Ordered situational map. (**c**) Relationship map

Surprise as a Cognitive Tool: Theoretical Sampling and Constant Comparison

A core cognitive strategy of GTM is to make human capacities, such as curiosity and sensemaking, into tools of inquiry throughout the research process. Surprise is one of those tools. In the example of collaboration-patterns (above), we were repeatedly surprised to find data that did not fit the current state of our theory, and we ended the data collection when there were "no further surprises." In accord with abductive inference, each surprise led to new hypotheses ("How could this be? What would have to be true, for this new information to make sense?"). We then sought new data, to test each new hypothesis, and to strengthen and broaden the theory accordingly.

In GTM, this overall strategy is called *theoretical sampling* (Corbin & Strauss, 2008; Glaser, 1978), a rigorous form of abductive reasoning that is "strategic, specific, and systematic" (Charmaz, 2006), exactly because it is guided by the questions needed to strengthen the developing theory. We gather the new data to test the hypothesis. The data inform the hypothesis, leading to stronger hypotheses which in turn guide further data collection: "Theoretical sampling tells where to go"

(Charmaz, 2006), and memos record our progress. Theoretical sampling is one of the major strategies within the overall GTM concept of *constant comparison* of data with data, and of data with theory (Glaser & Strauss, 1967).

But if data lead to new hypotheses, and new hypotheses lead to more data, and we need to make informal documentation of each new understanding through memos, then how will we ever stop? This is where surprise again becomes an important cognitive tool. Grounded theory researchers often write about the need to *saturate one's categories* (Glaser & Strauss, 1967) or to achieve *theoretical saturation* (Gasson, 2003). A coding category is considered "saturated" when all the available data are explained by the codes in that category. There is no further surprise. Similarly, theoretical saturation is reached when all of the categories appear to be adequate to explain all of the data. Phrased in this way, the concept seems very abstract. Stern (2007) concretized it as follows, describing her study of family violence: "I realized that I had reached the point of saturation when the [informant] was telling me how when he was a small child he stood witness as his mother shot his father dead, *and I was bored*. I made all the right noises… but I knew that my data collection for that study had come to an end." (italics in the original).

Summary and Recapitulation

In the section on abductive interference, I reviewed Peirce's philosophy of abductive inference (1903), and showed that it depends crucially on (a) recognizing when one is surprised, and (b) searching for an alternative explanation. Peirce's account of how that alternative explanation is found—"like lightning"—was unsatisfactory for scientific work. I then promised that GTM would provide a principled way of moving from lightning to careful thought and deep involvement in data. The long, imaginary research story about collaboration-patterns showed key aspects of abductive inference in GTM, in the form of interleaved and interdependent practices of data collection, coding, theorizing, and documenting. Surprise played a crucial role—in concert with the principle of constant comparison of data-with-data, and data-with-theory—to show where the developing theory failed to describe the available data. We then used theoretical sampling, allowing the problems with our theory to help us choose the next people to interview (or, more generally, the next data to collect). Theoretical sampling is the rigorous GTM response to the problem of Peirce's lightning, replacing mysterious intuitions with disciplined guidance toward collecting the best data to lead toward a productive new understanding. To borrow a turn of phrase from Stern (2007), we continued until we were bored—that is, until there were no more surprises when we compared data-with-data, and data-with-theory. Surprise told us where to go next. Lack of surprise told us we were done.

Different Forms of Grounded Theory Method in HCI and CSCW

In HCI and CSCW, GTM has developed in several distinct ways. One important distinction is in the use of the research literature. Glaser and Strauss (1967) seemed to advocate that the researcher should approach the data as a kind of tabula rasa (blank slate), and should therefore avoid reading the formal or published research literature, to keep her/his mind free of bias. Subsequent researchers noted that both Glaser and Strauss had already read hundreds of books and papers about theory, and that they already had this knowledge somewhere in the background of their thinking (Morse et al., 2009). Glaser remained adamant on this point, insisting that theory emerged from an immersion in the data (e.g., Glaser, 1992). Dey (1999) phrased the objection to Glaser's position succinctly as "there is a difference between an open mind and an empty head. To analyse data, we need to use accumulated knowledge, not dispense with it" (see also Bryant & Charmaz, 2007; Funder, 2005; Kelle, 2005). Corbin and Strauss (2008) cautiously suggested that the research literature can be considered another form of data, and can be used in that way (e.g., through constant comparison) as part of a grounded theory investigation. Opinion continues to vary across a wide range of positions.

It is unlikely that an HCI or CSCW project could find successful publication if it did not include a detailed literature review. Indeed, as Urquhart and Fernández (2006), most graduate students who undertake a grounded theory study must first pass their qualifying examinations, in which they are expected to demonstrate deep engagement with the research literature. If GTM is to serve as a way of knowing, then the knowledge that it produces should be placed in relation to other knowledge. For these reasons, I believe that GTM in HCI and CSCW will probably be closer to the position of Corbin and Strauss (2008); and Bryant & Charmaz, 2007; Dey, 1999; Funder, 2005; Kelle, 2005).

Three Usage Patterns of Grounded Theory in HCI and CSCW

GTM has been invoked in three different ways in HCI and CSCW. Two of the three usage patterns appear to have a valuable place in HCI and CSCW research. In my opinion, the third way is more problematic from a GTM perspective.

Using GTM to Structure Data Collection and Analysis

The first type of invocation of grounded theory is a series of variations on the practices sketched in this chapter—i.e., iterative episodes of data collection and theorizing, guided by theoretical sampling, and the use of constant comparison as a way to think about and develop theory during ongoing data collection.

Susan Leigh Star is perhaps one of the best known grounded theory researchers in HCI and CSCW. She used grounded theory as an organizing method in a life's work that spanned the use of concepts and artifacts (boundary objects and infrastructures, Star, 1999, 2002; Star & Griesemer, 1989), the implications of classifications for organizations and inquiries (Bowker & Star, 1999), and the sources of uncertainty in nineteenth century science (Star, 1985). In Star's research, grounded theory became a powerful way of knowing which informed highly influential theorizing.

Using GTM to Analyze a Completed Dataset

The second type of invocation of grounded theory applies deep and iterative coding to a complete set of data that have already been collected, gradually building theory from the data, often through explicit use of concepts of open coding, axial coding, categories, and core concepts. While this process involves constant comparison, the application of theoretical sampling is more subtle. If the dataset must be treated "as is" (i.e., no further data can be collected), then how can the researcher use the developing theory to guide further data collection? One answer that can occur in large datasets is that the developing theory suggests different ways of sorting and excerpting from the data. In this way, the researcher finds new insights and new concepts through a process that is very similar to theoretical sampling.

An example of this approach appeared in a well-regarded paper by Wyche and Grinter (2009) about religion in the home. Wyche and Grinter conducted interviews in 20 home settings. They ended their data collection when they reached saturation (i.e., no further surprises). This appears to have been the *beginning* of their grounded theory analysis: They describe an enormous dataset of interviews, photographs, and field notes, and make explicit reference to the constant comparative method for deep and iterative coding, in conjunction with reading the research literature. Their analysis is fascinating, and has been cited as an example of excellent and influential research, with implications for theory as well as design.

Paay et al. (2009) conducted a similar post-data-collection grounded theory analysis of hybridized digital-social-material urban environments, which was explicitly guided by theoretical concepts from the research literature. In addition to a very detailed discussion of open and axial coding, they used an affinity-diagramming method from Beyer and Holtzblatt (1998) that is similar in some ways to Clarke's cartographic techniques (2005). Outcomes included a process model for this complex design domain, as well as qualitative critiques of design prototypes.

Using GTM to Signal a Deep and Iterative Coding Approach

The third type of invocation of ground theory is, to me, more problematic. Some researchers make a general reference to grounded theory as a kind of signal that they coded their data carefully. However, they give no details of their coding strategies or outcomes, and it is difficult to find any convincing evidence that they built theory from the data. In some cases, they appear to have begun their study with very specific questions, and then collected data to answer those questions. It might make more sense for these papers to make reference to more general guidance in coding data (e.g., Dey, 1993; Lincoln & Guba, 1995; Miles & Huberman, 1994). As with much of grounded theory work, this point is probably controversial. My purpose in this chapter is not to criticize authors of good work over a difference in nomenclature, so I will not name specific examples of this kind of invocation. However, from the perspective of GTM, a lack of detail about the process makes it impossible to take up the work into the corpus; it is in this sense that this use of "grounded theory" as a description of method is problematic.

Research Quality and Rigor

The preceding section suggests some indicators of quality and rigor in grounded theory research when applied to HCI and CSCW research. However, it is important to note that issues of quality remain unresolved within the broader community of grounded theory researchers, with diverse views from many researchers (Adolph et al., 2008; Corbin & Strauss, 2008; Charmaz, 2006, 2008; Gasson, 2003; Locke, 2001; Matavire & Brown, 2008), dating back, in part, to the earlier split between Glaser and Strauss (Kelle, 2007; Morse et al., 2009).

Glaser and Strauss (1967) proposed some very general qualities for evaluation of grounded theory outcomes, focusing on four terms:

- Fit: How well does the theoretical description describe the data?
- Relevance: Does the description appear to answer important questions? (See Hayes, "Knowing by Doing: Action Research as an Approach to HCI" this volume, for a related perspective).
- Work (ability): Do the components of the theoretical description lead to useful predictions?
- Modifiability: Is the theory presented in a way that will encourage other researchers to use it, test it, and change it over time?

Charmaz (2006) proposed a similar set of criteria: credibility (overlapping with fit), resonance (overlapping with relevance), originality (overlapping with some aspects of relevance and work), and usefulness (overlapping with some aspects of work and modifiability). However, most of this advice remains very general, and it is difficult translate the generalities into criteria for review of grounded theory work.

Gasson (2003) argues that grounded theory research has been difficult to evaluate (or defend) because of the default assumptions about what makes "good" research (e.g., hypothesis-testing, confirmatory/disconfirmatory expectations—see Popper, 1968). In the general context of information systems research, she calls for researchers to move from a positivist stance of "objective" facts, to an interpretivist stance that each researcher reports her/his findings as honestly as possible, for comparison with the interpretations of other researchers. Here is a partial summary of her proposed movement from positivist to interpretivism criteria in evaluating research:

From positivist	To interpretivist
Objectivity	Confirmability (emphasis is placed on informants, not researchers)
Reliability	Dependability/auditability (clear path to conclusions)
Internal validity	Internal consistency (related to GTM concept of saturation—i.e., all the components of the theory work together; there are no more surprises)
External validity	Transferability (generalizability). Cooney (2011) recommends that external "experts" be requested to render judgments of validity, as well

Even these broad criteria may be problematic. For example, Gasson proposes to test via confirmability with informants, as do Cooney (2011) and Hall and Callery (2001); similar proposals have been made for collaborative ethnography (Lassiter, 2005) and action research (Hayes, "Knowing by Doing: Action Research as an Approach to HCI" this volume). However, Elliott and Lazenbatt (2005) argue that grounded theory uniquely *combines* perspectives of many informants (constant comparison of data-with-data), and also *abstracts* a more formalized theoretical description from their combined accounts (constant comparison of data-with-theory—see also Star, 2007). In this way, grounded theory method may produce a theoretical description (i.e., the core concept and its elaboration) that presents perspectives that would be rejected by some of the informants.

Within HCI and CSCW, applying these changes in criteria may take some time, and some further development to meet our own diverse subfields' requirements. During this period, it may be useful to follow the advices of Charmaz (2006), Hall and Callery (2001), and Locke (2001). They recommend making the research process transparent to the reader, so that the reader can make her or his own assessment of the quality of methods followed and their results (Locke, 2001).

For HCI and CSCW, a citation to Glaser and Strauss (1967) provides only a general orientation to the "family of methods" that collectively describe (but do not yet define) grounded theory (Babchuk, 2010; Bryant & Charmaz, 2007; Morse et al., 2009). A more useful citation would provide a later reference, preferably after the split between Glaser and Strauss, and preferably to a methodologist who provides specific guidance—e.g., Charmaz (2006), Corbin and Strauss (2008, or the previous editions of their procedural guide), Clarke (2005), Glaser (1992, 1998), or Locke (2001). It would be useful to know which specific coding practices were used in the analysis, and it may also be useful to see a brief recapitulation of the axial coding, leading to the core concept. It would also be useful to know how the research literature was used—e.g., as a source of candidate axial codes, or as a follow-on after the analysis was largely completed. The works that I cited in the preceding section ("Case Studies") provide this kind of methodological detail, and are strengthened by it.

Conclusion

Charmaz (2006), Gasson (2003), Hall and Callery (2001), and Locke (2001) recommend that grounded theory reports be reflective on their own process, and provide transparency into that process. This advice is, of course, exactly what is needed for GTM to work as a way of knowing. The researcher needs cognitive and methodological tools to be assured of the quality of her/his own knowing, and the reader needs strong visibility into the research methods to be convinced that she/he, too, wants to share in that knowledge.

In this chapter, I have provided an inevitably personal account of grounded theory. My account focused on the virtues of human curiosity, creativity, and surprise as cognitive tools for scientific rigor. I began with Peirce's analysis of abductive inference, and went on to detail some of the rich and powerful methods that grounded theory researchers have developed to turn Peirce's insight into scientific method. People think about what they are learning *while* they are learning, and GTM turns that tendency into a scientific strength through methodological underpinnings of disciplined coding practices, guided by principles of constant comparison and theoretical sampling. The goal is to remain faithful to the data, and to draw conclusions that are firmly grounded in the data. People (not procedures or methods) construct meaning and knowledge, and GTM can help them to do that, and to share their new knowledge credibly with one another.

Exercises

1. What modifications to GTM would need to be made if the researcher has an inkling of what theory might be relevant to their observations?
2. How well does GTM accommodate a team of researchers? Where would they work independently and where collaboratively?

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