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Annual Review of Sociology, Vol. 24. (1998), pp. 477-498.

Stable URL:
http://links.jstor.org/sici?sici=0360-0572%281998%2924%3C477%3AUCTAEF%3E2.0.CO%3B2-T

Annual Review of Sociology is currently published by Annual Reviews.

Annu. Rev. Sociol. 1998. 24:477–98

USING COMPUTERS TO ANALYZE ETHNOGRAPHIC FIELD DATA: Theoretical and Practical Considerations

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KEY WORDS: qualitative methods, ethnography, computer software, data analysis

ABSTRACT

Computer-assisted data analysis is usually associated with the analysis of aggregate data according to the tenets of logical positivism. But there are more than twenty computer programs designed to assist researchers analyzing ethnographic data, and these programs may be used by researchers with a variety of epistemological orientations. Some computer-assisted qualitative data analysis (CAQDA) programs automate analysis procedures that have been used by generations of ethnographers. Others open up new directions through the use of linked coding schemes, hypertext, and case-based hypothesis testing. Ethnographers interested in computer assistance must acquaint themselves with the variety of capabilities and programs available because no one program dominates the CAQDA field. In this article, we provide an overview of the theoretical and practical considerations bearing on the choice of CAQDA software.

0360-0572/98/0815-0477$08.00

INTRODUCTION

Computer-assisted analysis in sociology is currently associated with the profession's constructed category of "quantitative research" rather than its constructed category of "qualitative research."[1] Statistical procedures available in mainstream software packages such as SAS and SPSS facilitate the analysis of aggregate data, and most sociologists using these data have adopted an orientation of logical positivism. Thus, computer-assisted analysis carries connotations of hard data, computation, and objectivity. On the other hand, sociologists associated with qualitative research have generally held that aggregate data analysis using statistical procedures either misses important sociological causes of social action or emphasizes explanation (the hallmark of logical positivism) at the expense of understanding. The general overstatement of the differences between quantitative and qualitative research has meant that qualitative researchers have shown a slowness, if not reluctance, to use computer assistance in data analysis.

Just as it can with aggregate data, computer assistance can facilitate systematic computational research with qualitative data. In addition, CAQDA (computer-assisted qualitative data analysis) technologies can be useful for researchers who place themselves outside the positivistic research tradition. For example, within participant-observation research, there are three epistemological traditions: positivism, symbolic-interactionism, and ethnomethodology. While symbolic-interactionism and ethnomethodology appear antithetical to the use of computer-assisted analysis, a close look at the capabilities of current CAQDA software suggests these packages could be useful for research in these traditions and could become even more useful in the near future.

Software for the analysis of qualitative data has appeared relatively recently, and although qualitative sociologists have been slow to adopt this software, at present there are more than twenty packages available. No one package dominates, however, so the qualitative analyst interested in computer assistance must decide which package to use. The amount and kind of ethnographic data on hand or to be collected, the purpose of the research, the epistemological framework of the researcher, and the goodness of fit between the research project and the capabilities of available software all figure into this decision. In the end, the analyst may decide that no CAQDA software is called for. A review of ethnographies in journals and books published in the last five years suggests that many ethnographers either do not use any CAQDA soft-

[1]The constructed categories of "quantitative" and "qualitative" research have led sociologists to misunderstand the fact that real differences in research method are due to adherence to different epistemologies and not to the use of quantitative or qualitative data. For ease of reading, we drop the use of quotation marks, but the constructed nature of the categories quantitative research and qualitative research should be borne in mind.

ware or consider their use of it so unobtrusive that they fail to mention it at all in their ethnographic reports.[2]

In this article, we discuss the capabilities and limitations of CAQDA in general, the factors that distinguish one CAQDA software package from another, and specific qualities of a number of software packages. We intend this discussion to serve as a theoretical and practical introduction to CAQDA use. In the article's conclusion, we return to the methodological issues broached above to consider if the gap between quantitative and qualitative research might be bridged by current and future CAQDA packages. We do not endorse any particular analytical strategy nor do we recommend or review any particular software package in this article.[3]

QUALITATIVE DATA ANALYSIS AND THE PERSONAL COMPUTER

From QDA to CAQDA

Ethnographers have been using computers for decades. Interviews and fieldnotes have been transcribed into word processors (Kirk 1981), and many ethnographers now carry portable lap-top computers into the field. The use of computers for the analysis (rather than the gathering) of ethnographic data is a more recent development.

Many CAQDA software packages facilitate data analysis from the grounded-theory perspective codified by Glaser & Strauss (Lonkila 1995). Grounded theorists advocate close contact with raw data, the emergence of analytical categories from the data through memo writing, and comparison as the primary analytical tool (Glaser & Strauss 1967). Elements of grounded theory are common in CAQDA in part because Glaser & Strauss are explicit about the principles and procedures involved in this kind of analysis (see especially Strauss 1987).

Several general approaches to qualitative data analysis (QDA) incorporate elements of grounded theory or are consistent with that perspective. For example, while Pfaffenberger does not explicitly embrace the grounded-theory method of analysis, his three fundamentals for the analysis of qualitative data

[2]With few exceptions, ethnographic works published in *Qualitative Sociology, Journal of Contemporary Ethnography,* and *Symbolic Interaction* as well as in the *American Sociological Review,* the *American Journal of Sociology, Social Forces,* and *Social Problems* make no mention of the use of CAQDA. Book-length ethnographies in our areas of expertise (gangs, poverty, urban and community studies) reviewed in the journals listed above (as well as in *Contemporary Sociology*), and those discussed in three recent overviews of qualitative research (Charmaz & Olesen 1997, Horowitz 1997, Morrill & Fine 1997) also rarely mention CAQDA.

[3]By way of full disclosure, Sánchez-Jankowski is now using the askSam package, and Dohan is using the Folio Views package.

(rewriting, coding, and comparison) are consistent with grounded-theory methods (Pfaffenberger 1988:26–30). Huberman & Miles propose a three-part conceptualization of the analysis process: data reduction, data display, and conclusion drawing/verification. As in grounded-theory approaches, data reduction, display, and conclusion drawing are causally and temporally intertwined (Huberman & Miles 1994:429). Huberman & Miles expand these abstract procedures into a concrete set of thirteen "tactics" for undertaking qualitative analysis (Huberman & Miles 1994:432). These range from noting patterns and themes, clustering, and counting to making contrasts and comparisons, shuttling between data and categories, building a logical chain of evidence, and making conceptual/theoretical coherence. Tesch distills ten "principles and practices" in the analysis of many types of qualitative data. While the principles (data analysis is concurrent with collection, analysis is not rigid, and the result of analysis is a higher-level synthesis) outnumber the practices (data are segmented, data are categorized, the main intellectual tool is comparison), Tesch's approach follows the general thrust of grounded-theory analysis (Tesch 1990:95–97).

QDA that is consistent with grounded theory uses a sequential style of analysis that is highly data-intensive. Advocates of these methods urge the analyst to begin data analysis while collection is under way, to reduce the data using codes or categories, to shuttle between data and codes, and to compare coded and raw data to make tentative and ultimate conclusions. This analytical strategy returns the analyst to the database over and over again, and each step of analysis is readily translated into computer modules and procedures. Because grounded-theory and similar analytical strategies are consistent with logical positivism, they present practical challenges to computer programs but few epistemological challenges.

Researchers relying on context-dependent methods of analysis such as the extended-case method (Burawoy 1998, Burawoy et al 1991), symbolic-interactionism (Blumer 1969:Ch. 1), and ethnomethodology (Garfinkel 1967) may also find software designed around the grounded-theory principles helpful. But they are less likely to be able to take advantage of all the built-in features of these packages. The analytical principles of these context-dependent methods are more difficult to codify than those of grounded theory. So, while grounded theorists may find themselves able to take advantage of a wide variety of computer resources as they move from QDA to CAQDA, ethnographers working in other traditions may find that computer assistance limits their analyses unless they limit the extent to which they make use of computers.

First Steps and Basic Capabilities of CAQDA

Fortunately for ethnographers working outside of the grounded-theory tradition, computer assistance is not an all-or-nothing affair. Some features of con-

temporary CAQDA may be used and others may be ignored. We organize our discussion of the practicalities of CAQDA analysis around seven tasks performed by the user of CAQDA software (Weitzman & Miles 1995:Ch. 3). Analysts, whether positivists or not, may find some of the tasks required by CAQDA to be theoretically or practically onerous. But different software packages require different tasks, so analysts can pick and choose software that facilitates the tasks they are interested in without requiring those they find objectionable.

ENTERING DATA Seemingly mundane decisions made early in the ethnographic project may have significant practical, methodological, and theoretical consequences. How to enter data into the computer is a seemingly mundane decision with enormous consequences. Which data are entered into the computer, how they are entered, and which remain outside the computer shape all further analyses of the data. Fischer notes that data can enter a computer in a myriad of forms, from the "beginning" methods of text processing on a word processor to "advanced" methods of digital signal processing of videotape (Fischer 1994:15–21). For the moment, we confine ourselves to issues related to the entry of text; we address audio, visual, and graphic forms of data in later sections of this article. A primary consideration for researchers entering text data into the personal computer is the size of the textual unit of analysis. Notes entered into a dedicated CAQDA package are divided into analysis "chunks"—which can be single words, lines of text, paragraphs, hypertext note cards, or larger files. Especially important is the size of chunks—the indivisible units that are de-contextualized and re-contextualized during the analysis process (Tesch 1991b). For example, larger chunks of text are more likely to contain data falling into several analytical categories, and this may complicate positive correlational analysis. But for analysts interested in context-dependence, smaller chunks may prove worthless unless the CAQDA software contains elaborate coding or linking procedures.

Practical issues also arise at the data-entry stage. Should the qualitative database include expanded and annotated fieldnotes, interview transcripts, and memos? Memos can be electronically linked to existing data via hypertext connections or in situ "pop-up" notes. What are the advantages of integrating memos into the qualitative database? Are the advantages of an all-inclusive database worth the costs of greater storage overhead and slower processing times? Removing memos from the CAQDA software environment may hamper the goal of comprehensive analyses of ethnographic data, but it may bolster a sociological imagination that extends beyond the parameters of a particular software package.

ORGANIZING DATA Cases and variables organize quantitative datasets. The organization of ethnographic data varies depending on the research project at

hand. The number of ethnographers involved in the project, the number of field sites, the variety of data types, and the theoretical orientation of the researchers all influence how the ethnographic dataset is organized. Researchers should at least familiarize themselves with basic database-management principles (Tesch 1990:199–210; Winer & Carrière 1991) to be sure that early decisions about the structure of the qualitative database do not create insurmountable data-management problems later in the project.

SEARCHING FOR AND RETRIEVING DATA Computers increase the ethnographer's ability to search for and retrieve text. For some ethnographers, search and retrieval represents the end of the computer's usefulness as a qualitative data analyst assistant, and several CAQDA packages are designed for this kind of analysis. At the least, searching for and retrieving data involves the ability to find and display a string of text characters that has been entered into the database (Tesch 1990:181–94). CAQDA software usually allows ethnographers to search for root forms of words or synonyms, to use wildcard characters, and to mount combination searches such as those based on word proximity or word order. Boolean-defined searches for multiple items round out the menu for searches. Retrieval of searched-for items is governed, again, by the size of text chunks and the flexibility of the package in retrieving consecutive or proximate chunks.

CODING DATA Coding, also referred to as indexing (Richards & Richards 1991a, 1994:457) or content analysis (Berg 1995:Ch. 9), is a central feature of much CAQDA. The use of the computer need not affect the fundamentals of data coding. Weaver & Atkinson coded their illustrative fieldnote material manually before entering the data into their CAQDA package (1994:52–53). Most discussions of computer-assisted coding reinforce what Weaver & Atkinson learned through practical experience: The hard work in coding data is intellectual, not mechanical. Computer assistance does not relieve the ethnographer of the need to spend many hours devising, revising, and applying an indexing system that is reliable and valid (a general approach is Werner & Schoepfle 1987). Moreover, computer assistance can impose limitations or restrictions on the coding process that can create problems for ethnographers (Weaver & Atkinson 1994:38–42). Coding should be driven by the theoretical orientations that inspired the original research. Analysts must be confident that using the computer facilitates their work. They must remain alert to the possibility that coding data with a well-designed computer program can become an end unto itself; highlighting sections of text with combinations of on-screen colors or sorting and re-sorting half-coded notes can easily create the comforting appearance of progress.

ANALYZING CODES Analysis of codes begins as soon as the first data are coded. Codes are defined in relationship to each other, so their application to a

set of data implies theory. CAQDA software can make this implicit theory explicit by generating a list or map of codes and their relationships. Some packages constrain the development of a coding scheme to encourage the analyst to make positive connections between codes, such as hierarchical connections between more and less inclusive ones (Richards & Richards 1995) or sequential connections between coded events (Carsaro & Heise 1990). Analyzing codes is thus simultaneous with the coding process.

Once sufficient data have been coded, other analytical possibilities develop. In most CAQDA packages, analysts search for codes as easily as they explore raw data. Boolean capabilities are useful here, particularly for analysts interested in computation, because they allow the ethnographer to count instances of codes or conjunctions of codes. Alternatively, packages that retrieve text associated with particular codes or conjunctions of code may be useful for analysts interested in interpretational analysis.

Aside from data entry, the analysis of codes is the area of the computer's greatest influence on theory and methods. Software design may force the analyst to consider the previously unexamined relationship between concepts in the research project. The flip side of the coin is that software may limit the ability of the analyst to develop theory in desired directions. The ability to mount comprehensive searches for codes and sets of codes means that ethnographic analysis may benefit from less bias. But large-scale searches can also bury the analyst in chaotic results. In short, the computer-assisted analysis of codes has theoretical and methodological implications surpassed only by those taken during the first steps of data entry.

LINKING DATA The most recent development in the analysis of qualitative data requires computer assistance (Coffey & Atkinson 1996:181–87). Software available in the last decade allows analysts to create hypertext links between combinations of data, codes, memos, and research reports. Graphics, sound, and video may also be incorporated into "hyperspace" databases; (Weaver & Atkinson 1994:Ch. 5). Analysis based on data linking may prove a boon for ethnographers who collect non-textual data, especially if hypertext moves out of the researcher's office and becomes a medium for the distribution of research reports. Even for ethnographers who rely exclusively on text, the metaphor and activity of creating links in the ethnographic database have potential for generating innovative results. For researchers working outside of the positivistic tradition, linking data may be particularly valuable. Hyperlinks concretize nonlinear data-analysis techniques and free the researcher from reliance on computation. Reports that incorporate graphics, sound, and video can more readily make the case for the significance of context.

But hypertext technology also imposes special limitations on analysts. At present, the incorporation of text into hypertext "spaces" is inevitably fraught

with more burdensome formatting limitations than those imposed by traditional text databases. Integrating sound or video into an ethnographic database involves technological expertise beyond the use of the word processor. In addition, the publication of materials using sound or video technology may introduce new ethical considerations, such as the protection of research subjects' confidentiality.

ANALYZING LINKS Analyzing links within the database is a more general form of analyzing codes. As in the analysis of codes, links may be analyzed only after a certain number have been established in the data. Once established, the links may be abstracted from the original data and analyzed as a system or network of their own. Compared to the analysis of codes, the analysis of links is more flexible and general. Greater complexity is possible in hypertext links than in coding schemes, so the representation of linked data may consequently be more complicated. At the same time, the ability to grasp at a glance a properly abstracted set of links allows analysts to bring "right brain" analysis to ethnographic analysis even when coding and linking have produced a complex data structure (Agar 1991). Similar to linking technologies, the computer's ability to analyze links may be especially appreciated by those working in symbolic-interactionist, ethnomethodological, and other nonpositivist traditions. The challenges and drawbacks of linking data, codes, and memos apply equally to their analysis.

Summary

Computer-assisted qualitative data analysis does not differ fundamentally, for the most part, from the nonmechanical qualitative analysis traditions from which it has developed. Most computers ease the labor burden and broaden the scope of common analysis tasks such as typing up field data and memos, searching for text, coding data, and sorting and comparing codes. Hypermedia is an unique contribution of computer technology to the analysis of qualitative data. Linking text, analysis, and non-text materials (graphics, sound, and video) in a single analytical space outside of the mind's eye is not possible manually.

Computer assistance is not free—theoretically or methodologically. The design of most CAQDA software after the metaphors and practices of grounded-theory analysis means that ethnographers who are working outside of that tradition may have to coax a recalcitrant software package into aiding their preferred style of analysis. Naturally, the less assistance the ethnographer requires from the computer, the less intrusive the grounded-theory perspective is likely to be. The computer also makes demands on the form of ethnographic data collected. At present, the computer still favors word-processed text over other forms of data such as sketches, maps, photographs, video images, or re-

corded sound. But as computers increase in power, analysts can look forward to gaining greater digital control over non-text data. The experience of flipping through pages of fieldnotes—sketches, diagrams and coffee stains—will never be replicated on the computer monitor. But if knotty problems such as protecting the identity of research subjects can be overcome, computers may soon provide a compelling auditory and visual alternative to this tactile experience.

CAQDA SOFTWARE

Computers can be programmed to accomplish four different kinds of analysis: numerical/arithmetic analysis, writing and document processing, data organization, and symbolic manipulation (Fielding & Lee 1991:2–3). Ethnographers use computers for all these kinds of analysis. Our overview of contemporary CAQDA software is organized around major distinctions in how data are organized and how symbols are manipulated by different packages. This overview is not meant as a thorough guide for the prospective purchaser of CAQDA software. That reader should read reviews of programs (Prein et al 1995; Tesch 1990; Tesch 1991a, especially volume 2; Weitzman & Miles 1995), consult published discussions of researchers' experiences with CAQDA software (cited passim below), and try out different software with his or her own data. In preparing this overview, we have drawn especially on *Computer Programs for Qualitative Data Analysis* (Weitzman & Miles 1995), which contained the most thorough and up-to-date reviews available at press time.

Document Processing: Searching and Retrieving

Word processing is the bread and butter of computer assistance for the ethnographer. The only computer assistance many ethnographers require is searching with a word processor. Basic searches retrieve a text string from a single computer file. More advanced searches count the occurrences of a string, and stand-alone search engines can search multiple files and produce extracts of search "hits" in context. The General Inquirer, the first CAQDA package, produced lists of word counts from a selected file as a preface to content analysis (Stone et al 1966). This ability is no longer considered the province of CAQDA packages, and for many ethnographers, text searching within a word-processing file is sufficient (Stanley & Temple 1995). Specialized programs developed for both CAQDA and commercial uses enhance the search and retrieval process. Many of these programs are designed for what Tesch called descriptive-interpretive work rather than theory building (Tesch 1990, 1991a). For searching and retrieving, packages including GOFER, Metamorph, Orbis, Sonar Professional, The Text Collector, WordCruncher, ZyIN-

DEX, and FYI3000PLUS expand on the capacities of word processors in several ways (for FYI3000PLUS, see Weaver & Atkinson 1994).

First, these packages create and manage the ethnographic database. Some of these packages manage files off-line (data remain in separate, unaltered text files); others manipulate the data directly. Usually, document processors work on documents that have already been produced in a word-processing package. Orbis manages files produced in XyWrite or NotaBene; MetaMorph and WordCruncher are particularly adept with WordPerfect documents. Others read files produced by a variety of word-processing, database, spreadsheet, and even drawing programs. Nearly all can manage plain text files, and some packages require files to be in this format before they can work with them.

The second value-added feature of document processors is their search features. As part of their management of the qualitative dataset, document processors allow the analyst to specify a variety of computer files in which to conduct a single search. ZyIndex, for example, searches documents that remain in their native format off-line, allows the analyst to keep track of changes to documents through several revisions, and indexes files so they can be readily included or excluded from particular searches. Document processors can mount complex searches: combinations or sequences of text strings; strings within specified proximity of each other; word synonyms, stems, and roots; and searches defined through Boolean, fuzzy, or set logic. Some display the results of searches interactively so that analysts can see how the addition or deletion of certain search terms in a complex search affects the number of hits produced.

Document processors are designed to make it easy for ethnographers to investigate data they have collected. Compared to word processors, document processors do a better job of placing the complete ethnographic dataset in the hands of the analyst. They allow the ethnographer to search more easily for desired pieces of text and to investigate how the text is arranged in the dataset. But document processors place some limitations on the format of data, especially on the use of non-text data such as drawings, figures, or other freehand notes. Although searching and retrieving text from an ethnographic database is a relatively non-invasive way of using CAQDA software, ethnographers must not be lulled into a false sense of security. CAQDA software betters the odds of finding significant material in the ethnographic database, but it does not assure it.

Data Organization

Searching and retrieving allows the analyst to inspect but not alter the ethnographic database. However, CAQDA packages such as askSam, Folio Views, MAX, Tabletop, HyperQual2, Kwalitan, Martin, QUALPRO, and The Ethnograph allow the analyst to alter the form of the ethnographic database by or-

ganizing its text.[4] Data organization is one of the dominant forms of contemporary CAQDA, and the packages listed here include some widely discussed in the literature (see Armstrong 1995; Mangabeira 1995; Smith & Hesse-Biber 1996; Sprokkereef et al 1995; Weaver & Atkinson 1994, 1995).

Organizers expand on document processors in two ways. First, organizers allow the ethnographer to attach a structure to the ethnographic database. Some document processors can retrieve text chunks in context. Organizers create context by giving analysts control over the structure of the ethnographic database, and this structure can be manipulated and analyzed by the researcher. Organizers can also structure the ethnographic database by adding database fields for factual information and for memos that are produced during analysis. The second addition of organizers is the ability to code ethnographic data according to a theoretical scheme developed by the analyst. Organizers are designed to tag chunks of text with analytical codes and to retrieve codes and tagged text. Retrieval of codes frequently includes the ability to search for multiple codes, to retrieve the text associated with codes, or to count codes.

ORGANIZING AND ANNOTATING Organizing and annotating are two basic tasks of qualitative data analysis. Some computer applications are designed to translate these activities with fidelity from hard copy to electronic form. For example, HyperQual2 and Martin use note cards as an organizing metaphor. Like their hard-copy counterpart, the note cards of these CAQDA packages each contain a single chunk of text. Electronic cards can be replicated and sorted into stacks, and these stacks then provide the raw materials to write up memos, annotations, and the ethnographic report. Another way to organize a hard-copy database is to use database-like fields. Fields can contain a variety of information including factual information that situates the ethnographic text to which it is attached (data collector, date of interview or observation, information about the subject of the note) or analytical information about the text itself. CAQDA software such as askSam facilitates the creation, insertion, and organization of these fields. Once organized, these CAQDA programs can quickly search and retrieve information from database fields and quickly count and tabulate the results of these searches.

Note cards, memos, and database fields are easily grasped metaphors for organizing data; they have been used by generations of ethnographers. Other CAQDA software draws on metaphors without long pedigrees in the ethnographic community. Some of these packages, such as MAX and Tabletop, move the qualitative researcher closer to a quantitative research style. MAX

[4]Most CAQDA packages have capabilities that defy easy categorization according to the kind of analysis they perform. Among document processors, Sonar Professional, ZyINDEX, GOFER, and FYI3000PLUS also include significant data-organizing features. Similarly, askSam, Folio Views, MAX, and Kwalitan are able to search for and retrieve text from the ethnographic database.

allows ethnographers who have also collected quantitative data to integrate both text and numbers into a single analytical space. Tabletop displays relationships between previously identified features of the ethnographic database in graphs such as Venn diagrams and scatter plots. Finally, packages such as Folio Views provide a menu of organizational tools that includes outline levels, database fields, and "pop-up" notes. It is up to the analyst to determine which tools facilitate appropriate organization of the ethnographic database and how they should be applied.

CAQDA packages that accommodate organizing and annotating the ethnographic database are useful in a variety of situations, but they are particularly useful in research projects as they expand in size and scope. Multisite or multiyear ethnographic projects generate a plethora of notes that beg for efficient organization. Flexible annotations are particularly valuable in multiresearcher projects in that each researcher provides her or his own analysis and commentary.

CODING, RETRIEVING, AND COUNTING Coding and retrieving is one of the central tasks of CAQDA software packages. Many of the software packages discussed above can code textual data, retrieve text based on applied codes, and tabulate which codes have been applied to which text. Most packages discussed in this section and below use coding and retrieving as their primary method of analysis or as a preface to other kinds of analysis. There are many ways to apply codes to text. Software such as Kwalitan, QUALPRO, or The Ethnograph number each line in the ethnographic database and apply codes to specific lines. Some packages encourage coding on the computer screen, whereas others encourage the analyst to code a numbered print-out of the text for later entry. Multiple codes can be applied to one line or chunk of text, but some packages place limits on the number of codes that can be applied (Coffey & Atkinson 1996). No CAQDA package eases the intellectual labor involved in coding, but code-and-retrieve software eases the administrative labor of applying and altering a coding scheme. This is especially so for software packages that take advantage of the graphical user interface of the Macintosh or Windows operating systems; in these, the analyst uses a mouse to highlight a text passage on the computer screen and then selects the code that applies to that section.

Once codes are applied to the ethnographic database, CAQDA software greatly accelerates analysis based on retrieving codes. Code-and-retrievers find codes using the same powerful features that document processors applied to the raw database. Multiple codes may be searched for at once. Hierarchies of codes can be established so that searches for higher-order terms also retrieve instances of lower-order terms. Complex searches can be formulated using Boolean, sequential, and proximity logic. Retrieval may yield a display of text associated with a code or a union of codes, or it may yield counts where those

codes were applied. A number of CAQDA packages support cross-tabular displays of counts.

Organizing with CAQDA alters the ethnographic database in two ways. First, the database can be organized using database fields, hierarchical levels, or annotations so that the analyst has an easier time placing data in context and moving about in large ethnographic databases. Second, the database can be organized by applying codes to the text of the database so that the analyst can retrieve information from the database based on a theoretical mark-up of the text. CAQDA software facilitates the administration of both of these activities, but it does little to guide the intellectual work involved.

Symbolic Manipulation

A fine line separates CAQDA packages that organize data from those that manipulate symbols. Symbolic manipulation software helps the analyst develop or test theories about relationships in the ethnographic database. Like data organizers, symbol manipulators are a popular form of CAQDA, and software packages such as NUD.IST, AQUAD, ATLAS/ti, Inspiration, MECA, MetaDesign, SemNet, HyperRESEARCH, and QCA are widely discussed in published literature (Hesse-Biber et al 1991, Huber & García 1991, Muhr 1991, Ragin 1987, Richards 1995, Richards & Richards 1991b).

There are three kinds of CAQDA software for symbol manipulation. Some symbol manipulators begin where code-and-retrievers leave off. These packages focus analysts' attention on the coding process, encouraging them to create positive links between codes and to develop theory as they create a coding scheme. A second form of symbol manipulation is done by theory-building software. These packages take material that has been abstracted from the ethnographic database through coding or other means and analyze relationships between codes or concepts. The final kind of CAQDA software that facilitates symbolic manipulation is hypothesis testers. These packages facilitate the advancement and testing of causal statements about relationships between codes or concepts in multiple cases in the ethnographic database.

VALUE-ADDED CODERS The coding process already contains the seeds of symbol manipulation. Value-added coders add additional coding and analysis features to allow the analyst to move closer to the manipulation of concepts—usually by moving further from the ethnographic text. Software packages such as AQUAD allow the analyst to search purposefully through the ethnographic database for combinations of codes. The analyst can look for theoretically significant combinations of codes, tabulate the number of instances, and compare them to counts for combinations of codes that represent competing theories. Value-added coders consider the ethnographic database on a case-by-case basis so the counts and cross-tabulations they produce are a case-

based numerical summary in contrast to the variable-based summaries provided by quantitative analysis.

A second way of transforming coding into symbol manipulation is to involve the computer in the construction of the coding scheme. NUD.IST and other packages force analysts to develop hierarchical relationships between codes as they apply them to the ethnographic database (Richards & Richards 1995). The construction of hierarchical categories theoretically concretizes the codes used and makes the logic of the coding scheme explicit as it is developed and applied. Hierarchical coding schemes are particularly useful for grounded-theory analysis, where new codes and elaboration of existing codes occur continuously as the analyst works with the ethnographic database.

Other value-added coders involve the computer in the coding process without imposing hierarchical constraints on the coding scheme. In ATLAS/ti, for example, the coding scheme is not constrained by the software but is retained to manipulate and analyze on its own. Text, codes, and memos can be linked in the program and these links later inspected and manipulated in conjunction with the original ethnographic text. Maps of relationships between elements in the database provide an analytical metaphor distinct from quantitative summary statistics or cross-tabulations.

THEORY BUILDERS Compared to value-added coders, theory-building CAQDA software moves the analyst a step further from the ethnographic text. Software packages such as ETHNO, Inspiration, MECA, and MetaDesign are designed to facilitate the conceptual manipulation of ethnographic data. Theory-building CAQDA software packages do not actually construct theory, of course. They construct a graphical map (node and links) of ethnographic data. Nodes represent data (fieldnotes, memos, codes, etc), and links represent relationships between data. Maps may help the analyst picture the project's theoretical shape, the concepts in use, the relationship between those concepts, and the ethnographic data that have been collected regarding each of those concepts and links. Theory-building software facilitates experiments with different concepts and links within the research project.

But theory-building CAQDA packages need not be reserved for the armchair ethnographer idly speculating on abstract relationships in field data. Theory builders can also incorporate links to the original ethnographic text that encourage grounding in the original data and checks on concept validity. In addition, theory builders need not be reserved for analyses of a nearly finished research project (nor need they be the exclusive province of the principal investigator). Theory builders can aid ethnographers who are mapping complex empirical concepts or events during the course of fieldwork.

HYPOTHESIS TESTING Some value-added coders such as HyperRESEARCH and AQUAD as well as stand-alone packages such as QCA use hypothesis

testing, the third form of symbol manipulation. Hypothesis-testing software bridges the gap between qualitative and quantitative analysis by facilitating case-based analysis of qualitative data. These packages allow the analyst to specify hypotheses based on codes applied to text (in HyperRESEARCH and AQUAD) or based on a descriptive matrix of cases (in QCA). Hypothesis testers determine how causally antecedent features of cases are related to outcomes. Boolean algebra is used to define the antecedent conditions for each case in the database. CAQDA software reduces large numbers of cases into statements that identify under what conditions the outcome of interest prevails.

Qualitative hypothesis testing determines what qualities of cases are crucial for a specified outcome. In contrast, quantitative hypothesis testing focuses on the contribution of different variables to the outcome. Aside from this difference, CAQDA packages that include hypothesis-testing features are similar to statistics software that dominates computer-assisted analysis of quantitative data. Hypothesis testers encourage the analyst to develop ideas in the form of equations (Boolean rather than arithmetic) and to investigate how different terms (binary codes rather than multivalue variables) in the equation affect its ability to accurately explain outcomes.

Stand-alone hypothesis testers remove the analyst from the original ethnographic database. These software packages are useful in the analysis of data from a variety of sources and not only from ethnographic field studies. Hypothesis testers that include search-and-retrievers or data organizers may encourage the analyst to remain in contact with the ethnographic database even as analysis proceeds along more abstract and quasi-quantitative avenues. Ideally, hypothesis-testing software allows the analyst to ensure reliability through hypothesis checking and to maintain validity by returning frequently to re-examine the original ethnographic database and the codes, memos, and annotations that have accumulated over the course of the research project.

Symbol manipulation includes a variety of techniques for analyzing ethnographic data in ways that take advantage of microcomputers. Value-added coders encourage the analyst to develop explicit links between codes and data as the analysis proceeds. The software keeps track of the relationships between codes as they develop and then makes them available for later re-inspection and analysis. Theory builders facilitate exploration of concepts in ethnographic research projects through graphical displays and the ability to quickly move between different levels of detail. Finally, hypothesis testers move CAQDA closer to the practices of quantitative research by embracing the goals of reliability and explanation. Hypothesis-testing packages may even allow analysts to strive for reliability and causal explanation without losing the traditional advantages of qualitative data with respect to validity.

FUTURE DIRECTIONS AND RELEVANCE OF CAQDA

The current state of computer-assisted data analysis among qualitative researchers resembles the proverbial water glass that may be either half full or half empty. The large number of CAQDA software programs available suggests that we are in a preliminary stage of computer entry into the qualitative field. With time, the computer will do for qualitative data analysis what it has done in the quantitative realm: reduce labor, regularize procedures for data gathering and analysis, and establish conventions for the reporting of results. Moreover, the diversity of program options will allow these advances to occur along parallel methodological lines so that regularizing data-handling procedures will not require homogeneous epistemological stances. On the other hand, the still infrequent mention of CAQDA in ethnographic writing means that the expansion of software choices has not yet influenced the course of ethnographic research. CAQDA may be a significant advance for positivist ethnographers, but its potential for regularizing analysis in the qualitative field has not been reached. Of course, inertia among researchers and peer reviewers may account for some of the gap between expanding software choices and the dearth of CAQDA mention in published research (Lee & Fielding 1991:9). But there are fundamental issues about qualitative data analysis that inform the half-full and half-empty perspectives on CAQDA.

Lack of the "Killer App"

CAQDA software has proliferated in the last decade and a half, but no "killer app" has emerged from among the ranks of CAQDA software (Blank 1991). A killer app is a computer application that makes the use of the computer irresistibly compelling by doing tasks unmanageable without computer assistance, in the fashion that spreadsheet programs VisiCalc and Lotus 1-2-3 motivated United States businesses to place personal computers on employees' desks. Most CAQDA software diminishes the amount of labor needed to organize and code ethnographic data but does not fundamentally change the process of ethnographic analysis. In fact, ethnographers considering computer use must scale several learning curves (which programs are available, what are the basics of seemingly appropriate ones, what is the actual operation of the selected one) and then shape their data and analysis to the requirements of the chosen software package. Lacking an irresistibly compelling reason to adopt CAQDA, ethnographers may forgo computer assistance simply because the costs outweigh the benefits.

The computer offers three ways of facilitating qualitative analysis that may lead to, but are no guarantee of, the enthronement of a CAQDA killer app. First, CAQDA packages reduce the administrative burdens of ethnographic analysis. Administrative assistance is a strong reason to climb learning curves

in some research projects, such as those that use grounded-theory methods or those large projects that involve multiple sites or multiple researchers. But given the diversity of techniques for ethnographic analysis, administrative reduction is compellingly attractive to only a fraction of qualitative researchers. Second, many CAQDA programs allow the user to analyze ethnographic materials that are difficult to access without the computer. These packages integrate text, graphics, sound, and video; they encourage analysis based on the creation of links between distinct pieces of the ethnographic database; and they open up new possibilities for the presentation of ethnographic research. However, not only do many ethnographers work exclusively with text, but also text and graphics are the dominant form of the ethnographic report. Multimedia capability alone does not create a killer app. Third, some of the features of symbol-manipulation software are not easily replicated without a computer. Potentially, these packages contain the seeds of a killer app.

Any CAQDA software that aspires to the title of killer app must accomplish two tasks. Like symbol-manipulation software, it must offer analysts the ability to perform analyses that are unmanageable without a computer. To be compelling, the CAQDA software package will have to constitute its own best marketing device. In addition, the methodological and epistemological diversity of ethnographic data analysis means that CAQDA software will have to offer different analytical facilities to different analysts. The challenge of the CAQDA killer app is to facilitate the analytical strategies of positivists and non-positivists with diverse analytical goals without disproportionately imposing barriers to entry on any one group. At present, popular software packages meet the challenges of one group or another, but no killer app appears to be on the horizon.

The Crisis of Representation and CAQDA

Part of the reason that no CAQDA package is poised to become a killer app is that contemporary methodological discussions in ethnography are not related to the integration of computers into qualitative data analysis—a fact our survey of recently published ethnographic work makes clear (see footnote 1). References, implicit and explicit, to the double crisis of representation and legitimation, what Denzin & Lincoln have termed the fifth "moment" of qualitative research, appear frequently in published ethnographies, and the crisis is of great concern to methodologists (Denzin & Lincoln 1994b, 1995; Snow & Morrill 1995a, but see also Snow & Morrill 1995b).[5]

In this climate of ferment, the rules for analysis are open to question, and one of the CAQDA paradigms may emerge to organize future qualitative work. Users and developers of hypertext software are particularly excited and

[5]We hope not to open the Pandora's box of ethnography's decades-long crisis of representation. Consult Denzin & Lincoln 1994a for a variety of perspectives on this question.

optimistic about this prospect. Hypertext not only makes the case for CAQDA as a killer app but also addresses the limitations of previous conceptions of computer use. Hypertext analysis is less rigid, more susceptible to interpretation, and most importantly, not lineally descended from the numerical processing paradigm used by quantitative researchers.

But the crisis in legitimation is a particularly hostile atmosphere for computer-assisted methods that are often associated with a positivistic approach to data analysis. Qualitative researchers have already expressed concerns about the use of CAQDA in practice. One fear is that the computer will "take over" qualitative data analysis—turning against the ethnographer like Frankenstein's monster. Theoretically, this fear is calmed by the reminder that the real work of qualitative data analysis lies not in the mechanics of searching for text, applying codes to data, or testing hypotheses using those codes. Rather, the work lies in the annotation and rewriting of notes, in the conceptualization and development of a coding scheme, and in the art of proposing reasonable hypotheses (Hesse-Biber 1995). Practically, researchers report that the use of CAQDA software encourages the exact opposite of the Frankenstein scenario. Outside the computer—in piles and files of note cards, transcripts, and memos or in boxes of audiotape—the data overwhelm the ethnographer. The computer allows the ethnographer to manage the overwhelming amount of data. This encourages the ethnographer to approach the data and become comfortable "playing" with it and learning it (Smith & Hesse-Biber 1996). In short, rather than distancing the ethnographer from the data, the use of the computer reduces the distance between analyst and data by making the latter less overwhelming and more approachable. The computer can facilitate the analyst's movement away from the data, but it does not cause this movement.

There remains, of course, the issue of what the ethnographic enterprise is. When it is based solely on "understanding," as it is for the traditions of ethnomethodology and symbolic interaction, computer assistance cannot make up for the shortcomings in the researcher's basic talent to interpret. However, for ethnomethodologists interested in analyzing indexical language patterns, for example, CAQDA software has the potential to be quite helpful (see, for instance, Schegloff 1996). In the case of anthropology, there remains the question of whether it is necessary for the ethnographer to penetrate the psychological world of the native or simply to interpret it through what Geertz identifies as a series of symbolic forms—words, images, institutions, and behaviors (Geertz 1983: 58). CAQDA can help the researcher identify social patterns, but it cannot substitute for the insight of the researcher. For example, Geertz found in his study of Moroccan society that the linguistic concept of "nisba" was important in separating people from each other and determining what it meant to be a person. Using suffixes, the people he studied were able to identify who belonged to what tribe, city, family, etc. Although Geertz found this pattern without the use

of CAQDA, computer assistance would have increased the probability that a less insightful analyst would have seen this concept recur in a variety of contexts and grasped its significance. CAQDA can compensate for the limitations of the fieldworker by highlighting significant patterns recorded in the notes, even if the researcher did not recognize the pattern at the time the notes were recorded.

Systemization of Ethnographic Methods

For ethnographers not torn by the twin crises of representation and legitimation, the advent of CAQDA opens a couple of possibilities. First, the use of CAQDA software makes explicit the methods of analysis used in converting ethnographic data into ethnographic reports. The explicit discussion of methods of analysis in the grounded-theory school midwifed the development of much CAQDA software. Computer-assisted analysis goes beyond discussion, however, by allowing ethnographers to share details of their analysis process. Even when ethical concerns prevent the sharing of raw data, the use of CAQDA may increase reliability by making explicit the concrete steps taken in moving from data to conclusion.

Second, the use of computers fosters increased reliability and generalizability by expanding the amount of data that can be managed and exhaustively analyzed within a single ethnographic project. Data expand rapidly in ethnographies involving multiple sites or multiple researchers. In large-scale sociological and anthropological studies, the senior researcher becomes the analytical specialist (examples undertaken without CAQDA include Lewis 1963, Moore & Garcia 1978, Rainwater 1970, Sullivan 1989, Warner 1963). All members of the research team funnel data to the leader, who guides the analysis and writes research reports. Computer assistance makes it possible for researchers to collaborate more easily as data management devolves to the database system.

Combined, explicit systems of analysis and increased ability to generalize reliably suggest the development of a new way of organizing data, asking research questions, and systematically developing answers in ethnographic research. CAQDA software may allow ethnographers to access large ethnographic databases directly—without the theoretical intermediary of a single intellectual vision or research goal. The computer can accommodate data collected by multiple fieldworkers and facilitate coding, re-coding, linking, and re-linking by multiple investigators. Within this analytical space, differing understandings of the same database can be produced and compared, and analysts can examine the procedures undertaken to produce each account.

CONCLUSION

To date, all that many ethnographers have had to rely on was their memory of the data they collected and the meaning of those data in the context of their

study. However, the workings of memory create two potential problems for researchers analyzing ethnographic field data. First, researchers may use those data that were most dramatic in the fieldwork and erroneously present them as being the most significant; second, they may use more data from the later stages of fieldwork and less of what happened in the middle or beginning because the later data are fresher and clearer in their minds. CAQDA can help the careful analyst avoid both of these problems, but it is no panacea. Researchers who use CAQDA still face issues related to representation. Data quality is directly tied to the ability of the researcher to observe significant phenomena in the course of fieldwork and to recognize what he or she has seen. While CAQDA can compensate for small failures of detailed observation or sharp insight, it is no substitute for either.

The use of CAQDA could stimulate team approaches in ethnographic research that would generate a wealth of data and make important analytic contributions (see the examples cited above), but CAQDA does not eliminate the validity problems inherent to team ethnography. Because data in ethnographic teams are gathered by a number of researchers who in many cases have different degrees of training (as well as different degrees of insight), there is no way to assure consistency in what each researcher thinks it important to record. Thus, there are validity problems for which CAQDA cannot compensate. Ethnographers spend much of their time engaged in filework rather than fieldwork (Plath 1990), but quality analysis that has a high degree of validity and reliability remains dependent on the competence and consistency of fieldworkers.

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