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COMPUTER-AIDED QUALITATIVE DATA ANALYSIS: AN OVERVIEW¹

Udo Kelle

The last decade saw major advances in computer-assisted coding-and-retrieval methods for non-formatted textual data. These methods are especially helpful in interpretive social research where the researcher has to cope with sometimes huge amounts of unstructured textual data. Presently, qualitative researchers can choose between various coding and retrieval techniques by drawing on a variety of different software packages. The purpose of the paper is to give an overview of computer-aided techniques for the management and analysis of textual data in qualitative research and of the current debate about the methodological impact of these techniques on the research process. The initial sections contain a brief historical overview of the development of computer-aided qualitative data analysis whereby some epistemological aspects of the relationship between qualitative methodology and computer-use will also be discussed. Following that the paper also outlines basic elements of "computer-aided qualitative data analysis", namely the use of textual database management systems for the automatization of manual indexing and operations. Since the advent of the first coding-and-retrieve programs great hopes have been expressed that such coding techniques could revolutionize qualitative research by making the research process more transparent and by improving the reliability and validity of its results. In the last part of the paper these questions will be discussed thereby focussing on aspects of validity.

1. Introduction

In the past decade a variety of software programs have been developed to assist qualitative researchers² in analysing their data. More and more researchers now use these programs and there is a growing body of technical as well as sophisticated methodological literature about computer-aided qualitative data analysis (cf. LeCompte & Preissle, 1993: 279-314; Lee & Fielding, 1991; Richards & Richards, 1991; Tesch, 1990; Kelle, 1995; Weitzman & Miles, 1995). As with other technical innovations in their early stages one

can find enthusiastic forecasts and concerned warnings about their possible merits and dangers. While some qualitative researchers warn that computer-aided methods might alienate the researcher from their data (cf. Agar, 1991, Seidel, 1991), others are really thrilled by the prospect that computers could add trustworthiness to qualitative inquiry and foresee a methodological revolution (Richards & Richards, 1991).

In the following overview of the current state of the art of computer-use in interpretative research I will try to present some preliminary answers to the question of its potential methodological costs and benefits. I will start by giving an introduction to the basics of computer-aided qualitative data administration, in particular the techniques of coding and retrieval. The first programs specifically developed for managing qualitative data in the early eighties were based on these techniques and facilitated the mechanization of rather mundane mechanical tasks, namely the building of indexes, concordances and index card systems. These programs, e.g. Qualpro, The Ethnograph or Hyperqual are sometimes referred to as the *second generation* of computer-aided qualitative data analysis, while the first generation were word-processors and standard database management systems (Mangabeira, 1995:130). Second generation programs, in particular The Ethnograph, are now widely spread within the qualitative research community and it is now possible to draw on a growing body of practical experience when discussing their methodological impact on qualitative research.

The situation is completely different if one looks at the *third generation* of programs for analysis which (although they are based on the same principles as the second generation software) contain a variety of features that greatly exceed manual methods of textual data administration, for example Atlas/ti, HyperResearch, Aquad or NUD•IST. These programs have now been on the market for some years but the extended features are only seldom used as recent investigations among qualitative researchers have demonstrated (Dotzler, 1995; Lee, 1995). It is not yet clear whether this is due to a certain technological conservatism that adherents of the qualitative paradigm are supposed to share or whether the advanced features of these programs are not really useful for the purposes of qualitative research.

In the last part of my paper I will advocate the latter position by arguing that some of the extended features provided by third generation programs no longer support qualitative, interpretive analysis but require a style of coding of qualitative data that is much closer to that applied in classical content analysis.

2. Computer-aided Methods for the Management of Textual Data

Let me start with some short remarks about the history of computer use in qualitative research. Programs for the statistical analysis of textual data have been available since the mid-sixties. In 1966 *The GENERAL INQUIRER*, a program for computerized quantitative content analysis, began a train of development in history, linguistics and literary studies that led to the emergence of a whole scientific community concerned with computing in the humanities. In the social sciences, however, the use of software for computer-aided textual analysis initially only attracted scholars working in the field of content analysis. Qualitative researchers from interpretive traditions such as Chicago School sociology or ethnography who also used texts as their main (if not only) empirical data source made no attempts to integrate such software into their analytic work.

This is not at all surprising if one takes into account that qualitative analysis in these traditions meant a totally different style of analytic work than that found in content analysis. For the interpretive traditions textual analysis usually consists of a thorough, fine grained analysis of a text in order grasp its meaning through hermeneutic understanding - an operation that is often viewed as an artistic endeavour ("*hermeneutische Kunstlehre*"). Quantitative content analysis was criticized by such scholars as being too atomistic and oversimplistic to really capture the semantic content of texts. In contrast, hermeneutic analysis was considered to be the method that was capable of taking into account the ambiguity and context-relatedness which were regarded as the central characteristics of everyday language use (cf. Giddens, 1976).

The opinion that computers were not at all useful for textual analysis was supported by the paradigm of computer-use prevalent in the era of the mainframe. Computers were mainly seen as calculating machines; useful in the social sciences only for statistical analysis. The idea that electronic data processing machines could one day become an indispensable tool for the storage, retrieval and manipulation of text and thus also helpful to qualitative researchers was far away.

This situation was radically changed by the advent of the Personal Computer. In the mid 1980s many *hommes des lettres*, qualitative researchers among them, discovered rather quickly the enormous possibilities for text manipulation that were offered by the new technology. But, given the limited user-friendliness of early operating systems and software environments, many users (especially those working in a DOS environment) were also compelled to acquire a certain expertise in computer-use. After a strenuous apprenticeship, many of them experienced real enthusiasm when they discovered the numerous

possibilities for working with textual data offered by the new technology. Consequently, the dominant paradigm of computer-use changed from "computers as number-crunchers" to computers as devices for the intelligent management of data, incorporating facilities for the storage and retrieval of information that were far more complex and convenient than any manual system of information retrieval used previously.

With this paradigm shift it became clear that, although computers are not useful for the hermeneutic analysis of text, they can nevertheless be of great assistance to a hermeneutician. Since hermeneutic analysis tends to produce huge amounts of unstructured textual data, such as interview transcripts, protocols, field notes, and personal documents, there are many data storage and retrieval tasks involved in this kind of analysis. In hermeneutic sciences various strategies of intellectual craftsmanship have been developed to manage these tasks and to keep track of one's data. Many of these techniques are several hundred years old and widely used in all sciences that work with texts - in fact most of them were already used in the context of biblical exegesis.

1. *Building indexes*: on a separate piece of paper, the researcher notes the place (in terms of line, page, interview number) where a certain subject is discussed by the interviewee. The result of this process is similar to the index in a book.

Name Index		
Agar, 9, 12, 60	Barton, 135	Blackman, 28(N)
Aldenderfer, 165	Baszanger, 50(N)	Bogdan, 5, 57, 61
Altheide, 20	Becker, 4, 56	Bradshaw, 180
Anderberg, 165	Berelson, 53	Brownstein, 51(N)
Araujo, 9, 13, 68	Bertaux, 50(N)	Bryman, 152
Bailey, 165	Biklen 5, 57, 61	Burgess, 153
Bain, 22	Blashfield, 165	Campbell, 22, 152

Figure 1: Name Index

2. Including *cross references* in texts telling the reader where to find more information on the same subject, for example as seen in the margins of a Bible.

3. *Decontextualization and comparison of text passages*: Before the advent of computers, "cut-and-paste" techniques were the most widely used methods of organizing the data material to facilitate the comparisons of text passages - the researcher had to "cut up field notes, transcripts and other materials and place data relating to each coding category in a

separate file folder or manila envelope" (Taylor and Bogdan, 1984:136; see also Lofland & Lofland, 1984: 134). Other researchers used index cards for this purpose.

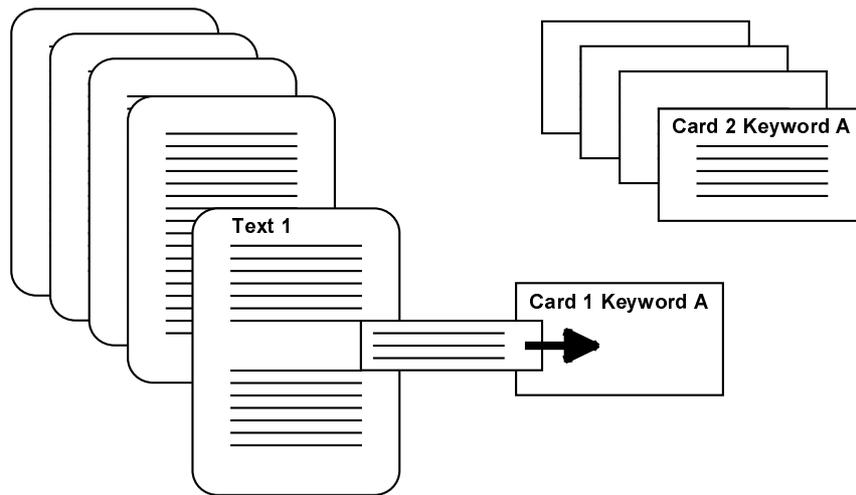


Figure 2: Cut and paste

Unfortunately such techniques of data management are rarely made explicit (with some exceptions, e.g. Miles & Huberman's source book (1994), Tesch (1990)). Instead they form a part of the "folklore" of qualitative research, i.e. a departmental tradition passed on orally among colleagues. From a methodological perspective such techniques are far from trivial, on the contrary, their methodological significance for hermeneutic research in the humanities or *Geisteswissenschaften* can hardly be overrated.³

The same holds true for qualitative studies in which a large amount of textual data are collected, for instance when 30 to 40 interviews or more are conducted. In such cases the validity of the study's results is highly dependent on the "folkloristic techniques" applied: A researcher who had organized his/her material in a sloppy way will certainly overlook and neglect crucial information, and his/her inferences and conclusions will be flawed because they are based on sparse data material and counter-evidence has not been systematically considered.

Although they are of great methodological significance, the manual methods of data management also have certain serious constraints. Firstly, they are rather inflexible. The code scheme cannot be modified easily, a restriction that contradicts the fundamentals of an inductive style of analysis which is typical for qualitative research. This inductive style requires that the category scheme is developed from the data and not constructed beforehand and then imposed on the data. Furthermore, if one uses "cut-and-paste" techniques to decontextualize text segments it is almost impossible to later enlarge an extracted text segment. In many studies this has become a major problem, especially since novices tend to choose segments that are too small. It can happen that when, several weeks later, the researcher returns to re-read the text passages that they have cut out and pasted on index cards, the decontextualized text segments turn out to be totally unintelligible. One strategy for coping with this problem is to include with the text passage information about its original site, so that the researcher could trace the path back to its context (Miles & Huberman, 1984:106). However: "*Cards and file folders are reasonably workable if the number of sites is small and the data collection not extended. But they are increasingly difficult and very time-consuming as the database gets larger*" (Miles & Huberman, 1984:67). The construction of an index will bring about the same disadvantage which tends to negate the advantage that it offers by leaving the text passages in their original context. As the database grows the search for text passages and especially their comparison becomes an increasingly tedious task.

This problem of "data overload" (Miles & Huberman, 1994) is often mentioned in the technical literature about qualitative analysis, and it is aggravated by a second problem. Since in interpretive analysis data analysis and theory construction are closely interlinked, the researcher generates many theoretical concepts in the process of data analysis which are often recorded as memos across numerous notebooks, manuscript pages and index cards. A central step in qualitative analysis is to compare the different text segments and memos in order to identify commonalities, differences or linkages between them. The purpose of this is to identify structures and to construct "meaningful patterns of facts" as Jorgenson (1989:107) put it. The crucial problem in the hermeneutic analysis of large amounts of textual data is that at any given point the analyst must be able to draw together all text passages, chunks of data and memos that relate to a certain topic. If one considers that an average study's database consists of 30 interviews with a transcribed length of around 30 to 40 pages one can easily imagine that this can be a mammoth organizational task.

It was the search for solutions to these problems that led to the first attempts to computerize cut-and-paste methods in the early 1980s. When the first qualitative researchers came to realize the advantages of word processing systems for writing texts, they tried to use these programs for managing their textual data. Manual cut-and-paste techniques were computerized by copying text segments from one file to another. As one can easily see, this method has hardly any advantage over manual methods - it simply replaces scissors, paper and glue with an electronic cut-and-paste facility. Other researchers started to experiment with the database programs available for microcomputers. But, although these programs permitted the storage and retrieval of text segments according to as many criteria as necessary, and also offered search and sorting procedures, they still imposed serious limitations on the management of unstructured textual data. For example, standard database management systems such as dBase require that the text segments are stored in a field that is defined before the data are entered. As has been mentioned above, this contravenes the inductive categorization strategy preferred by most qualitative researchers.

In spite of these drawbacks, some researchers used the macro or programming language often contained in standard software like word processors and database management systems to adapt these programs to their specific requirements. The results of these endeavours can be regarded as the *first generation* of programs for computer-aided textual data management in qualitative research. But it did not take long before some qualitative researchers with advanced computer programming skills started to develop *non-formatted textual database systems* for the management of unstructured textual data. The idea behind this kind of database management systems is straightforward: the addresses of certain text segments, in terms of line numbers, are stored as pointers in a special file together with the names of the codes allocated to these segments.

No of Document	Name of Code	First line	Last line
1	CLE	234	245
1	EMO	167	201
2	CLE	56	88
2	CLE	195	209
2	EMO	355	390

Figure 3: Codes as pointers

These pointers can be used by retrieval algorithms to find and retrieve those text segments to which certain codes were assigned by the researcher. Therefore, as opposed to standard database systems or word processors, coding with these programs does not entail the removal of text segments from their context. Text segments are only temporarily decontextualized for retrieval purposes. Consequently, the use of non-formatted textual database system has two central virtues: (1) in principle it is possible to electronically restore the original context of a text segment, and (2) the coding scheme can be changed much more easily than with a standard database.

Non-formatted textual database management systems represented the second generation of software for qualitative research. Since the mid-1980s a number of different software packages, like Qualpro, The Ethnograph, Textbase Alpha or Max have been developed that are based on these principles. All these programs allowed the researcher to code their data, that is to attach codes to certain text segments and to retrieve all text segments from a defined set of documents to which the same code had been assigned (see Figure 4).

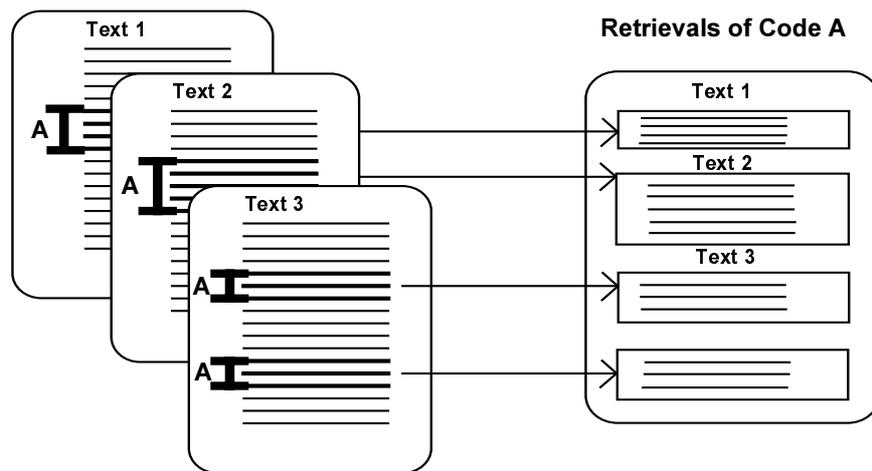


Figure 4: Coding and retrieval

These programs vary greatly with respect to their user-friendliness and they contain different additional features, e.g. facilities for editing and storing lengthy theoretical

comments or statistical features for calculating code or word frequencies. But since their basic function - the coding and retrieval of text segments - is the same these software packages can be subsumed under the heading "code-and-retrieve" programs.

The integration of code-and-retrieve programs into the research process can be regarded as a major methodological innovation. To understand why this is the case it is useful to take a closer look at the logic of qualitative reasoning. In analysing qualitative data the analyst usually does not start with ready-made hypotheses but with a broad and general heuristic framework of theories. While exploring, that is reading, re-reading and interpreting the data, the researcher will develop assumptions about associations, regularities and patterns in the field under investigation. Further analysis means the modification and concretization of these assumptions. This process often also contains elements of "proving" and "checking" them, and qualitative methodologists have often referred to this process as "examination" or even "verification" of "hypotheses" (cf. Strauss, 1987:12, Miles & Huberman, 1994:262, Strauss & Corbin, 1990:108). But in using these terms one must be very careful to not obscure the differences between the assumptions that a qualitative researcher develops in the ongoing process of analysis on the one hand and statistical hypotheses on the other. Qualitative hypotheses, when they first come into a researcher's mind, are usually not highly specified and definite propositions about certain facts, but tentative and imprecise, sometimes vague conjectures about possible relationships. Following the philosopher of science Norwood Hanson one should, instead of calling them hypotheses, rather call them hypotheses about what *kind* of propositions descriptions or explanations will be useful in the further analysis. They are insights that "*whatever specific claim the successful H(ypothesis) will make, it will nonetheless be an hypothesis of one kind rather than another.*" (Hanson, 1971:291) A researcher who conducts a field study about the distribution of power in a certain organization may, for example, gain the impression from the first interview that there is some sort of hidden competition between the different divisions of the organization. Or a researcher who carries out qualitative interviews among patients suffering from chronic pain may for example initially develop the idea that women form different pain management strategies to men. Using further empirical material the qualitative researcher would now try to further elaborate these tentative conjectures. As the hypotheses become more elaborated, they will also become more precise, gain empirical content and thus will come closer to hypotheses in the original sense, that means to empirically testable statements about distinct entities.

Only at this point in the ongoing process of analysis will it be useful to talk about "verification" or "hypothesis testing". However from the preceding discussion it should now be obvious that these terms have to be used in a completely different way than in

quantitative research. But, in the contemporary methodological literature about qualitative research the authors hardly ever make explicit what they understand by "hypothesis examination", "verification" or "falsification". One has to go back to the tradition of the late Chicago School in the 1950s to find an explicit account of qualitative hypothesis examination.

Lindesmith and Cressey (Lindesmith, 1968; Cressey, 1950; 1971) in seeking to apply the strategy of analytic induction outlined by Znaniecki (1934) to research practice proposed a methodology of hypothesis examination in which the researcher starts by formulating a vague definition together with a hypothetical explanation of the investigated phenomenon. Thereafter a single case is examined in the light of the hypothetical explanation to determine whether the hypothesis can account for the investigated phenomenon in this case. If not, either the hypothesis has to be reformulated or the investigated phenomenon has to be redefined in such a way that the case can be excluded - of course the new definition has to be more precise than the preceding one in order to avoid the immunization of the hypothetical explanation. "...this procedure of examining cases, re-defining the phenomenon and re-formulating the hypothesis is continued until a universal relationship is established, each negative case calling for a re-definition or re-formulation" (Cressey, 1971: 16).

Lindesmith regarded this methodology of qualitative hypothesis examination as a fallibilistic strategy in the Popperian tradition of critical realism claiming that by looking for crucial cases the researcher systematically exposes their hypothesis to the possibility of failure. Nevertheless, this strategy differs greatly from the concept of statistical hypothesis testing, because

1. firstly, it cannot be regarded as the application of a set of precisely defined rules. Furthermore, the guidelines (not "rules") outlined by Lindesmith and Cressey can be seen as a heuristic framework that help researchers to develop a theory via the successive refinement of working hypotheses.
2. Secondly, the empirical material not only serves as the basis for making a decision about the rejection or acceptance of a hypothesis, but also as an information source for the generation, refinement and modification of new and existing hypotheses.

In this context, "testing and confirming findings" or "verification" means: returning to the data (i.e. re-reading one's transcripts or field notes), or returning to the field (i.e. conducting new observations or interviews), in order to find some confirming or disconfirming evidence.

However, some serious threats for validity are associated with this strategy of hypothesis examination. The researcher is always in danger of treating their material selectively, that is of only noticing confirming evidence and overlooking disconfirming evidence. This potential danger is, as one can easily imagine, aggravated by data overload. A integral part of the folklore of qualitative research is anecdotal accounts of researchers who have thousands of pages of transcripts available and who desperately try to find at least two or three text passages that support their assumptions which they can quote in a publication.

It is obvious that this danger diminishes if the data material is well organized within a coding and retrieval system that allows the researcher to easily draw together all text passages that refer to a certain topic. Thus computer-aided methods for the administration of textual data will help to fully exploit the data material and prevent researchers from basing their results on sparse evidence. By reducing the negative effects of data overload they will also allow researchers to collect and analyse more textual data. As with hypothesis testing this should not seduce us into confusing different modes of sampling: the purpose of qualitative sampling cannot be to achieve representative samples in the statistical sense since this would require far more cases than could be analysed by means of interpretive methods. But methods of purposeful sampling regularly applied in qualitative research, for example "theoretical sampling" (Glaser & Strauss, 1967:45ff), can also benefit from greater sample sizes: such a strategy can be used to systematically search for crucial cases, i.e. cases with a high probability for providing evidence or counter-evidence for the developing hypotheses.

From this it can be concluded that second generation software represents a major methodological innovation for qualitative research since they allowed the researcher to analyse more data more systematically and carefully and thus increased the possibility to find evidence or counter-evidence for their hypotheses.

3. Enhanced Coding and Retrieval Techniques

Code-and-retrieve programs only mechanized widely used cut-and-paste or indexing techniques but did not change their underlying logic or offer analytic features which could not be employed using manual methods. This situation changed as more and more features were added to these programs, features that widely exceeded the analytic possibilities offered by manual methods, e.g.

1. facilities for *theory building* that offered the researcher the possibility of defining many kinds of linkages between codes, memos and text segments resulting in complex networks

2. tools for *hypothesis examination* that are based on complex retrieval techniques for searching for co-occurring codes.

These new techniques formed the basis of what have been called the *third generation programs* (Mangabeira, 1995). In the following I will briefly outline some of their basic principles and then move on to discuss their methodological impact on the research process. At present literature about the methodological advantages or disadvantages of the advanced theory-building and hypothesis testing capabilities of third generation programs are mainly published by the developers themselves. In contrast, very little has been written by neutral researchers about the practical experience of using these techniques. Therefore, I will draw on some general considerations about the nature of qualitative research to evaluate their possible methodological costs and benefits.

3.1 Enhanced Coding Techniques for Constructing Linkages and Building Networks

The theoretical categories which are developed in the ongoing process of qualitative analysis are often closely related to the codes used for coding the text. Since one would usually regard theories as networks of theoretical categories it is obvious that tools for connecting codes to each other could be helpful for displaying the structure of the emerging theory. Therefore, software that facilitates the connection of categories can make a major contribution towards theory building. As has been already mentioned, coding is technically realized in most code-and-retrieve programs by defining pointers. These pointers contain the addresses of text segments and thus establish linkages between codes and text segments. In the same way it is also possible to define a linkage between one code and another. This linkage can take the form of, for example, the subsumption of one code under a more general code, or the subdivision of one code into several more refined subcategories. If the researcher restricts themselves to this kind of connection their category scheme could be represented by hierarchical networks (see figure 5).

The program NUD•IST contains extensive features which support the construction of hierarchies of code categories. But linkages between codes may not only take the form of hierarchical relations but can form whole networks of categories, containing chains or loops (see Figure 6.).

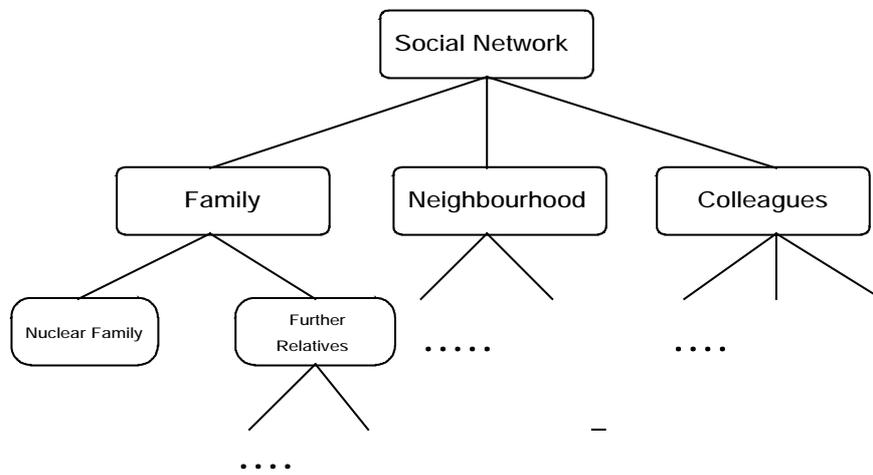


Figure 5: hierarchical network of code categories

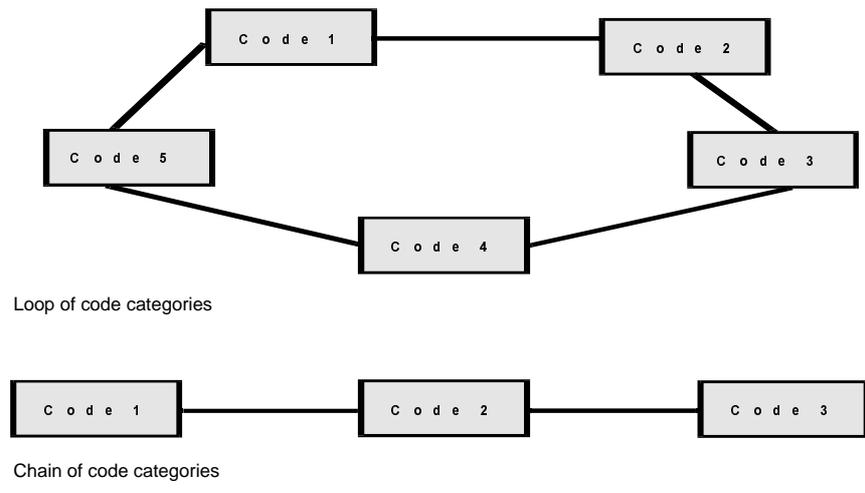


Figure 6: different kinds of networks of code categories

The program Atlas/ti offers a variety of features for building non-hierarchical networks. Additionally the user of this program can label the linkages between codes as being, for example, causal, contradictory, or hierarchical relationships, while Hypersoft, which is another program with extended theory building facilities, offers tools for defining the strength of a relation in quantitative terms.

It is also possible to link "memos" (see above) to other elements of the database. Since memos are often "*the theorizing write-up of ideas about codes and their relationships as they strike the analyst while coding*", as Glaser (1978: 83) said, they are most useful if linked to the relevant codes or text segments. Since memos can be regarded as signposts along the path between data and theory, linkages between text segments, codes and memos can help to retrace this path, enabling researchers to control the empirical background of their theoretical ideas. Further possibilities for linking elements of the qualitative database include the employment of *hyperlinks* for linking text segments to each other without using codes. In this way the technique of defining cross-references already mentioned earlier can be mechanized.

3.2 Enhanced Retrieval Techniques for Searching for Co-occurring Codes

In some of the third generation software programs, for example NUD•IST, these enhanced coding features for theory building are supplemented by enhanced retrieval techniques that are intended to help with the examination of hypotheses and thus support the "grounding" (in the sense Glaser and Strauss (1967) used this term) of the emerging theories in the data.

The first *enhanced retrieval facilities* were already added to second generation programs in the mid-80s. The researcher could define case-constant variables, such as age, gender, profession, assign them to the cases and then *selectively retrieve* text segments according to two criteria: First, that they have been coded with a certain code and second, that they belong to a specified subgroup of documents defined according a certain value of a case-constant variable. For example a researcher could examine the hypothesis that men and women generally have different attitudes towards a certain topic by searching for all statements on this topic (i.e. a certain code) made by male interviewees (i.e. value "male" of the case-constant variable "gender") and comparing them with those statements made by women. Or utterances made by respondents from different age groups or from different professions could be compared.

The next step in the development of enhanced retrieval facilities were algorithms for searching for *co-occurring codes*.

Facilities for searching for co-occurring codes can be regarded as a possible basis of a methodology of hypothesis testing in qualitative research (see Sibert & Shelly, 1995, Hesse-Biber & Dupuis, 1995, Huber, 1995). This is usually technically realized with methods of logic programming. The first step is the construction of a knowledge base that contains information about what codes are connected to which parts of the textual database. The researcher then formulates their hypotheses as relationships between code categories which, finally, are broken down in such a way that a query to the knowledge base can be conducted. This query is designed to provide information on whether the categories in question co-occur in the text

HyperResearch is one program that implements such ideas. As with second generation programs HyperResearch's basic principle is coding and retrieving text segments. In addition the program contains a hypothesis testing module which is designed to formalize the inference or thought process of a qualitative researcher analysing texts by inferring new codes from existing codes. When using the hypothesis testing module the researcher formulates their hypotheses in the form of "production rules" in which codes are connected with "if-then" statements. To give an example: a researcher who has coded his/her data with codes for "critical life events" and "emotional disturbances" may wish to examine the hypothesis that critical life events are always or frequently accompanied by emotional disturbances. They could then transform their hypothesis into a query about all co-occurrences of text segments coded as critical life event with segments coded as emotional disturbance. Using HyperResearch's hypothesis tester one would formulate the rule

IF "critical life events" AND "emotional disturbances" THEN ADD "life event has caused stress".

If the program finds both the code "critical life events" and the code "emotional disturbances" in a given document, the hypothesis is confirmed for that document and the code "life event has caused stress" is added to it.

HyperResearch only searches for the presence of certain codes within a given set of documents, and in doing so does not take the precise location of the text segments into account. In contrast, with programs like Aquad, NUD•IST or Qualog co-occurrences of codes can be defined more precisely. They can be:

- Indicated by *overlapping* or *nested* text segments to which the codes under investigation are attached, as shown in Figure 7.

- Indicated by text segments that are coded with certain codes (here A and B) that appear with a certain *specified maximum distance* of each other. If this maximum distance is set at, say, 8 lines, the program would retrieve all code A. (see Figure 8)
- indicated by *sequential ordering* (Code A is regularly followed by Code B), as shown in Figure 8.

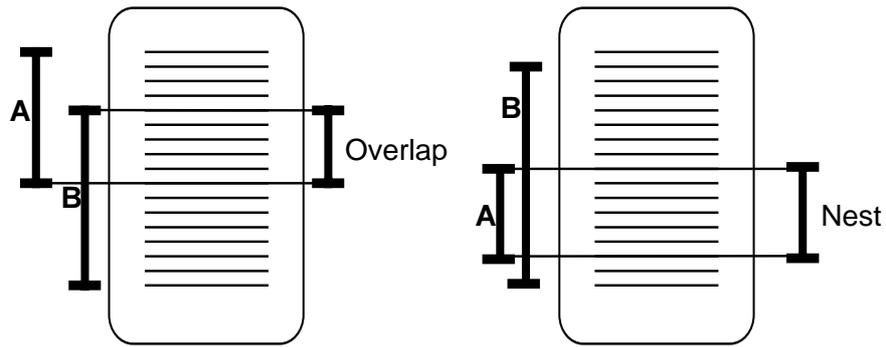


Figure 7: Overlapping and nesting text segments

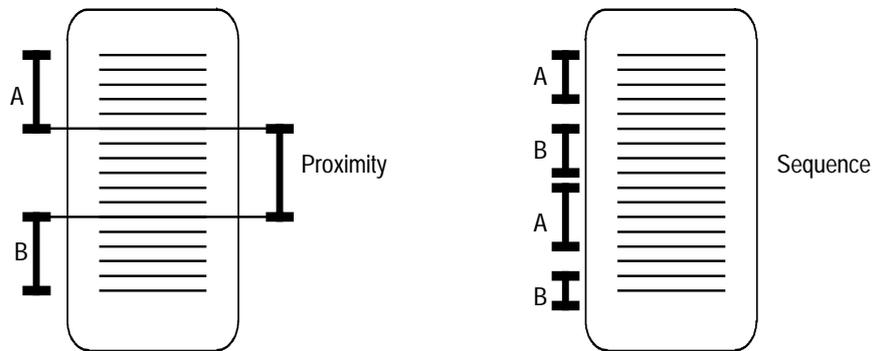


Figure 8: Proximity and sequence of codes

The program Aquad is an example of a program that helps the researcher to use information about the co-occurrence of codes for hypotheses examination. Aquad contains twelve ready-made hypothesis structures that are formulated as searches for co-occurring codes. These hypothesis structures can be expanded by users who are familiar with the Prolog programming language in which the whole program has been written. Taking our previous example and using Aquad one would first code the text segments with the codes "*cle*" (for "critical life events") and "*emo*" (for "emotional disturbances"). Let us assume that during this process the following hypothesis has come to the researcher's mind "Whenever interviewees talk about critical life events they will also, at the same time, mention emotional disturbances". One can now operationalize "at the same time" as "within a maximum distance of 5 lines in the interview transcript" and run a retrieval that finds all text segments coded with "*cle*" where a text segment coded with "*emo*" also occurs within a maximum distance of 5 lines. Looking at the result of such a retrieval shown in Figure 9 one can for example see that in the interview "bioss1" the association of "*cle*" and "*emo*" occurs only once (at line 102), while in interview "bioss2" there are 5 text passages where text segments coded with these codes are very close to each other.

Thus the co-occurrence of codes (defined as the overlapping, nesting, proximity or sequential ordering of text segments) indicates the presence of critical evidence for or against the hypothesis.

hypothesis 1 / codefile bioss1.cod

100	102	cle	-	102	104	emo
-----	-----	------------	---	-----	-----	------------

hypothesis 1/ codefile bioss2.cod

24	28	cle	-	26	30	emo
65	70	cle	-	72	82	emo
110	112	cle	-	111	115	emo
220	228	cle	-	212	224	emo
450	452	cle	-	456	476	emo

Figure 9: result of a co-occurring code search with Aquad

A similar technique called "Qualitative Comparative Analysis (QCA)" (Ragin, 1987, 1995) that uses enhanced retrieval techniques can be realized by both Aquad and the

program QCA. This method is similar to the hypothesis testing module contained in HyperResearch in that the presence or absence of codes in a certain case is the decisive criterion. However, with QCA it is possible to investigate far more complex configurations of codes. Ragin maintains that the application of this approach is especially useful for researchers who wish to investigate complex causal relationships. For this the material has to be coded in such a way that codes represent possible conditions, causes and outcomes. It should be pointed out that what are called "possible causes" and "outcomes" are solely defined by the user - as with HyperResearch QCA can be regarded as a tool for formalizing the thought processes of a qualitative researcher and not as a tool for "proving" hypothesized causal relationships.

QCA uses Boolean Algebra to determine the subset of codes (from a set of codes defined as "conditions" or "causes") which is essential for the occurrence of the code defined as "outcome". For this purpose, a strategy of redundancy elimination is applied, using the logical minimization of truth tables.

Let me give a simple example to illustrate this process. Let us define the two codes "male" (M) and "parents' high socio-economic status" (P) as causes and "respondent's high socio-economic status" (S) as the outcome. There are eight possible configurations of these three codes, as indicated in Figure 10.

	Causes		Outcome	
	M	P	S	
1.	0	0	1	
2.	0	0	0	x
3.	0	1	1	
4.	0	1	0	
5.	1	0	0	
6.	1	0	1	
7.	1	1	0	
8.	1	1	1	x

Figure 10: Example of Boolean Minimization

If only configurations 2.) and 8.) are actually present in the data then it is concluded that the outcome S is only achieved if both M and P are present. If additionally configurations 3.) and 6.) are realized it is concluded that the outcome S can also be achieved if only one of the causes M or P is present. Although this is a simple example the method can be extended to the investigation of numerous causes.

4. The Methodological Relevance of Enhanced Retrieval Techniques

It is interesting to note that recent investigations among users of qualitative analysis software have clearly shown that enhanced retrieval techniques are only seldom used (cf. Dotzler, 1995; Lee, 1995). It is not yet known whether this is due to the reluctance of users to adopt new analytic techniques or whether these techniques are inadequate tools in the context of qualitative research.

Due to the lack of practical experience with these techniques at the moment it will be only possible to give an answer to this question on the basis of general theoretical and methodological reflections. Since enhanced retrieval techniques are regarded by some authors as the basis of a methodology of qualitative hypothesis testing it will be useful to clarify first of all the different concepts of a hypothesis and hypothesis testing in the context of quantitative and qualitative research.

However, this attempt of clarification will be complicated by the fact that the notions of a hypothesis and hypothesis testing are themselves controversial among qualitative researchers and methodologists. On the one hand many authors often emphasize that qualitative analysis contains elements of hypothesis examination and verification (e.g. Miles & Huberman, 1994: 262ff; Strauss, 1987:11ff; Strauss and Corbin, 1990:107ff) From this perspective qualitative analysis is a series of alternating inductive and deductive steps: data-driven inductive hypothesis generation is followed by deductive hypothesis examination for the purpose of "validation", or "verification".

On the other hand scholars devoted to a relativistic epistemology rooted in postmodernist and constructivist philosophy would strongly object to the idea that qualitative research has anything to do with "verification" or the "testing of hypotheses" - after all, the concepts of hypothesis examination and verification form an integral part of standard social science methodologies which have been criticized by many qualitative researchers for imposing methodological models from the natural sciences onto social research (see e.g. Denzin & Lincoln, 1994: 101).

I think one will benefit from looking at the usage of the term "hypothesis testing" in its traditional domain of statistical analysis. Statistical hypothesis testing (or "significance testing") is a strictly rule-governed process of assessing the statistical significance of empirical results, whereby empirically observed sample findings are compared with theoretical expectations. This comparison requires the computation of the probability that the observed outcome is the result of mere chance. On the basis of this calculation a precisely formulated decision rule can be applied: if the probability that a certain result is merely the effect of a random process is above the so-called alpha-level, then the researcher has to reject the hypothesis.

4.1 Hypothesis Testing in Quantitative Content Analysis

The application of such a methodology to the analysis of textual data has certain important prerequisites which can be best explicated by taking quantitative content analysis as an example. Quantitative content analysis parallels qualitative research in certain ways: unstructured textual data are also often used as the primary data source and coding of these data is also the first step of data analysis. But coding in quantitative content analysis serves a quite different purpose than qualitative coding: codes do not primarily have an index function to help identify text passages relating to a certain topic. Instead, codes in quantitative content analysis represent values of certain variables. Each appearance of a certain code represents a certain event that is of interest to the researcher. For example, coding a text with the code "Liberal Party affiliation" would mean that the interviewee is a supporter of the Liberal Party. Coding is usually followed by information reduction which entails using the information provided by coding for the construction of a new (quantitative) data corpus that can be analysed with statistical procedures. The frequencies of certain codes can be calculated, and hypotheses about the co-occurrence of codes can be tested. Unlike qualitative research, it is crucial for this kind of analysis to focus almost exclusively on the codes and not on the raw data. But this is only possible if the codes can be seen as true representations of certain facts described by the raw data. Consequently, there has to be a high degree of certainty that the codes have been applied in a systematic and consistent way, in other words, the coding must have a high degree of validity and reliability. Furthermore, the coding of the raw data must be inclusive and exhaustive. This means that one must be certain that every single instance of the investigated phenomenon that occurs in the raw data has been coded.

These requirements make it essential that whenever codes are employed to condense the information contained in the data by representing facts described by the data, a *precise coding scheme* is developed *before* coding starts, since:

1. For pragmatic reasons alone, inclusive and exhaustive coding would not be possible if the researcher did not have a ready-made category scheme to hand right from the start. If, instead, the coding scheme was being permanently altered, it would be necessary to permanently re-code the previously coded data with the newly developed categories.

2. Objective, and therefore reliable, coding can only be conducted if all coders employ exactly the same coding scheme.

Consequently, a research strategy where codes are used to test hypotheses in the sense outlined above requires a deductive approach: the relevant variables and their values (that form the codes) have to be determined before data are coded.

4.2 Hypothesis Testing in Qualitative Research

However, this requirement for a deductive approach would cause severe difficulties in the context of interpretive social research.

Let us again take a short look at the logic of qualitative reasoning to clarify this point. Although there is a puzzling heterogeneity of qualitative approaches (cf. Tesch, 1990: 55ff.), it has often been emphasized that most of them are at least implicitly based on a common underlying concept of human action. This has been referred to with notions like the "*Interpretive Paradigm*" (Wilson, 1970), "*Interpretive Sociology*" (Giddens, 1976) or "*Interpretive Interactionism*" (Denzin, 1989).

According to the interpretive paradigm the meaning of human action and interaction can only be adequately understood if the interpretations and the common-sense knowledge of the actors are taken into account. This theoretical postulate has far-reaching methodological consequences: The researcher must be able to gain access to the interpretations and the common-sense knowledge of the members of the social world investigated. If the researcher's goal is to describe members' actions adequately (which is with respect to the meaning these actions have for them) he/she must be able, to a certain extent, to perceive the world in the same way as the members do.

This demand for "empathetic understanding" of or access to the common-sense knowledge of the investigated form of social life makes it difficult, if not impossible, to employ a hypothetico-deductive (H-D) research strategy, since this would require the development of useful hypotheses before collecting empirical data. Instead, if one wants to learn something about the actor's point of view one has first to enter the empirical field, to establish contact with the people in the field through interviewing or observation and thus collect data. Consequently, qualitative inquiry in most cases starts with observation, recording, listening etc., as also has been mentioned above. This means collecting some-

times large amounts of unstructured textual data, and then hypotheses and theories are developed on the basis of this material.

A qualitative researcher starts his investigation by noticing new and interesting phenomena, and not by searching for evidence for an already developed hypothesis. Of course this must not seduce us into thinking of his mind as a *tabula rasa*. The researcher always brings some theoretical preconceptions with them. These do not represent hypotheses in the classical sense, that means explicit propositions about empirical facts, but (partly implicit) broad heuristic frameworks which help him to identify and select relevant phenomena, and of course researchers with different perspectives will select different phenomena. Identifying phenomena within one's field notes, protocols or interviews quite often (but not always!) takes the form of "coding".

But this process is quite different from coding in quantitative content analysis, as Charmaz points out:

"Qualitative coding is not the same as quantitative coding. The term itself provides a case in point in which the language may obscure meaning and method. Quantitative coding requires preconceived, logically deduced codes into which the data are placed. Qualitative coding, in contrast, means *creating* categories from interpretation of the data. Rather than relying on preconceived categories and standardized procedures, qualitative coding has its own distinctive structure, logic and purpose." (Charmaz, 1983: 111).

And Becker and Geer explicate the peculiarities of qualitative coding as follows:

"A systematic assessment of all data is necessary before we can present the content of a perspective [...] We have tentatively identified, through sequential analysis during the field work, the major perspectives we want to present and the areas ... to which these perspectives apply. We now go through the summarized incidents, marking each incident with a number or numbers that stand for the various areas to which it appears to be relevant. This is essentially a coding operation, ... its object is to make sure that all relevant data can be brought to bear on a point." (Becker & Geer, 1960: 280-281).

Coding as described by Becker and Geer differs in certain aspects from that in quantitative content analysis. The incidents which are coded do not represent instances or examples of a general phenomenon or fact named by a code; instead the code only refers in a quite vague manner to one of "the various areas to which it appears to be relevant". The purpose is not to condense relevant information with the objective of creating a quantitative data matrix, but to "make sure that all relevant data can be brought to bear on a point".

For these authors the function of codes is clearly restricted to "signposting": codes are stored together with the "address" of a certain text passage, and, drawing on this information the researcher can locate all the possible information provided by the data on the relevant topic. Thus coding in qualitative research is a necessary preparation for the process of systematic comparison. This process forms the basis of the kind of "hypothesis examination" employed in interpretive research, which is quite different from hypothesis testing conducted in an hypothetico-deductive research design. As has been said before a qualitative researcher does not start with readymade and precise hypothesis but develops tentative and sometimes vague hypotheses *ex post facto* from certain parts of the data material, and then further refines and modifies them by drawing on other parts the data material.

This refinement or modification can be supported by code-and-retrieve-software. For example, our hypothetical researcher who developed the hypothesis from a certain interview that there is some sort of hidden competition between different divisions of an organization may be interested in finding all text passages where interviewees talk about the relations between different divisions. Or our other researcher who developed the idea that women and men develop different pain management strategies can try to examine his hypothesis by investigating all text passages where interviewees talk about strategies of pain management. These researchers may find confirming or disconfirming evidence for their hypotheses; in any case they will use the empirical material to further elaborate and modify their tentative conjectures, in line with the concept of Analytic Induction proposed by Lindesmith and Cressey (see also page 42).

For the following reasons, the approach to hypothesis examination adopted by most interpretive researchers is incompatible with the H-D model described above :

Unlike quantitative content analysis, the concepts and categories (the "variables and their values" in the language of quantitative content analysis) which form the basis of a hypothesis are not an integral part of the coding scheme right from the start. The organizational researcher for example did not begin coding the material with the category "competition" right away. A necessary prerequisite for using a certain theoretical concept as the basis of a hypothesis in interpretive research - which incorporates a methodology of discovery - is that this concept has *not* been used to code the raw data. In interpretive, as opposed to hypothetico-deductive, research the researcher must not restrict the scope of the investigation in advance by determining precise categories, since the goal is not to test already formulated hypotheses with empirical material but to generate new ones with the help of empirical material. Coding which support this process means the allocation of text segments to general topics of interest. Text segments that relate to a general topic can then be drawn together to develop hypotheses on the basis of a comparison of these

text segments. Consequently, codes will not be attached to precisely defined incidents in the data but to text segments which are "tentatively classified into the simple content categories we had decided in advance", as, for example, Freidson (1975:271) points out. So Coding and retrieval is nothing more than a mechanical preparation for interpretive analysis which is based on a careful inspection and analysis of raw data (i.e. segments of text) and on their comparison with the purpose of identifying patterns and structures and with the purpose of checking tentative assumptions about these patterns.

In the ongoing process of analysis researchers will usually examine their initial assumptions for the purpose of clarifying, modifying and refining them. But this requires further inspection of the interview transcripts or field protocols themselves, and not of the codes. In many qualitative approaches, especially in those with strong roots in hermeneutic philosophy or phenomenology, such an "interpretive hypothesis examination" would require a thorough fine-grained analysis of textual data. Thereby, further aspects of the phenomenon under study will be discovered through a careful and intensive inspection of the "raw data". In other words, the text itself contains materials that helps to modify the initial hypothesis. Consequently, examining a hypothesis in qualitative analysis is itself an act of interpretation and not an algorithmic procedure based on strict decision rules as with statistical significance tests.

4.3 Two Strategies of Computer-aided Hypothesis Examination

Let us now return to our question about the methodological impact of enhanced retrieval techniques on the research process. As has been said before, some authors claim that facilities for retrieving co-occurring codes can support the process of qualitative hypothesis examination.

It should be clear from the preceding discussion that one has to clearly distinguish between two different strategies, if one uses enhanced retrieval techniques for hypothesis examination, according to the kind of information the computer retrieves when it searches for co-occurring codes: Does the *mere fact of co-occurrence* lead to the rejection or acceptance of a hypothesis, or is it only used to *retrieve the original text segments* which are regarded as the basis for the decision on the hypothesis examined? These two possibilities correspond to the two conceptions of textual analysis mentioned above: one based on a hypothetico-deductive research strategy, the other on interpretive analysis. Both strategies have their individual merits. But since both also have certain mutually exclusive prerequisites, confusing them is likely to be harmful to the research process.

1. In applying a *hypothetico-deductive strategy* the mere fact of a co-occurrence is itself regarded as evidence or counter-evidence for a certain hypothesis. If the researcher proceeds in this way the techniques for searching for co-occurring codes provided by Aquad, NUD•IST or HyperResearch have a similar function to hypothesis testing in statistical analysis. The primary purpose is not to provide the researcher with text segments but to use the information about the co-occurrence of codes in a given document as a basis for decision making. As in statistical significance testing, the decision making process is strictly rule governed and hence algorithmic. So it parallels very much the kind of hypothesis testing which is regularly applied in quantitative content analysis. However, there are certain methodological requirements and limitations to the use of such a hypothesis tester for qualitative hypothesis examination, which are usually taken into account by content analysts. These requirements relate mainly to the nature of codes employed, since the codes must represent Boolean facts if an automatic hypothesis tester is to produce meaningful results. Furthermore, the reliability of the codes used is of utmost importance. But these requirements diametrically oppose the analysis strategy usually applied in qualitative research. In an interpretive analysis strategy codes tend to represent general topics of interest and not precisely defined Boolean facts. Furthermore, hypotheses are not logically stated propositions about the presence, absence or relationship of certain facts, but sometimes vague ideas about the relations between two or more concepts. A hypothetico-deductive strategy where the mere fact of the co-occurrence of certain codes in a given text passage is regarded as evidence or counterevidence can thus rarely be regarded as an adequate strategy of hypothesis examination in interpretive research. There are further reasons why the application of programs like Aquad, HyperResearch, NUD•IST or QCA for hypothetico-deductive hypothesis testing can be seen as a rather dubious endeavour. These strategies have not yet attained the status of statistical hypothesis testing because they do not contain any decision rules, grounded in inferential statistics, for determining when a hypothesis should be rejected or accepted. Instead, they are only suitable for investigating deterministic relationships where the discovery of one contradictory case leads to the rejection of the hypothesis. However, such relationships are extremely rare in social research, let alone in the qualitative field. It would be certainly possible to use methods from inferential statistics to, for example, expand Ragin's proposed process of logical minimization. However, in this case the result would be nothing more than a multivariate model for analysing categorical data. Consequently, one cannot help wondering whether these "new" approaches amount to nothing more than rediscovering the wheel.

There is a further, as yet unsolved, problem with Ragin's concept: that of degrees of freedom. As the number of possible causes increases so does the number of possible

configurations of these causes. With three variables a sample of at least 16 would be necessary to allow each configuration to occur at least once. Therefore, this is not unproblematic strategy for qualitative researchers who traditionally work with small samples.

Consequently, if a researcher wishes to employ searches for the co-occurrence of codes in a given set of documents in order to test hypotheses within the framework of a hypothetico-deductive strategy, I can only advise them to draw on the tried and tested methods in quantitative content analysis.

2. But the strategies of qualitative hypothesis testing implemented by third generation software as Aquad, NUD•IST, HyperResearch or QCA could nevertheless be extremely useful in qualitative research, if they are used in a quite different way. That would be the case if the results of co-occurring code searches are not regarded as evidence but are used as a heuristic device. The purpose of querying the database would then be to retrieve the original text to which the co-occurring codes are attached. Applying this strategy the result of the retrieval would allow the researcher to determine the meaning of a certain co-occurrence of codes by a thorough analysis of the original text. After the program has retrieved all locations of text passages where segments coded with *cle* co-occur with segments coded with *emo* the researcher would now inspect the original text to answer for example the question: *Has the emotional arousal mentioned by respondent X something to do with the critical life event he describes?* The acceptance of a hypothesis or its rejection (which leads to its further refinement) is not the result of the application of an algorithm (i.e. of a strictly rule-governed process) but is a result of the researcher's interpretation. This corresponds to Lindesmith's and Cressey's method of Analytic Induction, in which the interpretive analysis of interview texts or observations forms the basis for the researcher's decision about a certain hypothesis, while the empirical material, i.e. the textual data, also serves as an information source for generating, refining and modifying hypotheses.

5. Conclusive remarks

This paper started by querying the specific merits and dangers of newly developed computer-aided methods for qualitative research. Let me now try to give a tentative answer. With respect to the *second generation* programs for coding and retrieval, researchers' experiences with using these programs show that they have had a very fruitful methodological impact on the analysis process: by allowing researchers to systematically organize their textual data the software enhances more thorough analyses and reduces the risk that researchers base their results on sparse evidence, that is on a few quotations from some

highly untypical cases. So one has good reason to assume that the continued spread of computer-aided methods for coding and retrieving textual data will enhance the reputation of qualitative research while ensuring the trustworthiness of qualitative findings.

With respect to the newly developed methods of enhanced coding and retrieval, several urgent warnings are necessary: These facilities offer fascinating new possibilities for analysts to "play" with their data and thereby help to open up new perspectives and to stimulate new insights. They can also help to combine qualitative with quantitative methods or an H-D approach with interpretive research strategies. But these possibilities also contain specific dangers because the same technical tool can be used in the context of two totally different analysis strategies: (1.) a strategy in the tradition of interpretive social science whereby textual data are coded for the purpose of hermeneutic analysis of texts and (2.) a strategy in the tradition of content analysis whereby textual data are coded to condense the information contained in them. With the newly developed enhanced retrieval tools for qualitative analysis a qualitative researcher runs the danger of reifying the codes and losing the investigated phenomenon by confusing two analysis strategies. By seeking to test hypotheses without having observed the necessary prerequisites he will easily produce artifacts.

Therefore, I would like to advocate caution when transplanting methodological concepts like "hypothesis testing" or "verification" from one research tradition to another without clarifying their role in the new context.

Notes

- 1) I am especially grateful to Kate Bird for her comments and critique.
- 2) It should be mentioned here that by "qualitative research" or "qualitative analysis" I refer to the hermeneutic analysis of textual data in the tradition of interactionist, phenomenological or ethnographic approaches and not to the statistical analysis of categorical data which are also often termed "qualitative data".
- 3) Historical and critical biblical exegesis - which helped in the 18th and 19th centuries to overcome the dominance of dogmatic and literal interpretations of the scriptures - is a good example of this. In particular, the technique of comparing text segments (or "synopsis" as it is called in biblical exegesis) helped with the formulation of a theory about the influences of the four gospels on each other and the order in which they were written, a theory which today is still a generally accepted basis for understanding the New Testament.

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