THE BIBLIOGRAPHICAL INFORMATION CONTENT OF RESEARCH PAPERS

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ABSTRACT

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The occurrence, form, and content of the elements of research papers used in bibliographical control is examined in the whole range of disciplines - natural sciences, social sciences and humanities. Instructions given by primary journals to authors about these elements are considered in the light of requirements for bibliographic control.

1. The information content of titles is assessed firstly by counting the number of keywords in them, and variations with discipline, time and language are reported. A more refined measure depending on the probabilities of occurrence of title words is then used for samples taken from journals in chemistry, history and philosophy.

2. Suggestions are made for improving the presentation of author details to facilitate bibliographic control.

3. The information in abstracts of experimental papers is analysed into the four divisions traditionally used for the text: introduction, experimental/method, results, and discussion, and the proportion of each type is compared with that in the text. A wider range of abstracts are also analysed into informative and indicative content. Literature on the uses of abstracts is reviewed in a consideration of their purpose, and arguments are presented for indicative abstracts.

4. A comparison of authors' keywords with terms assigned by indexing services shows that such keywords are not usually adequate or accurate enough for indexing purposes. Instructions to authors to use a controlled vocabulary, e.g. Medical Subject Headings, did not seem to be observed very closely.

5. The average number of references per paper is reported for various subjects, broken down for experimental papers into the sections used in studying abstracts. The value of including the titles of cited papers in references is stressed.

As the use of on-line services takes over from use of printed indexes, reliance is likely to be placed entirely on authors (and editors) for index terms. Titles and abstracts seem to be a more reliable source than separate lists of keywords.

CONTENTS

CHAPTER ONE

INTRODUCTION

1.1 BIBLIOGRAPHIC INFORMATION ELEMENTS

Bibliographic control has so far operated almost entirely with surrogates of, and keys to, the documents to be controlled. These bibliographic elements are of varying length and information content. The fullest form in common use is the abstract, which may contain sufficient of the most important or original information from the paper to act as a substitute for it in some cases (see Section 4.12.5). Next down may be placed detailed precoordinated index entries, such as those created by PRECIS (the Preserved Context Indexing System, used in the British National Bibliography and British Education Index) and those in Chemical Abstracts subject indexes. These show several of the concepts brought together in the paper and the relation between them. They might even indicate the key finding of the paper, e.g. 'Kaersutite, Greenland, overgrowths on titanaugite' (Mineralogical Abstracts, 1977) indicates the main point of the paper, which was to record overgrowths of kaersutite on titanaugite in East Greenland. Titles of papers might be placed next down - or about equal for objective and detailed titles, which can play a similar role to a precoordinated index entry.

Abstracts are usually arranged in fairly narrow subject groups in abstract journals, so that readers can scan all the abstracts in their area of interest. Titles are sometimes arranged in such subject groups by secondary services and sometimes in groups according to the place where the paper appeared (e.g. in Current Contents).

Next down, there are non-coordinated index terms, 'keywords', or descriptors. These are not intended for scanning in groups, but are intended to be put in alphabetical order with pointers to the documents, or to surrogates of them (abstracts or titles). Usually a descriptor will not on its own be adequate for locating sought documents: it will need coordination with other descriptors. There may be some cases though where it is specific enough to be useful on its own, e.g. the name of a little-known person, or a rare mineral.

Finally, there are bibliographic elements which give information about other aspects of a document than its subject. A particularly important one is the author's name. Author indexes enable searches to be made for a particular author, and a pointer (e.g. an abstract number or page number) can then be followed to the original document.

References to journal articles, as given in reference lists or footnotes, consist of the author's name, journal title, date, volume and page number, and sometimes the title of the article. This combines two of the elements mentioned above, and enables direct access to the original article.

The coming of mechanised information retrieval methods has allowed some of these representations to be used in new ways. Although titles were sometimes rotated manually to give several entry points in the indexes of individual journals, the use of computers has enabled KWIC indexes to be constructed on a large scale. Automated retrieval systems have now made access possible not only by keywords in titles, but also by keywords in abstracts. The citations made in an article have been used to create another type of retrieval tool - the citation index. This uses the citations as descriptors of the document in which they are made. The usefulness of this approach depends on the assumed relevance of the cited document to the citing document. If one paper relevant to the desired topic is known, its reference can be used as the entry point for finding later related papers.

The next section outlines the studies carried out on these bibliographic elements.

1.2 SCOPE AND PURPOSE OF THE THESIS

This thesis is concerned only with bibliographic information contained in research papers as printed in the primary journal, and not with any bibliographic elements subsequently added by secondary services. The elements studied are thus:

(i) Titles (Chapter 2)

(ii) Authors' names and affiliations (Chapter 3)

(iii) Abstracts (Chapter 4)

(iv) Keywords (Chapter 5)

(v) References (Chapter 6)

The purpose of the thesis is to look at the occurrence, form and content of these elements in research papers in the whole range of disciplines - natural sciences, social sciences and humanities - from the point of view of their suitability for use in bibliographic control. The contents of each chapter usually cover the following aspects (though with some variation in order):

(i) Occurrence of the bibliographic element. (Titles, authors' names and references are found in almost all research papers, but practice regarding authors' affiliations, abstracts and keywords varies.)

(ii) Instructions to authors about the bibliographic element. The occurrence of these is very variable between subjects.

(iii) Measurement or analysis of the information content of that element in papers in various subjects.

(iv) Consideration of how that element is used in bibliographic control or information retrieval with special reference to the requirements of newly developed tools.

(v) Examination of the form and presentation of the elements as they affect bibliographic use.

(vi) Recommendations to authors, editors and publishers about how their practice could be improved from the viewpoint of bibliographic use.

(vii) Consideration of whether bibliographic tools using that element in some subject areas could be applied in other subject areas.

Many earlier studies have looked at some of these aspects of particular elements in particular subjects, but, as far as I am aware, no previous attempt has been made to take an overall view of the 'raw material' of bibliographic control across the whole range of subjects. Reported studies normally deal with one element only, or else compare the use of one element with another (e.g. titles with abstracts). These will be reviewed in the relevant chapters later in the thesis, so there is no review of the existing literature in this chapter. Unfortunately, the reported studies often differ so much in samples and methods that comparisons and integration are frustrated.

1.3 LIMITATIONS ON METHODS

With such an ambitious scope, some limitations have had to be imposed on the method of proceeding. Firstly, experiments which would involve approaches to users were ruled out. One could conceive, for example, of an experiment in which a number of titles of chemical papers are presented to a group of chemists and a number of titles of historical papers are presented to a group of historians. The specialists are then asked what they think the papers are about, and from these responses the experimenter judges how well the titles have conveyed the content of the documents. Such an experiment would require, perhaps, ten researchers of similar expertise from each subject area to be covered - to obviate effects due to their individual specialisms within the discipline. Given the intention to examine a fair number of subjects, this kind of experiment would not have been feasible with the resources available. For information on users' information needs and uses, reliance is thus placed on studies reported in the literature.

Another area which had largely to be rejected was the use of commercially-available machine-readable databases. The negotiations and technical problems involved in obtaining tapes and processing them on a local computer would have been insurmountable in the time available. Databases available on-line were rather limited in subject coverage when the project was begun, and on-line systems could not have been interfaced with additional programs to produce the data wanted (e.g. counting the average number of words per title). A further complication in the use of commercial databases is that information in the original paper is often modified or enhanced - e.g. 'enriching' terms are added to titles, and abstracts are modified or rewritten - which means that they cannot be used for obtaining data about information actually in the papers. However, it was possible to make use of some data from the Chemical Titles database supplied by UKCIS, and MEDLINE was used for a specific application described in Section 5.7. Two small computer files of historical and philosophical titles were set up especially for this project.

Many earlier studies have used indexer-assigned descriptors as a standard by which to judge other bibliographic elements, e.g. they have compared retrieval performance using such descriptors and words in titles or abstracts. A detailed argument of why such an approach is inapplicable to a comparative study across subjects is given in Section 2.3.2. Briefly, it is because the quality, depth and specificity of indexing varies between different sources, and there is no single source for all subjects. (Even if there were, the sets of index terms for each subject area might not be comparable - compare, for example, the treatment of philosophy and chemistry in UDC.)

Finally, any detailed analysis of the linguistic structure of papers and abstracts, while it might have been highly illuminating, had to be ruled out for reasons of time. It could not possibly have been applied to enough papers in enough different subjects to enable the sort of comparative study required in this project.

1.4 THE CONCEPT OF INFORMATION

Since this thesis is about 'information content' I ought to indicate at the outset what I mean by 'information'. Much has been written on the concept of information for information science, and the literature has been surveyed by Belkin (1978). The most commonly proposed information concept is that of Shannon (1948), interpreted by Weaver (1949). This is to define information in terms of an entropy-like expression, H, based on the probabilities, $p_1, p_2 \ldots. p_n$, of the individual symbols or events constituting a message:

$$H = - \sum_i p_i \log p_i$$

If logarithms to thebase 2 are used, the resulting units are 'bits'.

Because it is just about the only mathematical measure of information in existence, it has been applied to many fields other than that for which it was intended - communication theory. However, Shannon stated:

> The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to theengineering problem. The significant aspect is that the actual message is one selected from a set of possible messages.

More concisely, Weaver (1949, p. 100) wrote: 'This word information in communication theory relates not so much to what you do say, as to what you could say.' He also pointed out that 'it is misleading (although often convenient) to say that one or the other message conveys unit information. The concept of information applies not to the individual messages (as the concept of meaning would), but rather to the situation as a whole, the unit information indicating that in this situation one has an amount of freedom of choice, in selecting a message, which it is convenient to regard as a standard or unit amount.'

Maniez (1978) has illustrated the difference between such a definition of information and what is normally understood as information by the following examples:

(A) 'Is my husband dead? No.' Value = 1 bit

(B) 'On which day of 1947 was your husband born? On the 4th of May.' Value $>$ 8 bits.

The ability to give a numerical value for the information associated with answering these questions depends on the fact that the answers are selected from a set with a known number of possible answers - 2 in the first case and 365 in the second. If the question had been 'On what date was your husband born?' the number of possible answers would have been uncertain, and if it had been 'How tall is your husband?' the number would have been even more uncertain, since the value is a point in a continuum rather than one of a set of possible values.

I have been able to make use of a measure of information based on the probabilities of occurrence of words in studying titles from the point of view of machine retrieval using keywords (Section 2.8). There it is sufficient to assess the information associated with the author's choice of the words to be put in his title. The probability of a word being selected is assessed by counting how often it is used in a large sample of titles. Shannon's formula quoted above is not used, because what is required is a value for the information content of a <u>particular choice</u> of words - not the information-carrying capacity of a title given the set of possible words with known probabilities which <u>could</u> be chosen to make up the title.

Elsewhere in this thesis, a concept of information which takes account of meaning is needed. It does not seem useful to suggest that one statement has a higher information content than another if it says the same thing in less common words, or words consisting of less common letters. The natural way to extend Shannon's definition would then seem to be to base the measurement of information on the probability of the fact reported. But this raises some profound andintractable problems. Firstly, there is question of whether a statement can be broken down into individual 'facts'. Quine (1970, p. 4) has written: 'There is no evident rule for separating the information from stylistic or other immaterial features of the sentences.' The meaning of a sentence frequently depends on its context. For example, to assign an information value to the statement 'The mixture then turned bright red', the statement would first have to be expanded to include what the mixture consisted of, and what was meant by 'then' (which might be quite complex). Then, supposing the individual facts have been listed, how can their probabilities be determined? Usually, the set of possible values is not known, and on what basis could probabilities be calculated if they were? Should it be assumed that 'the mixture' had an equal probability of turning any colour in the rainbow, with any intensity from faint to brilliant? To what extent should one's existing knowledge be taken into consideration? A chemist who had studied the behaviour of ten similar mixtures in similar conditions and found that they all went red might rate the probability that this one would turn red rather higher than someone who lacked the benefit of this experience. Does this mean that information is necessarily subjective?

The prospect of determining the information content of a piece of text (e.g. an abstract) in any absolute way thus seems remote indeed. However, the concept of a probability-based measure does enable some assertions to be made about relative information contents. For example, all papers about Toulouse are about France, but the reverse is not true. Thus the statement 'This paper is about Toulouse' can be said to have a higher information content than 'This paper is about France', and the descriptor 'Toulouse' has a higher information content than the descriptor 'France'. If a paper has the descriptor ''Toulouse', then the probability that it is about France is one, and the descriptor 'France' adds nothing to the information. To take another example, an author could be indexed as 'James Edward Smith', 'J.E. Smith', or 'J. Smith'. Since these three forms cover increasing numbers of authors (and papers), they are of increasing probability, and decreasing information content.

Since most of the bibliographic elements can be reduced to statements of the form 'This paper is about X', or 'This paper is written by Y', such considerations enable a certain amount of progress to be made in evaluating the information content of the elements. The technique of looking at how often a term is used in a large sample of papers could be extended to compare the information content of an author's name with that of a keyword in a title (for retrieval from a given set of documents), and it could be used on keywords in abstracts as well as those in titles. However, such exercises would seem to be of limited usefulness. Usually the application of authors' names to a paper is governed by considerations other than those of information retrieval (though perhaps a supervisor could claim that inclusion of his name helped in bringing together papers resulting from the projects he supervised?). Also in informative abstracts the keyword content is regarded as of secondary importance to the expression of findings given in the paper. Evaluation of this kind of information content of abstracts thus leads to the problems discussed above.

Hence, apart from the study of keywords in titles, numerical values are not put on the information content of the bibliographic elements. Often the number or length of the elements is used as a superficial measure of their information content. In the case of abstracts, the main study is an analysis of the information they contain in terms of its relationship to the text of the paper. This seems to be the most practical approach for giving guidance to authors on abstracting.

C H A P T E R T W O

TITLES

2. 1 INTRODUCTION

The course of this chapter will be firstly to consider what are the functions of the titles of research papers in bibliographical control, and then to attempt to evaluate samples of titles with respect to these functions. One object is to see what differences there are between titles of papers in different subjects, and how these would affect the performance of title-based retrieval services in those subjects. Changes in the informativeness of titles with time will also be looked at, to see whether titles are becoming more suited to the requirements of such services.

When this work was begun, computerized information retrieval systems and printed products such as KWIC indexes were fairly well established in the sciences and in medicine and engineering, but at an early stage in the social sciences. Now in 1979 Current Contents has been extended to the arts and humanities, and a number of databases in those areas, such as Historical Abstracts, Art Modern, Language and Language Behavior Abstracts, and Magazine Index, are available for on-line searching. If the development of title-based services has been responsible for an increasing informativeness of titles in the sciences, as several authors, e.g. Black (1962), predicted it would, then it will be interesting to see whether this happens in the humanities over the next few years.

Some journals draw attention in their 'Instructions to Authors' to the function of titles in information retrieval. Such instructions are most common in the life sciences, and the most detailed set was found in the Journal of Biological Chemistry (1979):

> A clear and informative title is very important in bringing a paper to the attention of readers. The title should be as short as is consistent with clarity; in most instances two printed lines are adequate. The title should not include chemical formulas or

arbitrary abbreviations, but chemical symbols may be used to indicate the structures of isotopically labelled compounds. Bear in mind the increasing use of titles in the construction of certain types of indexes, e.g. Chemical Titles, Biological Abstracts. The main part of the title should include the name of the compound, system, enzyme, etc., that is the major object of the study. Series numbers are not permitted except when a group of papers, starting with I, are to be published together. Indication that the paper is part of a larger series may be placed in a footnote to the title.

Other examples of instructions on titles are:

American Journal of Physiology: The title, a widely circulated part of the article, should be informative. It should contain no unnecessary words like "Studies in ...", and should not exceed 85 characters, including spaces between words.

Archives of Internal Medicine: Titles should be short, specific and clear. They should not exceed 42 characters per line, including punctuation and spaces, and be limited to two lines, if possible.

Journal of Ecology: The title is the most important part of your paper. On the basis of the title, readers will decide whether to read further. It should be as accurate and as succinct as possible. It should reflect the content and the ecological significance of the paper.

Botanical Journal of the Linnaean Society: The title should be concise but informative and include, where appropriate, mention of the family or higher group for retrieval purposes. A sub-title may be included but papers in numbered series are to be avoided as far as possible. The name of a new genus or species must not be contained in the title.

Annals of Statistics: The title should be descriptive and as concise as feasible, i.e., it should indicate the topic of the paper as clearly as possible, but every word in it should be pertinent.

The suggested maximum title length may be related to the line length used in KWIC indexes (see Section 2.7), though it is rather greater than the length normally used in such indexes.

An early example of editorial guidance on titles in the humanities is that given by Hay (1962) in the English Historical Review: 'The title of any contribution should be as brief and precise as possible, so that the reader scanning contents or index knows where he is in time and space.'

2.2. FUNCTIONS OF TITLES

The places in which titles or parts of titles occur and are used for retrieval purposes are considered in this section.

2.2.1 In the primary journals

(a) In contents lists. The contents lists of individual issues usually appear prominently on the cover, and show titles, authors' names, and page numbers. Gushee (1968) wrote that 'when you ask a chemist how he reads a journal, he will frequently tell you that he goes to the table of contents, finds the articles he wishes to read, and then goes to those articles and reads them'. However, 'engineers and executives tend to leaf-through the magazines they read page by page'. (Perhaps the use of the word 'magazine' as opposed to 'journal' suggests publications of general rather than technical interest.) This observation about chemists' behaviour was borne out by a study by Kuney and Weisgerber (1970). They found that the first action of 76% of readers of the Journal of Organic Chemistry on receipt of an issue was to scan and read the table of contents. Twenty-three per cent of readers also scanned the author index. The use of contents lists is no doubt of greatest importance for journals containing a large number of papers in each issue. (The issue of the Journal of Organic Chemistry used by Kuney and Weisgerber contained 48 full papers and 33 notes.) Journals in the humanities usually contain a fairly small number of papers in each issue, so that full-text browsing is more practicable.

Apart from their use in the initial scanning of journals, contents lists are also useful for finding an article when one remembers in which journal and approximately when it appeared.

Gushee (1968) states that 'general titles get more attention than specific titles do, although if they become too general they again cause a loss of interest'. There is a divergence of views and practice on whether to make a title as informative as possible (within space limitations), so that a reader who knows what he wants can readily see whether this is it, or whether to make it interesting but less informative, so that a reader who does not know what he wants will turn to the article out of curiosity. Scientists will not normally tolerate the latter in technical journals, and titles in the sciences generally follow the first philosophy and are long and specific, e.g.

> Electrophilic bromination of aromatic conjugated olefins. II. The mechanism of the dual-path additions in stilbene bromination. Evidence from multiple substituent effects for carbonium intermediates. (Journal of Organic Chemistry, 1973)

On the other hand, authors in the humanities, especially in philospphy, often pursue the second course, and one finds titles such as

> Never smile at a crocodile (Journal for the Theory of Social Behavior, 1973)

and'The ceiling titles' (Psychoanalytic Quarterly, 1978)
These titles may be effective in attracting attention when scanning, but they frustrate the use of titles in information retrieval as discussed below.

(b) In reference lists in journal articles. References in journals in most subject areas (but not usually in the physical sciences - see Section 6.2.2) include the titles of the cited papers. Such papers will sometimes be seen to be relevant from the context in which they are cited, but it is often helpful to have the title too. Garfield (1963) claimed that this information could avoid many unnecessary interlibrary loans.

Wood and Bower (1970) have reported a survey on loan requests received by the National Lending Library for biolcgical and medical journal articles. They found that the most common source of references was from other periodical articles (41.5% of requests in biology and 36.6% in medicine). Similar findings were reported by Hakulinen (1974) from a survey of borrowers at the Karolinska Institutets Bibliotek - 32.8% of requests arose from references in articles or books - and by Van Styvendaele (1977) at the Antwerp State University Centre - 39% of periodical loans in science and technology arose from references in papers, and 27% of loans in the social sciences. Thus reference lists must be considered as one of the most important tools of information retrieval, and I argue in Section 6.2.2 that the extra space needed to include titles of cited papers appears to be amply justified.

2.2.2 In secondary services

(a) In reproductions of contents pages. Some secondary services, such as the various parts of Current Contents, and the Psychological Reader's Guide, contain facsimile contents pages from primary journals, and others, such as the bibliography of Chemical Titles and many local services, such as CABLIS and L.A. Information in librarianship, contain transcribed contents lists. Primary journals, e.g. the Journal of the Royal Statistical Society. A, sometimes contain reprinted contents lists of other journals. (This practice may be a hang-over from times when journals were less readily acquired.) In this application the title needs to generate rather more interest in the paper, since the reader has to expend effort in obtaining a copy instead of just looking it up in the issue he is holding. Current Contents contains authors' addresses (in an abbreviated and distinctive form) and was shown to be the source of about 40% of reprint requests in Posen and Posen's (1969) study in biochemistry. The reprint requests received for my paper in the Journal of Documentation also frequently used the form of address given in Current Contents.

In 1959, Voigt commented that some chemists were giving up using Chemical Abstracts for current awareness and relying on titles alone in Current Chemical Papers (see next Section). Due, no doubt, at least in part to the ever-increasing numbers of papers appearing, this trend has continued. Urquhart (1965) found that 855 of chemists replying used Current Chemical Papers to keep up to date, compared with 756 who used Chemical Abstracts. In May 1963, references from abstracting journals provided 43% of the loan demand. Wood and Bower (1970) reported that abstracting and indexing publications accounted for 23.7% of requests in biology and 30.7% in medicine. The major service in biology was Current Contents (4.6%), while in medicine it was Index Medicus (11.2%) with Current Contents second (4.3%). For 1968 literature, Current Contents provided the references for 21.6% of biomedical loan requests. Hakulinen (1974) reported that 42.2% of loans arose from references in abstracting and indexing journals, with Current Contents accounting for 26.7% and Index Medicus for 9.8%. Finally, Van Styvendaele (1977) found that abstracting and indexing journals produced 14.5% of loans in the social sciences, and 33.5% in science and technology (18.0% from Current Contents).

Current Contents has thus achieved a high popularity as a current awareness tool. Hakulinen (1974) suggested the main reasons as being the speed of delivery of information, partly due to its weekly publication (but perhaps more to the simplicity of production) and the large circulation, leading to low cost. Although Garfield (1970) has pointed out that titles examined on a contents page have more value than titles seen out of context, the titles of papers are presumably being relied on as the main indication of interest.

(b) _In index journals arranged by descriptors_. Such services include _Index Medicus_, _Repertoire bibliographique de la Philosophie_, _International Bibliographie der Zeitschiftliteratur_, and the now-defunct _Current Chemical Papers_. The depth of indexing in these publications varies widely, but often the headings are so broad, and the number of papers under them is so considerable, that reliance has to be put on the titles of papers (plus, perhaps, the journals in which they occur) in judging likely relevance. The high popularity of _Index Medicus_ and _Current Chemical Papers_ has been noted above.

(c) _In KWIC indexes_. In the early days of computerized KWIC indexes (see e.g. Luhn (1960)) they were seen as useful mainly for current awareness purposes, because they could be compiled rapidly by keying in titles with little or no intellectual effort. They would thus fill the gap until the documents were covered more adequately by abstract journals with more sophisticated indexing.

Chemical Titles comes out fortnightly, and provides a very up-to-date index to the chemical literature. It is not cumulated, and so likely to be of use only for current awareness. However, BASIC, the subject index to _Biological Abstracts_, is cumulated semiannually, and the index to _Geo Abstracts_ is produced annually, so these are available for retrospective searching. The _Bulletin of the American Association of Petroleum Geologists_ has had a manually-compiled index based on title keywords for its annual volumes since 1923. (The index is now computerized and includes keywords from the abstract, text and captions.)

Chemical Titles refers from KWIC entries to journal references by means of CODEN, few, if any, of which can be recognised by readers.

In Biological Abstracts and Geo Abstracts the reference is by means of abstract number. Thus the title, or part of title, is usually the sole information available at the time of selecting items of interest from the index.

With regard to the possibility of introducing KWIC indexing into the social sciences, Foskett (1970) has written: 'Since I am convinced of the need for controlled vocabularies, it will surprise no one to hear that I regard KWIC indexes as of doubtful value in the form in which they are often produced: as a subject index to a bibliography arranged in alphabetical order of authors' names.' He complains that the lack of references from synonyms and related terms, and the absence of guides to help the user to structure his thinking are a retreat from all that good indexing sets out to be. Hall (1976) rejected the use of KWIC or similar indexes based on titles in archaeology 'because the title is notoriously a very poor indicator of the content of the work.'

Several authors, e.g. Voress (1965), Fischer (1966) and Chones (1968), have suggested enhancements to KWIC indexing, by augmenting inadequate titles and standardising or giving cross-references for variant spellings, singulars and plurals, hyphenated words, etc. Such enhancements require some human indexer effort, and so detract from the benefits of computerised index production, though some compromise may well be effective. Biological Abstracts 'enriches' titles by adding names of organisms, organs, drugs, geographical and geological locations, etc., when necessary, and standardises on American spellings and certain abbreviations and hyphenations. Geo Abstracts sometimes adds terms from the abstract.

(d) In Permuterm indexes. The Permuterm indexes of the Science

Citation Index, Social Sciences Citation Index, Arts and Humanities Citation Index, and the Journal of the Electrochemical Society function in a somewhat similar fashion to KWIC indexes, except that each title keyword is given only in the context of the other keywords one at a time. There may be considerable ambiguity as to the relation between such pairs of keywords, since they may be widely separated in the title. The Arts and Humanities Citation Index adds the names of people, places or things that the articles are about to the original titles where necessary, with a limit of ten terms per item. Unlike the other Indexes, it includes 'see also' references.

(e) In single keyword indexes. The various parts of Current Contents have an even simpler index, in which references are listed under each keyword in the title. The indexes are not cumulated.

(f) In machine-readable databases. Mechanized information retrieval systems usually allow searching by keywords in titles, and by truncated words (e.g. ELECTR? to retrieve electrical, electricity, electron, etc.)

2.2.3 Discussion

A distinction can be drawn between those functions where the title as a whole is selected by the user - viz. in contents lists, reproductions of contents lists, index journals arranged by descriptors, and reference lists - and those where individual words in the title are used for selection - viz. in Permuterm indexes, single keyword indexes, and machine-readable databases. KWIC indexes are rather a borderline case.

When the title is seen in its entirity, metaphors can often be recognised as such (and sometimes even understood) and ambiguities can be resolved. However, in using services which depend upon individual words, these words are expected to be used in their normal senses. (If they have more than one, e.g. 'cell' in biology and physics, the searcher may be able to combine them with another search term to ensure that the right sense is selected.) The use of an unusual expression, such as a metaphor, to describe a concept may result in its being non-retrievable by title words, and in false drops. For example, 'Never smile at a crocodile' (which is about the need for communication between psychologists and philosophers) would be a false drop for someone searching for papers about the behaviour of crocodiles. The title 'Is money a four-letter word?' (Psychoanalytic Review, 1977) gives some idea of what the paper is about - 'money' as a dirty word, or 'filthy lucre' - when seen in its entirity, but contains only one useful keyword - 'money'. The title 'Good-bye teacher ...' (Journal of Applied Behavior Analysis, 1968) contains the keyword 'teacher', but the paper is in fact about a new method of personalised instruction which redefines the role of the teacher. This is hardly covered by 'good-bye'.

One supporter of 'attractive' rather than 'informative' titles is Anders Martinsson. In an editorial in Lethaia (Martinsson, 1972) he claimed that the title serves primarily the selective reader, and that the abstract serves to extend the title. Thus overcrowded titles can be 'cleaned up' and the information transferred to the abstract. He considered that the development of 'automatic documentation' means that the drawbacks of having fewer keywords in the title 'do not carry much weight'. In a later conference paper (Martinsson, 1978) he went further and suggested that a list of keywords can relieve the abstract of its indicative (or indexing) function and so allow it to concentrate on its informative function.

Mechanized information retrieval systems usually allow keyword searching of abstracts, though not usually of authors' keyword lists. It seems rather inefficient to have to invert on (i.e. create index terms from) every non-stopword in the abstract for the sake of a fairly small proportion of useful additional keywords. The quality of authors' keyword lists is discussed in Chapter 5, and is not very encouraging.

In the other contexts listed above where titles are used for retrieval purposes, the abstracts are not present, so that searchers are reliant on the titles alone (except where additional effort is put in by the secondary service). Since some of these services are heavily used, I cannot accept that editors should encourage titles designed only with the primary journal readers in mind.

2. 3 PREVIOUS EVALUATIONS OF TITLES

2.3.1. Relative studies

When keyword indexes of titles were first being introduced, offering considerable savings in time and cost over traditional indexes, concern centred on whether they could perform as well as indexes based on descriptors assigned manually by indexers. The early evaluations compared the words found in titles with descriptors assigned to the corresponding papers in indexing journals, making allowance for the facts that KWIC index users would spot adjacent inflexional variants such as singulars and plurals when using the index, and might also be expected to think of looking under some synonyms and perhaps related terms. Later studies were related to the introduction of computerised retrieval systems using words in titles, and compared the recall (and sometimes precision) obtained when profiles were searched against titles and index terms respectively.

In view of the level of interest and activity in information retrieval in biomedicine and chemistry, it is perhaps not surprising that a fair number of studies relate to those areas. In particular, the carefully controlled and deep indexing of Index Medicus /MEDLARS and Chemical Abstracts provides ready sources of descriptors for comparison exercies, and UKCIS and MEDLINE have provided suitable systems for retrieval exercises.

(a) Biomedicine. Montgomery and Swanson (1962) studied 4770 entries in Index Medicus. They found that 4093 (86%) of the title entries contained words identical or synonymous with words in the headings under which they appeared. For matches with multiword headings, the requirement was that if the heading contained a word found in that heading alone then the word (or a synonym) must be in the title: if it did not contain a unique word then all words in the heading (or synonyms) had to be in the title.

The breadth of Montgomery and Swanson's concept of synonymity was criticized by O'Connor (1964). He pointed out that as well as true synonyms and inflexional variants, they had admitted generic relationships (e.g. 'antibiotics' and the names of seventeen particular antibiotics), and other relationships such as that between calcium and nephrocalcinosis. O'Connor accepted only words given as synonyms by a dictionary in his investigation of the correspondence between titles and index terms in the Index-Handbook of Cardiovascular Agents, the Merck Sharp and Dohme Retrieval System, and the N.I.H. Research Grants Index. He found a match of 19-45% for the first, 40-68% for the second, and 13-39% for the third (using 95% confidence limits - his sample sizes were rather small).

Miller (1971) has compared searching on the MEDLARS database using title words and descriptors, and reported that for equal output, title searching retrieves four relevant references for every five retrieved by index term searching. Harley and Myatt (1972) have also compared searching on titles and descriptors. They claimed that 66% of the references retrieved from MEDLARS and judged relevant by users would have been missed by title searching alone.

Ghosh (1974) examined the titles of 2792 papers in a bibliography of prostaglandin literature (which is equivalent to their having been indexed under 'prostaglandin') for the presence of the fragment PROSTA- or a related acronym. Eighty per cent of the titles contained at least one such term, and the proportion was significantly higher for 1972 than for the earlier years.

Another study by Ghosh (1975) involved 2435 papers listed under ninety-one eponymous disease and syndrome headings in Index Medicus for 1973. Of these papers, 72.2% had the eponym in their titles, another 8% had corresponding noneponymic synonyms, and 19.8% had neither. Ghosh points out that his two results approach the 86% match found by Montgomery and Swanson and almost parallel that of

Miller. They also come close to Windsor's (1971) figure of 71% for the presence of 'DOPA-words' in the titles of his collection of 1310 papers on DOPA and dopamine in mammalian systems. They also show some correspondence with Saracevic's (1969) study (reviewed in Section 4.12.5) which implied that, with the help of titles alone, users would be able to recognise about 66-75% of the documents which they judged relevant from the full text. However, there is a considerable discrepency with respect to O'Connor's results, which shows the dependency on the exact criteria for matching, and, as I shall argue later, on the source of index terms.

Ghosh (1977) also looked at 2152 papers recorded in Index Medicus between 1973 and 1975 under headings containing the fragment CONTRACEP- or under INTRAUTERINE DEVICES. Four lists of different types of words relating to contraception were compiled using dictionaries and subject specialists, and the titles were examined for the inclusion of such words. 1984 of the papers had at least one 'contraception term' in their titles, so that 'solely on the basis of a title search (manual or computerised) with the "contraception terms" it is possible to retrieve about 92% of documents pertinent to the areas of interest to contraception research workers.' This is the highest success rate reported in such studies, and is no doubt a consequence of the wide range of relationships between title word and index term which were allowed as matches. A second set of 567 titles listed under contraception headings in Index Medicus during 1963-65 included 88.0% with at least one 'contraception term', which was taken to suggest that titles had become more informative during the following ten years.

Schultz et al. (1965) performed a study primarily intended to compare author-assigned descriptors for 285 biomedical papers with terms assigned by potential users. A limited amount of standardization was done 'when two phrases or words appeared to be equivalent as used by Federation scientists'. The authors' sets of descriptors contained on average 33% of the terms in the potential users' sets, while the titles contained 24%. However, the mean number of terms in the users' sets was about eleven, so a high degree of matching could not be expected.

(b) Chemistry

Ruhl (1964) compared the indexing of 84 documents in Chemical Titles and Chemical Abstracts Subject Index. The Subject Index entry was considered to be 'covered' if each word or concept itself, a synonym of each word, or a generically related term was included in the title. She found that 57% of the titles covered all subject headings used by Chemical Abstracts for the paper, 17% missed one entry, 14% missed two, and 12% missed three or more. The average number of Chemical Abstracts Index entries was four. Ruhl was concerned with the development of KWIC indexes, and wrote that 'we might conclude that titles, on the whole, defined adequately the work which was being reported in the document'. However, the relationships allowed in matching were rather broad, e.g. 'cells' in the title was allowed as "adequately synonymous" to 'Neoplasms' in the index, and 'ketones' in the title was considered equivalent to specific ketones in Chemical Abstracts. One might doubt whether the use of these broad terms in searching on titles would secure very much precision.

A comparison of 171 titles with index entries in Chemical Abstracts was made by Bottle and Seeley (1970). They found it necessary to split up the complex index entries into 'keyword groups' corresponding to 'conceptual entities' before matching. Overall, 77.4% of concepts in the index entries were represented in the titles, 42.9% identically or as syntactical variants and 34.6% as synonyms or related terms. (Ruhl's results recalculated on the same basis give 73-81%.) The proportion was 86% for 'processes and reactions' concepts and 84% for properties and their measurement, but only 70%

for specific chemical substances. A similar comparison was made for 74 titles in Nuclear Science Abstracts. There the overall match was 69.8% and the representation of chemical substance names was again 70%.

The comparison which Jahoda and Stursa (1969) made was of document titles and the single index terms used to order the 3,204 documents in the offices of three research chemists. The titles provided an average of 4.55 access points per document in a KWOC index, but there was no significant difference in the retrieval performance of the two indexes either as regards precision (about 20%) or recall (about 50%) on the fifty-five searches made.

Lynch and Smith (1971) evaluated retrieval using the Chemical Titles service at UKCIS against a parallel manual service. Their profile, concerned with field-ion microscopy and its use in studying the initial oxidation of metals, was carefully constructed so that it would retrieve virtually every entry in their collection of useful references for the previous year. A total of 1,783 items were retrieved by the computer, of which 200 were considered relevant - a precision of 11%. (This is low by normal standards, but required a scanning time of about 15 minutes per fortnight, which was considered acceptable.) Of the 180 items retrieved by manual or computer searches and classed as 'important', 89% were actually retrieved using their titles and 93% would have been but for programming errors. The high figures obtained here must be attributed to the low precision tolerated, as well as the care in profile writing.

Barker et al. (1972) at UKCIS compared searching on titles and on keywords in the Chemical Abstracts Condensates database for 193 profiles. Different versions of the profiles were used for the two types of searching, and the recall ratios were calculated as proportions of the total number of relevant items retrieved by all versions of the profile. The average precision found was 53.6% for titles and 47.5% for keywords, while the average recall was 65.7% for titles and 72.8% for keywords.

(c) Physics

Maizell (1960) compared the titles of 25 articles with the corresponding 52 subject index entries in Physics Abstracts. Of these, 69% were found to be 'given in the words of the title', and 63% of the titles contained all of the entries supplied by the indexer. Chemical Abstracts indexed 23 of the articles. Of the 92 subject headings used there, 47% were given in the words of the title and 23% of the titles contained all the information supplied by the indexer. Most of the additional index entries given by Chemical Abstracts, and some given by Physics Abstracts, were names of chemical substances, which Maizell believed to be 'of relatively little value' to the physicist. He suggested that many of the titles could easily have been modified to include all the concepts under which they had been indexed.

A retrieval study was reported by Fisher and Elchesen (1972) in which twenty-five profiles for questions of interest to laboratory personnel were run against titles, index terms assigned by Nuclear Science Abstracts, and titles and index terms combined. The questions were chosen to produce high precision. Of the total citations retrieved by all methods, 92% were obtained by searching index terms alone but only 31% by titles alone. The authors took the results to show that 'in the field of nuclear science and technology, there seems to be a high probability that retrieval on the basis of titles alone is inadequate'.

(d) Engineering

A study by Bottle (1970) of the correspondence between the titles of engineering papers and their index terms in three different secondary journals is perhaps the only one to recognise the possible effect of the standard taken for comparison. Bottle defines a 'specificity index' for each journal based on whether the titles were, on average, much more (5 points), more, equally, less or much less (1 point) specific than the corresponding full index entries. Using a sample of 90 papers, he obtained the values 3.2 for British Technology Index (BTI), 2.1 for Engineering Index (EI) and 1.7 for Applied Science and Technology Index (ASTI). The specificity rating of the indexes are dependent on two factors: the number of keywords per heading, and the specificities of these keywords. The first factor was measured, and was 2.7 for BTI, 1.7 for EI and 2.1 for ASTI: the larger number of keywords in BTI thus corresponds to greater specificity. The second factor was not, however, evaluated.

The proportion of index concepts not covered by words in the titles was found to be 37.5% for BTI, 32.4% for EI, and 51.2% for ASTI. For a set of chemical papers, the differences were even greater but in the opposite direction: 39.1% for BTI, 21.9% for EI, and 19.6% for ASTI. The source of index terms for such comparison experiements may thus have a considerable effect on the results. Probably the fewer the keywords used by the indexing service, the more informative will the titles appear by comparison. The effect of differences in the specificities of the words involved is less easy to predict. Index terms probably tend to be more general than title words, but several of the comparative studies allowed some related-term matching, including generic relationships.

(e) Librarianship

Brodie (1970) compared keywords in titles with the subject headings in Library Literature. She included words added by the indexes to nonsignificant titles in with title words - so that she was strictly evaluating a potential KWIC index rather than the titles *per se*. Of 1,379 titles, 35.1% contained words which were identical with or inflexional variants of the headings, 10.4% contained terms in a thesaurus relationship, and 10.0% contained terms in a generic relationship. Thus 44.5% of titles exhibited no defined relationship with the subject headings, but this was blamed partly on the headings rather than on the titles. Brodie claimed that the relevance of titles in the literature of librarianship is not substantially lower than that of other subject fields where KWIC indexes are currently in use.

(f) Psychology

Bottle and Preibish (1970) estimated the performance of a proposed KWIC title index in psychology by comparing 300 index entries in Psychological Abstracts with words in the corresponding titles. Fifty-three per cent of the keywords in the index terms were identical with, or inflexional variants of, words in the titles and 8% were synonymous, so 39% were lacking in the titles.

A somewhat different method was used by Papier (1963). Scientists working in psychology were asked to supply titles for papers sent to them. After eliminating the 'small words', and allowing words with the same root as matches, Papier found that 53% of the scientists' words were in the authors' titles, and 46% of the authors' words were in the scientists' titles. Assuming that scientists would use the same words in approaching a KWIC index, they would have a 46% chance of retrieving the article on a first try. Only one of the 51 titles returned had no word coinciding with the author's title.

(g) Law

The potential for KWIC indexes in law was examined by Kraft (1964). Eight hundred and three titles were compared with the headings under which they were found in the Index to Legal Theses and Research Projects and 2,625 titles with headings in the Index to Legal Periodicals. Kraft found that 64.4% of titles contained a word from the subject heading (or an inflexional variant), 5.3%

contained another subject heading which was equally acceptable, 6.4% contained synonyms of the subject heading, 13.4% contained keywords 'that would enable a legal researcher to find it (sc. the title) in an obvious manner under a KWIC indexing system, and 10.5% were 'non-descriptive'.

(h) Interdisciplinary

Lane (1964) compared the suitability of titles in different subject areas for KWIC indexing in a study involving nine different indexing journals. Fifty titles were sampled in each and were counted as 'acceptable' if they contained a word which was 'identical or similar' to the subject heading under which they appeared. If they did not, a similar check was made under other possible subject headings. The acceptability of the titles in the various journals was:

Applied Science and Technology Index	86%
Engineering Index	82%
Bulletin of the Public Affairs Information Service	78%
Index to Legal Periodicals	66%
Bibliography of Agriculture	60%
Business Periodicals Index	58%
Education Index	56%
International Index to Periodicals	50%
Readers' Guide to Periodical Literature	42%

Lane concluded that 'in science and engineering the titles of the articles usually describe or imply the contents of the articles. In non-technical fields titles reveal the contents much less frequently; and in a general index such as Readers' Guide titles are indicative less than half the time.'

Finally, there is the study by Sedano (1964) which compared title words and subject headings for samples of 200-510 titles in six different indexing journals. The comparisons were classed as: (a) the title contained the index term or a word with the same root; (b) the title contained a synonym of the subject heading; (c) the title contained useful keywords but not those of the subject heading(s); and (d) nondescriptive. Sedano's results are summarised in Table 2.1.

Table 2.1 Results of comparisons of title words and subject headings from Sedano (1964)

Indexing journal	(a)	(b)	(c)	(d)
Engineering Index	83.1%	2.0%	12.8%	2.1%
Appl. Sci. & Technol. Index	88	1.0	7.5	3.5
ASM Rev. [metals]	86	0	14.0	0
Bull. PAIS [public affairs]	55.3	3.3	37.7	3.7
Business Periodicals Index	45.0	7.5	32.0	15.5
International Index [social science & humanities]	32.2	1.5	44.2	22.1

(i) Evaluations against abstracts

There are a number of studies which compare the results of retrieval using titles and using abstracts. These will be discussed in the chapter on Abstracts (Section 4.12.5).

2.3.2 Criticism of relative studies

Many of the evaluations of titles reported in the previous section were designed to determine their suitability for retrieval when formatted into a KWIC index. They assume that a reader would look under the same terms in the KWIC index as he presently uses in the conventional index, and measure how often this approach would be successful. It is reasonable to expect that inflexional variants would normally be spotted when looking for terms (e.g. 'vibration' and 'vibrational' when the conventional index has 'vibrations') as these will normally be adjacent, though not in such cases as 'mouse' and 'mice' or 'ovum' and 'ova'. One does not know how careful the experimenters were on this consideration.

As mentioned in Section (a) above, O'Connor (1964) criticised Montgomery and Swanson's study for their wide definition of synonymity. The underlying question is under what synonyms or related terms would a user think of searching to find articles on his desired topic - especially if he finds some articles under the first word he tries. The use of dictionaries or thesauri to determine related terms does not really solve the problem, since there is no guarantee that a prospective user would use the same (or any) reference work. Some of the studies reported above had quite high percentages of 'synonym' or 'related term' matches, and the use of different criteria by different experimenters must throw doubt on the comparability of their results. In the interdisciplinary studies the authorities were presumably different for each subject, or more likely the decisions were purely subjective.

All the studies reviewed above are relative ones, in the sense that the titles are evaluated against indexer-assigned terms as a standard. It must be recognised that such index terms provide neither an ideal nor a constant standard. The differences between indexes which may affect the results of matching experiments are the number of index terms per paper (i,e. the exhaustiveness of the indexing), the number of keywords in each, and the specificity of the keywords. These points were discussed in connection with Bottle's (1970) study in Section (d) above. 'Subject headings' are used in many indexing journals to bring related papers together - perhaps discussing particular individuals in a class of entities - but the index terms used in other indexes are even more specific than the title. For example, Philosophers' Index used the heading 'Science' for the title 'Elementary causal structures in Newtonian and Minkowskian space-time', whereas at the opposite extreme Chemical Abstracts indexed 'Manganese catlyst as a possible cation carrier in thermoluminescence from green plants' with an entry 'Scendesmus obliquus: thermoluminescence of, manganese in relation to'.

One factor which must have a considerable effect on particular experiments is whether the indexing service has an existing authority list or whether it coins terms on an ad hoc basis. Some indexing services use a controlled vocabulary for the headings and add free-text qualifiers. Where free-text is allowed, indexers are likely to be influenced strongly by the title in their choice of terms.

O'Connor (1964) has observed that 'an indexing duplication investigation should not be called a test of mechanised indexing methods. For one can always ask: how good, really, is the human indexing being used as a standard?' The performance of MEDLARS indexing has been investigated by Lancaster (1969). In a programme of 302 searches, 238 contained recall failures (recall ratio 57.7%), so that 797 articles were relevant but not retrieved. The number of individual failures was 868, which included 279 attributable to the searching process, 199 to inadequate user-system interaction, 298 to the indexing process, and 81 to lack of appropriate terms in the indexing language. Of the indexing failures, 46 were due to the indexing being insufficiently specific, 162 to its being insufficiently exhaustive, and 78 to the indexer omitting important concepts.

A number of studies of interindexer consistency also throw doubt on the reliability of human indexing as a standard. Zunde and Dexter (1969) have reviewed some of these, mainly from American report literature. One study gave consistency values of 35-45% for experienced indexers using aids such as controlled vocabulary.

Another, without aids except for indexing rules, gave consistencies of 16.3% for experienced indexers and 12.6% for inexperienced indexers. A third investigator reported values of 40%, 42%, 48% and 70% with varying indexing systems and types of document. Cooper (1969) has demonstrated that the general relationship between inter-indexer consistency and successful retrieval is more subtle than might have been expected. However, the point here is that indexers are not consistent with one another, so their indexing cannot be taken as an absolute or an ideal with which to compare other forms of indexing.

Hines and Harris (1970) have pointed out that one factor which has been neglected in comparisons of KWIC and conventional indexes is the lack of meaningful structuring under the index word in the former. For indexes of relatively small numbers of documents designed for current awareness this is not much of a problem. However, Brodie's sample index, for example, that of Library Literature, would contain about 12,000 entries in each bimonthly issue, so that lack of structuring would be a problem under some words. Hines and Harris proposed that actual computer runs on a realistically large body of data would provide a better means of evaluation. They also mentioned that some topics used in retrieval experiments are more specific than would be appropriate for current awareness use - which is the principal intention of KWIC indexes.

Finally, Feinberg (1973) criticised the various samples used in the investigations. One comprised five articles and twenty subject specialists, another 84 titles, and another 50 papers from each entry. She suggested that conclusions based upon such sampling are 'open to question'.

2.3.3 Absolute studies

An evaluation of the information content of titles which depends not on comparison with indexing but purely on the titles was made by Tocatlian (1970). His method was to measure the information content by the number of 'substantive' words which the title contains, i.e. words for which an entry would be made in a KWIC index. Nonsubstantive words were defined as 'words that convey little or no information by themselves, such as articles, prepositions, conjunctions, pronouns, and auxiliary verbs. The object of his study was to find whether titles had become more informative between 1948 and 1968 (i.e. since the introduction of the computerised KWIC index in 1958). He used samples of ten articles from each of ten chemical journals published in 1948, 1958 and 1968. The mean numbers of substantive words per title were 5.57, 5.46 and 6.77 respectively, so that there was a statistically significant increase in information content since 1958. He also counted the number of titles with three or fewer substantive words in the selected years of the journals. There was a statistically significant decrease in the number of such titles between 1958 and 1968 for all the journals. Thus 'uninformative' titles were being progressively eliminated.

Another study using the same method is that of Bird and Knight (1975). They defined non-keywords rigidly as 'the 650 common words on the Permuterm Index stop-list, as well as single letter, number or hieroglyph codes'. For titles in Nature they found the mean numbers of keywords per title to be 4.5 in 1954, 5.5 in 1964 and 5.8 in 1974. The increases in both decades are statistically significant. The increase in overall title length was mainly due to the increase in the number of keywords, with the number of non-keywords remaining fairly constant.

They also looked at the mean numbers of all words in the titles of papers in the Journal of Clinical Endocrinology and Metabolism, Analytical Chemistry and Chemical Abstracts (Analytical Section). All these increased during the period 1954 to 1974, but not uniformly.

Kuch (1978) has studied the relationship between the number of substantive words in the title and the number of authors of a paper. For the American Journal of Physiology, Biochimica et Biophysica Acta, and the Journal of the American Society for Information Science, he found significant positive correlations, but no correlation for Biochemistry. He suggested two explanations for the positive relation: (i) that multiauthor papers are based on more extensive studies and hence have longer titles; and (ii) that each author of a multiauthor paper may want his own ideas of what is significant to be incorporated in the title.

The proposition that more substantive words in a title lead to better performance in mechanised retrieval has been put simply by Mitchell (1968, P. 95), 'The more keywords and unitems a writer can place in a title, the more likely it is that a machine will retrieve the article. Conversely, the fewer keywords, the less chance there is that a machine will be programmed correctly for retrieval.' A study by Olive et al.(1973) partly bears this out. In operating an SDI service based on Nuclear Science Abstracts, they found that for titles of fewer than 100 characters index terms gave better recall than titles; while for longer titles, the titles gave better recall. The shorter titles gave 51% precision and the longer ones 40%. (One factor responsible for this difference may be that papers with shorter titles tend to be on more general subjects. They are more likely to be of some interest to the user, whereas a highly specific paper on the wrong aspect of a subject will be irrelevant.)

2.4 A STUDY OF THE NUMBERS OF KEYWORDS IN TITLES: METHOD

To use numbers of keywords as a basis for comparison of titles in different subjects, it is necessary to decide on what words should be treated as nonsubstantive in each. Obviously the most suitable stop lists vary considerably; e.g. 'history' should be stopped in a history index, but not for astronomy; 'solution' should probably be stopped in mathematics, but not in chemistry; and 'reflections' will be useful in physics, but not in English literature. Clearly, there is no way of deciding on an ideal stop list for interdisciplinary studies, and it seemed safest to confine the list to prepositions, pronouns, conjunctions and auxiliary verbs, together with very general words such as 'aspect', 'different', 'method', 'problem' and 'very'. In the following measurements, a common stop list of about 230 words (including inflexional variants) was used, and in the studies of non-English titles the equivalents of these words were stopped. The frequency analysis of 1,000 English history titles reported in Section 2.8 shows that 36.7% of all words were stopped using this list. Twenty words, all of which were on the Permutem Index stop list, stopped 34.4% of all words, so the effect of minor differences in stop lists is quite small.

The next problem is to decide on what will be counted as a 'word'. As Tocatlian says, the formulation of clear rules is difficult. Chemical formulae, e.g. NaCl, Fe^{2+} and ^{40}Ar, serve much the same purpose as the chemical names, and are here counted as single words. Tocatlian counted multiword chemical names, e.g. 'hydrogen cyanide', as one word. I have counted them as written, so that my results are not directly comparable with his. To count concepts rather than words may not be too difficult in chemistry or biology, but becomes impractical in the social sciences. If the number of keywords is meant to measure the access points in a KWIC index, one should also cater for fragmentation, as carried out by

Chemical Titles or Biological Abstracts Subject Index. For example, *trans* - 2, 3 - dimethyl - 1 - phthalimidoaziridines is split into five fragments by Chemical Titles. However, the names of entities in other disciplines cannot be fragmented in the same way, and it would be misleading to allow fragmentation for a comparative study of information content in a general sense.

Numbers, e.g. '1949', with following units as symbols if any, e.g. '273K', have been counted as single words, but a range of numbers, e.g. '1914-18' as two. Hyphenated words were counted as two if each part can stand alone as a word, e.g. 'twentieth-century', but otherwise as one, e.g. 'non-English'. Abbreviations, e.g. 'NMR', were counted as single words. Subtitles have been included with the titles - as they are in the indexing journals - but substantive words in both the title and subtitle were counted once only.

2.5 A STUDY OF THE NUMBERS OF KEYWORDS IN TITLES: SAMPLES AND RESULTS

The numbers of all words, substantive words and proportion of substantive words in titles were examined as a function of various factors. The two most interesting factors are subject area and date, but other factors considered were country of publication, specialism within the subject area, language, and letters *vs*. full papers.

To examine the distribution of title lengths, a histogram was plotted for 200 titles in the Journal of the Chemical Society Faraday Transactions I of 1973, and is shown in Figure I. The mean length was 8.63 words and the standard deviation was 3.23. Bird and Knight (1975) found that the distribution of title lengths is fitted most satisfactorily by the negative binomial distribution, but Figure I shows that there is moderately good agreement with the normal distribution. The test for statistical significance used in the following comparisons was whether the difference in means was greater than 2.33 times its standard error. Such a difference has a probability of less than 1% of arising by chance with normal distributions.

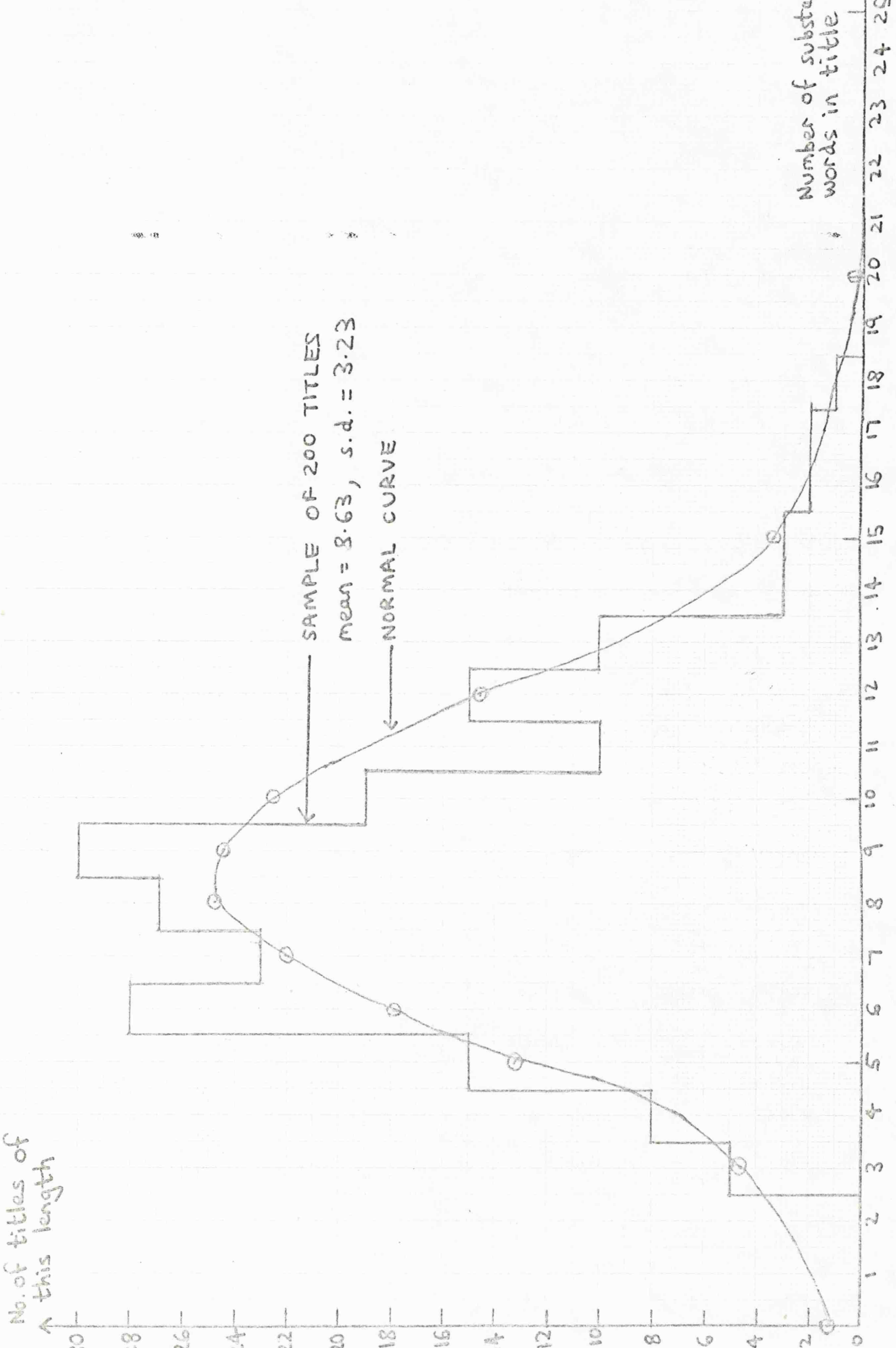
2.5.1. Variation with time

The principal set of samples was of 100 titles in each of the 1947, 1962 and 1973 volumes of thirteen leading U.K. and U.S. journals. These journals covered a range of subject areas across the natural sciences, social sciences and humanities. The selection of journals was partly limited by the availability of the journal throughout that period without alteration. The results are given in Table 2.2, and the cases where a periodical showed a significant difference in the mean value of a parameter between two different years are indicated.

Both Tacatlian (1970) and Bird and Knight (1975) suggested that the increases in the information content of titles in scientific journals which they found might be related to the introduction of KWIC indexes. As shown in Table 2.2, the present results indicate a significant increase in the number of substantive words per title for all three chemical periodicals examined during the period 1962-73 (i.e. following the introduction of Chemical Titles in 1960.) However, these periodicals also showed an increase in the earlier period 1947-62, though the increase was significant only for Analytical Chemistry. The two life science periodicals, Annals of Botany and Lancet also showed significant increases in substantive words during 1962-73. (The BASIC index of Biological Abstracts was introduced at the end of 1959.) The Lancet showed a significant increase for the period 1947-62, while Annals of Botany actually showed a decrease in this period.

The Bulletin of the American Association of Petroleum Geologists had a manually-produced index for title words from before the beginning

FIGURE I. Distribution of lengths of titles in J.Chem.Soc. Faraday Trans. I compared with a normal distribution



of the period studied up to 1964. From 1965 onwards it was replaced by a computer-generated KWIC index and also included keywords from the abstracts, texts and captions of the papers. The Bulletin showed a significant increase in the number of keywords per title for the period 1947-62, but not during 1962-73.

There were significant increases in the numbers of keywords during 1962-73 for the Proceedings of the Institution of Mechanical Engineers, the Journal of the Optical Society of America and Economica and during 1947-62 for the English Historical Review. Whilst there may have been some minor or private KWIC indexes including titles from the first two, it seems most unlikely that KWIC indexing could be a cause of the increases in title length in the last two.

TABLE 2.2 Mean numbers of words and substantive words in titles

Journal	Year	All words per title mean	s.d.	Substantive words per title mean	s.d.	Proportion of substantive words mean	s.d.
J. Phys. A	1973	9.81	3.98	6.44	2.53	0.67	0.12
J. Phys. D	1973	10.66	3.66	7.03	2.24	0.68	0.11
(letters)	1973	9.53	3.06	6.23	1.95	0.69	0.12
J. Opt. Soc. Am.	1947	9.50	4.03	5.67	2.06	0.63	0.15
	1962	8.34	3.26	5.53	1.75	0.69*	0.14
	1973	9.33	3.71	6.55†*	2.19	0.73*	0.12
Trans. Faraday Soc.	1947	11.30	5.07	6.44	2.78	0.59	0.12
	1962	9.91	4.02	6.51	2.19	0.68*	0.10
J. Chem. Soc. Faraday Trans.I	1973	13.27*†	5.64	8.43†*	3.06	0.66*	0.09
Anal. Chem.	1947	8.64	3.29	5.59	2.02	0.66	0.11
	1962	9.75	3.54	6.68	2.35	0.70	0.11
	1973	11.58*†	4.29	7.98†*	2.38	0.72*	0.12
J. Org. Chem.	1947	7.18	3.68	4.73	2.03	0.65	1.17
	1962	7.40	3.32	4.92	1.99	0.69	0.14

Journal	Year	All words per title mean	All words per title s.d.	Substantive words per title mean	Substantive words per title s.d.	Proportion of substantive words mean	Proportion of substantive words s.d.
J. Org. Chem.	1973	10.18†*	4.23	6.55†*	2.72	0.66	0.12
(notes)	1973	9.15	4.26	5.91	2.80	0.64	0.11
Bull Am. Ass. Petrol. Geol.	1947	7.62	2.76	5.68	2.07	0.75	0.14
	1962	9.20*	3.13	7.02*	2.51	0.76	0.12
	1973	9.69*	3.73	7.34*	2.79	0.76	0.10
Ann. Bot.	1946-9	15.47	6.17	7.66	3.11	0.51	1.12
	1962-3	11.76*	4.66	6.82	2.81	0.59*	0.12
	1973	13.58†*	4.81	8.40†	2.81	.63*	0.08
Lancet	1947	6.24	3.06	4.15	1.84	0.71	0.16
	1962	8.20*	3.17	5.46*	1.83	0.69	0.12
	1973	9.04*	3.20	6.29*†	2.19	0.71	0.10
J. Pharmacol& Exp. Ther.	1974	12.97	3.98	8.35	2.44	0.65	0.08
Proc. Inst. Mech. Eng.	1946-8	8.80	3.88	5.33	2.12	0.65	0.16
	1961-3	9.44	3.90	6.09*	2.40	0.67	0.14
	1974-5	11.00†*	4.69	7.19*†	2.90	0.67	0.14
J. Soc. Psych.	1947-9	9.50	3.74	5.44	2.12	0.59	0.13
	1962	9.64	3.98	5.89	2.32	0.63	0.12
	1973	9.82	3.62	6.05	2.21	0.63	0.11
Br. J. Soc. & Clin. Psych.	1973-4	10.32	3.62	6.22	1.16	0.60	0.12
Br. J. Sociol.	1950-4	7.42	3.55	4.46	1.97	0.63	0.14
(started 1959)	1960-4	7.36	3.48	4.37	1.86	0.63	0.15
	1971-3	8.42	3.70	4.89	2.15	0.60	0.12
Economica	1946-50	6.72	3.04	3.82	1.58	0.60	0.16
	1960-3	7.39	3.43	4.50	1.97	0.64	0.16
	1971-4	8.90†*	3.23	5.17*	1.85	0.60	0.14

Journal	Year	All words per title mean	s.d.	Substantive words per title mean	s.d.	Proportion of substantive words mean	s.d.
Engl. Hist. Rev.	1946-50	7.51	3.05	4.64	1.71	0.65	0.16
	1960-3	8.81*	3.61	5.56*	2.06	0.65	0.13
	1971-4	9.26*	3.37	5.79*	1.86	0.64	0.12
Hist. J.	1972-4	9.62	3.33	6.28	2.16	0.65	0.14
Philosophy	1945-50	4.82	2.36	2.82	1.09	0.64	0.17
	1960-3	5.03	2.65	2.99	1.45	0.63	0.17
	1971-4	4.47	1.91	2.84	1.13	0.66	0.19

NOTES: * significant change since 1947 † significant change since 1962

To examine the time-dependence of title lengths more precisely for subjects with important KWIC indexes, samples for intermediate years were taken for the Transactins of the Faraday Society, Journal of Organic Chemistry, Analytical Chemistry, Lancet and Annals of Botany. The results are plotted in Figures 2 and 3. The only journal which showed the sort of behaviour one would expect to be caused by the introduction of the KWIC index Chemical Titles in 1960 was the Journal of Organic Chemistry, which may thus be fortuitous.

The increase in information content of chemical and biological titles since 1960 is thus to be seen in the context of a trend to more informative titles which has occurred over a wide range of subjects (philosophy being the only exception found), and which was already apparent before KWIC indexes and mechanised searching of title words became common. The introduction of these tools may be responsible to some extent for an awareness of the need for informative titles, but it cannot provide an explanation for the generality of the trend observed. An alterantive explanation for the increase in title length in the sciences will be put forward in the next section.

An attempt was made to discover what kinds of words were represented by the increases in the number of substantive words. Of

FIGURE 2. Changes in title length with time for chemical papers

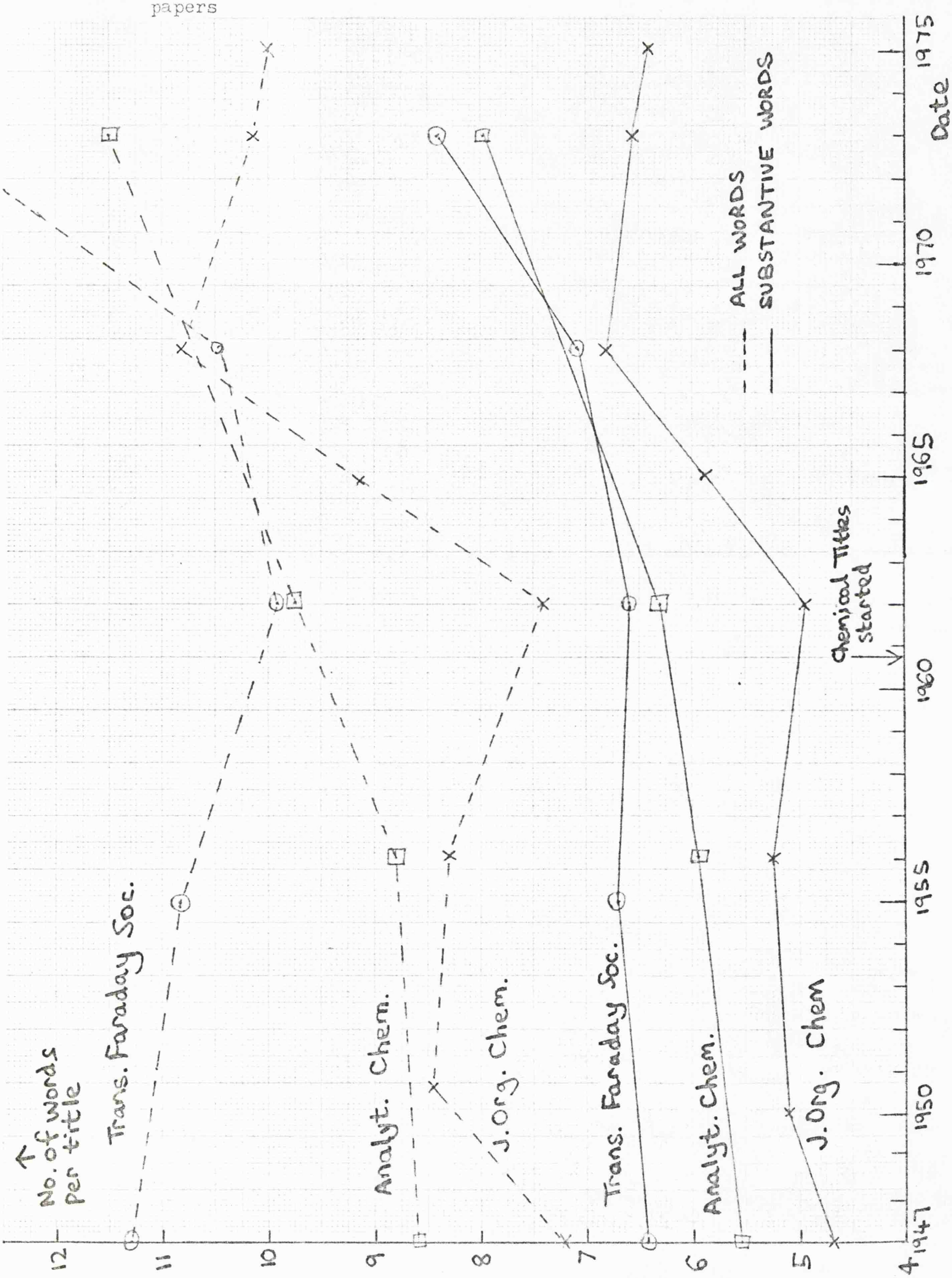
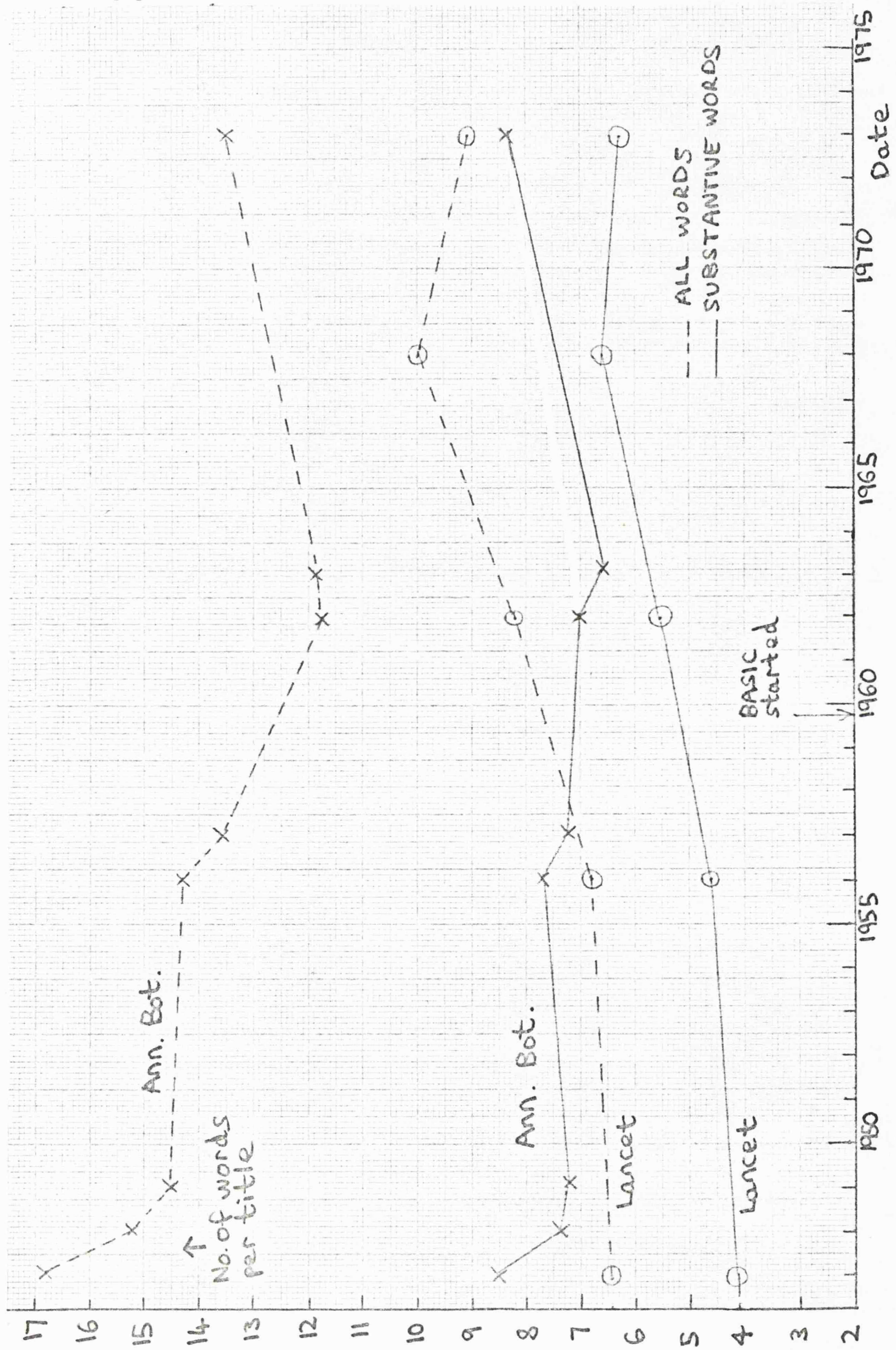


FIGURE 3. Changes in title length with time for life science papers



the increase of 1.16 words in the Journal of Organic Chemistry over 1947-73, the biggest contribution was found to be +0.70 from words relating to structures and mechanisms; +0.30 was due to chemical names and +0.26 to names of reactions. The increase of 2.39 substantive words in Analytical Chemistry during the same period included +1.62 from words relating to instrumentation and techniques. The increases in chemical titles thus represent the introduction into the titles of words relating to new techniques used and aspects studied. In the social sciences and arts the presence of words relating to techniques and aspects of study is rarer, and their influence on the information content correspondingly less. In the Journal of Social Psychology, for example, words relating to tests and techniques contributed only 1.0 substantive word per title in 1947 and 0.4 in 1973. (Bottle and Preibish (1970) found the value to be 8% of keywords or about 0.5 per title, for 300 titles from 1968 Psychological Abstracts.)

There seems to be a general increase in the proportion of substantive words in English scientific titles with time. (Bird and Knight (1975) reported that the increase in title length in Nature over 1954-1974 was sensibly equal to the increase of keywords per title - the mean number of non-keywords remaining constant.) This may arise partly from the increasingly common use of nouns attributively, giving rise to such multiword concepts as 'the nuclear magnetic resonance spin echo technique'. The coining of single words for new apparatus and phenomena seems to be less common now than formerly.

2.5.2 Variation between subject areas

For mean numbers of substantive words per title, physical chemistry, botany and pharmacology excelled. These are areas where mechanised tools for searching on title words are well established. Next down came the Bulletin of the American Association of Petroleum Geologists which, as mentioned above, has its own KWIC index. After this came engineering, physics and organic chemistry. The social sciences and humanities followed in the order psychology, history, economics, sociology and philosophy. The small number of substantive words in philosophy titles make it doubtful whether KWIC indexes or mechanised searching could usefully be applied there, quite apart from the nature of the substantive words, which will be considered later. However, titles in psychology and history fall little short of those in areas where KWIC indexes are published. As suggested on other grounds by Bottle and Preibish (1970) for psychology, they appear to be useful areas for mechanised retrieval tools.

Bird and Knight suggest a second possible cause of the increasing informativeness of titles, viz. the need to pick out papers of possible interest from ever-increasing numbers of papers in the field. If there are only a few periodicals of interest, each containing say twenty papers a year, it is an easy matter to scan all the papers as they appear. This is possibly still the position in philosophy: the number of papers in Philosophy increased from 11 in 1947 to 33 in 1973. As the numbers of periodicals and papers per year grow, increasing reliance must be placed on scanning lists of titles either in the journals themselves or in a secondary journal. The Journal of Organic Chemistry grew from 122 papers in 1947 to about 1,100 in 1975, and the number of periodicals of possible interest to an organic chemist has alsoescalated. Clearly, his current awareness problem is of a different order from the philosopher's. I would suggest this as an explanation both of the greater number of substantive words in chemical titles than in philosophical ones, and of the increase in title-length with time in chemistry.

2.5.3 Variation within subject area

Two history journals, the English Historical Review and Historical Journal were sampled for 1972-4. They are both published in England and contain similar papers. The mean title length differed by 0.36 words (0.49 substantive words) which is not significant. Also two journals in social psychology were sampled: the Journal of Social Psychology (published in the U.S.A.) and the British Journal of Social and Clinical Psychology. Their mean title lengths differed by 0.50 words (0.17 substantive words) which again is not significant.

Some comparisons were made for different specialisms within a discipline. The difference between Section A (Mathematical and General) and Section D (Applied Physics) of the Journal of Physics was not significant. However, that between Faraday Transactions and Analytical Chemistry was significant ($t = 2.38$, $p < 0.02$), as was that between Analytical Chemistry and the Journal of Organic Chemistry ($t = 2.33$, $p \simeq 0.02$). Whereas titles in organic chemistry often have the form 'The preparation of X (from Y)', those in physical chemistry generally have several facets: 'Measurement of P [property] of X in C [conditions] using A [apparatus] '. Titles in the Journal of Pharmacology and Experimental Therapeutics were significantly longer than those in the Lancet ($t = 7.71$, $p < 0.01$ for all words; $t = 6.24$, $p < 0.01$ for substantive words). The former journal is intended mainly for researchers and the latter for practitioners, for whom highly technical titles may be less acceptable (or necessary?).

2.5.4 Letters vs. full papers

Samples of the titles of letters in the Journal of Physics D and 'notes' in the Journal of Organic Chemistry were compared with those of full papers. Lester (1977) found differences between letters and papers with respect to citation patterns and numbers of authors, so it was of interest to see whether there were differences in title length. Bird and Knight (1975) found a weak correlation between title length and paper length.

For the Journal of Physics D, the mean length for letters was 1.13 words shorter (0.80 substantive words), which is significant ($t = 2.37$, $p < 0.02$; $t = 2.70$, $p < 0.01$). For the Journal of Organic Chemistry, the title length for letters was 1.03 words shorter (0.64 substantive words), which is hardly significant ($t = 1.72$; $p < 0.1$; $t = 1.64$; $p \simeq 0.1$).

The subjects of letters are likely to be at least as specific as those of papers, but their titles may be shorter (a) because they refer to previous papers in an abbreviated way, e.g. 'The breakdown polarity effect' (J. Phys. D 6 (1973) L44) which refers to 'The electrical breakdown of solid dielectrics in non-uniform fields'; or (b) because fewer entities are likely to be studied. It might be argued that since letters are often preliminary reports to be followed by full papers, then their importance in information retrieval is not great. However, Kean and Ronayne (1972) found that only 29% of those in Chemical Communications and 20% of those in Tetrahedron Letters were followed up within 2-3 years. Some letters are pointing out defects in previous papers. They ought to be as readily retrievable as the papers themselves, and preferably to include the full title of the former paper in their titles.

2.5.5 Variation with language

To examine possible variations in the informativeness of titles with language, the Zeitschrift für physikalische Chemie (Leipzig) and the Journal de chimie physique were compared with Faraday Transactions, and Historische Zeitschrift and Annales: Économies, sociétés, civilisations were compared with English Historical Review. The results are given in Table 2.3.

TABLE 2.3 Mean numbers of words and substantive words in titles of papers in English, French and German

Journal (1973)	All words per title mean	s.d.	substantive words per title mean	s.d.	Proportion of substantive words mean	s.d.
J. Chem. Soc. Farday Trans. I	13.27	5.64	8.43	3.06	0.66	0.09
Z. Phys. Chem. (Leipzig)	11.78	4.76	6.62	2.40	0.58	0.10
(English translation)	14.25	5.25	8.18	2.68	0.59	0.10
J. Chim. Phys.	16.11	6.38	8.39	3.29	0.53	0.09
(English translation)	14.36	5.76	8.29	3.21	0.59	0.11
Engl. Hist. Rev.	9.26	3.37	5.79	1.86	0.64	0.12
Hist. Z	8.84	4.21	5.14	2.30	0.60	0.13
(English translation)	11.39	5.50	6.05	2.74	0.55	0.12
Annales	10.76	4.00	5.68	2.13	0.54	0.11

The numbers of substantive words in the English and French titles in the same subject were very similar, whereas those in the German titles were rather fewer. In fact, the number of substantive words does not form a valid basis for comparison of the information content of titles in different languages because languages differ in the extent to which several concepts may be combined into a single word, e.g. German 'Arbeiterklasse', English 'working classes'; French 'autodiffusion', English 'self diffusinn'. The differences between the average numbers of characters per substantive word, shown in Table 2.7, are to some extent a reflection of this: German substantive words were significantly longer than English ones in both history and chemistry.

As a more valid basis for comparison, data were also obtained for the translations of the chemical titles in Chemical Abstracts (with preliminary nonsubstantive words added where Chemical Abstracts eliminated them), and on the forty-four translations of the German historical titles which could be found in Historical Abstracts. These are also given in Table 2.3. The numbers of substantive words in the English translations of the German and French physical chemistry periodicals were very similar to each other, and to that in J.C.S. Faraday Transactions of 1973. Likewise, the number in the translation of Historische Zeitschrift compared well with that in 1971-4 English Historical Review. Thus there appears to be little difference between the information content of French, German and English titles of the same date and subject.

There was a significant difference between the proportion of substantive words in the titles of Journal de Chimie physique and its English translation ($p < 0.005$). This seems to be due partly to the attributive use of nouns in English, e.g. 'gallium oxide', 'Montbéliard region', where French uses a preposition: 'oxyde de gallium', 'pays de Montbéliard', and partly to the less frequent use of the definite article in English. That the proportion was lower in the English translations (despite the correction mentioned above) than in titles from corresponding English journals may be due to the rephrasing of the original titles by the abstracting journals. This eliminates some non-substantive words, and makes the titles more concise than is ordinarily found in English.

2.6 SUBTITLES

As mentioned in Section 2.4, subtitles are normally treated as part of the title by indexing journals and mechanised services, and so were included with the titles for the study above. (The Permuterm index, though, only permutes main title words with main title words, and subtitle words with subtitle words.) However, the keywords in subtitles are not independent of those in the main title, in the sense that they may add less than one 'keyword's-worth' of information to the keywords in the main title. It was therefore thought desirable to examine the occurrence of subtitles in different subjects and the relationship of words in them to words in the main title.

2.6.1 Occurrence of subtitles

Subtitles can be divided into two classes - those which are titles of parts, and those which are not. Examples of the former are:

Studies of the surfaces of desert plant seeds. II.
Ecological adaptations of the seeds of Blepharis persica.
(Ann. Bot., 1973)

Tumor inhibitors. Part LXXXI. The structure and partial synthesis of fabacein. (J. Org. Chem., 1973)

and examples of the latter are:

Dimensions of ethnic identity: an example from Quebec.
(J. Soc. Psychol., 1973)

Alienation: trying to bridge the chasm. (Br. J. Sociol., 1973)

Another distinction may be made between substantive and nonsubstantive subtitles - the latter consisting only of nonsubstantive words, e.g.

Parent-child relationships of black and white high school students: a comparison (J. Soc. Psychol., 1973)

Supremacy and vicegerency: a reexamination (Engl. Hist. Rev. 1966)

The frequencies of occurrence of subtitles of these kinds are shown for various journals in Table 2.4. When both were present in the same paper, only the part subtitle was counted. The sample sizes of titles examined were normally 100, but were increased to 200 or 250 where subtitles were relatively rare.

TABLE 2.4 Frequencies and vocabulary overlap of subtitles.

Journal		NON-PART SUBTITLES					PART SUBTITLES				
	sample	Frequency per 100 titles	i	e	g	Non-subst. per 100 titles	Frequency per 100 titles	i	e	g	mean part no.
J. Org. Chem.	100 papers	21.0	14	0	24	0	25.0*	60	0	68	18.0
	100 notes	24.0	8	0	21	12.5	12.0	8	0	58	49.8
J. Phys. Chem.	100 papers	6.0					24.0				10.9
	50 comms.	8.0					4.0				6.0
J.C.S. Faraday Trans.	100 papers	9.0	22	0	44	0	31.0	61	13	61	3.1
J. Chim. Phys.	100 papers	31.0					25.0				2.0
	40 letters	13.3					16.7				6.8
Z. phys. Chem. (Frankfurt)	100 papers	2.0					11.0				2.7
Z. phys. Chem. (Leipzig)	100 papers	1.0					28.0				6.8
	50 notes	0					6.0				14.7
J. Phys. D	250 papers	1.6	25	0	25	0	4.8	42	0	17	2.4
	100 notes	2.0	-	-	-	100	0	-	-	-	-

		NON-PART SUBTITLES					PART SUBTITLES				
	sample	Frequency per 100 titles	i	e	g	Non-subst. per 100 titles	Frequency per 100 titles	i	e	g	mean part no.
J. Parmacol. & Exp. Ther.	200 papers	15.0	20	3	27	0	6.0	42	8	25	3.1
Ann. Bot.	250 papers	4.4	18	9	9	0	7.6	105	16	21	1.8
J. Soc. Psychol.	150 papers	18.0	15	11	7	0	0	-	-	-	-
	100 notes	17.0	0	12	6	17.6	0	-	-	-	-
Br. J. Sociol,	100 papers	46.0	0	9	0	26.1	0	-	-	-	-
Engl. Hist. Rev.	200 papers	18.5	3	5	14	5.4	0	-	-	-	-
	150 notes	20.7	3	3	16	25.8	0	-	-	-	-
Philosophy	250 papers	4.8	8	0	8	16.7	0	-	-	-	-
	150 discns	.8.0	0	0	0	33.3	0	-	-	-	-

NOTES: *some papers had the series title as a footnote

i = frequency of identical words in main title and subtitle per 100 subtitles

e = frequency of equivalent words in main title and subtitle

g = frequency of generically-related words in main title and subtitle

\- not applicable

Subtitles for numbered parts are found to be most common in chemistry, with the highest proportion in J.C.S. Faraday Transactions. They were much less frequent in the other scientific journals studied, and did not occur at all in the journals of the social sciences and humanities. As can be seen from the values for 'mean part number' in Table 2.4, the longest series occurred in the Journal of Organic

Chemistry, followed by the physical chemistry journals. The highest mean part number was for the notes in the Journal of Organic Chemistry - perhaps to achieve such long series one has to resort to short communications. Papers in a long-running series normally originate from a supervisor spending several years in a particular research area with various co-workers. There may be an element of prestige in showing in the title how many papers have already been produced. This pattern of work is less characteristic of the social sciences and rare in the humanities, where the output of papers by researchers is also lower (Hagstrom, 1965, p. 57). One would thus expect part subtitles to be more common in multi-author papers than in single author papers. This may be an additional explanation of the positive correlation between the number of authors of a paper and the length of its title found by Kuch (1978).

Some journals also have a policy of not allowing series titles, possibly to avoid any implied right of authors to have subsequent papers in the series published. Knight (1967), a joint editor of the Journal of General Microbiology, wrote that 'generic titles followed by a specific title, e.g. on the study of froth. Part 5. Beer, should be avoided', and some further examples are given in the instructions to authors quoted in Section 2.1.

Subtitles which are not associated with numbered parts showed a much less consistent pattern. They were most common in the British Journal of Sociology and the Journal de chimie physique, and least common in the Zeitschrift fur physikalische Chemie. A popular form in sociology and humanities is a metaphorical or cryptic title, followed by a (more-or-less) explanatory subtitle, e.g.

> The TEA set: tacit knowledge and scientific networks (Sci. Stud., 1974)
>
> Right, left and centre: the Second Spanish Republic (Hist. J., 1972)

Sunt lacrimae rerum: a study in the logic of pessimism (Philosophy, 1970)

Robertson and Kapur (1972), writing under the title 'Social change, emotional distress, and the world view of students: an empirical study of the existentialist ethic and the spirit of suffering', said 'Connoisseurs of the sub-title may recognise in the present case that blend of the pretentious and the half-informative which tends to characterise the genre.'

Subtitles also arise commonly in the humanities, especially in philosophy, from the prevalence of comments or criticisms of earlier papers, sometimes followed by rejoinders from the original authors, e.g.

Collective responsibility - again (Philosophy, 1969)

The Wensleydale peerage case: a further comment (Engl. Hist. Rev., 1968)

Such succeeding papers are often in the form of 'notes' or 'communications', hence the high proportion of nonsubstantive subtitles for these types of papers. Otherwise, the use of a non-part subtitle appears to be merely a stylistic option, available to writers in any area.

2.6.2 Lengths of subtitles and main titles

The mean numbers of all words and substantive words were counted in the part and non-part subtitles in the Journal of Organic Chemistry, and in the non-part subtitles in the English Historical Review. The results are shown in Table 2.5. It is interesting to note that for titles-without-subtitles the numbers of words were almost identical in the two journals. Not surprisingly, titles-with-subtitles contained significantly more words and substantive words on average than titles without. For titles in a series, the subtitles tended to be much longer than the main titles - no doubt because the main title was chosen to be general enough to cover a number of related studies. The difference in length between main titles and non-part subtitles was not significant (t = 0.88 for the Journal of Organic Chemistry) - again indicative of the lack of any general pattern to such usage.

2.6.3 Overlap of substantive words in subtitles and main titles

Table 2.5 shows that the proportions of substantive words in the subtitles were significantly lower than in the main titles. This is due to (i) the repetition of substantive words in the subtitle, in which case they were not counted again, and (ii) the use of nonsubstantive subtitles.

To examine redundancy in the substantive words in subtitles, the numbers which were identical, equivalent, or in a generic relationship with words in the main title were assessed. The results are given in Table 2.4.

It can be seen from the Table that the greatest degree of redundancy occurred in the part subtitles of the scientific journals. This usually arose from a substance or process being named in the main title and the name being repeated in the subtitle, or else a class of substances or creatures occurred in the main title and a specific member in the subtitle. Terms in such a generic relationship are especially common in chemistry. As mentioned in Section 2.6.3, the non-part subtitle is primarily a stylistic device, and less frequently functions to make concepts in the heading more specific.

When both a generic term and a more specific term occur in the same title, e.g. 'lanthanide systems' and 'cerium (III) nitrate' in:

> Interactions in lanthanide systems. Part 2. Raman study of aqueous cerium (III) nitrate (J.C.S. Faraday Trans., 1973)

TABLE 2. 5 Mean numbers of words and substantive words in main titles and subtitles

Journal	Types of subtitle	No. in sample	% of all titles	Whole title			Main title			Sub title		
				words per title	Subst. words per title	Propn. of subst. words	Words per title	Subst. words per title	Propn. of subst. words	Words per title	Subst. words per title	Propn. of subst. words
J. Org.Chem.	none	137	57.1	8.23	5.31	0.66						
				(3.36)	(2.07)	(0.12)						
	part	45	18.3	12.11	7.64	0.65	3.52	2.77	0.85	8.59	4.89	0.59
				(5.04)	(3.04)	(0.13)	(2.07)	(1.41)	(0.19)	(3.92)	(2.21)	(0.14)
	non-part	58	24.2	12.48	8.15	0.67	5.97	4.20	0.74	6.51	3.95	0.62
				(4.38)	(3.35)	(0.10)	(3.26)	(2.12)	(0.14)	(3.34)	(1.99)	(0.17)
Engl. Hist. Rev.	none	155	77.5	8.18	5.11	0.63						
				(2.95)	(1.78)	(0.12)						
	non-part	45	22.5	10.62	6.16	0.59	5.33	3.42	0.69	5.29	2.73	0.51
				(3.83)	(2.01)	(0.13)	(2.35)	(1.23)	(0.17)	(2.90)	(1.80)	(0.28)

NOTE: standard derivations given in brackets one could argue that the generic term is redundant, because it is implied by the specific term. If a full allowance of this sort (and for 'equivalent' terms) were made in the value of mean substantive words per title for J.C.S. Faraday Transactions, a correction of

$$-\left(\frac{9}{100} \times \frac{44}{100}\right) - \left(\frac{31}{100} \times \frac{74}{100}\right) = -0.27 \text{ substantive words}$$

should be made. This would be the largest correction to be applied for any journal. (As explained in Section 2.4, a correction has already been applied for exact repetition of substantive words in subtitles.) However, whilst such a correction should no doubt be made in measuring the theoretical information content of a title, it may be inappropriate if assessing the value of a title for information retrieval purposes. If a searcher was looking for papers on lanthanide systems, he would have to search for the names of each of the fourteen lanthanons to pick up all of them, and other classes (e.g. insecticides, towns in England, mammals) contain so many members that searching for each individually is impracticable. Thus the generic term may enable retrieval when the specific terms, even though making the generic term 'redundant', would not. The value of including family or higher group names in titles is mentioned in the Instructions to Authors of the Botanical Journal of the Linnaean Society (Section 2.1).

Since the effects of redundancy in subtitles were relatively small (and would not affect conclusions about variations in information content with subject), and there are strong practical grounds for treating such redundancy as valuable, it was decided not to make corrections to the values reported in Table 2.2.

2.7 TITLE LENGTHS IN CHARACTERS

The existence of a relationship between the length of a title, in terms of number of characters, and its value for retrieval was mentioned in Section 2.3.3. Another reason for looking at title lengths in characters is their effect on KWIC indexing. In a KWIC index, only one line is available per title, with a limited number of character positions. If a title has more characters it will be truncated, and some information will be lost.

Kaplan (1955) made a study of the number of words on either side of a keyword which are needed to resolve the ambiguity of its various senses. His texts were from books in exact sciences. One preceding word of context was the least effective, being significantly worse than one following word. One word on each side was more effective than two preceding or two following, while two words on each side were comparable in effect to the entire sentence in which the word occurred.

The mean lengths of keywords in the titles of various journals are given in Table 2.7. For English titles in chemistry and history, the mean length is about seven letters. Thus, to accommodate a keyword with two keywords on each side a mean of about 40 characters will be required - and less if some of the context words are non-keywords. The numbers of characters per line in some published KWIC indexes are given in Table 2.6. These line lengths should be adequate to contain two words on each side, though some indexes (perhaps for improved legibility) give only the following context.

TABLE 2.6 Context included in some KWIC indexes

Index (1978 edition)	Characters before keyword	Characters of keyword and after	Total
Biological Abstracts	20	35	55
Chemical Titles	29	38	67
Geo Abstracts	0	70	70
J. Am. Soc. Inf. Sci.	0	~ 60	~ 60

However, the context of keywords in a KWIC index is intended not only to resolve the sense of the keyword but also to coordinate it with other keywords - as is normally done in a mechanised search. Johnston (1978) has reported some searches conducted at the Ministry of Agriculture, Fisheries and Food where relevant references were missed using the BASIC Index of Biolgical Abstracts, but retrieved in on-line searching by coordination of title words which the former, because of the limited context given, did not show.

To allow all the possible coordinations of title keywords in a KWIC index, the line length would have to be sufficient to accommodate the entire title. A study was therefore made of the distribution of title length to see what proportion of titles can be shown in full for various line lengths.

For carrying out the study reported in Section 2.8, 1000 titles from history journals and 1000 titles from philosophy journals had been punched onto cards. A program was written in Fortran to read data from these cards, to determine the title length in characters, and then to produce a histogram of the distribution using the CERN HBOOK routines available on the Leicester University computer. All 1000 titles were used for the philosophy sample, but the history sample was limited to the 248 titles from the English Historical Review. The data from the histograms were then replotted as title length against cumulated percentage of titles, and the graphs are shown in Figures 4 and 5. Similar data were obtained by manual counting for a sample of 100 titles in J.C.S. Faraday Transactions, and the results are plotted in Figure 6.

As can be seen from the graphs, a line length of 70 characters, as in Geo Abstracts, would allow 93% of philosophy titles to be

FIGURE 4. Title length distribution in _English Historical Review_ (248 titles)

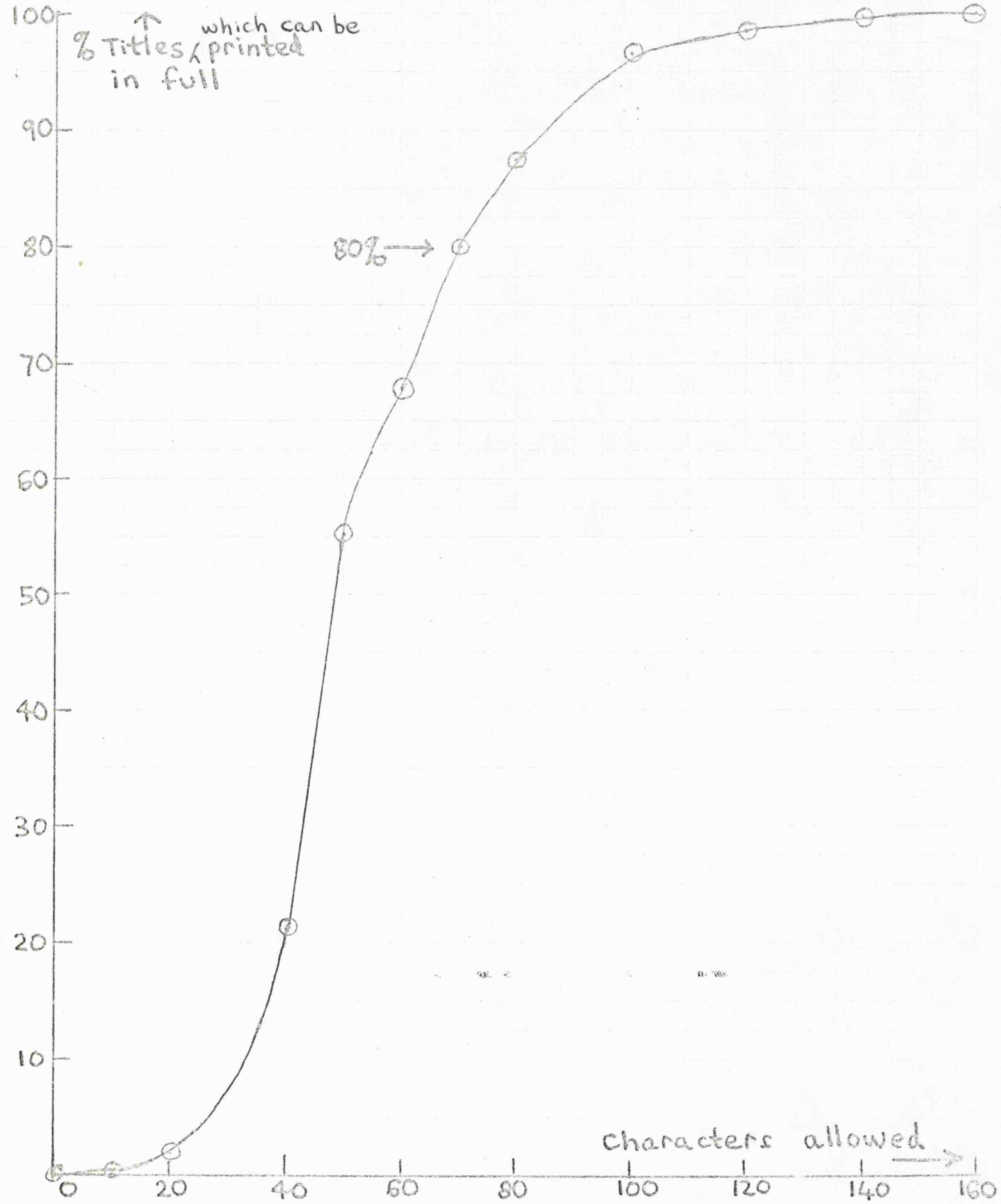


FIGURE 5. Distribution of lengths of titles in philosophy

(1000 titles)

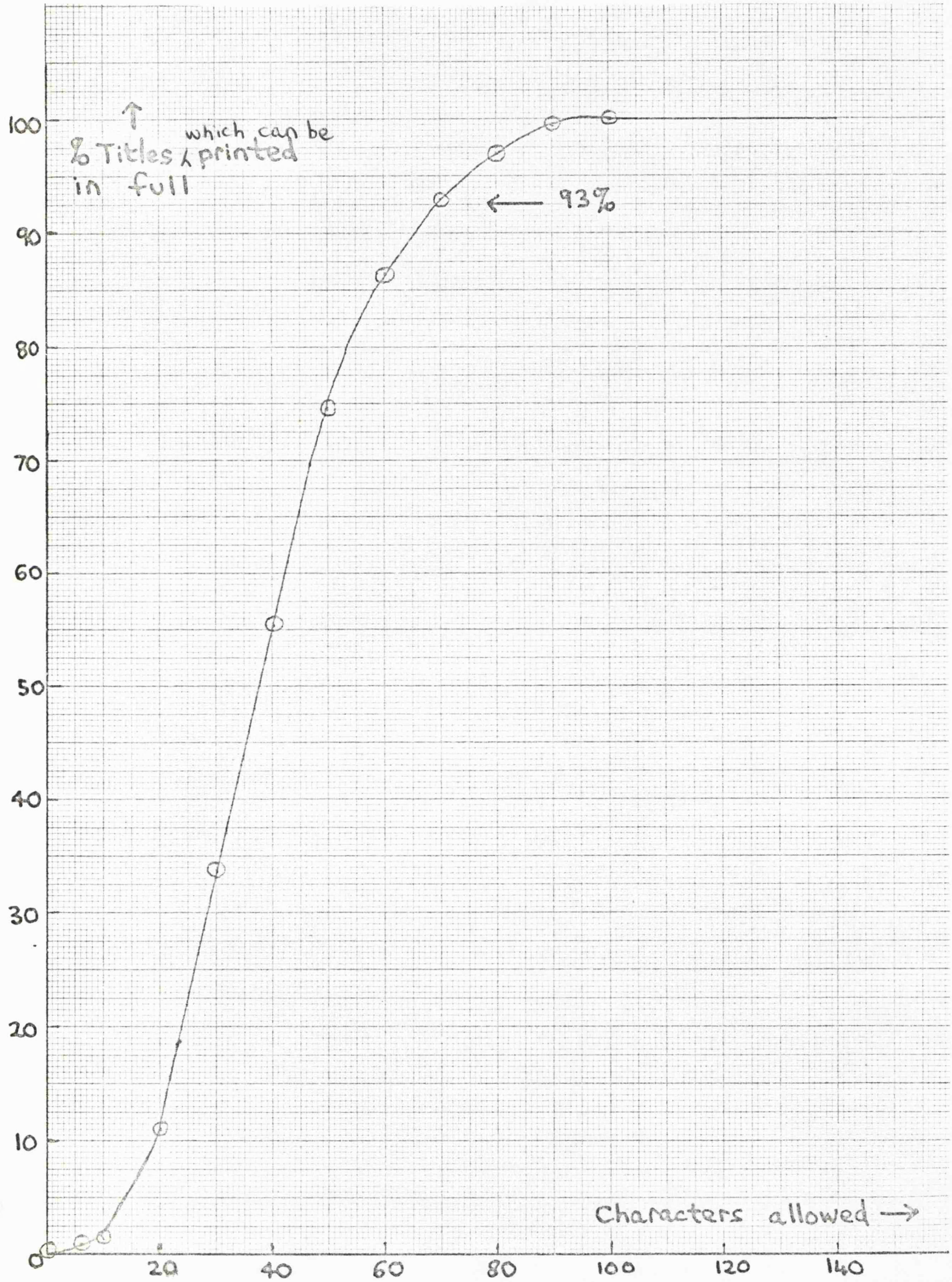
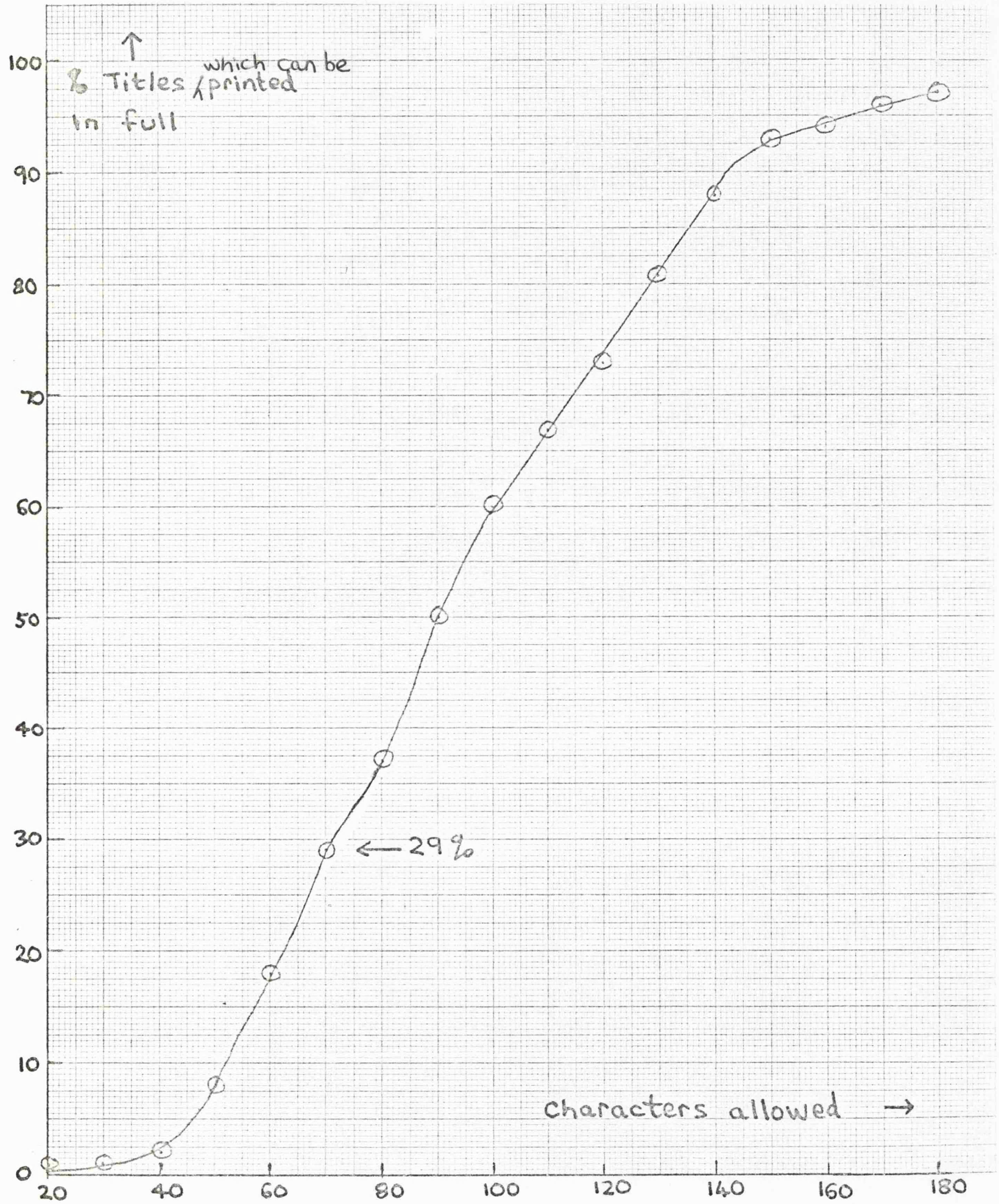


FIGURE 6. Title length distribution in J.C.S. Faraday Trans. I (1973) (100 titles)



printed in full and 80% of history titles, but only 29% of chemistry titles. A line length of about 130 characters would be needed to accommodate 80% of the chemistry titles. Presumably the editors of Chemical Titles have weighed the benefits of including more of the information in titles against the increased size of the index, but it is clear that a good deal of title infomration is being lost, so leading to useful coordinations not being picked up.

To examine whether titles in different languages differ in their numbers of characters, the mean title lengths were determined of French titles, in the Journal de Chemie physique and Annales: Économies, sociétés, civilisations and of German titles in the Zeitschrift für physikalische Chemie and Historische Zeitschrift for comparison with J.C.S. Faraday Transactions. The results are given in Table 2.7. In both subject areas, the French and German titles were of very similar mean lengths, but the English titles were significantly shorter - partly due to the facts that the substantive words were shorter in English and the proportion of substantive words was higher (Table 2.3). Thus longer line lengths are needed in French and German KWIC indexes for the same proportion of titles to be printed in full, and somewhat more storage space is needed to hold them on machine-readable files.

The principles of the Permuterm Index, as used in Science Citation Index does lead to each keyword being coordinated with all the other keywords in the title. It rarely allows coordination of more than two keywords (only when a commonly-cooccurring pair of words is treated as a single keyword), and since the pair of words may be considerably separated in the title, it may lead to some misleading coordinations. It is thus not likely to be very helpful in clarifying ambiguities in the senses of keywords.

TABLE 2.7 Title lengths in characters inEnglish, French and German journals (sample size = 100)

Journal (1973/4)	Title length		Characters per substantive word	
	mean	s.d.	mean	s.d.
J.C.S. Faraday Trans. I	96.6	39.8	7.45	2.96
Z. Phys. Chem. (Leipzig)	110.2	41.6	11.02	4.80
J. Chim. Phys.	111.6	43.8	9.04	3.87
Engl. Hist. Rev.	54.3	18.1	7.14	2.61
Hist. Z.	66.9	30.9	9.63	4.39
Annales	64.9	23.6	7.59	2.61

2.8 AN EXPERIMENT WITH FREQUENCY WEIGHTING OF TITLE WORDS

2.8.1 Introduction

In Section 2.5, the usefulness of the titles of reseach papers in various subjects for mechanised retrieval was assessed in terms of the number of substantive words that they contained. A shortcoming of this method is that it treats all substantive words as being of equal value (or, at least, the mean value of words in each subject as being euqal). It is clear that all substantive words in a title are not equally useful for retrieval. For example, consider the title 'When and why did Hastings lose his head' (English Historical Review, 1974). This contains three substantive words

'Hastings', 'lose' and 'head'. A searcher looking for information on the demise of William Lord Hastings would certainly use the search term 'Hastings', but would be unlikely to think of 'lose' or 'head'. A much more useful word for the author to have included in the title would have been 'Lord' which would have allowed one to distinguish between Lord Hastings and the town Hastings, Sussex in a mechanised search.

It was therefore decided to attempt to assign different weights to substantive words according to their value in retrieval, so as to permit a better assessment of the information content of titles.

2.8.2 Assignment of weights

I have discussed in the Introduction (Section 1.4) the use of a concept of information based on probabilities. Shannon (1948) pointed out that a measure with a logarithmic dependence on probability has the desirable property of being additive. If two independent events have probabilities p_1 and p_2 respectively, the probabilities of their co-occurrence is p_1p_2, and given a logarithmic measure of information $I = \log p_i$, the information conveyed by the co-occurrence is $I_1 + I_2$. Since p_i is less than or equal to one, I can be made positive by redefining it as $- \log p_i$.

It is therefore proposed to use this quantity, $- \log p_i$, as a measure of the information conveyed by a particular title word. The probability of occurrence of a word in a title belonging to a given set can be determined by counting the number of times it occurs throughout the set and dividing by the number of titles in the set. So, for example, if a word occurs twice in 1000 titles, $p = \frac{2}{1000}$ and $I = 8.97$. The information content (IC) of a complete title can then be obtained by summing I for each word in it.

Nonsubstantive words will normally occur very frequently, so that p will be large, and the contribution to the IC will be small.

To determine word frequencies for words in history and philosophy titles, where no machine-readable data were available, 1000 titles from each subject were punched onto cards. The philosophy sample was taken from the first two issues of the Philosopher's Index for 1975. The history sample was made up from 1965-1975 volumes of the more important historical journals available at Leicester University Library, with a bias towards English history. In keying the titles, plural words were keyed as the singular followed by '-s', and dates of the form '1914-18' were expanded as '1914-1918'.

The titles were then stored on a file at the University of Manchester Regional Computer Centre and processed using the COCOA (word COunt and COncordance generation on Atlas) package to give a list of words and their frequencies in alphabetical order. Hyphens were treated as word delimiters - hyphens not so required having been eliminated at the keying stage. From the frequencies, the information I attributed to each word as defined above could be calculated.

For word frequencies in chemical titles, a copy of the 'KLIC' (Key Letter In Context) List was borrowed from UKCIS. This shows the frequencies of words and word fragments occurring more than twice in a six month period of Chemical Titles, and is based on 65,000 titles. In Chemical Titles chemical names are split up into useful fragments and entries made in the KWIC index for each fragment. Thus I values were obtained for each fragment of chemical names rather than for each word. With a sample size of 65,000, the maximum possible I is $- \log_2 (3/65{,}000) = 14.4$, whereas for the history and philosophy samples the maximum value is $\log_2 1000 = 10.0$.

For interest, the twenty most frequent words in the three samples, together with their frequencies and I values, are given in Table 2.8. Since they are considered to be of no value in retrieval, nonsubstantive words were assigned no I value. The different frequencies of words of the same rank in the different samples are principally a consequence of the different average lengths of titles.

TABLE 2.8 Ranks, frequencies, and I values of the twenty most frequent words in titles in chemistry, history and philosophy.

RANK	CHEMISTRY*	Freq./ 1000 titles	I	HISTORY	Freq./ 1000 titles	I	PHILOSOPHY	Freq./ 1000 titles	I
1	of	1382	-	the	1094	-	the	484	-
2	and	482	-	of	595	-	of	476	-
3	the	466	-	and	437	-	and	436	-
4	in	422	-	in	415	-	in	175	-
5	on	141	-	a	160	-	a	159	-
6	by	138	-	century	101	3.3	on	154	-
7	a	132	-	to	76	-	to	66	-
8	acid, -s	113	3.7	on	53	-	theory	58	4.1
9	di	108	4.4	England	51	4.3	philosophy	47	4.4
10	effect, -s	104	3.3	new	49	4.4	logic	43	4.5
11	with	102	-	early	42	4.6	for	43	-
12	for	84	-	an	38	-	an	40	-
13	2	74	-	English	38	4.7	language	27	5.2
14	from	71	-	British	36	4.8	as	26	-
15	to	58	-	trade	30	5.1	problem	25	5.3
16	1	56	-	American	29	5.1	concept	25	5.3
17	3	53	-	economic	29	5.1	note	24	-
				some	29	-	reply	24	-

RANK	CHEMISTRY*	Freq. 1000 titles	I	HISTORY	Freq. 1000 titles	I	PHILOSOPHY	Freq. 1000 titles	I
18	methyl	52	4.0						
19	reaction, -s	51	4.1	for	27	-	is	23	-
20	oxide, -s	51	5.2	history	27	5.2	science	21	5.6
				politics	27	5.2			
				south	27	5.2			

*Frequencies taken from Heaps (1975) (the KLIC List does not include stop-words) but I values computed from KLIC List data

2.8.3 Evaluation of titles

(a) Chemistry The sample of chemistry titles chosen for evaluation consisted of (i) the first twenty-five titles in each of the 1976 volumes of the Journal of the Chemical Society: Faraday Transactions, the Journal of Organic Chemistry, and Analytical Chemistry and (ii) five titles appearing in Chemical Titles from each of the Journal of Economic Entomology, the Journal of the Science of Food and Agriculture, the Journal of the Society of Dyers and Colourists, Nuclear Technology and Polymer Engineering Science, to give examples of titles from fringe areas. For words not in the KLIC list (because they occurred fewer than three times in the sample used), the maximum value of 14.4 was used. The I values for each fragment and substantive word were summed for each title, and the mean IC per title was calculated. For comparison with the history and philosophy titles, IC values were also calculated with a maximum of 10 per fragment. The results are shown in Table 2.9.

TABLE 2.9 Mean IC values of titles in chemical journals

Journal	Mean words per title	Mean words or fragments per title	Mean IC (max I = 10)	Mean IC (max I = 14.4)
J.C.S. Faraday Transactions	15.2 (5.7)	16.6 (6.7)	87.6 (31.0)	92.4 (34.6)
Journal of Organic Chemistry	12.3 (6.6)	14.2 (7.4)	78.1 (40.8)	85.9 (44.8)
Analytical Chemistry	12.4 (4.2)	12.9 (4.3)	74.6 (21.6)	79.4 (21.6)
(Fringe areas)	10.2 (3.8)	10.6 (4.0)	64.5 (24.9)	71.1 (28.6)
Mean	12.5 (5.5)	13.6 (6.1)	76.2 (29.6)	82.2 (33.9)

NOTE: standard deviations given in brackets

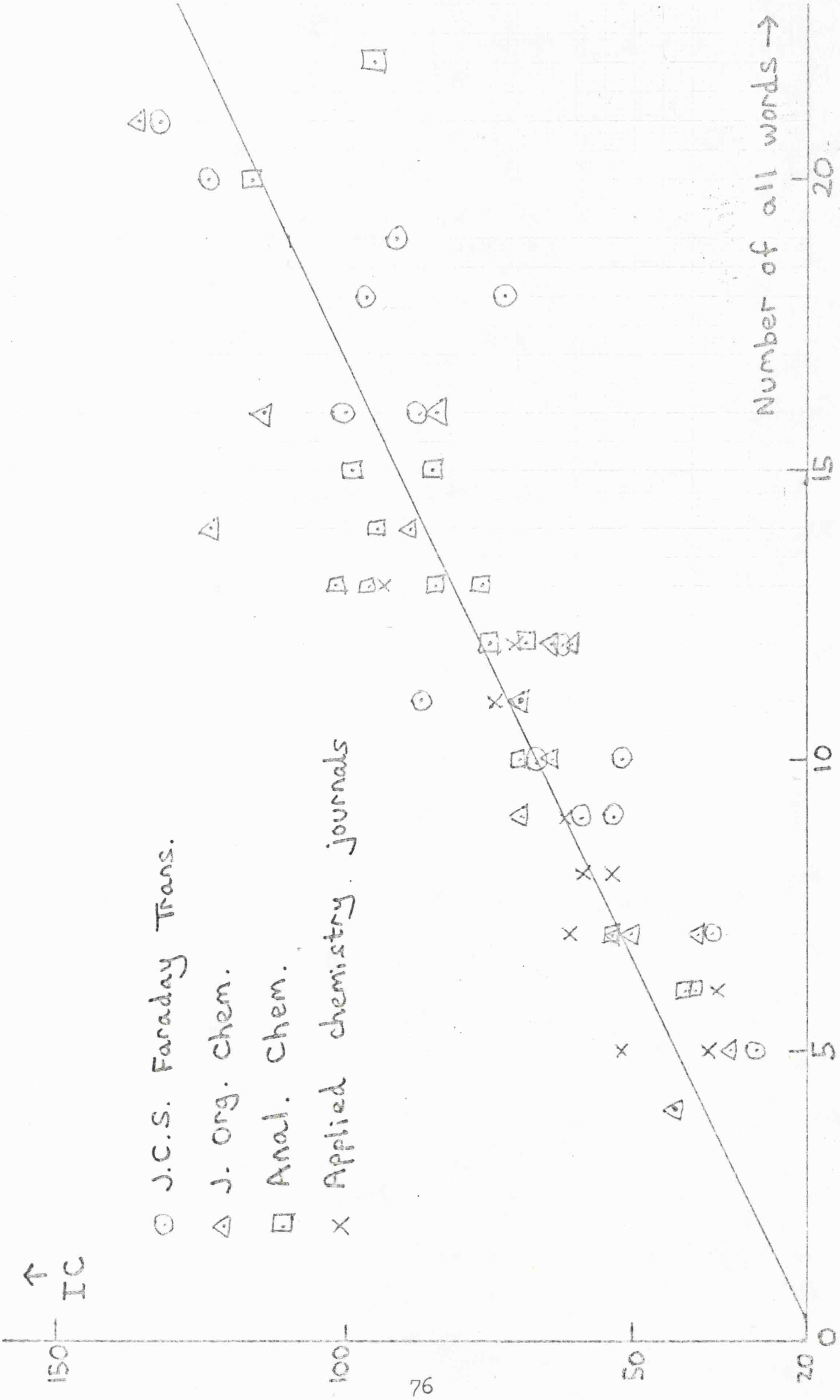
The differences in IC values between the journals are largely due to differences between the mean numbers of words or fragments per title, but the mean I value of words and fragments in the 'fringe' areas is significantly higher than that in the _Journal of Organic Chemistry_ ($t = 3.0$, $p < 0.01$). The fringe areas have title words which are relatively unusual in chemical titles, while organic chemistry title words are often long chemical names made up from relatively common fragments. Coordination of search terms is thus likely to be more necessary in searches in organic chemistry.

Of the 100 titles in the total sample, 59 could be evaluated exactly since they contained only words found in the KLIC index. The IC values of these titles are plotted against title length in words in Figure 7. The best straight line through the points was calculated and was found to be

$$IC = (5.05 \times \text{number of words}) + 14.13$$

and the correlation coefficient r was 0.87. The correlation coefficient between IC (for the 59 titles evaluated exactly) and the number of substantive words was also 0.87. The best straight line was calculated for all 100 titles evaluated with a maximum

FIGURE 7. Relation between information content ($-\log_2 f$) and total number of words for chemistry titles



I value of 10. Its equation was

$$IC = (5.31 \times \text{number of words}) + 9.82$$

and the correlation coefficient was 0.92. Thus about 85% of the variance in IC can be explained by regression on the number of words. It therefore seems that evaluation of titles on the basis of frequency-weighting does not offer a substantial advantage over a simple evaluation by the total number of words.

The title giving rise to the point furthest above the line in Figure 7, i.e. having the highest IC in relation to its number of words, was:

Electrochemical reduction of α,α'-dibromoketones in acetic
8.2 7.1 12.7 9.1 7.6 7.7
acid. Convenient synthetic route to highly branched
3.7 10.9 7.8 9.9 9.3 10.6
α-acetoxyketones.
12.7 6.5 - TOTAL: 131.6

While the one with the lowest IC in relation to its number of words was:

Quneching of the luminescent state of the uranyl ion
9.9 9.9 6.2 9.9 5.3
by metal ions. Evidence for an electron transfer mechanism.
5.6 - 7.8 5.8 6.6 5.9
TOTAL: 72.9

One of the main causes of the high IC of the first title is fragmentation of the organic chemical names. The second title is lacking in any particularly infrequent title words (i,e. words of high I value).

(b) History. Fifty titles in history periodicals were evaluated, taken from the original sample used in the frequency analysis. They comprised fifteen each from the *English Historical Review* and *Economic History Review*, and five each from the *Canadian Historical Review*, *History*, the *Journal of Southern History* and *Past and Present*. All words could, of course, be evaluated exactly (with reference to the original sample), and the maximum I value was 10.0. A graph of the number of words per title against the IC of the title is shown in Figure 8. The best straight line was calculated as

$$IC = (4.22 \times \text{no. of words}) + 7.64$$

and the correlation coefficient, r, was 0.81. The mean number of words per title was 8.3, and the mean IC per title was 42.6.

The contribution per word to the IC of a title in history is thus less than that per word in chemistry (with a maximum I of 10) - due largely, no doubt, to fragmentation of words in Chemistry. The correlation of IC with number of words is less than in chemistry, only 66% of the variance being explicable by regression. This may, however, be due to the less reliable values of I arising from the smaller sample size used in their calculation. Examples of high- and low-scoring titles in relation to their lengths are:

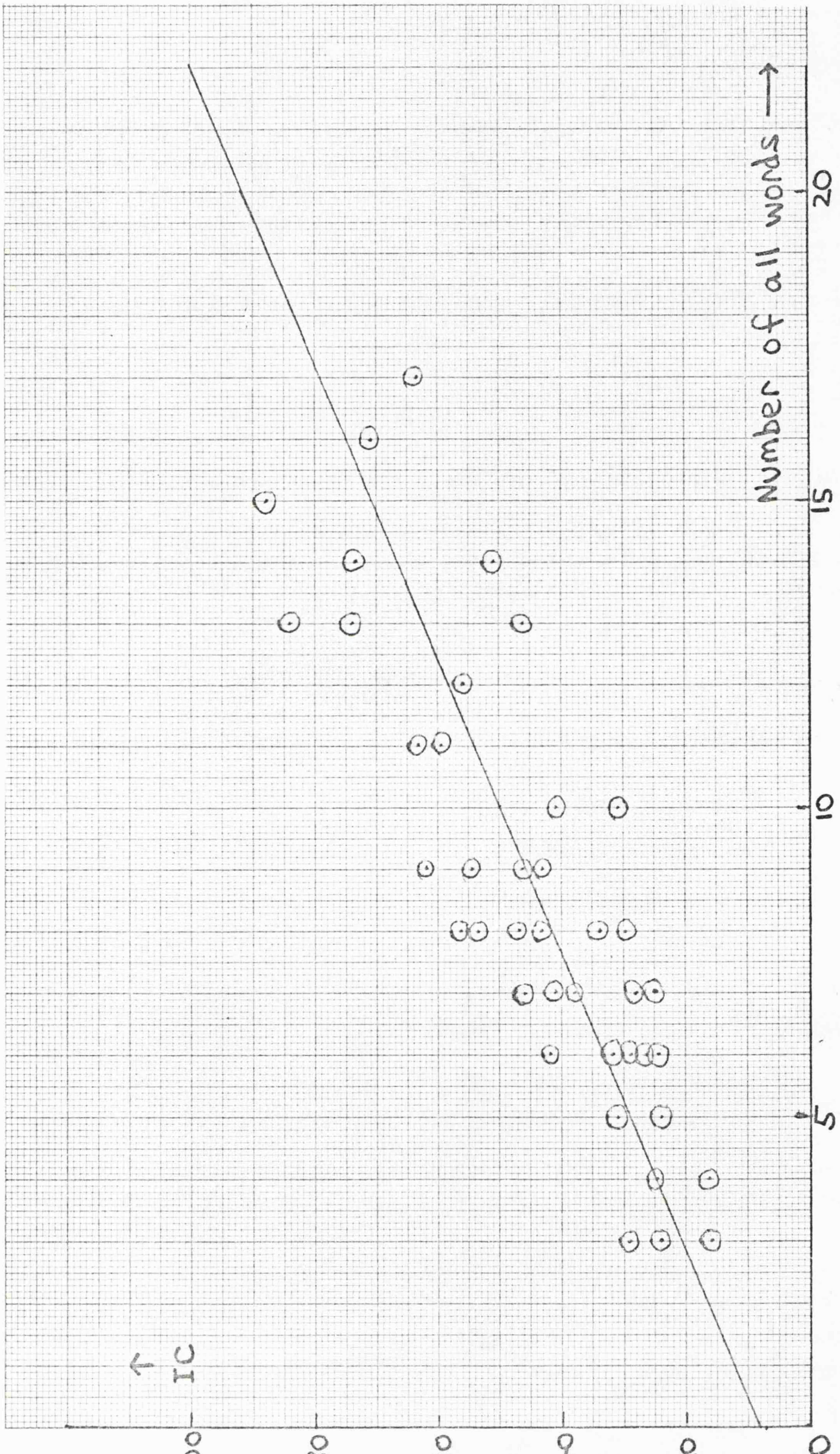
English humanitarianism and the colonial mind: Walter
4.7 10.0 5.6 7.4 8.4

Bromley in Nova Scotia 1813-1825
10.0 10.0 10.0 10.0 8.0 TOTAL: 84.1

and (also of thirteen words):

Government expenditure and the growth of the printing industry
5.9 10.0 5.6 10.0 5.7

FIGURE 8. Relation between information content ($-\log_2 f$) and total number of words for history titles



in the nineteenth century

5.5 3.3 TOTAL: 46.0

The first title indicates fairly precisely a person, a place and a time period, while the second indicates only the broad time period. The IC values do, therefore, seem to be in line with subjective assessments of the titles.

(c) Philosophy. Fifty of the sample of philosophy titles were evaluated. The maximum possible I was again 10.0. A graph was not plotted in this case, but the best straight line was calculated to be

$$IC = (4.97 \times \text{no. of words}) + 3.42$$

and the correlation coefficient, r, was 0.84. The mean number of words per title was 5.9, and the mean IC per title was 32.6. The contribution per word to the IC of the titles is thus very similar to that in history, as is to be expected from the similar word frequency distribution (see next Section). It is possible, however, that larger samples sizes might make a difference. History titles may contain a large variety of personal names and place names not matched in philosophy.

2.8.4 Theoretical treatment

Zipf's (1949, p.24) first law, which applies to words of high frequency (i.e. high rank when arranged by frequency) is that the product of the rank, r, and frequency, f, is a constant c. Thus

$$\log r + \log f = \log c$$

$$\log f = \log c - \log r.$$

If a graph is plotted of log frequency against log rank, the result should therefore be a straight line (at least for the high frequency part) with slope -1.

To check on how well the frequencies from the analyses of history and philosophy titles followed this law, graphs were plotted of log r against -log f and are shown in Figures 9 and 10. A further graph was plotted for the word frequencies in <u>Chemical Titles</u> as reported by Heaps (1975), and is shown in Figure 11. As can be seen, all three graphs were sigmoid-shaped, but fitted reasonably well to a straight line between about ranks 10 and 400. The gradients of these lines were -0.78 for chemistry, -0.77 for history, and -0.80 for philosophy. These are reasonably consistent, but suggest that a better approximation for medium frequency is

$$\log f = \log c - \alpha \log r$$

$$\text{i.e. } f(r) = \left(\frac{c}{r}\right)^{\alpha} \qquad (1)$$

where f (r) is the frequency of a word of rank r, and $\alpha \simeq 0.79$.

Following the argument of Booth (1967), the condition for a single occurrence is taken to be

$$2/T > f(r) \geqslant 1/T$$

where T is the number of words (tokens) in the sample, and, in general, for n occurreneces:

$$\frac{n+1}{T} > f(r) \geqslant \frac{n}{T}$$

Substituting for f (r) from equation (1)

$$\frac{n+1}{T} > \left(\frac{c}{r}\right)^{\alpha} \geqslant \frac{n}{T}$$

FIGURE 9. Plot of - log (frequency) against log (rank) for words in 1000 history titles

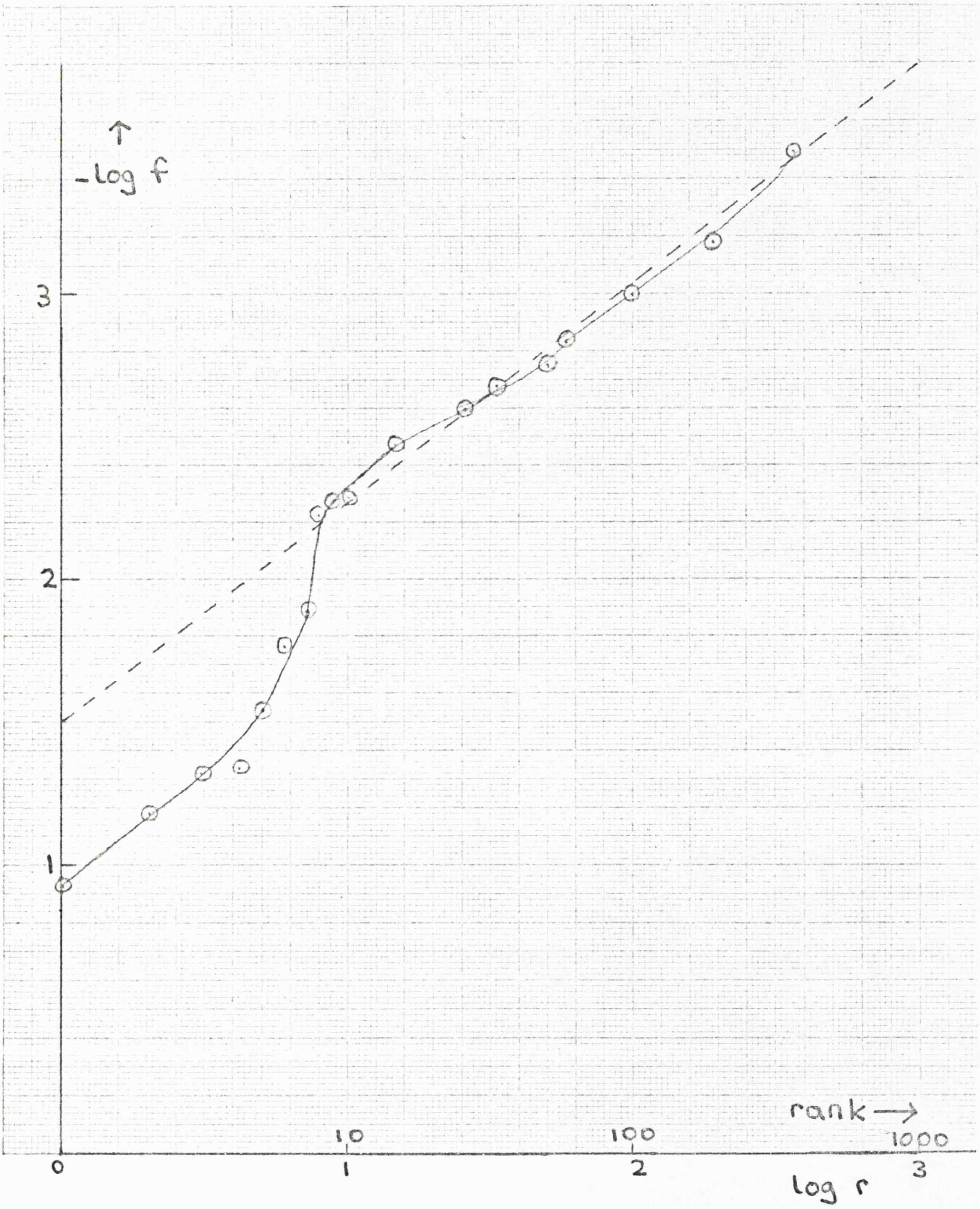


FIGURE 10. Plot of - log (frequency) against log (rank) for words in 1000 philosophy titles

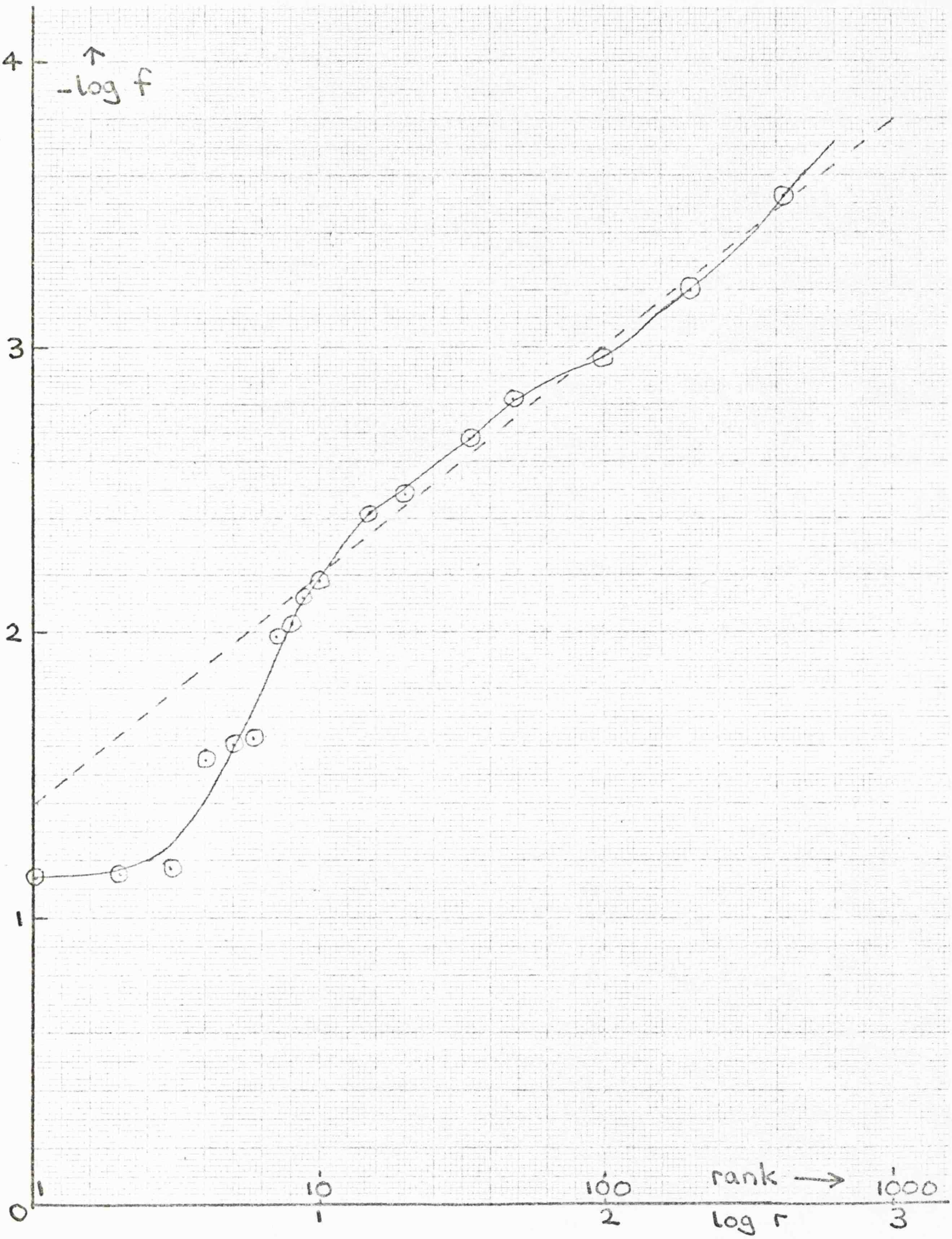
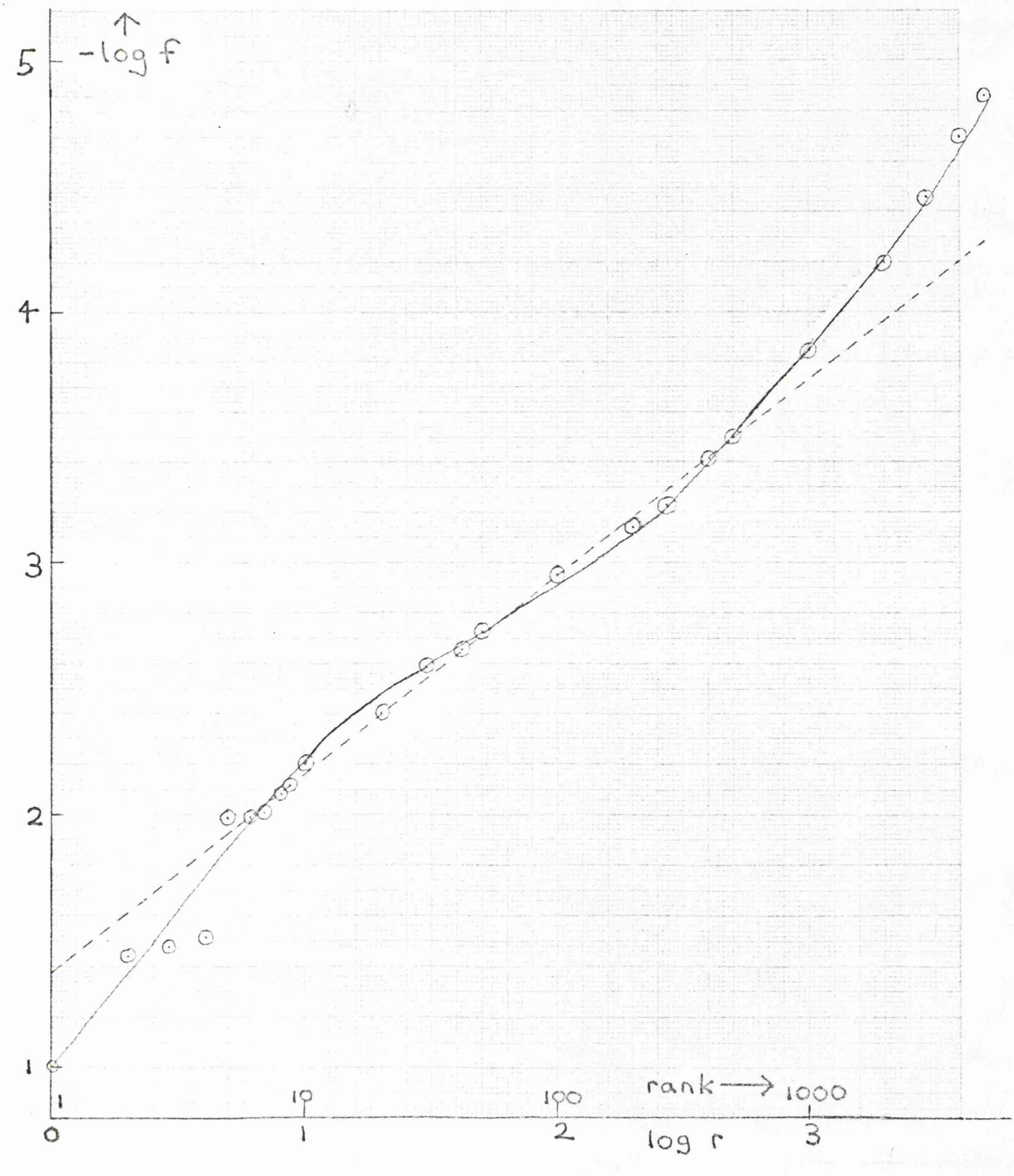


FIGURE 11. Plot of - log (frequency) against log (rank) for words in Chemical Titles (1965)

(Data from H.S.Heaps J. Chem. Inf. 15 (1975) 34)



so that $r_{min} = C\left(\frac{T}{n+1}\right)^{1/\alpha}$ and $r_{max} = C\left(\frac{T}{n}\right)^{1/\alpha}$

for words of frequency $f(r)$. The number of occurrences, I_n, is given by

$$I_n = c\,T^{1/\alpha}\left[\frac{1}{n^{1/\alpha}} - \frac{1}{(n+1)^{1/\alpha}}\right] \qquad (2)$$

The number of different words (types) in the sample, D, can be found from

$$T\,f(D) \geqslant 1$$

since D is the highest rank of any word, so

$$D = c\,T^{1/\alpha} \qquad (3)$$

The number of words occurring once only is given by equation (2) as

$$I_1 = c\,T^{1/\alpha}\left[1 - \frac{1}{2^{1/\alpha}}\right]$$

$$I_1/D = \left(1 - \frac{1}{2^{1/\alpha}}\right)$$

Using the values of α determined from Figures 9 - 11, the predicted values of I_1/D are:

Chemistry	0.59
History	0.59
Philosophy	0.58.

In the frequency analysis performed using COCOA for the history and philosophy titles, the values obtained were:

History: $D = 2591, \quad I_1 = 1607, \quad I_1/D = 0.62$

Philosophy: $D = 1947, \quad I_1 = 1235, \quad I_1/D = 0.63$

Thus the predicted values agree with the actual values to within about 7%.

The information value of a word occurring n times in 1000 titles was defined in Section 2.9.1 to be

$$- \log_2 \frac{n}{1000} = 6.908 - \log_2 n$$

Combining this with equation (2) , the total IC of all the words occurring n times in 1000 titles will be given by

$$\sum_{n=1}^{n=n_{max}} n\, c\, T^{1/\alpha} \left[\frac{1}{n^{1/\alpha}} - \frac{1}{(n+1)^{1/\alpha}}\right] (6.908 - \log_2 n)$$

Therefore the mean IC of a title containing t words out of all these T words will be

$$\frac{t}{T}\, c\, T^{1/\alpha} \sum_{n=1}^{n=n_{max}} n \left[\frac{1}{n^{1/\alpha}} - \frac{1}{(n+1)^{1/\alpha}}\right] (6.908 - \log_2 n)$$

assuming that the words are randomly distributed through the titles. Using equation (3) :

$$\overline{IC} = \frac{Dt}{T} \sum_{n=1}^{n=n_{max}} n\,(6.908 - \log_2 n) \left[\frac{1}{n^{1/\alpha}} - \frac{1}{(n+1)^{1/\alpha}}\right]$$

A program was written in BASIC to perform this summation up to any desired value of n , and was run on-line on the Cyber 72 computer. The input values were:

History: $D = 2591$, $T = 9020$, $\alpha = 0.77$, $t = 8.28$

Philosophy: $D = 1947$, $T = 6457$, $\alpha = 0.80$, $t = 6.46$

Chemistry: $D = 3300$, $T = 12500$, $\alpha = 0.78$, $t = 12.5$

The value of T for the chemistry sample is 1000 times the mean number of words and fragments per title, 12.5. The value of D was obtained by extrapolating the graph of D against T in Figure 4 of Heaps (1975). The results are shown in Table 2.10.

TABLE 2.10 Mean IC values for titles obtained theoretically

summation to	IC for title of mean length		
n =	History	Philosophy	Chemistry
1	14.7	12.3	38.2
5	31.0	25.3	88.3
10	36.8	29.7	109.7
50	44.7	35.4	146.3
100	46.3	36.5	157.4

The mean value obtained experimentally for history titles was 42.6, and for philosophy titles 32.6. The calculated values agree well with these when I values for words occurring up to about 50 times in 1000 titles are summed. From Table 2.8, this corresponds to about the change-over point from substantive to nonsubstantive words. The experimental mean value for chemistry titles was 82.2, which is somewhat lower than the calculated value (up to an estimated n of about 20, from Table 2.8). This may be due to the fact that a maximum possible I value corresponding to 3 occurrences in 65,000 titles rather than 1 in 65,000 titles was used in the experimental determination.

2.8.5 Criticism of the technique

The information content of words and titles defined as above is a direct measure of a word's retrieval performance. A word with information content I occurrs 2^{-I} times in 1000 titles and the greater the value of I the more discriminating will the use of that word be in selecting from a set of titles. The I value corresponds to what Sparck Jones (1972) has called 'specificity', but it does not always agree with one's intuitive ideas of specificity. For example, in the first chemical title quoted in Section 2.8.3 above, the words 'highly' and 'convenient' had higher I values than the words 'acetic' and 'ketones', whereas it would be hard to argue that they were, in the normal sense of the word, more specific. If one knows that one is looking for a paper with the word 'highly' or 'convenient' in its title, then these will be efficient search terms and will achieve high precision. The point is, of course, that these words do not define particular subjects but are likely to be distributed fairly randomly through the specialties of chemistry.

Salton et al. (1975) conducted an experiment on the effectiveness of index words in discriminating the documents in a collection. They considered the documents to be defined by weighted properties W_{i1}, W_{i2}, W_{i3} ... W_{it}, which could be represented by the point in space to which a vector so defined pointed. A good discriminator was defined as one which increased the separation of these points in space. They found, for three test collections of documents, that when the index terms were ranked in frequency order very few good discriminators were included in the 70% of lowest frequency or the 4% of highest frequency. In the history and philosophy samples used above, these conclusions imply that most of the good discriminators are included among the words occurring 2-9 times per 1000 titles, i.e. those having I values of 6.8 to 9.0.

However, whilst Salton's results may give some useful guidance for automatic indexing from text, or for the design of a controlled indexing vocabulary, they do not necessarily apply to the assessment of words which authors have deliberately chosen to include in their titles. There will be cases where one wishes to search for a single rare term - for example, to find all reports on a rare mineral since its discovery, or to see what has been written about an individual with a very distinctive surname. In these cases, the word of very low frequency would be of very high value for searching.

The more common way of searching, though, is to combine two or more relatively broad terms with an 'AND' operator, e.g. 'cadmium AND soil', or 'heart AND transplant'. The number of titles retrieved by coordination should, at first sight, be governed by the sum of the I values. For example, 'amino' has the I value 5.9 and 'acid' the value 3.7, so amino + acid has a value of 9.6, corresponding to a frequency of about 1 in 1000 (chemistry) titles. However, this is almost certainly an underestimate. 'Amino-acid' is a common combination, and given that a title contains the fragment 'amino-' the probability that it also contains 'acid' is higher than for chemical titles in general. Commonly occurring compound terms will have overestimated I values using the technique reported above, because of this dependency in the occurrence of their components. Unfortunately the KLIC Index did not give data on the frequencies of compound terms, and selecting terms for investigation (e.g. in Chemical Titles) would theoretically involve looking at the frequency of co-occurrence of each possible pair of words in the sample (and one should not really stop at pairs!) It would be quite beyond the capabilities of computer storage to do this automatically. The inability to cater for non-random co-occurrence of words and fragments is thus an inherent defect of the method as a means of evaluating the information contents of titles.

2.9 THE VOCABULARIES OF TITLES

Some quantitative measures of the information contents of titles have been applied above, with special reference to the use of title words in retrieval. There are also some qualitative features of titles which vary between subjects and which may have a significant effect on retrieval possibilities. The varying prevalence of subtitles has already been discussed in Section 2.6.

2.9.1 Systematic nomenclature

The nomenclature of chemistry permits searches on two or more components of a compound, for instance a paper having 'ammonium trifluoracetate' in its title could be retrieved by someone interested in ammonium compounds, acetates or fluoro-compounds. However, no-one is likely to want papers on the class of people with the Christian name 'Samuel', so the word 'Samuel' in 'Samuel Johnson' serves only to improve precision when searching under the word 'Johnson'. Similarly, topographical nomenclature does not indicate broader terms in the hierarchy. In expanding fully the concept 'United States' for searching an historical file, one would have to include the name of each state, town, region, etc.

2.9.2. Fragmentation

This might be regarded as a special case of 2.9.1. In chemistry, and to a lesser extent in biology and medicine, word-fragments are often meaningful enough to be useful in retrieval. For example, the fragment '-ase' will retrieve a large proportion of enzymes such as 'oxidase', 'urease', 'ligase' and 'hydrogenase' (as well as a few false drops such as 'base', 'release', and 'phase') on a system which allows left-hand truncation. Complex chemical names such as '*trans* - 2, 3 - dimethyl - 1 - phthalimidoaziridines' give rise to several entries (five in this case) in *Chemical Titles* by being split before each meaningful fragment. 'Hemocytoblastosis' is indexed at three points in the KWIC index of *Biological Abstracts*. Such fragmentation is not possible to anything like the same extent in the social sciences and humanities, so the number of entry points will be almost limited to the number of substantive words.

In the experiment reported in Section 2.8, I values were assigned to individual fragments, so the method took this factor into account.

2.9.3 Dates

An important facet in searches in history-related subjects will often be date. The ways in which titles may indicate coverage of a particular period are many and unpredictable. For example, consider a search on 'English agriculture during the period 1750-1850'. The title words 'Georgian', 'eighteenth-century', '1800-1914', would all indicate the inclusion of potentially useful information. Thus natural language searching seems to present formidable difficulties for searching by date. (If, on the other hand, a title is located in a KWIC index by a word relating to another facet of the problem, a date given in the context should indicate whether the title is relevant.) The only solution would seem to be to require authors to write date ranges out in full (e.g. 1914-1918) and to employ a special routine in searching which determined whether a specified period in the search profile overhapped with the period stated in the title.

2.9.4 Metaphorical Titles

As mentioned in Section 2.2, titles in philosophy and sociology, have so far been used much less for information retrieval than for catching the attention of browsers. Authors have thus designed them to show off their wit and erudition, and to mystify the reader, rather than to inform him, e.g.

> 'The cow on the roof' (Journal of Philosophy, 1973)
>
> 'The seven sexes: a study of the sociology of a phenomena' [sic] (Sociology, 1975)
>
> 'On the construction and care of white elephants' (Library Association Record, 1968)

Some examples of a metaphorical title followed by a more informative subtitle were given in Section 2.6.1.

In evaluating such titles by counting substantive words (Section 2.4), any word not on the stop list was counted. To have done otherwise would have involved deciding what the article was 'about' (so tending towards the comparative techniques criticized in Section 2.3.2), and impossible decisions on when a metaphorical use of a word became a technical use, e.g. 'chain' of a molecule, and 'intelligence' of a computer terminal. The technique thus over-estimates the average information content of titles in subjects where such titles occur. So also does the frequency-weighting technique of Section 2.8. The words used metaphorically will usually be rare in the subjects concerned (though they may well be common in other subjects, e.g. 'cow' will be common in agricultural titles), so that they will be assigned high I values. This may be an argument for a low-frequency cut-off as suggested in Section 2.8.5.

2.10 CONCLUSIONS

Two principal techniques have been used to evaluate the information content of titles: counting the number of substantive words, and summing the values assigned to title words depending on the logarithm of their frequencies in the titles of the subject area.

One of the main objectives of developing such techniques was to investigate differences between subjects in the information content of titles. From a straight-forward count of all words in the title, botany, physical chemistry and pharmacology came highest, followed in order by engineering, physics, organic chemistry, psychology, history, economics, sociology and philosophy. The biggest gap in this series was between sociology (mean = 8.4 words) and philosophy (mean = 4.5 words). Counting substantive words rather than all words hardly altered this order. French and German titles, when translated into English, had very similar mean numbers of substantive words to English titles in the same subject.

A study of the frequency distributions of words in the titles of chemistry, philosophy and history papers showed them to be very similar, at least for moderate sample sizes. When frequency-weighting of title words was applied, a strong correlation was found in each subject between the information content (IC) so obtained and the number of substantive words in the title. Fragmentation of chemical names was allowed for, and led to chemical titles receiving higher IC values in relation to their numbers of substantive words than historical and philosophical titles had.

The more-or-less systematic nomenclature of chemistry was pointed out as a further advantage of titles in that subject, while the use of metaphorical titles in sociology and philosophy is a further disadvantage there.

The overall conclusion of the work reported in this chapter is thus that the subject areas in which titles are longest are also those in which the title words show features which are likely to make them ~~are~~ most useful for retrieval. Counting the substantive words in titles seems to be a reasonable first approximation for comparison between fair-sized samples (though for individual titles it may be unsatisfactory). The extra effort involved in using frequency-weighting does not seem to be justified.

The areas in which KWIC indexes first became established on a large scale - chemistry and biology - and later, mechanised searching on title words - medicine, chemistry and physics - thus correspond to those in which the titles provide most information for retrieval purposes. However, the social sciences do not come far behind, and there has been a move toward more informative titles in these during the last decade or so. Mechanised systems are now starting to put up more files relating to the social sciences from which references can be retrieved by searching on title words. However, the supplementing of title words by indexer-assigned descriptors is likely to remain of importance for the immediate future, and KWIC is not an adequate type of index given the present forms of titles in the softer subject areas.

CHAPTER THREE

AUTHORS' NAMES AND ADDRESSES

3.1 FUNCTIONS OF NAMES AND ADDRESSES

In library catalogues, the author's name is usually the main heading for his works. It is also one of the most important bibliographic elements for research papers. All the major secondary services have author indexes. If someone knows of the existence of a paper, he will often be more sure of the author's name than of the title, and so will use the name as a search term. One might also search by author's name if one knows of his activity in a field of interest and wishes to find what he has written on his work. Students in the humanities may be more interested in all works by a particular author (either because they are studying his contribution to the discipline, or because they subscribe to his school of thought) than all works on a particular subject, which is the normal approach in the sciences. Even in the sciences, though, one may associate a particular author with a particular approach. The name of a known author attached to a paper may make a reader give more (or less) credence to it than he would for an unknown author, and so affect whether or not he obtains or reads the paper. Kuney and Weisgerber (1970), in their study of the behaviour of readers of the Journal of Organic Chemistry, found that 23% scanned the author index after looking at the table of contents.

The function of the author's affiliation is partly to identify him (e.g. as Smith, J. of Wanganui College as opposed to Smith, J. of Mogdon Sewage Works), though authors may, of course, move about. A known institution or department may also serve, like a known author's name, to add, or detract, esteem to, or from, a paper, and to identify it with an approach or school of thought. One may wish to search for all papers from a particular institution because of its housing a research team involved in one's area of interest. Alternatively, one might want to know in what areas a department is working, though publications are likely to reflect the interests at some time in the past. The Science Citation Index allows searching by institution, and on Dialog the 'corporate source' can be searched on several files including CA Condensates, Psychological Abstracts, Sociological Abstracts, and INSPEC.

The author's address is principally of use for ordering offprints (and is often given as such in a footnote). With the easy access to photocopiers nowadays, offprints are really only necessary for users of secondary services who do not have a copy of the journal easily available. Posen and Posen's (1969) study of offprint requests which they received suggested that 40% were from people seeing the title in Current Contents. For such people, the inclusion of the full address of the author is highly desirable, and this can normally be done only if the full address is given in the original paper. An affiliation without an address will put the user to the inconvenience of having to look it up, or, as often happens, will lead to his writing off with an inadequate address.

3.2. OCCURRENCE AND POSITION OF AUTHOR DETAILS

Ten journals in each of fifteen subject areas were selected from those available at Leicester University Library. The samples were chosen to include a French and a German journal where possible, with the remainder being mainly leading U.K. and U.S. journals. The subjects, journals, publishers and countries of publication are shown in the table in the Appendix. For each journal, the position of the author's name, affiliation, address and further biographical details if present were recorded and are shown in the table. It was also noted whether authors' Christian names were always, mostly, sometimes, or never given.

3.2.1. Author's names

The author's name was given for all papers in all the journals studied. In all subjects most journals gave it at the head of the article, but three journals in literature, two in philosophy, and two in history had the authors' names at the end. This is an inconvenient position for indexing purposes (and possibly for readers) and may persist in the humanities because of the lesser importance of secondary services there at present.

The forms in which authors' names are given will be discussed in Sections 3.3 and 3.4.

3.2.2. Authors' affiliations

Nearly all journals gave the authors' affiliation, the exceptions being two journals in philosophy, one in politics, one in economics, two in literature, and two in history. Whereas in all the physics journals and all but one of the chemistry journals the affiliation was given at the head of the paper, it was given at the end in six journals in philosophy, six in mathematics, and five in literature. Since the affiliation serves partly to identify the author and also has some functions in common with the author's name, it would seem most useful to print the two together.

3.2.3. Authors' addresses

The occurrence of authors' addresses in the journals sampled is shown in Table 3.1.

TABLE 3.1. Occurrence of authors' addresses by subject (sample size = 10)

Subject	No. of journals with authors' addresses	Subject	No. of journal with authors' addresses
Philosophy	1	Biochemistry	10
Psychology	6 + 1*	Botany	9
Sociology	0	Zoology	9
Politics	0	Medicine	10
Economics	2	Engineering	6
Mathematics	8	Literature	0
Physics	10	History	1
Chemistry	10		

*addresses sometimes given

As discussed in Section 3.1, the main use of authors' addresses seems to be for requesting offprints. Hagstrom (1970) has reported a survey of U.S. academic scientists concerning the number of offprints of their papers which they sent to people outside their institutions. The proportion of those who sent more than 100 offprints varied from 7% in mathematics and 8% in experimental physcis through 14% in chemistry to 61% in experimental biology and 56% in other biology. Thus the slightly lower occurrence of authors' addresses in mathemtics journals may be related to the lower importance of offprints there.

Whereas journals in the natural sciences, mathematics and medicine tend to offer authors around 50 free offprints of their papers (but sometimes only 25-30 in nonexperimental biology), journals in the humanities, if they contain any information for authors at all, usually offer around 25 or fewer. This might indicate less need for authors' addresses in the humanities due to a lower level of use of offprints, one reason for which is no doubt the lesser use of current awareness services. An additional reason for the lower occurrence of authors' addresses may also be that the institutions are usually university departments and more easily traceable than the institutions of authors in the pure and applied sciences. (Of course, the main reason may be tradition.)

As regards the position of the address, the beginning of the paper was the most popular except in psychology, mathematics and engineering. In mathematics there was a preference for the end of the paper, in engineering the majority of addresses appeared as footnotes, and psychology had three journals using each of these positions. If the main value of authors' addresses is for reproduction in the secondary services, to facilitate writing off for reprints, then the best position would seem to be at the head of the paper, so that all the information needed by the secondary services is found together (Garfield, 1976).

3.2.4. Biographical information

Some journals gave other information about authors apart from their affiliations and addresses, such as their positions in their institutions. The occurrence of this in the samples is shown in Table 3.2. The reason for the commonness of authors' credentials in politics and sociology may be that papers there depend on authors' experience and opinions far more than in the sciences, where premises are backed up by references, and studies are carried out by accepted techniques and (usually) to accepted standards.

One of the engineering journals, IEEE Transactions, included photographs of the authors. This is unusual for a learned journal, where

TABLE 3.2. Occurrence of biographical information on authors (sample size = 10)

Subject	No. of journals with biographical information
Philosophy	1
Sociology	5
Politics	7 + 1*
Medicine	1
Engineering	2
History	1

* sometimes given

printing methods would usually make them prohibitively expensive. They may perhaps be useful for recognising or recalling the authors.

When given, biographical information was usually located in a footnote on the first page of the paper, or at the beginning of the issue of the journal - perhaps implying that browsing through authors is as important as browsing through titles in sociology and politics.

3.3 FORENAMES AND INITIALS

Table 3.3. shows the number of journals in each sample which never gave forenames and of those which usually or always gave at least one forename. (The significance of the groups will appear later.) Journals which gave initials only were commonest in physics and engineering, and

TABLE 3.3. Occurrence of forenames/initials in journals (sample size = 10)

Subject	No. of journals where forename never given	No. of journals where forename usually or always given
Physics	5	2
Chemistry	0	6
Biochemistry	0	10
(Mean)	1.7	6.0
Botany	2	6
Zoology	0	5
Economics	0	9
(Mean)	0.7	6.7
Psychology	0	9
Sociology	0	9
Politics	0	9
(Mean)	0	9.0
Philosophy	0	10
Literature	0	9
History	0	8
(Mean)	0	9.0
Mathematics	1	7
Medicine	1	5
Engineering	3	2

were not found at all in the social sciences and humanities. Journals which always gave forenames were found in all subjects except physics and botany.

Storer (1967) was interested in how the relative 'hardness' of a science affects the social relationships among its disciples. He used as an indication of hardness the frequency of tables in papers in the subject, on the assumption that a table involves at least some mathematics. This led to groups of three hard sciences (physics, chemistry and biochemistry), three medium-hard sciences (botany, zoology and economics), and three soft sciences (psychology, sociology and political science). As an indication of the social relationships in the sciences he looked at the frequency with which authors cited other people's work by their Christian names rather than their initials. For samples of papers published in 1966, the hard sciences had 100% initials-only references, the medium-hard group had 95%, and the soft sciences had 52%. Storer considered that use of initials-only was to distinguish the person from others of the same surname and so indicated a degree of 'social distance' compared with the more personal practice of using Christian names.

A similar trend seems to exist for the form of authors' names given with the papers. In Storer's 'hard' group there were more journals where forenames were never given and fewer where forenames were always or usually given than in the 'medium' group. Similar differences were found between the 'medium' and 'soft' groups. Practice in journals in the humanities was similar to that in the social sciences.

To provide data of greater significance, samples of 100 citations were examined from various abstracting journals for the presence of at least one author's forename, and some comparisons of practice in 1947 and 1978 were made. The results are in Table 3.4.

TABLE 3.4. Occurrence of authors' forenames in papers in various subjects

Abstracting journal	Section	Date	% of papers with authors' forenames
Chemical Abstracts	Electrochemistry	1947	32
	"	1978	19
" "	Organic chemistry	1947	59
	"	1978	60
Biological Abstracts	Botany	1947	47
	"	1978	55
" "	Biochemistry	1947	49
	"	1978	73
Psychological Abstracts	(Averaged)	1947	65
		1978	90
Sociological Abstracts	Political interactions	1978	95
Historical Abstracts	(Averaged)	1978	71
Mathematical Abstracts	Complex variables	1978	41

Electrochemistry, which was the 'hardest' subject sampled, had fewest authors' forenames given. The significantly lower number in 1978 than in 1947 seemed to be partly due to a high proportion of Russian authors, who hardly ever have forenames given. Biochemistry, which is 'hard' in Storer's grouping, had in 1978 significantly more forenames than had botany, which he classed as 'medium hard'. In 1947 there was very little difference. This change could be due to the recommendation of the IUB Commission to Editors of Biochemical Journals quoted in Section 3.5. Giving forenames has now become as common in biochemistry as in the humanities, and so seems to be governed by informational rather than social considerations. Despite the fact that psychology has attained the rank of a 'social science', authors' forenames are given significantly more often now than in 1947, so that, in this respect, it has become less like the 'hardest' sciences. Mathematics itself is not a science, and so not classifiable as 'hard' or 'soft'. However, in common with the more mathematical sciences, it does have a large proportion of papers giving only authors' initials.

Two journals in botany, the Botanical Journal of the Linnaean Society and Planta, gave forenames of female authors only. Knight (1967) considered that there was 'something to be said' for this practice, and it is useful when citing a paper to know the sex of the author. However, in these days of acute awareness of discriminatory practices, something will no doubt be said against it.

3.4 AUTHORS' NAMES AND INDEXING

The importance of consistency in the form of authors' names is generally recognised in book cataloguing. The British Library Bibliographic Services Division, for example, keeps a name authority file of all authors' names already used in cataloguing with cards for references from nonpreferred to preferred forms of names. The file is large, and checking every name to be used is time consuming. Keeping such a file would not normally be viable for indexing services, and reliance is usually placed on the form of the name as given in the paper. This leads to obvious dangers of inconsistency.

(a) Inconsistencies in forenames. If an author on different occasions writes under one Christian name, a Christian name and an initial, and two initials, three different entries may be made in indexes, e.g.

LINE, Maurice

LINE, M.B.

LINE, Maurice B.

A user may not realise that all three entries refer to the same person, especially after looking up one of them and finding that it is the author he is seeking. In some indexes and on-line files, e.g. Medline, INSPEC, *Bulletin Signaletique*, and *Biological Abstracts*, only authors' initials are given. Others give forenames when available, e.g. *Chemical Abstracts* (cumulated indexes), *Sociological Abstracts* and *Historical Abstracts*. In either case, because of the possibility of entries in various forms, one needs to use truncation after the first initial to be sure of finding all forms. For example, entering LINE, M? should retrieve all the forms shown above. However, with common surnames this will generally lead to low precision. Some authors write under all initials and under a forename other than the first - e.g. 'A.J. Meadows' and 'Jack Meadows', which means that even the first initial will not always be reliable.

(b) Inconsistencies in surnames. Whereas for many authors it is fairly obvious which part of the name is to be treated as the surname, double-barrelled names, names with prepositions or articles, and the exotic names characteristic of certain nationalities present problems. For example, should Derek J. de Solla Price be indexed as:

PRICE, Derek J. de Solla

DE SOLLA PRICE, Derek J.

or SOLLA PRICE, Derek J. de?

The Anglo-American Cataloguing Rules (1967) have a lengthy chapter on how to create headings for persons. For example, Augustus de Morgan (English) should be entered under DE MORGAN, and Pietro Maria de Amicis (Italian) under DE AMICIS, but Alfred de Musset (French) should be entered under MUSSET, and Emil de Puscariu (Romanian) under PUSCARIU. Muhammad ibn Ishaq Sadr al-Din al-Qunaivi is to be entered under SADR AL-DIN (the Khitab). Where possible, an author is to be entered under the name 'by which he prefers to be entered, or ... by which he is listed in reference sources'. 'If it is not certain that a surname with the appearance of a compound surname is one in fact, it is not to be treated as one if the bearer's language is English or a Scandinavian language.'

Again, such sophisticated procedures are beyond the reach of the indexing services, which must either use simpler rules, or else go by the way that the primary journal treats the name, e.g. in the contents list. Some journals - Acta Psychologica, European Journal of Biochemistry, Social History, and Surface Science - distinguished the surname from other parts of the name by the use of capital letters, e.g.

which shows readily that the index entries are

BAKKER, Dirk J.

and KLEIJ, Pien C.M. van der

However, their 'Instructions to Authors' did not ask the authors to make the distinction.

3.5 RECOMMENDATIONS

Few journals have any instructions to authors on the form of name to use, and they are mainly in the field of biochemistry. The Journal of Biological Chemistry carried the following statement in 1979: 'Occasionally confusion arises when authors are identified by surname and initials alone. To minimize this possibility the JOURNAL urges authors to follow the recommendation of the IUB Commission to Editors of Biochemical Journals that either the first or second given name should be spelled out in full.' Whilst most journals seemed to allow forenames in full or initials, some evidently always gave initials, regardless of authors' preferences.

Since it seems unreasonable to expect either primary or secondary journal editors to check authors' names against their previous works for consistency, I would suggest that the onus be put on the author to use a consistent form of his name. Primary journal editors must then be flexible enough to allow this form to be printed, rather than imposing a journal style. This should then ensure the same form of the name in all entries in indexes. New authors might be encouraged to give a forename in full, so as to provide some discrimination between authors with the same initials. If and when this became the norm, editors would easily be able to spot any deviations.

Some authors show different degrees of formality as befits the context - for example, the polymath referred to above has written under the name 'A.J. Meadows' in the Journal of Documentation and in Theology, but under 'Jack Meadows' in New Scientist and the editorial of the Journal of Research Communication Studies. The desirability of standardization for bibliographic control needs to be set against such otherwise cordial adaptability.

Even if forenames were always reduced to initials, there would still be problems in determining the entry point for surnames with prepositions or articles. Again, the onus could be put on the author, who ought to be in the best position to judge what his surname is. (The practice noted above of putting the surname in capitals and the rest of the name in lower case provides a simple way of indicating the surname, even in typescript.) This should achieve consistency for the particular author, but it may not do for different authors of the same surname. For instance, A. van der Graaff may decide that his surname is VAN DER GRAAFF, while B. van der Graaff may give his as GRAAFF, especially if they are of different nationalities. Thus until a searcher found one paper by the required author he would not be able to tell under what name to look. Perhaps a ruthlessly simple policy of always entering names under the last element, regardless of hyphenation or the inverted order of Chinese names, would be the only way to remove ambiguity for the searcher.

The value of including the affiliation of each author, and the full postal address for correspondence in the same **place as** the authors' names has been pointed out above.

C H A P T E R   F O U R

ABSTRACTS

4.1 INTRODUCTION

In order to make any detailed observations about the process of abstracting it is necessary first to look at how the texts of the papers themselves can be analysed. Only when a generally-applicable structure has been recognised in texts can one begin to formulate principles about what parts of the text should go into the abstract, and in what proportions.

Experimental papers in many journals in the sciences and social sciences have a ready-make structure - at least on the surface - by being divided into sections labelled 'Introduction', 'Experimental' or 'Method', 'Results' and 'Discussion'. (Whether the content of these sections really fits their headings is examined in Section 4.6, and, as a by-product, some suggestions are made for improving the content and arrangement of papers.) It is also for experimental papers that abstracts are most commonly found. Therefore the major part of this chapter is taken up with the abstracting of experimental papers. Instructions to authors about abstracting are usually framed in terms of these traditional divisions, and so such an analysis can show how well they are being followed.

In Section 4.7, I consider a more linguistically-based analysis of the structure of papers. As put forward by Gopnik, it applies only to experimental papers. However, since Gopnik's three types have been shown to reduce to a 'Brémond cycle', which is a structure basic to a very wide variety of narratives, the approach seems to offer the possibiaity of extension to other kinds of papers.

The major controversy in abstracting concerns the nature of abstracts - whether they should be informative (i.e. quote results from the paper) or indicative (i.e. indicate what results are in the paper). After I have considered the problems of labelling statements as 'indicative' or 'informative', I will examine a sample of abstracts in these terms. The distinction can be made for abstracts of both experimental and nonexperimental papers. Section 4.10 is devoted to a consideration of the occurrence and value of numerical results in abstracts.

To give some idea of how authors' abstracts might be improved, at least for use by the secondary services, a comparison is made of authors' abstracts and abstracts written for the same papers by a secondary service. On a wider scale, the requirements of various possible users of abstracts are considered, and some studies of the performance of abstracts in such applications are reviewed. This leads to some conclusions about how abstracts should be written to improve this performance.

The most detailed study of authors' abstracts published so far is that by Landau and Weiss (1976). It covered 240 journals in the life sciences, of which one-third were from the BIOSIS list, one-third were ELSE (European Life Science Editors) journals, and one-third were from the top journals in the Science Citation Reports. The total number of papers surveyed was 3,416, of which 77% covered experimental studies. Frequent comparison will be made with Landau and Weiss' results throughout this chapter.

4.2 OCCURRENCE AND LANGUAGE

The journals listed in Table A.1 were examined for the presence of abstracts, both of English and (where appropriate) foreign-language papers. The results are given in Table 4.1, and summarised by subject in Table 4.2.

TABLE 4.1 Occurrence of Abstracts

Subject	Journal	English papers		Non-English papers	
		Abstr. in Engl.	Abstr. in other lang.	Abstr. in Engl.	Abstr. in other lang.
Philosophy	Analysis	-	-		
	Br. J. Philos. Sci.	-	-		
	Inquiry	b	-	-	b
	J. Philos.	-	-		
	Mind	-	-		
	Philosophy	-	-		
	Am. Philos. Q.	-	-		
	Rev. Fil. Neo-Scol.			-	-
	Kant-Stud.	-	-	-	-
	Rev. Metaphys. & Morale			-	-
Psychology	Acta Psychol.	b	-		
	Br. J. Psychol.	b	-		
	J. Soc. Psychol.	b	-		
	J. Behav. Ther.	b*	-		
	Am. J. Psychol.	b	-		
	Br. J. Soc. & Clin. Psychol.	b	-		
	Child Dev.	b	-		
	Int. J. Psychol.	b	e		
	J. Res. Pers.	b	-		
	Neuropsychologia	b	e	e	b

* also on slips at E

Subject	Journal	English papers		Non-English papers	
		Abstr. in Engl.	Abstr. in other lang.	Abstr. in Engl.	Abstr. in other lang.
Sociology	Br. J. Sociol.	b	-		
	Int. Soc. Sci. J.	-	-		
	Man	b	-		
	Sociol. Rev.	-	-		
	Am. J. Sociol.	b	-		
	Human Relat.	b	-		
	Social. Probl.	b	-		
	Social Res.	-	-		
	Sociol. & Soc. Res.	b	-		
	Sociometry	b	-		
Politics	Polit. Sci. Q.	B+	-		
	Am. Polit. Sci. Rev.	B	-		
	Foreign Aff.	-	-		
	Polit. Q.	-	-		
	Int. Aff.	-	-		
	Polit. Sci.	b	-		
	Br. J. Int. Stud.	-	-		
	Europa Arch.			-	-
	Polit. Vierteljahrschr.			-	-
	J. Polit.	-	-		
Economics	Economica	-	-		
	J. Econ. Theory	-	-		

+ as editorial introduction

Subject	Journal	English papers		Non-English papers	
		Abstr. in Engl.	Abstr. in other lang.	Abstr. in Engl.	Abstr. in other lang.
Economics	J. Publ. Econ.	b	-		
	Rev. Econ. Stud.	-	-		
	West. Econ. J.	-	-		
	Int. Econ. Rev.	-	-		
	Finanzarchiv	-	-	-	-
	Econ. J.	-	-		
	Econometrica	-	-		
	Am. Econ. Rev.	-	-		
Mathematics	Proc. Am. Math. Soc.	b	-		
	Ann. Stat.	b	-		
	J. Symb. Logic	-	-		
	Ann. Math.	-	-		
	J. London Math. Soc.	-	-		
	Adv. Math.	-	-		
	Acta Math.	-	-	-	-
	J. Math. Pures & Appl.	-	-	(b)	(b)
	J. Reine & Angew. Math.	-	-	-	-
	J. Algebra	-	-		
Physics	J. Chem. Phys.	b	-		
	J. Phys. (London)	b	-	b	b
	Philos. Mag.	b	-	b	b

Subject	Journal	English papers		Non-English papers	
		Abstr. in Engl.	Abstr. in other lang.	Abstr. in Engl.	Abstr. in other lang.
Physics	Phys. Rev.	b	-		
	Surf. Sci.	b	-	b	-
	Z. Phys.	b	-	b	-
	Ann. Phys.	b	b	b	b
	J. Acoust. Soc. Am.	b	-		
	J. Phys. (Paris)	b	b	b	b
	Physica	b	-		
Chemistry	Acta Chem. Scand.	b	-	b	b
	Bull. Soc. Chim. Fr.			-	b
	Chem. Ber.			b	b
	J. Am. Chem. Soc.	b	-		
	J. Chem. Soc. Faraday Trans.	b	-		
	J. Inorg. & Nucl. Chem.	b	-		
	J. Org. Chem.	b	-		
	J. Organomet. Chem.	b	-	b	b
	Tetrahedron	b	-	b	b
	Z. Phys. Chem. (Leipzig)	b	b	b	b
Biochemistry	Anal. Biochem.	b	-		
	Arch. Biochem. & Biophys.	b	-		
	Biochemistry	b	-		
	Biochem. & Biophys. Acta	b	-		

Subject	Journal	English papers: Abstr. in Engl.	English papers: Abstr. in other lang.	Non-English papers: Abstr. in Engl.	Non-English papers: Abstr. in other lang.
Biochemistry	Biochem. J.	b	-		
	Eur. J. Biochem.	b	-	b	-
	Biochimie	b	e	b	e
	J. Biol. Chem.	b	-		
	J. Histochem. & Cytochem.	b	-		
	Phytochemistry	b	-		
Botany	Ann. Bot.	b	-		
	Am. J. Bot.	b	-		
	Ber. Dtsch. Bot.Ges.			b*	-
	Bot. J. Linn. Soc.	E	-		
	Bot. Jahrb.			e*	e
	Bryologist	b	-		
	J. Exp. Bot.	b	-		
	Physiol. Plant.	b	-	b	-
	Planta	b	-	b	-
	Watsonia	b	-		
Zoology	Am. Zool.	b	-		
	Acta Zool.	b	-	b	b
	J. Anim. Ecol.	e	-		
	J. Exp. Zool.	b	-		
	J. Insect Physiol.	b	-		
	J. Molluscan Stud.	e	-		
	Ecol. Entomol.	b	-		

Subject	Journal	English papers: Abstr. in Engl.	English papers: Abstr. in other lang.	Non-English papers: Abstr. in Engl.	Non-English papers: Abstr. in other lang.
Zoology	J. Zool.	b	-		
	Physiol. Zool.	b	-		
	Zool. Anz.	b	(e)	b	e
Medicine	J. Am. Med. Assoc.	b	-		
	J. Exp. Med.	e	-		
	J. Pharmacol. & Exp. Ther.	b	-		
	Lancet	b	-		
	Zentralbl. Bakteriol.	b	b	b	b
	Am. J. Surg.	e	-		
	Eur. J. Cancer	b	-		
	J. Nerv. & Ment.Dis.	b	-		
	Ann. Endocrinol.	b	b	b	b
	Virchows Arch. A	b	-	b	b
Engineering	AIAA J.	b	-		
	Trans. ASME	b	-		
	Automatica	b	-		
	IEEE Trans.	b	-		
	Proc. Inst. Mech. Eng.	b	-		
	Int. J. Heat & Mass Transfer	b	e		
	J. Mec.	b & B	b	b & B	b

Subject	Journal	English papers		Non-English papers	
		Abstr. in Engl.	Abstr. in other lang.	Abstr. in Engl.	Abstr. in other lang.
Engineering	J. Fluid Mech.	b	-		
	Solid-State Electron.	b	-		
	Meas. & Control.	(b)	-		
Literature	Engl. Stud.	-	-		
	Mod. Lang. Rev.	-	-		
	Essays Crit.	-	-		
	J. Mod. Lit.	-	-		
	Mod. Philology	-	-		
	Am. Lit.	-	-		
	Bibl. Hum. & Renaissance			-	-
	Crit. Lett.			-	-
	Dtsch. Vierteljahrschr. Lit. & Geist.	b	b	b	b
	ELH	-	-		
History	Past & Present	-	-		
	Hist. J.	-	-		
	Econ. Hist. Rev.	-	-		
	J. Am. Hist.	-	-		
	J. Econ. Hist.	B	-		
	Soc. Hist.	-	-	-	-
	Hist. Z.			-	-
	Byzantinische Z.			-	-
	Cah. Hist.			-	-
	Speculum	-	-		

* synopsis

KEY:
- b beginning of paper
- e end of paper
- B beginning of issue
- E end of issue
- ( ) sometimes
- – not given

TABLE 4.3. Languages of Abstracts in Life Science Journals (from Landau and Weiss (1976), p. 21)

Country of publication	Number of journals	Native language abstracts only	English abstracts only	Abstracts in more than one language
Australia	3	3	3	0
Canada	2	2	1	0
Czechoslovakia	11	1	3	7
E. Germany	10	1	0	9
France	16	8	1	7
Hungary	4	0	4	0
Irish Republic	1	1	1	0
Italy	10	2	2	6
Japan	6	0	4	2
New Zealand	1	1	1	0
Poland	11	4	5	2
Switzerland	4	1	0	3
UK	45	43	43	2
USA	41	39	39	2
USSR	11	11	0	0
W. Germany	28	7	5	16

TABLE 4.2. Prevelance of abstracts by subject (Sample size = 10)

Subject	Journals which contained abstracts	Number with English abstracts of all papers
Mathematics	3	2
Physical sciences		
Physics	10	10
Chemistry	10	9
Engineering	10	9
Life Sciences		
Biochemistry	10	10
Botany	10	10
Zoology	10	10
Social Sciences		
Psychology	10	10
Sociology	7	7
Politics	3	3
Humanities		
Philosophy	1	0
Literature	1	1
History	1	1

Inclusion of abstracts is thus the norm for scientific journals, including medical, engineering and psychological ones, but is rare in the humanities. In mathematics, the physical sciences, psychology and engineering, abstracts are found at the beginning of each article. In botany, medicine and zoology, they are sometimes at the end of the article. (Landau and Weiss (1976, p. 25) found that 14.3% of journals in botany, 42.8% in zoology, and 35.9% in medicine had abstracts at the end of the articles.) In politics, two journals had them at the beginning of the issue, as did one of the history journals. The prominence afforded to abstracts by their position, therefore, does not seem to reflect entirely the importance of abstracts journals in the subjects.

It is noticeable that abstracts are found most often in areas with a high proportion of experimental papers - thus in psychology and physics, but not politics and mathematics. It would be interesting to know whether this is because experimental papers are more easily abstracted in a useful manner. Such instructions as are available for abstracting seem to concentrate on experimental papers. Certainly, a paper which presents a definite conclusion is easier to summarise informatively than one which is wholly descriptive or discursive (Landau and Weiss, 1976, p. 63).

Considering now the journals which did have abstracts, all of them printed English abstracts of English papers. Inquiry, Acta Astronomica and Bulletin de la Société chimique de France were the only ones which did not print English abstracts of non-English papers. On the other hand, several journals gave only English abstracts of non-English papers. A fuller study of the language distribution of abstracts in life science journals is given by Landau and Weiss (1976) and some of their results are reproduced in Table 4.3. In countries where the native language is English (UK, USA, Australia, New Zealand, Eire) abstracts were almost always given in English and rarely in other languages. Other countries generally take account of the size of the potential English-speaking readership and publish abstracts in English. The principal exception is the USSR, which, in Landau and Weiss' samples, printed only

Russian abstracts. This may be justified since Meadows (1974, p. 102) has reported that even the greatly improved availability of cover-to-cover translations of Soviet journals has failed to stimulate much reference to Soviet work in Western literature.

Western journals are at least as parochial with regard to including Russian abstracts. The only ones which did so, of those I examined, were Il Nuovo Cimento (Italy), Oikos (Denmark), and Revue française de Sociologie (France). It seems unlikely that these journals are of exceptional interest to Russian readers.

Considering the importance of the Russian abstracting journal, Referativnyi Zhurnal, and the fact that Russian is probably the world's second most-used language after English for scientific papers (Bourne, 1962; Chaika, 1977), there would appear to be a case for giving Russian abstracts more widely. Perhaps the difficulty of finding people who can write them is one obstacle.

Fundamental to the matter of including abstracts in languages other than that of the text of the paper is the question of the purpose of abstracts. They are sometimes regarded as a guide to enable someone to see if he wants to read the full paper. In that case, the only purpose of having an abstract in a language the reader can understand to a paper which he cannot is so that he can commission a translation, if he considers the paper to be of sufficient importance. If, on the other hand, abstracts are accepted as sometimes acting as substitutes for the original paper, then an abstract in an intelligible language is of obvious value. This question will be taken up in Section 4.12.

4.3 INSTRUCTIONS TO AUTHORS

The International Organisation for Standardisation (1976), following the suggestions of Weil (1970), states that most documents describing experimental work can be analysed into purpose, methodology, results and conclusions, and suggests that the abstract should contain the most important information from each section:

> Purpose. State the primary objectives and scope of the study or the reasons why the document was written.
> Methodology. Describe techniques or approaches only to the degree necessary for comprehension. Identify new techniques clearly.
> Results: Describe findings as concisely and informatively as possible ... . Limits of accuracy and reliability and ranges of validity should be indicated.
> Conclusions. Describe the implications of the results and especially how these relate to the purpose of the investigation or ... document.
> Collateral information. Include findings or information incidental to the main purpose of the document, but of value outside its major subject area.

Few primary journals contain instructions for authors about abstracting in any detail. (Landau and Weiss (1976, p. 31) in their survey of 240 life-science journals found that 138 had instructions about writing abstracts and 48 of these had information about the content required.)

Some examples from journals which do mention categories of information are:

Journal of the American Society for Information Science - The abstract should present the scope of the work, methods, results and conclusions.

Physical Review - The abstract ... should be adequate as an index (giving all subjects, major and minor about which new information is given) and as a summary (giving the conclusions and all results of general interest in the article).

Institute of Physics: Notes for Authors - The abstract should ... be informative and not only indicate the general scope of the article but also state the main results obtained and conclusions drawn.

Journal of the Acoustical Society of America - An abstract ... should mention the subjects studied and new methods used and it should set forth quantitatively new observations and conclusions. Brief numerical results and their accuracy may be included.

Journal of the American Chemical Society - Abstracts should state briefly the reason for the work, the significant results and conclusions.

Biochemistry - The abstract should briefly present the problem and experimental approach, summarise important new results and clearly state major findings and conclusions.

Blood - An abstract ... summarising the reason for the study, the methods used, the results, and the major conclusions.

Journal of Pharmacology and Experimental Therapeutics - The abstract ... should present in a concise fom the purpose, the general methods, the findings and the conclusions of the manuscript.

AIAA Journal American Institute of Aeronautics and Astronautics - It [sc. the abstract] should be a summary (not an introduction!) and complete in itself (no numerical references). The abstract should indicate the subjects dealt with in the paper and should state the objectives of the investigation. Newly observed facts and conclusions of the experiment or argument discussed in the paper must be stated in summary form.

Further examples are found in the ELSE-Ciba Foundation 'Guide for Authors' (O'Connor and Woodford, 1975), p. 48:

> Begin the abstract by stating the category (original article, case history, etc.) to which the paper belongs, if this is not obvious from the title. Describe the purpose of the investigation being reported ... . Indicate the methods used and summarise the results and conclusions.

and Linton's (1972) 'Simplified Style Manual' (for the social sciences), p. 48:

> The abstract of an experimental paper should state (a) the problem, purpose, or hypothesis, (b) the experimental design, (c) the method ..., (d) the results, and (e) the conclusions.

The American Psychological Association (1974) Publication Manual is one of the few sources to give instructions for abstracts of nonexperimental papers (p. 15):

> An abstract of a review or theoretical article should state the topics covered, the central thesis, the sources used (e.g., personal observation, published literature, or previous research bearing on the topic), and the conclusions drawn. It should be short but informative ... . The abstract should tell the reader the nature or content of the theoretical discussion.

4.4 A STUDY OF THE CONTENT OF ABSTRACTS OF EXPERIMENTAL PAPERS

To what extent the instructions quoted above accord with the needs of users of abstracts will be considered in Section 4.12. Here I am concerned with how well authors' abstracts follow the instructions. This was identified as an area in need of research by Borko and Chatman (1963), who carried out an extensive survey of instructions to abstractors, especially in secondary services.

The traditional sections of experimental papers are 'Introduction', 'Experimental' or 'Method', 'Results' and 'Discussion'. The 'introduction' should contain details of the problem investigated, or the scope of the paper. The 'purpose' of the study may be given as the solution of a problem of practical importance, or the resolution of a conflict arising from earlier studies, but I would question whether in many papers there is any clear indication of purpose. The division of findings into 'results' and 'conclusions' in the instructions quoted above reflects the traditional division in papers into 'results' and 'discussion', where the results are interpreted. Sometimes conclusions are set out as a separate section at the end of the paper, but more commonly they are embedded in the 'discussion' section.

In view of this correspondence between the categories used in abstractors' instructions and the traditional divisions of a paper, I have investigated what are the average lengths of the four sections of experimental papers in various disciplines, and how much of the authors' abstracts is devoted to summarising each section. If the guidelines quoted above are being followed, it would be expected that:

(i) the proportion of 'results' will be higher in the abstract than in the corresponding paper, since nearly all the guidelines stress results or findings;

(ii) the proportion of 'experimental'/'method' will be lower in the abstract - several of the sets of instructions do not ask for 'method' at all (or just for novel methods);

(iii) the proportion of 'discussion' will be lower in the abstract, since the instructions ask only for 'conclusions'.

TABLE 4.4. Comparison of the text of an abstract with the corresponding parts of the paper (Ann. Bot. (1973), vol. 37, p. 1)

ABSTRACT	PAPER
The ultrastructural changes in nectar-secreting cells of V.r., V.m. and C.s. during ontogenetic development are described.	Intr. We studied the ultrastructure of some floral nectaries.

A B S T R A C T	P A P E R
	Meth. Segements of floral nectaries of V.r., V.m., and C.s. at different stages in ontogenetic development were fixed.
The most pronounced changes occur in the amount and morphology of the endoplasmic reticulum.	Obs. The most pronounced changes occur in the amount and morphology of the ER.
The amount of ER elements increases gradually and reaches a maximum at the stage of secretion.	Obs. The development of the ER during the period preceding secretion is a common feature of the secretory cells.
At this stage the ER is the dominant element in the cytoplasm.	The ER is the dominant element in the cytoplasm.
A process of swelling of a lamellar ER, followed by formation of vesicles, was noted in the secretory cells during the stage of secretion.	Obs. The ER elements in secretory cells at the stage of secretion are partially or entirely dilated. Vesicular dilations commonly occur.
Many vesicular elements appeared to be in a close association with the plasmalemma.	Obs. Throughout the stage of secretion smooth or partly rough vesicular elements were observed in the vicinity of the plasmalemma.
It is suggested that sugar is secreted as a solution by means of vesicles derived from the ER.	Disc. It is suggested that the vesicular elements contain a sugar solution and that by means of their fusion with the plasmalemma this solution is secreted.

Ten journals, covering the physical, life and social sciences, were selected for study. The choice was based on that in the study of titles (Section 2.5), but the requirement of suitably divided papers necessitated some changes. The Journal of Chemical Physics was included so as to permit further study of abstracts in secondary services (Section 4.11).

The first thirty papers published in 1973 in each journal which consisted of introduction, experimental/method, results and discussion sections only were selected. The number of lines of text in each section was counted and multiplied by the mean number of words per line. The criterion of what constituted a word was the same as that in the study of titles in Section 2.4.

The words in the authors' abstracts of these papers were then divided up according to the section of the paper which contained the same information. It was not possible to be absolutely rigorous about this for various reasons. In a few cases information in the abstract did not correspond to any statment(s) in the paper, or it was a generalisation from more than one statement in the paper, so that a subjective assignment had to be made. In other cases the same information appeared in more than one section of the paper: here it is attributed to the earliest section.

The way that information appeared in the sections of the paper was often at variance with the alleged functions of the sections (see Section 4.6). The method adopted at least gives an indication of how little of the information needed for the abstract can be obtained by reading the introduction only, which is a procedure sometimes (cynically?) suggested for abstractors. An example of the breakdown of an abstract is shown in Table 4.4.

4.5 RESULTS OF THE STUDY

The results are given in the form of mean percentages in Table 4.5. The <u>t</u> test was used to check for significant differences between the papers and abstracts. The numbers of abstracts in each journal which had five or fewer words representing each part of the paper were recorded and are reported in Table 4.6.

It can be seen from Table 4.5 that, in all cases, the differences between the proportions of the several sections in the papers and the abstracts lay in the direction expected from the examination of the guidelines to authors. Of the three hypotheses of Section 4.4, number (i) was supported by nine significant results out of ten, number (ii) by seven, and number (iii) by eight. It is also evident from Table 4.5 that there are considerable differences between subjects in the amount of text under each heading. I will now discuss what kind of information is usually put in each section, and how its importance varies between subjects. The total lengths of abstracts will be considered in Section 4.9.1.

4.6 EXPERIMENTAL PAPERS IN RELATION TO THEIR ABSTRACTS

4.6.1 'Introduction'

> The introduction gives the background of the work and the approach of the author. It should contain a clear statement of the problem, the specific questions asked, and the reasons for asking them. (Linton, 1972)

TABLE 4.5 The mean proportions of introduction, experimental (or method), results and discussion in papers and abstracts. (Sample size = 30)

Journal	Paper					Abstracts					t values for difference			
	% intro.	% exper.	% res.	% disc.	No. of words	% intro.	% exper.	% res.	% disc.	No. of words	intro.	exper.	res.	disc.
J.C.S. Faraday Trans. I	12.3 (7.1)	15.6 (7.7)	29.1 (17.0)	43.1 (16.0)	2745 (970)	19.0 (14.2)	10.3 (13.2)	31.1 (26.8)	39.6 (23.4)	129.5 (53.2)	2.32 *	1.89	0.35	0.68
J. Chem. Phys.	15.2 (5.2)	18.5 (11.4)	23.4 (11.9)	42.9 (12.8)	2789 (976)	26.4 (25.8)	5.5 (8.3)	34.9 (22.1)	33.3 (22.0)	125.4 (56.7)	2.33 *	5.06 **	2.51 *	2.06 *
J. Phys. D.	14.9 (7.3)	23.9 (10.2)	26.0 (11.7)	35.2 (10.5)	2598 (982)	18.0 (13.0)	11.1 (11.6)	41.3 (11.6)	29.6 (16.7)	113.8 (47.8)		4.45 **	5.10 **	1.55
J. Pharmacol. & Exp. Ther.	9.8 (4.4)	29.2 (10.0)	27.2 (9.8)	33.8 (8.3)	3347 (1061)	11.6 (13.6)	9.2 (10.6)	55.5 (20.8)	23.7 (13.4)	190.6 (65.4)		7.52 **	6.75 **	3.52 **
Lancet	14.3 (7.2)	24.5 (9.6)	26.4 (10.5)	34.8 (11.1)	1772 (651)	12.3 (12.5)	13.3 (14.4)	50.0 (21.5)	24.4 (20.0)	111.3 (44.8)		2.91 **	5.40 **	2.48 *
Ann. Bot.	14.2 (6.0)	18.0 (8.7)	35.7 (9.9)	32.1 (7.5)	2489 (971)	12.0 (16.2)	8.2 (10.8)	62.0 (24.4)	17.9 (15.3)	162.3 (65.7)		3.87 **	5.46 **	4.56 **
Anim. Behav.	16.0 (8.7)	21.2 (10.1)	31.9 (15.6)	30.9 (9.7)	3504 (1681)	15.5 (16.9)	11.3 (15.4)	55.5 (23.4)	17.8 (17.9)	114.1 (36.0)		2.91 **	4.62 **	3.54 **

Journal	Paper					Abstracts					t values for difference			
	% intro.	% exper.	% res.	% disc.	No. of words	% intro.	% exper.	% res.	% disc.	No. of words	intro.	exper.	res.	disc.
J. Soc. Psych.	23.5 (9.3)	31.0 (11.4)	24.5 (15.2)	21.1 (7.8)	2411 (789)	22.1 (19.0)	27.2 (19.3)	37.7 (19.3)	13.0 (17.0)	132.5 (48.3)		0.93	2.94 **	2.38 *
Sociometry	27.8 (9.7)	23.0 (7.4)	25.7 (9.7)	23.5 (10.3)	3782 (1561)	32.3 (24.8)	14.7 (14.0)	40.7 (17.8)	12.3 (10.4)	122.3 (30.5)	0.92	2.86 **	4.05 **	4.19 **
Lang. & Speech	20.3 (12.9)	25.3 (10.0)	23.9 (10.9)	30.5 (12.1)	2567 (1048)	25.7 (21.9)	22.2 (18.3)	33.5 (16.6)	18.6 (16.2)	132.4 (49.4)	1.16	0.81	2.65 *	3.22 **

Notes: Standard deviations given in brackets. * $p < 0.05$ ** $p < 0.01$

TABLE 4.6 Abstracts in a sample of 30 which had five or fewer words representing each part of the paper.

JOURNAL	Intr.	Exp.	Res.	Disc.
J.C.S. Faraday Trans. I	3	15	6	3
J. Chem. Phys.	4	18	4	6
J. Phys. D.	4	11	1	3
J. Pharmacol. & Exp. Ther.	10	14	1	3
Lancet	9	13	0	8
Ann. Bot.	8	16	1	7
Anim. Behav.	7	15	1	11
J. Soc. Psych.	5	7	2	13
Sociometry	4	11	2	10
Lang. & Speech	3	6	2	8

(a) The problem. The part of the introduction which is most often represented in the abstract is the 'topic sentence'. This sentence states what exactly is the subject of the study. For example:

> The present study examined children's perception and evaluation of the October Crisis in Quebec. (J. Soc. Psychol. 89 (1973) 3)
>
> In this paper we present results and conclusions on NaY exchanged with several other ions. (J. Chem. Soc. Faraday Trans. I (1973) 22)

Mention of 'this paper', or 'the present study', indicates that the author is turning from his review of the background to what he, himself, is going to attempt. The statement often occurs towards the end of the introduction, though it may be followed by a list of hypotheses to be tested. It will normally be an amplification of the title, and contain several of the same 'keywords'. Wilson (1974) has suggested that the resulting redundancy of information in title, abstract, and paper could be provided 'with some financial saving'. In some papers, especially those in J.C.S. Faraday Transactions and the Journal of Chemical Physics, the subject of the study was implied, rather than stated, in the introduction, e.g. the introduction on (1973) p. 169 of the former journal had only 'Hexagonal Ca SO_4 is extremely reactive towards water vapour, and the rehydration has been little studied.' Since a reader may well not bother with the abstract (or even the title?), if he knows by some other means that the paper is worth reading, I consider it desirable that the paper should be complete in itself. The editor of Physics Review Letters (Goudsmit, 1961) mentions as one of his pet peeves 'an author who fails to make clear in the introduction the scope and significance of his paper'. I shall also suggest in Section 4.12 that expansion of the title to describe the exact subject of the paper is the most important function of the abstract.

(b) The background. Borko and Bernier (1975, p. 68) state that, because a particular secondary service 'is designed for a designated class of users with a specified background knowledge, ... background information is assumed and need not be stated.' It can be seen from Table 4.7 that all the journals in my study did, in fact, have some abstracts containing old (i.e. previously reported) information - in most cases coming from the 'introduction' section of the paper. It is perhaps surprising that this was so prevalent in the Journal of Pharmacology and Experimental Therapeutics, which had the smallest proportion of 'introduction' information in the abstract. It thus appears that authors either disagree with Borko and Bernier's consideration, or else feel that it is necessary to include brief information on the background for the sake of readers who may be interested in the subject area, but unable to recall the earlier study on which the present work is built. Some instructions to abstractors specifically rule out such information (Borko and Chatman, 1963).

(c) The approach. It can be seen from Table 4.5 that there are significant differences between the average lengths of 'introduction' in different subjects. That in sociometry is about three times as long as that in pharmacology, and more than twice that in physical chemistry.

In pharmacology and in chemistry there is a large body of generally accepted theory on which to base new work. The approach to be taken in solving a problem will often be fairly

TABLE 4.7. Old information in abstracts

JOURNAL	Abstracts in sample of 50 containing old information	Mean percentage of old information in these abstracts	Mean percentage of old information in whole sample
J.C.S. Faraday Trans. I	10	21.6	4.3
J. Chem. Phys.	3	16.5	1.0
J. Phys. D.	6	12.1	1.5
J. Pharmacol. & Exp. Ther.	14	11.9	3.3
Lancet	4	18.5	1.5
Ann. Bot.	3	21.6	1.3
Anim. Behav.	8	25.6	4.1
J. Soc. Psych.	4	36.9	3.0
Sociometry	11	19.8	4.4
Lang. & Speech	9	20.8	3.7

standard and require little justification. Some experiments are intended to decide between rival hypotheses, which will have to be outlined in the introduction, but the majority are of the 'puzzle-solving' type, characteristic of 'normal science' (Kuhn, 1970). Very few are designed to test the fundamental theoretical approaches of the discipline. Trials of a new drug, intended to combat a specific complaint, are perhaps the extreme case of studies in which little consideration of underlying theory or approach are called for, and little justification required for the experiment. In the social sciences, on the other hand, there is much less agreement on experimental approaches; and rival theories, each held by a substantial proportion of the practitioners, can exist together for considerable periods of time. Methods and apparatus are less standardised than in the natural sciences, and more space has to be devoted to justifying those selected.

(d) The specific questions asked. Linton (1972, p. 54) writing for authors in the social sciences, states that the introduction should 'end with a formal or informal statement of the hypothesis'. The exceptional length of introductions in *Sociometry* arises largely from the presence of extensive sections on the building of models and formulation of hypotheses. In the *Journal of Social Psychology*, especially, the final statement of the hypothesis or hypotheses is often preceded by a phrase such as 'in summary', or 'to summarise', which implies redundancy of information. Whilst the process of formulating and testing hypotheses is that by which science is popularly held to work, I did not find it evidenced to the same extent in the introductions to research papers in the natural sciences. There, the building of new models tends to occur in the discussion rather than the introduction, i.e. it appears to follow from the results rather than being a prerequisite to their acquisition. It is probable that little is lost by making hypotheses implicit rather than explicit. For example, if one is studying the prevalence of left-handedness in males and females, one can say just that, rather than saying, 'It was hypothesised that a higher proportion of males than females would be left-handed', and then in the discussion, 'The hypothesis was proved' (or 'not proved').

When hypotheses are quoted in the abstract, it is normally to say that they were supported by the experimental findings, in which case they have been counted in the results or discussion section here.

(e) Other kinds of content. Introductions sometimes give an outline of the method, or anticipate the findings, and so take on the function of a summary. For example:

(1) Introduction: 'Ss were exposed to the labels two at a time in all possible combinations and were asked to make a judgment about the similarity between the labels of each pair.'

Method: 'The Ss were presented with the stimulus labels two at a time in all possible combinations. For each pair the S's task was to judge the similarity between the two stimuli on a rating scale.'

(J. Soc. Psychol. (1973) 89 186)

(2) From the temperature dependence of the rate constant, $\Delta G^{\ddagger}$, $\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$ for process (2) were obtained. A mechanism will be proposed on the basis on the basis of the thermodynamic data of activation obtained.'

(Introduction in J.C.S. Faraday Trans. I (1973) 113)

(3) 'The results are quantitatively in accord with expectations, i.e. that the enthalpies of association are extremely high for the strongest hydrogen bond forming acid-base couples.'

(Introduction in J.C.S. Faraday Trans. I (1973) 151)

No doubt, it is helpful to the reader to have an overview of the paper before studying the material in detail, and this is the traditional function of the 'introduction' of a book. However, since the abstract is normally printed at the head of the paper, I would question whether this further orientation of the reader is necessary.

If an introduction states some of the key points of later sections of the paper, then, as a result of the practice mentioned in Section 4.4, such points in the abstract will be attributed to 'introduction'. This is the main reason for the exceptionally high proportion of 'introduction' in the abstracts in the Journal of Chemical Physics. There, one abstract's information was found entirely in the introduction of the paper. The fact that it is the papers, rather than the abstracts, which are exceptional in this journal is shown by the unexceptional proportions of 'findings' and 'study' in Section 4.9.

4.6.2 'Experimental'/'Method'

(This is taken to include 'materials', 'patients' and 'procedure'.)

The longest method sections in papers were found in the Journal of Social Psychology and the Journal of Pharmacology and Experimental Therapeutics. In the case of the former only, these were represented by a high proportion of such information in the abstract. One reason for long descriptions of method in psychology seems to be the uncertainty on the part of the experimenter as to what are significant factors in his set-up. I would not, however, have thought it necessary to go to such lengths as the following:

> 'After all had been interviewed, the Ss were debriefed and each received a free soda (all four groups) and a free pass to the first school dance of the school year (Groups B, C,D), compliments of the principal's office.'
>
> (J. Soc. Psychol. 89 (1973) 95)

At the opposite extreme, papers in physical chemistry tend to include only the minimum of experimental details. Williams (1967) mentions the temptation to authors to cut the 'method' section to the bare bones. Sometimes only the materials are described (e.g. the supplier and purity) and the apparatus is named. The experimental procedure may be worked into the results, e.g.:

'An ammonia buffer system was used to measure $\underline{K}_1$ for Phenol Red, and an acetic acid buffer for Bromophend Blue and Bromocresol Green.'

(Results in J.C.S. Faraday Trans.I (1973) 562)

There seem to be more cases in the natural sciences where previously described methods are used again. The 'experimental' section can then be confined to details of the new samples plus a reference to the previous paper. There may also be some self-interest in not disclosing enough detail to allow competitors to replicate the study or equipment (Collins, 1974).

The range of temperature, pressure, etc., over which the experiments were carried out is frequently given in the abstract, but can be inferred from the paper only by examining results tables or graphs. In such cases, the data were counted as 'results' in the analysis of the abstract. Thus information which one would normally class as 'experimental' or 'method' often corresponds to 'results' in the paper. This is one of the main reasons for the low proportions of 'experimental' in physical chemistry abstracts.

Table 4.6 shows that for every journal examined the 'method' section was more often represented by five or fewer words in the abstract than any other section of the paper. This is in line with the study by Landau and Weiss (1976, p. 48) in which they asked user panels to criticise authors' abstracts in the life sciences. In the pure science journals, 33.9% of the criticisms were of the 'method' (the most common type of criticism being 'deficiency') followed by 26.1% of the 'results', 11.1% of the conclusions, 5.6% of the 'purpose' and 23.3% were 'unspecified'.

4.6.3 'Results'

It is not customary in papers to list raw experimental data which would often occupy enormous tables and be highly particular to the samples, apparatus and experimental arrangement. Instead, the raw data are usually 'reduced', for example quoted as mean values and standard deviations based on many observations. This could be held to involve a certain amount of interpretation of the results. The application of statistical tests for the significance of differences, or to look for correlations, which is normally done in the 'results' section, involves a larger element of interpretation. The distinction from 'discussion' is thus not entirely clear-cut.

Since the reduced data and the results of statistical tests are normally given in the form of tables, my assessment of the proportion of 'results' in papers, based on text alone, considerably underrates the information content. Unfortunately, there is no basis for converting numbers in tables into equivalent numbers of words.

The numbers and sizes of tables and graphs (an alternative way of reporting data) in the samples are given in Table 4.8. Annals of Botany which has the largest amount of text in the 'results' section, also has the largest amount of tabular information. The next highest amount of text in 'results' occurs in Animal Behaviour, which is also quite well up in tabular material. In this subject area, the results often have the nature of (and are sometimes called) 'observations', i.e. they consist of detailed descriptions of processes observed, rather than measurements of a few selected properties. To a lesser extent this is also true in

TABLE 4.8. Tabular and graphical information (sample size = 30)

JOURNAL	Mean no. of Tables per paper	Mean no. of Elements* per paper	Mean no. of Graphs per paper	Mean no. of Lines per graph
J.C.S. Faraday Trans. I	2.3(1.8)	47.8(47.4)	4.8(4.5)	3.0(1.9)
J. Chem. Phys.	2.0(2.8)	65.9(77.3)	5.2(4.1)	2.7(2.0)
J. Phys. D.	0.8(1.4)	32.1(34.5)	4.5(2.6)	3.4(4.5)
J. Pharmacol. & Exp. Ther.	2.8(2.1)	40.1(32.3)	13.0(18.3)	1.8(1.6)
Lancet	1.8(1.7)	47.6(50.2)	2.1(2.9)	2.8(4.0)
Ann. Bot.	2.9(2.7)	60.7(91.9)	5.4(8.2)	2.4(1.9)
Anim. Behav.	2.5(2.7)	46.9(42.6)	4.4(4.8)	2.1(1.8)
J. Soc. Psych.	1.2(1.0)	33.4(36.1)	0.2(0.6)	2.6(0.8)
Sociometry	3.1(2.2)	29.6(26.7)	0.3(0.7)	2.9(1.4)
Lang. & Speech	3.2(2.7)	44.1(47.1)	3.6(14.9)	2.7(1.4)

Note: standard deviations given in brackets

* i.e. entries in tables

pharmacology and medicine.

In other cases, what makes up the text in the 'results' section? I have found examples of the inclusion of various types of material which seem to belong more properly to other sections of the paper. For example:

(a) hypothesis-formulation (which would be expected in the 'introduction':

> 'Because of the status difference between men and women in traditional Xhousa culture (9) it was expected that in a M-W doll placement if there was angle asymmetry, it would be the man who would face more directly, since his higher status would make him more confident.'
>
> (J. Soc. Psychol. 89 (1973) 169)

(b) experimental method (see also Section 4.2):

> 'These quenching measurements at 90K were made after the samples had been heated to 388K and cooled to 90K in the dark.'
>
> (J. Phys. D. 6 (1973) 341)

(c) conclusions:

> 'We concluded from this experiment that being deprived of nest materials and the opportunity to practise nest-building during the first year may result in severe retardation of the ability to weave.'
>
> (Anim. Behav. 21 (1973) 375)

(d) Comparison with other workers' results (which might be expected to form 'discussion'):

> 'The results were rather similar to those previously reported by Woods and Nicholas (1964) and Cowell and Woods (1969), in that the density of trap H appeared to increase continuously with temperature <u>T</u>i.
>
> (<u>J. Phys. D</u>. <u>6</u> (1973) 345)

Another kind of information which is perhaps not strictly 'results', but is sometimes found in the 'results' section, is the mention of problems in applying the method. For example:

> 'It was not possible to apply the definition of a syllable based entirely on the certainty of the sequence of parts in all cases .... In such cases the syllables were arbitrarily defined on the basis of their intervals.'
>
> (<u>Anim. Behav</u>. <u>21</u> (1973) 29)

The degree to which results are represented in the abstract will depend on whether the findings of interest are those reported in the 'results' section, or whether the 'results' consist only of experimental data, and the values of scientific importance (e.g. the precision of a new procedure, or rate constants in a kinetic study) are not found until the 'discussion'. This seems to be the main factor responsible for the relatively low proportions of 'results' in the abstracts of <u>J.C.S. Faraday Transactions</u>, <u>Journal</u>

of Chemical Physics and Journal of Physics D compared with the life sciences. The usefulness of quoting results in abstracts will be discussed in Sections 4.10 and 4.12.

4.6.4 'Discussion'

The average length of the 'discussion' section of papers in the Journal of Chemical Physics is more than twice that in the Journal of Social Psychology. I have already mentioned some of the factors responsible for the extent of this range. Firstly, the findings in sociometric or social-psychological papers are virtually complete once the significance tests have been performed (in the results section). All that remains for the discussion section is to point out that they confirm, or fail to confirm, the hypothesis. The way in which the experimental results relate to the hypotheses will have been made clear in the introduction. In the natural sciences, however, and especially in physical chemistry, the data are often subjected to further processing to produce results of interest. For example:

> 'From the intensity of components IV and V the angle (α) between two neighbouring coupled dipoles is calculated (table 7).'
>
> (J.C.S. Faraday Trans. I (1973) 369)
>
> 'Substituting values of $\alpha_{\parallel}$ and α_{m} from the results of the present work into equation (8) led to a value of $\alpha_{\parallel}^{f}$ of -9.1×10^{-7} K^{-1} at room temperature.'
>
> (J. Phys. D. 6 (1973) 319)

Secondly, I discussed in Section 4.6.1 the way that studies in the social sciences frequently begin with formulation of a model, whereas those in the natural sciences are based on generally accepted paradigms. Thus, once the experiment has been done and the results are known, it remains in the former area only to say that the choice of model is vindicated. In the latter area, however, the significance of the findings for the theoretical structure of the specialty concerned has now to be discussed. One would expect that the number of other studies with which the new work has to be compared, and the number of theories which are affected, will vary between subject areas in a similar way to the size of the body of existing knowledge in those areas. Although measurement of the latter would be impracticable, there is certainly a much larger corpus in physical chemistry than in sociometry or social psychology.

There may be further experimental work reported in the 'discussion' to resolve a problem which does not become evident until that stage. For example:

> 'To test this theory of CO_2 poisoning, a boron-aluminium oxide catalyst was prepared as described by Emelyanov _et al._ and then tested for catalytic activity.'
>
> (Discussion section: _J.C.S. Faraday Trans I_ (1973) 650)

The prevalence of this practice varies between subjects, and is probably greatest in chemistry and physics.

TABLE 4.9 Treatment of 'discussion' in abstracts (sample size = 30)

JOURNAL	No discussion	'is/are discussed'	'discussed in terms of' or 'in relation to'	other non-informative cases
J.C.S. Faraday Trans I	2	0	2	0
J. Chem. Phys.	5	1	2	2
J. Phys. D.	3	0	3	1
J. Pharmacol. & Exp. Ther.	3	0	0	1
Lancet	7	0	0	0
Ann. Bot.	7	3	1	0
Anim. Behav.	11	2	1	0
J. Soc. Psych.	13	3	1	1
Sociometry	10	4	3	0
Lang. & Speech	8	1	2	0

The variation in the proportion of 'discussion' material in abstracts varies even more between subjects than does that in papers. The order of subjects is, however, almost identical. The instructions to authors quoted in Section 4.3 stress the importance of 'conclusions' in abstracts, but do not ask for other aspects of 'discussion'. As has just been mentioned, in the social sciences the 'conclusions' are often clear from the 'results' section, so that, as can been seen from Table 4.9, information from the 'discussion' section is often not incorporated into the abstract at all. In the physical sciences however, where most of the conclusions are not clear until the 'discussion', very few of the abstracts contain no information drawn from the 'discussion'.

The treatment of 'discussion' in abstracts is characterised by the use of certain expressions, such as 'the results suggest that', 'it is concluded that', and 'may' rather than 'is' or 'was'. Certainly it needs to be made clear to the reader what was observed, and is regarded as fact, and what was hypothesised. 'Discussion' material apart from conclusions is often difficult to summarise, and recourse is made to the expression '... is/are discussed'. The numbers of abstracts where the 'discussion' was only treated indicatively in this way, or in other ways, are shown in Table 4.9. Twenty-six of the thirty J.C.S. Faraday Transactions abstracts had informative treatments of the 'discussion', whereas only thirteen of the Sociometry abstracts and twelve of the Journal of Social Psychology abstracts did so.

Apart from conclusions based on the findings, abstracts sometimes mention the results of comparison with other work, possible applications of the findings, and even suggestions for future work, e.g.

> 'Measurements on other hydrogen-bonded systems may help to establish the validity of this result.'
>
> (J. Physics D 6 (1973) 1998)

4.6.5 Recommendations for writing papers

The division of experimental papers into 'introduction', 'experimental', 'results', and 'discussion' is certainly accepted as the norm in a wide range of subjects. It should thus be helpful to the reader in locating the piece of information he is looking for in the paper, if he does not wish to read it all, and in verifying pieces of information when he wishes to use them. It should also be able to serve as a basis for instructions on writing abstracts, since there seems to be fairly general agreement between different sources on the selection of material in these terms.

When writing a paper, the author should attempt to report his work in a logical order:

Introduction -	what was known before he did the experiment, and what he decided to do (but not a summary of the whole study)
Experimental -	what he did (as well as the materials used)
Results -	what he found in the experiment. This section could often be reduced to a set of tables or graphs, with perhaps some comment on accuracy, and qualitative observations where appropriate. Significance tests may be included here.
Discussion -	what he deduced from the results - further implications, numerical results and theories; comparison with other work and theoretical studies.

I have noted three ways in which deviations from this straightforward arrangement arise.

(i) In the physical sciences, and especially in engineering, the paper often covers more than one experiment. 'We did A and found X, then we did B and found Y, so we did C and found Z.' This means that there will be three sections of results, X, Y and Z, and some explanation is required in the 'results' section of what actions led to each set. If the material on each experiment is sufficiently extensive, the paper can contain an 'experimental' and 'results' section for each. (This is quite common in Animal Behaviour.) Otherwise, authors tend to mention only the common features of the experiments (e.g. materials, apparatus) under 'experimental', and to work other details into the 'results'. Another practice is to include subsidiary experiments and results in the discussion section, when the reason for their inclusion has been made apparent. This is suggested by O'Connor and Woodford (1975) p. 10.

(ii) Sometimes, the 'experimental' section includes only the briefest of information, even when the problem mentioned above does not apply. The temptation for authors to cut this section to the 'bare bones' has been noted by Williams (1967). I suggest that it should contain an outline of what was actually done, and especially the experimental conditions. These are important to abstractors, and should not need to be deduced from tables or graphs.

(iii) My overall impression is that authors in the physical sciences may go too far in their attempt to achieve conciseness.

One way in which this shows up is in the absence of the sort of information one expects to find in the various sections of the paper. In particular, omission of the 'topic sentence' (see Section 4.6.1 (a)) is a serious deficiency in some papers. Such practices reduce the readability of the papers, and the ease of locating information in them. Studies in the social sciences, on the other hand, tend to be much less complex, and so allow authors much more room to relate them in a logical order. There may be a case for accepting longer papers in the physical sciences, so allowing some redundancy for the sake of readability, while imposing more restriction on space in the social sciences and eliminating excessive redundancy there. There does not seem to be justification for the practice of making experimental papers in all subjects about 3,000 words long.

4.7 A STRUCTURAL APPROACH TO STUDYING ABSTRACTS

The analysis of papers and their abstracts in the study reported above covered a fair range of subject areas, but did not cover the whole range of different sorts of paper. Firstly, it was confined to experimental papers in these subject areas, and secondly, it was confined to papers already divided by their authors into ('introduction', 'experiment', 'results' and 'discussion'. Whilst this is the traditional model of a scientific study, it does not apply universally. Sometimes papers seem to be unnaturally distorted to get a reasonable-length piece of text under each heading, when sometimes there is really little, or nothing, to say. One example, mentioned in Section 4.6.4 above, is the discussion sections of some papers in psychology and sociometry. Also, as noted in Section 4.6.3, the results can often be covered in a table or graph, without needing any text.

Papers in areas such as analytical chemistry, applied physics, and surgery are often more concerned with reporting a new technique than with producing any intrinsically interesting results. Sometimes the papers are cast in the traditional pattern, but often one or more sections are absent. The model is still less applicable to preparative papers in inorganic and organic chemistry, which are essentially recipies with the only possible results being the yields and characterising properties of the products.

4.7.1 Gopnik's types of scientific texts

Gopnik (1972) made a study of short scientific texts (intended as summaries of work to be reported at a conference) from the point of view of their linguistic structures. On the basis of these, she distinguished three main types of text:

(a) The 'controlled experiment', which was the most prevalent in her sample (experimental biology). It was characterised by the occurrence of comparative structures throughout the text. An essential feature of this type was a 'container sentence' at the end, which interpreted the results. It had the form:

$$\left.\begin{array}{l}\text{This}\\ \text{These results}\\ \text{This experiment}\\ \text{These data}\end{array}\right\} \left\{\begin{array}{l}\text{show/s}\\ \text{indicate/s}\\ \text{suggest/s}\end{array}\right\} \quad \text{that ...}$$

(b) The 'hypothesis verification' type was divided into two subtypes:

(i) A single hypothesis was examined and results found which either confirmed or disconfirmed the original hypothesis. This hypothesis often appeared in some other work which was cited in the first sentence of the text.

(ii) Several explanations of the same phenomenon were treated, and the experiment was intended to decide between them. The explanations could be mutually exclusive, or more than one could play a part.

In this type, the container sentence occurred either at the beginning of the portion of the text in which the evidence was given, or at the end of the text. It was a function (a direct restatement or negation, or else an indirect one requiring some additional knowledge) of the hypothesis statement.

(c) The 'technique descriptive' type. This contained little hypothesising and no control of the process. The texts primarily described a scientific technique or phenomenon. Few conclusions were drawn from the information, and very little comparison was done with other information. It was usually pointed out that the technique was being applied to some new data, or that the description of the phenomenon had not yet been provided. The characteristic structures of this type are temporal expressions and successively-modified noun phrases, e.g. 'Antigen solutions are [1] mixed with melted agar at 40-50°C, [2] allowed to gell, and [3] quick frozen.' This type does not have comparative sentences or the container structure.

The abstracts studied above were reexamined in the light of Gopnik's types to see to what extent these latter provided the basis for a useful analysis. On considering the abstracts without reference to the papers, it was found difficult in some subjects to assign them to a single category. The categories tend to merge into one another, and there were few cases as clear as those in Gopnik's examples. It was found easiest to recognise the types in the life sciences (as studied by Gopnik) and the social sciences. About half the abstracts in the sample from Sociometry could be considered as being of the 'hypothesis verification' type, and about a third of those from the Journal of Social Psychology. The preference in the social sciences for explicit statement of the hypothesis behind the experiment has already been mentioned in Section 4.6.1 (d). 'Hypothesis verification' abstracts would be expected to contain 'old' information fairly often (i.e. previously-reported hypotheses). Table 4.7 shows that Sociometry abstracts did have a relatively high proportion of 'old' information, but so did some other subjects where this did not apply. Such abstracts will necessarily contain a statement of the hypothesis taken from the introduction of the paper, and Sociometry abstracts contained the highest proportion of 'introduction' material. The 'container sentence' will usually be derived from the 'discussion' section of the paper, though some abstracts with no 'discussion' material seemed to be of the 'hypothesis verification' type.

The 'controlled experiment' type was particularly common in the life sciences. In pharmacology, one group is treated and one is not, or one is given one treatment and another a second treatment. Often there is more than a single dichotomy - especially in psychology, where sexes, races, social classes, etc., may all be compared in a single experiment. The 'controlled experiment' type was the predominant one in Animal Behaviour, Annals of Botany, the Journal of Pharmacology and Experimental Therapeutics, the Journal of Social Psychology and Language and Speech.

If Gopnik's three classes form a complete classification of scientic texts, then the majority of the abstracts in the physical sciences must be assigned to the 'technique descriptive' type. However, they often did not show the characteristic features of temporal expressions and successively-modified noun phrases. They were generally concerned with reporting quantitative or qualitative properties of an object or substance under certain conditions, and 'technique descriptive' seems somewhat of a misnomer.

The abstracts in the samples studied above were all of papers divided by their authors into 'introduction', 'experiment', 'results' and 'discussion'. Thus the kind of papers mentioned in the introduction to this section, which are concerned with new techniques and may not have 'results' or 'discussion' sections, are inadequately represented. The paradigmatic 'technique descriptive' structures would be expected to occur there. For example, quite a high proportion of the papers in the Journal of Physics D (Applied Physics) which were rejected because they were not of the 'introduction-experiment-results-discussion' pattern were found to be of the 'technique descriptive' type. Expressions such as 'A new method is described for ...' were common.

It is, perhaps, unreasonable to expect to find the structures described by Gopnik in abstracts, which may consist of significant pieces of information taken from the full text with little regard for the structure. However, they do not seem very adequate either as models for full-length papers. Different parts of the same paper may have functions characterised by different linguistic structures, and it may be impossible to assign the paper as a whole to one of the types. In any case, the distinctions may be due to style rather than content, e.g. whether a paper is cast as 'hypothesis verification' (using a controlled experiment') or as 'controlled experiment'.

4.7.2 Brémond's cycles

According to Brémond (summarised in Hendricks (1972, p. 102)), every narrative integrates a succession of events of human interest oriented towards a goal. At the beginning of a narrative there exists either a state of deficiency (disequilibrium) or a satisfactory state (equilibrium). From a state of disequilibrium there is a movement towards a state of equilibrium, while from a state of equilibrium there is a movement towards a state of disequilibium. There may be a number of such cycles, successively or embedded within one another in a narrative.

Hutchins (1977) treated Gopnik's 'controlled experiment' type of paper as a progression from a state of disequilibrium (uncertainty about what the results might show) to a state of satisfaction (where the 'container sentence' assertion could be made). The 'hypothesis verification' type may be (a) an existing hypothesis (equilibrium) is shown to be unsatisfactory (disequilibrium); (b) a proposed hypothesis which is still tentative (disequilibrium) is confirmed (equilibrium); (c) a state of conflicting hypotheses (disequilibrium) is resolved by showing which is to be preferred. In the 'technique descriptive' type, either (a) a previously satisfactory technique is found wanting (degradation of equilibrium) or an insufficiently tested technique is proved to be effective (amelioration of disequilibrium). Thus Gopnik's three types of paper are reduced to a single Brémond cycle. Hutchins suggests that a more complex paper might exhibit two cycles, and asserts that the following structure seems to underline many scientific papers:

(1) 'current' hypothesis/paradigm
(2) demonstration of inadequacies } the 'problem'
(3) statement of 'problem'
(4) statement of 'new' hypothesis or of alternative hypotheses
(5) testing of hypothesis or hypotheses } the 'solution'
(6) 'proof' of hypothesis or one of alternative hypotheses
(7) implications of 'solution'.

In terms of the analysis used in Section 4.4, items 1 to 4 belong to 'introduction', item 5 to 'experimental' and possibly 'results', item 6 to 'results' and/or 'discussinn', and item 7 to 'discussion'. Thus Hutchins' analysis gives a more detailed breakdown in the 'introduction' area.

This approach is also of interest for its description of the sections in more general terms. It might be extended to non-experimental papers, where the 'testing' is of a theoretical, rather than experimental kind. It also shows that the scientific paper continues a long rhetorical tradition. Hutchins mentions the similarity in organisation to expositiory philosophical texts (from Plato onwards) and Brémond demonstrated his theory in an analysis of French fairy tales.

There seems to be scope for further research on applying Hutchins' analysis to various types of research papers and seeing whether such analysis is useful for identifying what information from the paper should go into the abstract. It appears that the process of summarising scientific papers might not be very different from that of summarising other kinds of texts, and it may be possible to formulate guidelines of wide applicability. The fact that several of the sets of instructions quoted in Section 4.3 required statements of the problem and conclusions suggests that the fundamental classification proposed is sound. Unfortunately, time did not permit further study based on this approach, but, as suggested above, the analysis used in Sections 4.4 to 4.6 amounts to a simplified and specialised version of Hutchins' analysis.

4.8 INFORMATIVE AND INDICATIVE CONTENT: PROBLEMS OF DEFINITION

The traditional classification of abstracts is into informative and indicative ones. 'Ideally, the informative abstract is an intelligible and complete summary of the significant content and conclusions of the original article, so complete in itself that reference to the latter is not essential' (Collison, 1971, p. 27). Of course, this raises the problem: Essential for what? Obviously an abstract of 150 words cannot contain all the information of a 2500-word paper. (Maizell et al. (1971) p. 73, however, suggest a comment 'No more info. in article' which may be placed at the end of an abstract.) The writer should make his selection so that the information in the abstract will satisfy the needs of as many users as 150 words can, but there are almost certain to be parts of his paper that are of interest to some people but completely unrepresented in the abstract. Apart from the main conclusion(s), which should be in the abstract, there will probably be several lesser conclusions which, through limitations on length, cannot be included.

Sherrod (1957), in reviewing the abstracting procedures followed in a bibliography project at the Library of Congress, says:

> The indicative or descriptive abstract consists of generalised statements of the content of the article ... and is characterised primarily by the absence of qualitative and quantitative data. It is often little more than a listing of the principal subjects presented in narrative form.

Borko and Chatman (1963) mention some features which are characteristic of indicative abstracts, in particular the prominence of 'metatext' terms such as 'are given', 'are listed' and 'is indicated'. These give the writer the style of an outsider, and highlight the process of writing the article rather than the research behind it. In informative abstracts, the past tense (referring to what was done or found in the experiment) is used rather than the present (referring to what exists in the paper).

I will now discuss the informativeness or indicativeness of the treatment of the different sections the paper in abstracts.

(a) Results. Statements about results are fairly easy to categorise as informative or indicative. For example, 'The development of the ER during the period preceding secretion is a common feature of the secretory cells' (Table 4.4) and 'The molar extinction coefficients at 450 nm are $140 \pm 50\ M^{-1}$ and $1240\ M^{-1}$ respectively' are clearly informative, in that they contain qualitative or quantitative information from the paper. On the other hand, 'The ... results of Brinell and scratch hardness tests on single ice crystals are given' is clearly indicative (Sherrod, 1957), since it indicates results which are in the paper, but does not quote them. But what about statements of the type 'Initial (zero-order) rates were used in conjunction with the ratios CO_2: CO to estimate the relative dehydration and dehydrogenation activities of the catalysts as a function of Na content'? This is phrased so as to make it a statement about the study, rather than about the paper, but it amounts to much the same as 'The relative dehydration and dehydrogenation activities of the catalysts are reported as a function of Na content'. (A reader would surely assume that if the activities were estimated they would be reported in the paper.)

(b) Discussion. Statements such as 'The results were compared with the findings of Smith' (i.e. as part of the study) are also dubious. Is there any difference from 'The results are compared with the findings of Smith (i.e. in the paper)? The word 'correlated' leads to problems of classification, for example does the sentence 'The chemisorbed state of the olefins and the mechanisms of these reactions were correlated with the electron configuration of the EDA complexes' mean that a possible correlation was investigated, or that an actual correlation was found?

I have mentioned in Section 4.6.4 that information about 'discussion' is often treated indicatively in abstracts. 'Implications of the results for the study of attitude and behaviour were discussed' is indicative, since it is talking about the paper (despite the use of the past tense!) One step up from this is to mention a model used in the discussion, e.g. 'A model is discussed in which the radicals from both processes are adsorbed on cation sites neighbouring an oxygen vacancy' (J. Chem. Soc. Faraday Trans. I, (1973), 1). Insofar as it implies that the model is a satisfactory one for understanding the system, this could be regarded as an informative statement. There is evidently a problem of where to draw the line. In theoretical papers, the difficulty of categorising statements about the proporties of models is even more common. It is often unclear whether the behaviour reported is a feature of its design (or implied by the design) or is a 'finding' about the behaviour.

(c) Introduction. Even the most informative of abstracts will often start with a sentence of the sort '... was studied/examined/ determined', corresponding to the topic sentence of the introduction of the paper (Section 4.6.1 (a)). This could equally be considered a statement about the content of the paper: 'This paper contains a study of ...', and so be classed as indicative. In theoretical work, mathematics and the humanities, the setting out of the proof, comparison, criticism, etc., is both the point of the study and the content of the paper.

(d) Method. It does not seem to be clear from the definitions and examples of informative and indicative abstracts what the status of statements about method is. In Sherrod's (1957) examples, the indicative abstract has 'The experimental procedures and results of Brinell and scratch hardness tests on single ice crystals are given', and the informative abstract has 'Brinell and scratch hardness tests were made on single ice crystals with a modified Olsen Baby Brinell Hardness Tester and a Spencer Micro-character, respectively.' As I have discussed already the choice of verb does not significantly affect the information content: if results are reported the tests must have been made. Is it the mention of the apparatus which affects the status? Then what about cases where this is obvious, such as 'The infra-red spectrum of toluene has been studied' (evidently using an infra-red spectrometer)? At what degree of detail is the line to be drawn - does one need the manufacturer and model?

4.9 INFORMATIVE AND INDICATIVE CONTENT: A STUDY

Most of the difficulties in deciding between informative and indicative content seem to arise from the problem of distinguishing what was done in the study from what was done in writing the paper. The problem is particularly acute in abstracts of nonexperimental papers, which are precisely those for the analysis of which a technique other than the one used in Section 4.4 is needed.

What does seem fairly easy to separate, however, is (a) direct statement of qualitative or quantitative results, findings and conclusions from (b) other material on what the paper is about, and what was done in the study or in writing the paper. To avoid the four terms used in Sections 4.4 and 4.5, I will refer to (a) as 'findings' and (b) as 'study'. It must be remembered that indicative statements about results and conclusions (rather than statements of them) will be included in 'study', so the proportion of 'findings' is not necessarily equal to that of 'results' plus 'discussion' in Table 4.5. One type of content in abstracts which does not seem to fall into either of the categories 'findings' and 'study' is 'old' information, in the sense used in Section 4.6.1 (c). This is not very common, but has been counted separately in the following study.

Since the classification into 'findings' and 'study' does not require comparison with the paper (though 'old' does) and is therefore much quicker than the analysis used in Section 4.4, it was possible to take larger samples in this study (50 papers instead of 30). It is applicable to papers in any subject, so in addition to six of those journals considered in Section 4.4, others covering theoretical physics, mathematics, engineering, philosophy and history were included. It was also possible to include samples of abstracts in French and German in physical chemistry journals, and two samples of 1962 abstracts for comparison. The mean proportions of 'old', 'study' and 'findings', together with their standard deviations calculated by the formula, are given in Table 4.10. In fact, the distributions are not very close to normal, and some examples of distributions of 'findings' are shown in Figure 12. For comparison, the percentage of 'results' plus 'discussion' is listed for those journals included in Table 4.5.

4.9.1 Length of abstracts

By far the longest abstracts were those of the Journal of Pharmacology and Experimental Therapeutics. Next came Annals of Botany. Some results of Landau and Weiss (1976) for much larger samples of journals in the life sciences are quoted in Table 4.11 for comparison.

FIGURE 12. Distributions of proportions of 'findings' in abstracts

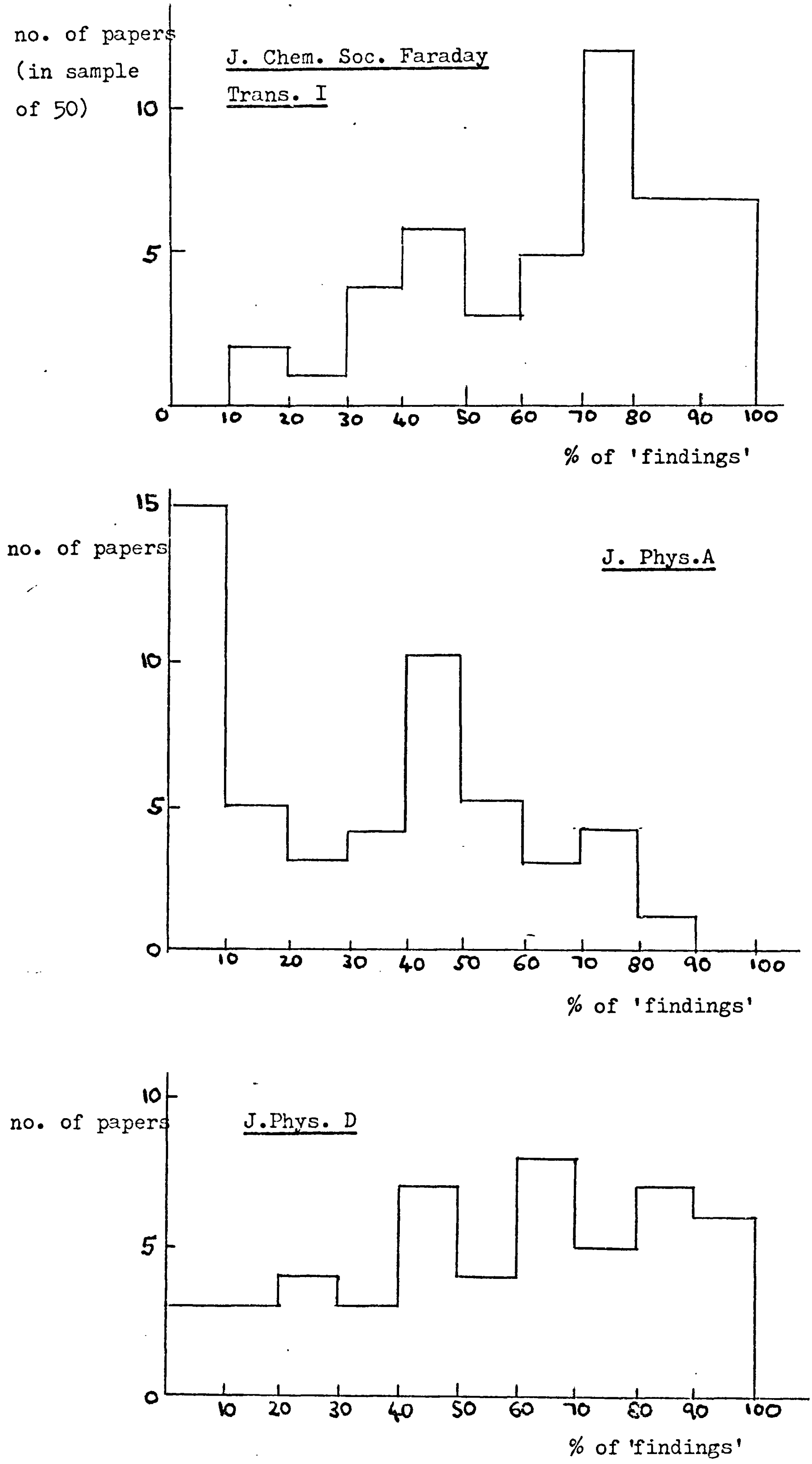
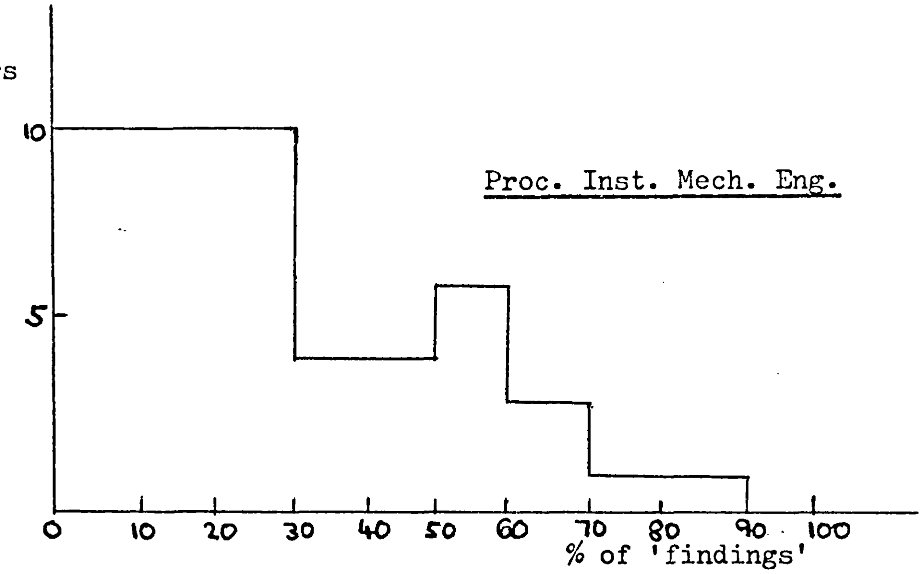
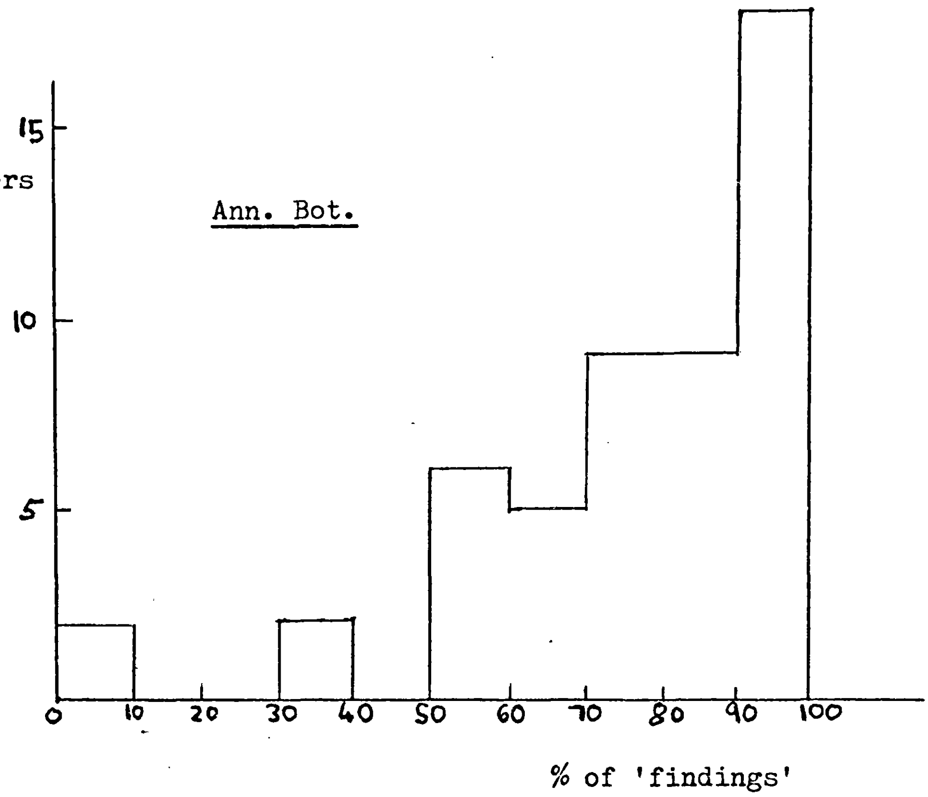


FIGURE 12 continued

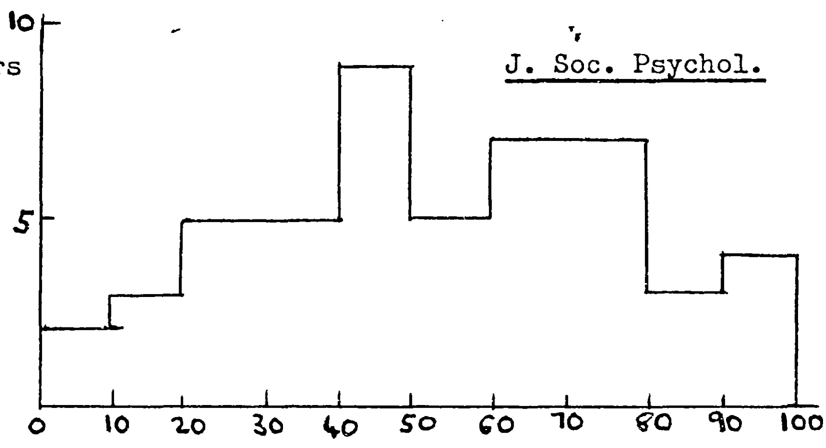
no. of papers
(in sample
of 50)



no. of papers



no. of papers



% of 'findings'

TABLE 4.10 Mean proportions of 'old', 'study', and 'findings' types of information in abstracts (Sample size = 50)

JOURNAL	% old	% study	% findings	total words	% abstracts with no findings	% all-findings abstracts	% res. + disc.
Proc. Am. Math. Soc.	9.3	41.5	49.2	62.8	26	16	
	(20.3)	(34.1)	(35.6)	(26.6)			
J. Phys. A	4.1	63.6	32.3	91.9	28	0	
	(12.2)	(27.5)	(26.9)	(52.4)			
J. Phys. D (exp. papers)	1.3	41.2	57.5	114.5	6	8	70.9
	(4.5)	(27.1)	(27.0)	(43.7)			
(letters)	3.0	43.1	53.9	58.8	14	24	
	(11.6)	(33.7)	(32.7)	(31.9)			
Acta Crystallogr. B	1.6	31.2	67.2	127.8	0	2	
(exp. papers)	(5.9)	(16.1)	(16.1)	(41.9)			
J. Chem. Soc. Faraday Trans. I	4.3	31.0	64.6	129.5	2	16	70.7
(exp. papers)	(12.8)	(26.5)	(27.6)	(47.6)			

JOURNALS	% old	% study	% findings	total words	% abstracts with no findings	% all-findings abstracts	% res + disc.
J. Chem. Soc. Faraday Trans. II (exp. papers)	1.6	39.7	58.6	110.5	4	6	
	(8.5)	(25.3)	(24.3)	(48.3)			
J. Chim. Phys.	1.4	43.3	55.3	106.2	14	10	
(exp. papers)	(5.7)	(32.1)	(31.3)	(54.5)			
Z. Phys. Chem. (Leipzig)	1.7	41.6	55.6	108.5	14	10	
(exp. papers)	(6.9)	(33.2)	(33.2)	(72.3)			
Z. Phys. Chem. (Frankfurt)					10		
J. Chem. Phys.*	6.3	36.2	63.2	127.4	4	4	68.2
(exp. papers)	(3.4)	(21.5)	(21.6)	(58.7)			
Ann. Bot.	1.2	20.8	78.0	152.9	2	26	79.9
	(5.0)	(19.1)	(21.0)	(71.9)			
Lancet				111.3*	0		
				(44.8)			

JOURNAL	% old	% study	% findings	total words	% abstracts with no findings	% all-findings abstracts	% res. + disc.
J. Pharmacol. & Exp. Ther.	3.5	15.9	80.6	194.1	0	18	79.2
	(6.0)	(14.2)	(16.0)	(62.4)			
Br. J. Pharmacol.					0		
Arch. Int. Pharmacodyn. Ther.					0		
Proc. Inst. Mech. Eng. 1976	4.5	67.0	28.4	105.4	18	0	
	(11.4)	(25.8)	(22.2)	(38.9)			
Anim. Behav.				114.1*	2		
				(36.0)			
J. Soc. Psych.	3.0	44.3	52.7	127.6	0	6	50.7
	(11.3)	(23.6)	(24.2)	(47.1)			
Sociometry	4.4	45.7	49.9	124.9	0	0	53.0
	(9.0)	(15.5)	(14.8)	(28.7)			

JOURNAL	% old	% study	% findings	total words	% abstracts with no findings	% all-findings abstracts	% res. + disc.
Lang. & Speech				132.4*			
				(49.4)			
J. Econ. Hist.	10.9	35.2	53.9	99.0	6	6	
	(20.0)	(23.7)	(26.0)	(18.9)			
Inquiry	15.0	24.3	60.7	137.0	4	12	
	(18.2)	(27.5)	(25.7)	(55.8)			
Faraday Trans., 1962	0.1	44.5	55.4	110.4	12	6	
	(0.6)	(28.2)	(28.2)	(41.5)			
Ann. Bot., 1962	3.6	25.5	70.9	129.4	6	10	
	(9.6)	(26.5)	(25.5)	(59.3)			

*Based on sample size of 30

Note: standard deviations given in brackets

TABLE 4.11 Average lengths of papers and abstracts from Landau and Weiss (1976, p. 27)

Discipline	Av. length of papers (words)	No. of abstracts	Av. length of abstracts (words)
General biology	2900	584	143
Medicine	2600	360	140
Physiology	3300	241	192
Pharmacology	2630	104	151
Botany	3310	146	125

The pharmacology and botany journals chosen for the present study thus have considerably longer papers and abstracts than the averages for the disciplines.

The shortest abstracts were of the letters in the Journal of Physics D. Since letters are significantly shorter than papers, it seems reasonable that they should have shorter abstracts. Next shortest were the abstracts in the Proceedings of the American Mathematical Society and the Journal of Physics A (Mathematical, Nuclear and General). (The difference between the Journal of Physics A and the Journal of Physics D (Applied Physics) gives a *t*-value of 2.34, $p \simeq 0.02$.) Their shortness may be because mathematical material is hard to summarise in words (API Technical Abstracts Manual, quoted in Borko and Chatman, 1963). As shown in Table 4.2, mathematics journals tend not to carry abstracts at all.

The journal with the greatest variation in lengths of abstracts was the Zeitschrift für physikalische Chemie (Leipzig).

One abstract was 468 words long (94% 'findings') and another 25 words (no 'findings'). There appears to be scope for more editorial control in this journal. The most consistent lengths were in the Journal of Economic History. Here the abstracts are printed at the beginning of the issue, and are probably written by the editor rather than the authors. (They are not asked for in the instructions to authors.)

The change in length of abstracts in Annals of Botany between 1962 and 1973 gives $t = 1.78$, and in Faraday Transactions, using the mean of Parts I and II for 1973, gives $t = 1.07$. Neither of these is statistically significant. Because of the differences between the numbers of words used to express the same concept in English, French and German (see Section 2.5.5), the lengths of the French and German abstracts cannot be compared directly with those of the English abstracts.

4.9.2 Proportion of 'findings'

The two highest proportions of 'findings' were in the abstracts in the Journal of Pharmacology and Experimental Therapeutics and in Annals of Botany, which were also the longest. They included relatively high proportions of 'all-findings' abstracts. This lends support to Sherrod's (1957) assertion that 'the indicative or descriptive abstract ... is ordinarily shorter than the other type'. However, short abstracts are not necessarily indicative, e.g.

> Vacuolaria virescens Cienk. has a chromosome number of 97∓2. At metaphase these range in size between small dot-like chromosomes 1μm in

diameter to rod-shaped structures 12μm long. Centromeres and less densely stained regions of chromosomes are recognizable.

(Ann. Bot. 37 (1973) 423.)

In these two journals the 'findings' almost exactly equalled 'results' plus 'discussion' because of the very low incidence of indicative treatments of discussion (Table 4.9).

In the physical science journals, the proportion of 'findings' was between 54% and 67%, except for the Journal of Physics A (32%). The highest was for Acta Crystallographica B: this journal contained the highest number of numerical results in its abstracts, the reason for which will be discussed in Section 4.10. The lowest was in the letters of the Journal of Physics D. This may be due partly to their shortness, and to their inclusion of some theoretical studies.

The abstracts with the lowest proportion of findings in the whole set of samples were those in the Journal of Physics A and the Proceedings of the Institute of Mechanical Engineers. They had quite large proportions of 'no-findings' abstracts. In oth journals there are many theoretical papers whose 'results' are a set of complicated mathematical equations, not suitable for inclusion in an abstract. Probably the most common type of statement of 'findings' in the Proceedings is on a comparison between theoretical and experimental results (of the authors or of others), e.g.

It [sc. a computer program] gave good agreement with experimental results published by Brown and France.

(Proc. Inst. Mech. Eng. 190 (1976) 627)

The papers in the Proceedings are considerably longer (mean length about 4500 words) than in the other journals examined. This may force authors to make more use of indicative treatments. The fundamental reason for the difference between engineering and the sciences seems to be that, whereas the science papers are concerned with finding laws or reporting values of properties which are of universal applicability, the engineering papers are much more problem-oriented. They do not give results which can be used directly by other workers: rather they discuss techniques or equipment which can be used to analyse and solve particular problems, when the relevant values of parameters will have to be inserted and the relevant factors emphasized.

The Proceedings of the American Mathematical Society had a fairly large number of 'no-findings' abstracts, but the mean proportion of 'findings' was not far short of the average for the physical sciences. Its papers are comparatively short (mean length about 1600 words), which should mean that the findings to be summarised are shorter and can be dealt with more informatively. The abstracts do sometimes contain mathematical equations, but usually as 'study' rather than 'findings'.

The proportion of 'findings' is somewhat lower in the social sciences than in the natural sciences, in agreement with the comments made in Section 4.6 about the greater importance placed on method in the former.

It is interesting that the proportion of 'findings' in the history and philosophy abstracts is about the same as that in the sciences. It is often difficult in these subjects to separate 'findings' from 'old' without a detailed study of the paper or being an expert in the subject area. It could be argued that in history all external statments (i.e. about the world rather than about the paper or study) are 'old', since they could presumably be found in, or are generalised from, previous written material. However, unless the abstract appeared to take such a statement as a premiss, rather than putting it forward, it was counted as 'findings'.

(c) Informative and indicative abstracts

If the clause in Sherrod's definition of indicative abstracts (see Section 4.8) that they are 'characterised primarily by the absence of qualitative and quantitative data' is a necessary condition, then any abstract containing no 'findings' is a purely indicative one. Also, presumably any abstract consisting entirely of 'findings' is a purely informative one (though I doubt whether this would be ideal). Many writers do not seem to recognise intermediate cases: perhaps an informative abstract is allowed some 'study'. Details in a 'study' statement may provide an essential complement to a 'findings' statement, e.g.

(i) We have studied the compounds A, B, C, D and E (Study).

All have the property p. (Finding)

This reduces to an 'all-findings' statement:

Compounds A, B, C, D and E have the property p.

(ii) The following hypotheses were proposed:

(1) — , (2) — ,

(3) — . (Study)

The hypotheses were supported by the data. (Finding)

This reduces to:

The data show that (1) — ,

(2) — , (3) — .

Thus, whereas the figures under 'no-findings abstracts' in Table 4.10 give the percentages of indicative abstracts, perhaps those under 'all-findings abstracts' should be regarded as a lower limit of the percentages of informative abstracts.

Landau and Weiss (1976) reported the percentages of informative, indicative and informative-indicative abstracts in their samples of life-science journals. Some of their results are quoted below.

TABLE 4.12 Percentages of different types of abstracts found by Landau and Weiss (1976, p. 26)

Discipline	% informative abstracts	% informative-indicative abstracts	% indicative abstracts
General biology	57.6	35.1	7.3
Medicine	49.2	39.2	11.6
Physiology	85.9	12.4	1.7
Pharmacology	71.2	21.1	7.6
Botany	54.8	37.7	7.5

Their results also support the association between length and informative nature of abstracts. They found higher prportions of indicative abstracts than I did in corresponding subject areas. As shown in Table 4.10, physical chemistry journals in French and German had considerably more indicative abstracts than those in English. Perhaps a similar effect happens in the life sciences and affected Landau and Weiss's results. Their percentages of informative abstracts are much higher than mine of 'all-findings' abstracts: presumably they adopted a less stringent criterion as suggested above.

The American Psychological Association (1974, p. 15), in giving instructions for abstracting a review or theoretical paper, says:

> It should be short but informative. For example, 'The problem was further discussed in terms of Skinner's theory' is not an informative statement. The abstract should tell the reader the nature or content of the theoretical discussion; 'The discussion of the problem centred on Skinner's theory and the apparent fallacy of determinism.'

This seems to imply that whereas the first example is not an informative statement, the second is. As I have argued in Section 4.8 (b), I would regard both examples as 'study' - they do not state what conclusions the discussion reached. (Or the second mean that the fallacy of determinism was shown to be apparent only? It is certainly not clear.) Thus the A.P.A. Manual seems to employ a less rigorous definition of 'informative' also.

The variation in the proportions of indicative abstracts reported in Table 4.10 is fairly well in line with the variation in proportions of 'findings'. The largest proportions of indicative abstracts were found in the Journal of Physics A, the Proceedings of the American Mathematical Society, and the Proceedings of the Insitute of Mechanical Engineers, which had the lowest proportion of 'findings'.

The differences between the numbers of indicative abstracts in the 1973 and 1962 samples of the Faraday Transactions and Annals of Botany were not significant according to the χ^2 - test.

Since examples of informative and indicative abstracts from the humanities do not seem to have been given before, two examples each of 'all-findings' and 'all-study' abstracts are quoted below.

All-findings (informative):

> Wars in early modern times, although frequent, generated little price inflation because of their limited demands on real resources. The invention of paper currency and the resort to deficit financing to pay for wars changed that situation. In recent centuries wars have been the principal causes of inflation, although since World War II programs of social welfare unmatched by offsetting taxation have also fuelled inflationary flames.
>
> (J. Econ. Hist. 37 (1977) 13)
>
> The human body is 'transmogrified' (caricatured) under physicalistic descriptions of it. These imply that it is a contingent fact that rational beings such as human persons have the sort of bodies they do have. (Or, that, say, baboons are not rational creatures.) The human body is 'transfigured' under a description that makes it necessary to the performance of rational functions, including speaking a language. Any view of the matter that excludes this notion, either by reduction to the physicalist treatment or simple denial, is inadequate.
>
> (Inquiry 16 (1973) 355)

All-study (indicative):

> This article presents annual slave export figures for western Guinea, Bight of Benin, Bight of Biafra, Congo North, Angola, and southeast Africa. The sum of exports from these regions yields exports from Africa as a whole. The series are derived from imports into the Americas and thus include estimates of the African origin of slave imports into Cuba, Brazil and the French Carribean, estimates of slave mortality on the transatlantic crossing, and slaves captured by the British navy. Exports from some individual African points of embarkation are also included. (J. Econ. Hist. 37 (1977) 409)

> I try to expose the distinguishing marks of moral blackmail, why it is thought so objectionable, and how it is related to these other practices that also involve a raising of the moral stakes. The study as a whole is intended to underline the ambiguous nature of human action. (Inquiry 18 (1975) 23 - excerpt)

The characteristic expressions in these indicative abstracts, as in scientific ones, are the article, study or author as subjects of the verbs, and passive sentences derived from these (e.g. 'Exports ... are also included' from 'The paper also includes exports ...').

4.10 NUMERICAL INFORMATION IN ABSTRACTS

The numbers of experimentally-controlled numbers (part of 'study') and numerical results (part of 'findings') for the abstracts studied in Section 4.9 are given in Table 4.13. Dates were not included.

The task of someone assembling data, or looking for a particular numerical value, is certainly made easier if the abstract indicates that the paper contains these data, and easier still if the values are actually given in the abstract. If the primary journal is not available in the reader's library, the time and expense of an inter-library loan may be avoided if the abstract in a secondary journal provides the value he needs. It seems remarkable, therefore, that papers which contain so much quantitative information in tables and graphs should often contain none in their abstracts. That the normal length of an abstract does provide room for quantitative data is shown by the fact that some of the abstracts studied here contained ten or more numerical results. (One in <u>J.C.S. Faraday Transactions</u> contained thirty-five, but they were treated indicatively by <u>Chemical Abstracts</u>.)

An instructive example of the task of the data-gatherer is provided by Boyle <u>et al.</u> (1977) in setting up a database of interatomic potential energy functions extracted from the literature. They report: 'To our surprise we found that, in more than 80% of cases, those who have published potential data have failed to provide estimates of the accuracy. Another major difficulty arose in trying to supply details of the range of interatomic distance over which the reported potential data

TABLE 4.13 Numbers in abstracts (Sample size = 50)

JOURNAL	Number of exp. contr. numbers		Number of numerical results		% abstracts with no numer. results
	mean	s.d.	mean	s.d.	
Proc. Am. Math. Soc.	0.30	0.79	0.24	0.52	80
J. Phys. A	0.76	1.94	0.26	0.69	86
J. Phys. D (exp. papers)	1.66	1.70	2.06	2.81	50
(letters)	0.60	1.08	0.54	1.31	78
Acta Crystallogr. B (exp. papers)	0.94	0.93	7.04	4.60	2
J. Chem. Soc. Faraday Trans. I (exp. papers)	1.67	1.97	2.74	4.84	39
J. Chem. Soc. Faraday Trans. II (exp. papers)	1.19	1.92	2.16	4.62	58
J. Phys. Chem. (exp. papers)	1.48	2.02	1.96	2.55	42
J. Chim. Phys. (exp. papers)	0.87	1.33	1.00	2.27	69
Z. Phys. Chem. (Leipzig) (exp. papers)	1.16	2.06	1.94	3.06	52
Z. Phys. Chem. (Frankfurt)	1.64	2.26	1.98	4.60	62
J. Chem. Phys. (exp. papers)	2.20	2.39	2.80	3.40	44
Ann. Bot.	1.64	2.81	1.66	3.81	62
Lancet	1.96	1.93	2.62	2.93	26
J. Pharmacol. & Exp. Ther.	3.30	3.85	2.64	3.56	46
Br. J. Pharmacol.	2.30	3.44	1.28	2.34	62
Arch. Int. Pharmacodyn. Thér.	1.76	2.43	1.38	2.23	60
Proc. Inst. Mech. Eng., 1976	0.16	0.55	0.08	0.40	96
Anim. Behav.	1.20	1.82	0.92	1.51	60
J. Soc. Psych.	1.02	1.36	0.22	1.17	94
Sociometry	1.04	1.65	0.26	0.99	92
Lang. & Speech	1.30	1.62	0.72	1.60	76
J. Econ. Hist.	0.18	0.60	0.14	0.53	92
Inquiry	0		0.04	0.20	96
Faraday Trans., 1962	1.30	1.43	1.52	2.23	54
Ann. Bot., 1962	0.90	1.37	1.10	2.23	67

was valid when it was given in a parametric form ... . Thus, often, the published data is worthless.' Kieffer (1969) has reported a similarly unsatisfactory state in the field of atomic collision physics. If these are typical of the status of numerical data in research papers, they paint rather a gloomy picture of the value of such data. Abstracts have far less space for mentioning accuracy and range of validity (the inclusion of which is suggested in ISO 214 - see Section 4.3) so the amount of numerical data which can usefully be included may be quite small. In particular, it is necessary to guard against numbers being taken out of context by someone who has time only to read the abstract, and so is unaware of the limitations on the numbers. We may expect that numerical results in the physical sciences will be more objective, in the sense of being less dependent on samples and experimental procedures, than those in the social sciences. It can be seen from Table 4.13 that whereas the Journal of Social Psychology and Sociometry have far fewer numerical results than the physical sciences, they still have about almost as many experimentally-controlled numbers. Thus numerical information about samples is considered important by the authors in the social sciences, but the actual numerical results are considered less important than in the natural sciences. The results of their studies are usually stated in the form that the hypothesis was, or was not, confirmed.

The highest number of numerical results I found in abstracts was in Acta Crystallographica B. This journal consists almost entirely of reports on the structures of crystals determined by

X-ray diffractometry. The parameters required are quite standard, e.g. dimensions and angles of the unit cell, number of molecules per cell, bond lengths and angles, final value of _R_; the sample is sufficiently well defined by its chemical formula (and, perhaps, phase), and the errors can be estimated quite accurately. It is thus an ideal subject for inclusion of numerical data in abstracts - indeed, there may be little other information worth putting into the abstract. The opposite extreme, found in the _Proceedings of the Institution of Mechanical Engineers_, was discussed in Section 4.9.2.

The amount of numerical data which can usefully be put into the abstract does of course vary between papers in the same discipline. For one thing, an author may be faced with so many data of equal importance that any selection would be arbitrary or distorted. The difference in numbers of numerical results between the two parts of _J.C.S. Faraday Transactions_ is not significant (t = 0.87), but the difference in the percentage of abstracts with no numerical results is ($\chi^2 = 6.9$, $p < 0.01$), with Part II having more. Part I covers 'physical chemistry' (e.g. kinetics, catalysis, physical properties of polymers) and Part II covers 'chemical physics' (e.g. spectroscopy). The latter often contains tables of considerable length giving wavelengths, intensities, and assignments of peaks. The abstracts in the _Journal de Chimie physique_ contain significantly fewer numerical results than those in the _Journal of Physical Chemistry_ (t = 2.25, $p < 0.05$), and there are significantly fewer abstracts which contain numerical results ($\chi^2 = 10.1$, $p < 0.005$). They include a relatively high proportion of noninformative abstracts and also tend to be rather short (mean length = 97.8). Perhaps this reflects a different philosophy concerning the value of abstracts held by the authors or editors. There is also a significant intradisciplinary difference between the numbers of numerical results in the (American) Journal of Pharmacology and Experimental Therapeutics and the European journals British Journal of Pharmacology and Archives internationales de Pharmacodynamie et de Thérapie. (t = 2.27, p <0.05 for J. Pharmacol. & Exp. Ther. and Br. J. Pharmacol.) This difference is in the same direction as that between the Journal of Chemical Physics (American) and J.C.S. Faraday Transactions II (t = 1.1, not significant).

4.11 COMPARISON WITH PROFESSIONAL ABSTRACTS

One would expect that professional abstractors working for secondary services would have a better idea than authors of the requirements for such services. Comparison of abstracts written by each for the same paper should, hence, give an indication of how authors' abstracts might be improved - at least for use in abstracts journals. A comparison was therefore made of some of the samples of authors' abstracts used in Section 4.4 with the corresponding abstracts in the major abstracts journals: Biological Abstracts, Chemical Abstracts, Physics Abstracts and Psychological Abstracts. Differences were divided into substantive ones, which involved a change in the information content (even if only the expansion of an abbreviation) and nonsubstantive ones, such as changes in the tense of verbs or in word order. The results, with some observations made during their collection, are given in Table 4.14. The numbers of experimentally-controlled numbers and numbrical results in three of the samples of authors' and professional abstracts are shown in Table 4.15.

Biological Abstracts altered fewest abstracts, whereas _Psychological Abstracts_ and _Chemical Abstracts_ made alterations to nearly all abstracts. _Physics Abstracts_ usually uses authors' abstracts (with minor modifications to accord with its conventions), but for copyright reasons it is not able to use those in American Institute of Physics journals, such as the _Journal of Chemical Physics_, and has to prepare its own. Clearly, _Chemical Abstracts_ (which made deletions from fifty-four abstracts out of ninety and additions to thirty-six) and _Psycholcgical Abstracts_ (which made deletions from thirty-five and additions to sixty-three) adopt the most critical approach to authors' abstracts, and I will concentrate on their practices.

In _Psychological Abstracts_ the main alteration was the addition of experimental details, such as the number or type of subjects (e.g. 'undergraduates'). Thus the number of experimentally-controlled numbers is significantly higher than in the authors' abstracts ($t = 4.49$, $p < 0.001$). All the additions to _Language and Speech_ abstracts were of this type. It was mentioned in Section 4.6.2 that experimental details tend to be inadequately covered by authors' abstracts. As examples of the kinds of deletions made, those from _Language and Speech_ abstracts contained two cases of unusual characters probably not available

TABLE 4.14. Comparison of authors' abstracts with those in abstracts journals. (Sample size = 30)

Primary journal	Secondary journal	Secondary abstracts with no alteration	non-subs. alteration only	subst. additn.	subst. deletn.	subst. additn. + deletn.
Anim. Behav.	Biol. Abstr.	22	7(b)	1	0	0
Ann. Bot.	Biol. Abstr.	21	5(b)	4(a)	0	0
J. Pharmacol. & Exp. Ther.	Biol. Abstr.	4	21 (b)	4	1	0
J. Chem. Soc. Faraday Trans.	Chem. Abstr.	0	3 (bd)	5	16	6
J. Chim. Phys.	Chem. Abstr.	2	13	4(c)	10	1
J. Pharmacol. & Exp. Ther.	Chem. Abstr.	0	4 (bd)	5(e)	9(f)	12
Anim. Behav.	Psychol. Abstr.	0	5 (h)	13(g)	9	3
J. Soc. Psychol.	Psychol. Abstr.	0	2 (h)	12(g)	3	13
Lang. & Speech	Psychol. Abstr.	0	6(h)	17(g)	2	5
J. Phys. D.	Phys. Abstr.	22	0	0	8	0
J. Chem. Phys.	Phys. Abstr.	0	2	5	11	12

NOTES (a) Some abbreviations expanded. Additions made in [ ] .

(b) Expressions such as 'it was concluded that' or 'it is suggested that' often eliminated and 'may' or 'probably' used.

(c) Three major ones

(d) Present tense converted to past

(e) Structural formulae often added

(f) Known properties of drugs often eliminated

(g) Experimental details (e.g. sample size) often inserted

(h) Abstracts often start with a verb.

TABLE 4.15 Numbers in authors' and professional abstracts (sample size = 50)

JOURNAL	Authors' abstracts: Exp. controlled numbers mean	Authors' abstracts: Numerical results mean	Abstracts journal	Professional abstracts: Exp. controlled numbers mean	Professional abstracts: Numerical results mean
J. Chem. Soc.	1.67	2.74	Chem. Abstr.	1.82	1.65
Faraday Trans. I	(1.97)	(4.84)		(1.86)	(2.12)
J. Chem. Phys.	2.38	3.04	Phys. Abstr.	1.67	1.70
	(2.59)	(4.41)		(1.74)	(2.93)
J. Soc. Psychol.	1.02	0.22	Phychol. Abstr.	2.22	0.07
	(1.36)	(1.17)		(1.31)	(0.33)

NOTE: standard deviations given in brackets

TABLE 4.16 Comparison of the mean proportions of introduction, experimental, results and discussion in authors' and professional abstracts. (Sample size = 30)

	% Intro.	% Exp.	% Res.	% Disc.	No. of words
J. Chem. Phys. Papers	15.2	18.5	23.4	42.9	2789
	(5.2)	(11.4)	(11.9)	(12.8)	(976)
Authors abstracts	26.4	5.5	34.9	33.3	125.4
	(25.8)	(8.3)	(22.1)	(22.0)	(56.7)
<u>Physics Abstracts</u>	36.0	7.6	29.6	26.8	78.1
	(23.5)	(11.1)	(20.8)	(19.3)	(24.7)

NOTE: Standard deviations given in brackets

to the printer, two pieces of old information, one set of statistical probabilities (so reducing the number of numerical results), and one which appeared to be erroneous. The main type of non-substantive alteration in Psychological Abstracts was rewording of the first sentence to make the abstract start with an active verb, e.g.'Presents the case history of ... rather than 'The case history of ... is presented'.

In Chemical Abstracts the substantive additions were again often experimental details, e.g. temperature conditions, techniques, and specific examples studied. Thus the number of experimentally-controlled numbers is somewhat higher than in the abstracts of J.C.S. Faraday Transactions. Substantive deletions included old information, comments about the relation of new results to previously-reported ones, and indicative statements about discussion (including one case where the abstract mentioned that the findings were relevant to a particular problem, but the paper did not discuss how.) Additionally, subsidiary findings and even numerical results were sometimes deleted, especially when the abstract contained more than three or four. This is in line with the Chemical Abstracts Service's 'Directions for Abstractors' (see Section 4.12. 5 (a)).

Two main types of non-substantive alteration were made in Chemical Abstracts. Firstly the present tense was converted to past in reporting findings (perhaps this indicates some reservation about their generality, unless it is merely stylistic.) The second was deletion of such phrases as 'This is taken to imply that' and 'has been measured and found to be' (use 'was'!).

The one case of completely rewritten abstracts was that of the Journal of Chemical Physics in Physics Abstracts. These were subjected to the same kind of analysis as that applied to the authors' abstracts in Section 4.4, and the results are shown in Table 4.16. The professional abstracts were significantly shorter (t = 4.18, $p < 0.001$): as can be seen from Table 4.14, this lead to a loss of information in most abstracts. However, this is presumably considered a satisfactory compromise by the abstracting service. None of the differences in the proportions of the categories of information was significant for thirty cases, but the greatest difference was in material from the introduction. As discussed in Section 4.6.1, the proportion in the authors' abstracts is exceptionally high, but it is even higher in the professional abstracts.

The propotions of 'old', 'study' and 'findings' as defined in Section 4.9, were assessed for the authors' and professional abstracts, and are reported in Table 4.17.

TABLE 4.17 Comparison of the mean proportions of 'old', 'study' and 'findings' in authors' and professional abstracts. (Sample size = 30)

	% 'old'	% 'study'	% 'findings'
J. Chem. Phys.:			
Authors' abstracts	6.3 (3.4)	36.2 (21.5)	63.2 (21.6)
Physics Abstracts	1.5 5.0	57.0 (28.2)	41.5 (29.0)

The abstracts in Physics Abstracts contain significantly more 'study' (t = 3.21, $p < 0.01$) and less 'findings' than the authors' abstracts. They also contain less 'old' material (t -test inapplicable). In the authors' abstracts, the percentage of 'findings' is not much less than that of results and discussion (68%), whereas in the professional abstracts it is considerably less (results + discussion = 57%). The professional abstracts thus make much more use of indicative treatments of results and conclusions. The professional abstracts contained fewer experimentally-controlled numbers than the authors' abstracts (in contrast to the practice of Chemical Abstracts and Psychological Abstracts) and far fewer numerical results.

The implications of these findings will be discussed in Section 4.12.

4.12 ABSTRACTS AND THEIR USERS

Wilson (1974) has suggested that abstracts of research papers are of interest to at least five groups:

(i) the author, to help him in ordering his thoughts;

(ii) the editor, to be able to decide quickly whether the papers falls within his scope;

(iii) the reader of the primary journal, to decide which papers are worth reading;

(iv) CODATA;

(v) secondary service producers and users.

I shall consider what requirements each makes of the authors' abstracts, and whether these could be fulfilled by surrogates requiring less time and intellectual effort to prepare.

4.12.1 The author

For the author's use the abstract should preumably contain same information from each part of the paper, and probably in the same order as the paper. The conclusions will no doubt be the most important part for the author to clarify for himself. However, this use cannot be regarded as an important constraint, as the author could write his own abstract and then throw it away when the paper is finished.

4.12.2 The editor

For editorial selection, the abstract is functioning as little more than an expansion of the title. A list of keywords might be as useful. Again this should not be a constraint on the printed abstract.

4.12.3 The primary journal reader

This user would probably be helped to some extent by a list of keywords supplementing the title, provided they are specific enough (see Chapter 5). The main requirement is for more detailed information on what the paper is about. Abstracts can provide this information in a way that indexing probably cannot, whatever its specificity. For example:

> Title: Competence and helping (J. Soc. Psychol. 89 (1973) 203)
>
> Index entry (in Psychol. Abstr.): Perceived competence, altruism, college students
>
> Abstract: In order to test various explanations of the fact that perceived competence appears to correlate positively with altruism ... .

Because it is longer than the title, the abstract is able to provide more context for the 'keywords' or 'index terms' and so to show relations between them and help to remove ambiguities.

An indicative abstract should be able to mention more topics in the paper than an informative one of the same length, though an indicative statement such as 'Implications of the results are discussed' tells the reader no more than he would have expected. An informative abstract may occasionally be advantageous in that a conclusion other than that which the reader would have expected may induce him to read a paper which he otherwise would not have done.

Thompson (1973) has studied the usefulness of abstracts to readers of primary journals in U.S. military laboratories. He found that the addition of a separate, identifiable abstract at the beginning of a report or journal article did not significantly increase the ability of the readereither to decide what disposition to make or to judge its relevance. These decisions could be made by other means such as the title, contents table, introduction, and the journal title. Thus, perhaps the needs of this group of users have been over-emphasied.

4.12.4 CODATA

CODATA is the Committee on Data for Science and Technology, and exists to support data collection, compilation and evaluation in science and technology (Waddington, 1969). From the viewpoint of compilers of data it is sufficient if the abstract indicates clearly the type, quantity and quality of the data in the paper.

The potential for including numerical results in abstracts has been considered in Section 4.10.

4.12.5 Secondary services

This is a compound category. It includes both current-awareness and retrospective-search functions, and one needs to consider both the value of the abstract on its own and its value in pointing to the relevance of the original paper. In Herner's (1954) study, he found that of the interviewees who made significant use of indexing and abstracting publications, 45% used them for current awareness and 55% used them primarily for searches of the past literature. Martyn (1967) considered the two uses to be about equal, but suggested that retrospective searching may be done by computerised systems in the future. Urquhart (1965) found that of 1335 research workers in physics and chemistry 366 used abstracts journals for finding specific information, 411 for keeping up to date, and 558 for both purposes.

I consider that for the sake of economy and speed the author's abstract should be suitable for use in the major secondary services without alteration. Landau and Weiss (1976, p. 55) report that at the Meeting of the Panel of Editors of Secondary Journals, 'Members agreed that there was little conflict between the needs of primary and secondary journals, i.e. an abstract adjuged satisfactory for the primary journal was likely to prove useful for the secondary journal'.

(a) Current awareness. What the researcher working on a project wants to know are such things as:

(i) Whether someone else has solved the problem on which he is working - in which case he will no doubt want to see the original paper before abandoning his project or looking for a different solution.

(ii) Whether someone has tried his problem and failed, so that he can avoid the same fate. (It is unlikely that a paper in which the main problem is not solved would be published, so abstracts are not likely to help much here.)

(iii) Whether someone has solved a related problem, so that he can use their method, or compare his results with theirs, or use their results as data for his work.

The abstract thus serves merely as a guide to its paper. Martyn (1967) wrote: 'I suggest that when an abstracts service is used for keeping up-to-date, the abstract itself serves no purpose other than that of providing an additional, deeper index to the document to which it relates. As an illustration, a person using United States Government Research and Development Reports may turn to the appropriate section ... . He may then scan the titles until an apparently relevant title crops up. Then he may read the list of descriptors beneath the title, and ... he may then read the abstract, and on the basis of the abstract, finally decide one of three things. Either the document is not really relevant, in which case he continues scanning, the document is relevant but not immediately useful, in which case he may note the existence of the document but not bother to acquire it, or it looks as though it is relevant and more or less immediately useful to him, in which case he will take steps to acquire it. The abstract ... is serving as a syntactically-arranged group of indexing terms. I suspect that this is typical of the function of many abstracts services, particularly those which are indicative rather than informative.'

If the abstract is sefving to describe the paper and amplify the title, then the traditional arrangement with the first sentence giving a statement of the problem investigated seems to suit users' needs better than the alternative 'findings-oriented' form (Weil, 1963), sometimes found, which starts with a statement of results.

The increasing use of titles indexes rather than abstracts journals for current awareness was mentioned in Section 2.2.2. One advantage of the abstracts journals, though, over the journals listing titles is that the former are usually divided into narrow subject sections, whereas the latter are arranged by journal, with a KWIC (Chemical Titles and Bioresearch Index) or Permuterm (Current Contents) index. A notable exception is Index Medicus, which is arranged like an abstracts journal. The limitations of title-based indexes have been considered in Chapter 2.

Kent et al. (1967) have looked at the effectiveness of the citation (title, author, date and journal title), abstract, and first and/or last paragraph as predictors of relevance. Their subjects were 'motivated' users (i.e. people who had a need for literature in their research) in the medical complex of the University of Pittsburgh. After the full texts of the documents had been judged by the subjects, it was found that there was no significant difference between the accuracy of predictions from the various surrogates, although first-plus-last paragraphs performed best. A study of selective dissemination of information at IBM by Resnick (1961) also showed that there was no significant difference between the rate of acceptance of documents ordered on the basis of seeing the title and of seeing the abstract.

Abstracts are almost necessarily inadequate in the transmission of techniques (Bernal, 1959). The extent to which the technique used needs to be indicated in the abstract will vary between disciplines, as discussed in Section 4.6. In particular, in the social sciences there may be different approaches to problems in terms of different schools of thought, and it will be important for a prospective reader of the paper to know the approach used. (In some cases he will no doubt be able to guess this from the author's name.) Some workers in the natural and social sciences may be more interested in the applications of a particular technique than in the solution of particular problems. If the primary purpose of a paper is to report a new technique, this should be made clear in the abstract (or, better still, in the title) so that the reader will know that he should go to the original paper for the details.

The main controversy over the requirements of an abstract with respect to current awareness concerns the treatment of results. Should the abstract be indicative (so requiring reference to the full paper) or informative (actually quoting results, so that the researcher can keep abreast of his subject - or at least his fringe interests - by reading the abstracts and not needing to go to the full papers)? Urquhart (1965), commenting on the fact that references from abstracts journals provided only 43% of the loan demand at NLL during March 1963 says, 'It is possible then that whilst many scientists say they use abstracts as a means of keeping up to date, this is in fact not a very productive occupation in terms of the numbers of originals they eventually consult.' [This assumes that loan requests are a useful measure of total consultation of originals.] 'Alternatively it is equally possible that in general scientists are happy with the amount of information that they are able to extract from conventional abstracts.'

The only direct investigation I could find in the literature into users' preferences for informative or indicative abstracts was that by Gray (1950). Of the 1477 U.S. physicists replying to a questionnaire, 46% used abstracts principally as a guide to the literature, 48% used them 'half as a guide and half as a substitute' for the literature, and 6% gave their major use 'as a substitute for the original'. Eighty-three per cent said that they preferred informative abstracts, and over half were prepared to pay more for an abstracting service including informative rather than indicative abstracts. (The use of the term 'informative' may have helped to sway respondents' opinions - despite the definition given in the questionnaire. Surely a user is bound to prefer that an information service be informative?) Nevertheless, almost without exception, the physicists interviewed would seldom, if ever, accept technical data without checking the original document. Gray suggested that the preference for informative abstracts arose because (a) the original is occasionally unavailable, (b) an indicative abstract may not contain enough information for the reader to be certain whether he is interested in the paper, and (c) an indicative abstract may not contain enough information for adequate indexing. However, (a) can apply only occasionally, (b) does not seem to be supported by the findings of Kent et al. and of Resnick above, and (c) should be capable of improvement by better indicative abstracting. It seems to me that the value of informative abstracts lies not in providing research results for use as data in one's own work, but for general awareness over a wider area.

The Chemical Abstracts Service states in its 'Directions for Abstractors' (quoted in Borko & Bernier, 1975, p. 38): 'In general, Chemical Abstracts contains informative abstracts. Their primary purpose is to give the reader accurately and quickly enough information on the chemical content to the document abstracted to allow him to determine whether he wants to consult the original publication'. INSPEC (Information Services in Physics, Electrotechnology, Computers and Control) states in its 'Notes for Abstractors': 'The purpose of the abstract is to tell the reader what subjects are discussed in the article, and the treatment of them (e.g. theoretical, experimental). Even if nothing more than this is given, it will at least help the reader to decide whether to look up the original article.' However, the 'Notes' go on to say 'In addition ... it is usually possible to include a fair proportion of the factual content of the article in summary form, particularly if an investigation leads to a formula or numerical result, or a general qualitative conclusion.'

Both these services are thus inclined towards the indicative function of abstracts, though they imply that some statement of results is helpful. The American Bibliographical Center, however, which publishes abstracts in history and related disciplines, says in its 'Policies and Procedures' (quoted in Borko and Bernier, 1975, p. 39) that abstracts 'assist the researcher in deciding whether the contents of the articles abstracted should be read in full', but adds that 'they provide summaries of ideas, concepts and interpretations so that it is frequently unnecessary to read articles in full'. It also asserts: 'They provide the specialist a means of surveying literature in his field and of keeping abreast of developments in other fields and interest and specialisation'. The Institute of Physics in their 'Notes for Authors' also intend that abstracts should fulfil both functions: 'The abstract ... should (a) help workers in the subject of the article to decide whether the contents are such that they need to read it, and (b) give readers for whom the subject is of 'fringe interest' as much information as possible so that it is unnecessary for them to read the whole article. The abstract should therefore be informative and not only indicate the general scope of the article but also state the main results obtained and the conclusions drawn.'

I would expect that the use of abstracts for direct information would be more important to industrial than academic users. Shera (1951) stated that the pure scientist (e.g. physicist, chemist, astronomer) 'needs comprehensive and primary materials for the results (factual findings) that they set forth, for verification of those findings, or for the presentation of the method which he may possibly apply.' The needs of the technicians (engineers, mechanics, inventors and manufacturers) 'are sharply contrasted with those of the pure scientists, in that they are primarily concerned with the results of research rather than the materials, methods or verifications of the experimental process. The established facts with which the technicians deal ... can be in large part derived from secondary sources.' Herner (1954) looked at the different information-gathering habits of pure and applied scientists at the Johns Hopkins University. He stated, 'As a rule, pure scientists survey their literature critically and exhaustively, while applied scientists give a relatively small amount of their time to the literature.' In conclusion, he wrote, 'To the pure scientist, research in the literature is likely to be as necessary and as routine as his researches in the laboratory ... . The typical applied scientist generally prefers to have his bibliographic searches done for him... . If possible, he wants the references evaluated, extracted, and summarised ... . He makes relatively little use of written or published materials.' Haygarth Jackson (1976) wrote that 'abstracts may provide the required fact or figure, especially in the area of business information, so that further look-up is unnecessary'. Thus it seems that the pure scientist will generally be prepared to go from the abstract to the original paper, while the applied scientist or industrialist would prefer to be able to get his results without further effort.

The Publications Committee of the American Society for Horticultural Science sent questionnaires to its readers about their views on its publications (Westwood et al., 1976). In reply to the question of whether they would favour the printing of extended abstracts of research work rather than full papers, 33% of professors, 38% of other academics and 43% of readers in other occupations replied in the affirmative. This shows a significant difference between academics and other professions (χ^2 = 9.33,

$p < 0.01$). Not surprisingly, though, there was an even greater difference of opinion between those readers who did and did not publish in the Journal, so the main factor influencing the academics' replies may have been the desire to have their work published in full, rather than convenience for current awareness.

Borko and Chatman (1963) wrote to 315 journals and secondary sources to enquire about the purpose of, and instructions for, their abstracts, and obtained 130 usable replies. They summarised their results on policies relating to the function of abstracts as:

Informative	23	(17.7%)
Descriptive	48	(36.9%)
Both	32	(24.6%)
Other or unclear	4	(3.1%)
No information	23	(17.7%)

Surprisingly, they stated that 'these differences do not apparently correspond to any contrast in subject matter or field, as, for example, the difference between pure science and technology.'

With regard to practice (which was not examined by Borko and Chatman) as opposed to policy, the data of Landau and Weiss (1976, p. 26) can be summarised as follows:

TABLE 4.18 Informative and indicative abstracts in pure and applied life sciences, from Landau and Weiss (1976).

	Informative	Informative-indicative	Indicative
Pure sciences	1113 = 61.0%	578 = 31.7%	133 = 7.3%
Applied sciences	423 = 53.7%	279 = 35.4%	86 = 10.9%
Total	1536 = 58.8%	857 = 32.8%	219 = 8.4%

The pure science journals contained significantly more informative abstracts than the applied science journals ($\chi^2 = 12.2$, $p < 0.001$), contrary to what appears from the above discussion to be the difference in needs. The journals I studied in Section 4.9 do not cover applied science well enough to permit a similar comparison. The most 'applied' ones were the _Proceedings of the Institute of Mechanical Engineers_ and the _Journal of Pharmacology and Experimental Therapeutics_-which were almost opposites in informative _vs_ indicative content - and the _Journal of Physics D_.

The comparison in Section 4.11 of authors' abstracts with those in abstracts journals seemed to indicate a preference for more indicative abstracts than those supplied by authors. _Psychological Abstracts_ and _Chemical Abstracts_ frequently put in additional information about the experimental method and subjects. _Chemical Abstracts_ deleted both qualitative and quantitative results much more often than adding them. The sample of abstracts written specially for _Physics Abstracts_ made much more use of indicative treatments of results and conclusions, and contained far fewer numerical results than the authors' abstracts.

As well as the possible hazards of taking numerical results from abstracts without appreciating the qualifications and limitations imposed by the sample or method, discussed in Section 4.10, there is a further danger in taking them from abstracts in the secondary services, _viz_., errors in the transcription of the authors' abstracts. During the comparison of the _Faraday Transactions I_ abstracts with those in _Chemical Abstracts_, I noticed three errors: 'ligand number' had been printed as 'liquid no.', 'an activation energy of 46kJ/mole' was given as '45 kJ/mole' and, more seriously, 'an upper limit of 10^{-16} ml molecule^{-1} s^{-1} was given as '10^{-6} ml/ mole-sec.' _British Archaeological Abstracts_, in a bold-type note in each issue, states that 'Abstracts should never be used as primary sources; ... the subscriber is always responsible for consulting the originals.' This would appear to be sound advice for using any abstracts journal, and something to be borne in mind in writing the abstracts.

(b) Retrospective searching. The need for exhaustive retrospective searching arises when the researcher starts work on a new investigation, and is intensified when he reports the results in a paper, lecture or patent application (Voigt, 1959). Here again, the subject of the paper, rather than its results and conclusions, is the important part of the abstract. If exhaustiveness of the search is vital, every paper which looks potentially relevant should be examined in full text. The significance of numerical data quoted in the abstract may be not so much to give useful values as to show that the study did, in fact, result in a numerical value, rather than merely being discursive, or expressing some quantity in terms of other parameters. Voigt (1959) states that Chemical Abstracts is the chief tool for retrospective searching in pure chemistry, but this probably arises from the excellence of its indexes and broadness of coverage rather than the fact that it contains abstracts. At present, title indexes are not cumulated (except for Index Medicus) and may cover narrower fields than the abstracts journals (e.g. Chemical Titles vs. Chemical Abstracts), so they do not provide an acceptable substitute for retrospective searching.

Saracevic (1969) investigated the accuracy of judgments of relevance, partial relevance, and nonrelevance based on titles and abstracts of documents as compared with judgments on full texts. Of 1086 documents on tropical diseases, 207 were judged from the full texts to be relevant to the questions they were supposed to answer. One hundred and thirty-one of these were judged relevant from the titles and 23 nonrelevant, while from the abstracts 160 were judged relevant and 12 nonrelevant. Of the 762 judged nonrelevant from the full text, 671 were judged nonrelevant from the title and 690 from the abstract. Although no tests of significance were performed, it may be concluded that selection from titles rather than abstracts did not greatly increase the amount of nonrelevant material retrieved, but did result in nine more relevant papers being missed. Whether this justifies the expense of writing, printing and storing abstracts depends on how vital exhaustiveness is.

4.12.6 Mechanised searching

ISO 214 (International Organization for Standardisation, 1976) mentions that abstracts are also of value in computerised full-text searching for alerting and information retrieval. At the present state of the art, this involves looking for the presence in the abstract of words or word-fragments listed in a user's profile. Maloney (1974) ran 228 S.D.I. profiles of 104 research chemists in industrial laboratories against Basic Journal Abstracts (a Chemical Abstracts Service database for 35 major chemical journals). The mean number of citations retrieved if titles only were searched was only 27% of that retrieved by searching titles plus abstracts. This is said to represent a 73% loss to the S.D.I. user. If only a single term was needed for a match, as opposed to compound terms linked by operators, the percentage of 'hits' retrieved from titles rose to 39%. However, no results are given about the acceptability of the documents so retrieved to the users: the extra ones retrieved using abstracts may have included many where the term which produced the hit was of only minor importance.

A more satisfactory study has been made of the effectiveness of its current awareness service by the United Kingdom Chemical Information Service (1974). Users were required to judge documents provided as relevant, of general interest, irrelevant, or undetermined on the basis of their titles. Of the 323 references retrieved from the Chemical Biological Activities and Polymer Science and Technology databases which were judged of 'major interest' by the users, 222 were retrieved by searching titles alone and 315 by searching titles-plus-abstracts. Including the references 'of general interest', 768 documents were retrieved, 437 by titles and 731 by titles-plus-abstracts. (Different profiles for each user were written for searching against titles and titles-plus-abstracts, so that not all documents retrieved by title were retrieved by title-plus-abstract.) However, the inclusion of abstracts caused a drop in precision from about 33% to 18% in the former category and 65% to 40% in the latter. It was claimed that although a titles-only search may miss many papers of fringe interest, 'relatively few really important papers are lost by searching titles alone'. An analysis of cost-effectiveness showed that the greater the cost of output to the user, the more cost-effective is the titles-only service. It was proposed that the improvement in recall obtained by using titles-plus-abstracts could rarely be justified in terms of cost.

Searching titles-plus-keywords did not produce as great improvements in recall as searching titles-plus-abstracts did over titles alone. From the way the machine searching worked, it should presumably be possible to improve titles-plus-keywords searches by more adequate provision of keywords and expansion of users' profiles.

One of the objections to the increased use of keywords in the social sciences (and even more in the humanities) is that different schools tend to use different words to mean the same thing, or the same words to mean different things. If terminology is not stable with time, this will make retrospective searching on keywords more difficult. Presumably such instability will affect machine searching of titles and abstracts also (especially the construction of thesauri), but for a reader it may be easier to understand the senses of words in titles or abstracts rather than in a list.

There do not seem to be data available on the relative performance of informative and indicative abstracts in mechanised searching, but the important factor is the number of potential index terms that each contains. Carras (1968) compared the descriptors assigned by indexers to documents with those found in the abstracts of the documents in International Aerospace Abstracts (informative) and Engineering Index (indicative). The former contained 71% of the descriptors and the latter 53%. However, the average length of the informative abstracts was 111 words, and of the indicative abstracts 71 words, so that the better performance of the former can be more than accounted for by their greater length. In fact, the informative abstracts contained 28.5% 'significant' words, and the indicative abstracts 36.8%, so that for indexing purposes indicative abstracts were more efficient.

4.13. CONCLUSIONS

Most detailed sets of instructions to authors about writing abstracts ask for a statement about the problem investigated, or scope of the paper, and an informative presentation of the results and conclusions. The experimental or other method is often not mentioned as a requirement. A study of what parts of experimental papers are drawn on for the information in the abstract showed that method was frequently represented poorly, while a large part of the abstract's information was taken from the results.

Although abstracts are most common in the pure and applied sciences (including psychology), they are found occasionally in mathematics and the humanities. It is possible to examine these abstracts also as regards their proportions of indicative material (about the paper or study) and informative material (quoting results and conclusions). They are shown not to differ much in this respect from abstracts in the sciences, and it seems that, given the demand, abstracts could feature more widely in these areas. The lowest proportions of informative material were found in theoretical physics and engineering. Papers in these subjects tend not to have easily summarised results.

Abstracts in the major abstracts journals, when they do not use authors' abstracts verbatim, tend to contain more details about the methods and samples, and fewer quantitative and qualitative findings. A consideration of the needs of users of abstracts, both in primary and secondary journals, suggests that specification of the subject of the study and probably experimental methods are more important elements than are findings for most purposes. Because of the lack of space in abstracts for giving limitations and conditions on numerical findings, and the danger of errors in the transcription of authors' abstracts, it seems undesirable to encourage users to take figures directly from abstracts.

C H A P T E R F I V E

KEYWORDS

5.1 INTRODUCTION

Clark (1961) suggested that, as the greatest authority on any item of literature is the author, he is the one best able to classify the item. It ought, therefore, to 'simplify the whole matter of information handling if each author provided the necessary index terms with his manuscript'. Black (1961), who took the suggestion to refer to book indexing, was quick to assert that 'authors are seldom qualified to do indexing ... . Authors nearly always have special slants or blind spots that make it difficult for them to do a good index.' Schultz et al. (1965) tested author indexing by comparing terms assigned by the authors of 285 documents reporting biomedical research with those assigned by twelve potential users of the documents. Each indexer was given a form with 373 printed terms, from which he could pick two together with space for four or more terms of his own. These latter terms were standardised by the editor to a limited extent. The users' terms were weighted by the square of the number of users assigning them. It was found that the average author set contained almost half of all the terms, employed by more than one user, and it scored 73% of the maximum possible score for matching. In contrast, keywords taken from the authors' titles scored 44%, so that, by this criterion, author indexing is substantially better than indexing from titles.

Quite a number of journals do, in fact, now print index terms with each paper (and, sometimes, letter). They are called variously 'keywords', 'keyterms', 'index words', 'index terms', 'descriptors' and 'subject headings' (for controlled terms). Since they usually need not appear elsewhere in the paper, as British Standard 5408 (1976) requires of a keyword, and in order to avoid the problem over words and phrases, I would prefer the term 'descriptor'. However, I will use 'keyword' in this chapter (to mean a word or phrase), since it is the commonest term, and reserve 'descriptor' for terms supplied by secondary services. The keywords usually come just after the title or the abstract, but occasionally at the foot of the first page.

The study of keywords involved looking at similar aspects to those in the study of abstracts. A survey was made of which journals carry keywords. The purpose and use of keywords were considered, both as stated by the journal and as found in practice. Instructions to authors were examined in the light of these uses, and the actual performance of authors was evaluated. Two particular points considered were whether keywords are usually too broad to be of use in retrieval, and whether the same information could be incorporated into titles. On the basis of the findings, it is questioned whether authors can be expected to provide useful keywords.

5.2 OCCURRENCE OF KEYWORDS

A survey was made of the latest issues of all the periodicals taken by Leicester University Library in 1977, to see in which subjects and with which publishers keywords occur. The sample includes most of the core journals in the main disciplines, though the coverage of different disciplines of course varies. There is a preponderance of English-language material in the sample. The journals including keywords are listed in Table 5.1.

By far the greatest prevalence was found in the life sciences, especially clinical medicine. This is partly a consequence of the number of such journals in the sample, but nevertheless it indicates a much higher proportion of journals with keywords in this area. Engineering had a smaller proportion, and the physical

TABLE 5. 1 The Occurrence of Keywords and Instructions about them (1977)

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Psychology					
Physiol. & Behav.	Pergamon, USA	1966 (vol.1)	3-12+		NK
Psychometrika	Psych. Soc., USA				-
Psychophysiology	Soc. Psych. Res., USA				-
Sociology					
Am. Anthropol.	Am. Anthr. Assoc., USA	1976	$\leqslant 5$		K
*J. Am. Stat. Assoc.	Am. Stat. Assoc., USA	1977	3-6	Used in Current Index to Stats. May be taken from title.	-
*Appl. Stat.	R. Stat. Soc., UK				-
Reg. Stud.	Pergamon, UK		$\leqslant 6$	(a)	-
*J.R. Stat. Soc.	R. Stat. Soc., UK	1972			(K)
Science					
J. Res. Natl. Bur. Stand.	U.S. Govt. Printg. Off., USA		(b)		K
Proc. Natl. Acad. Sci. USA.	Natl. Acad. Sci., USA	1971	$\leqslant 5$	Not in title. To alert readers & indexers	NK

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
*Technometrics	Am. Soc. Qual. Contr. & Am. Stat. Soc., USA	1972			-
Z. Naturforsch.	Verl. Z Nat., W.Ger.	1972	5		K
Mathematics					
Adv. Appl. Probab.	Appl. Prob. Trust, UK			For computer inf. retr.	
Bull. Am. Math. Soc. Proc. Am. Math. Soc. Trans. Am. Math. Soc.	Am. Math. Soc., USA	1970		Describing subj. matter of the paper and taken from it	-
*Ann. Probab.	Inst. Math. Stat., USA	1973 (vol. 1)		Should describe the subj. matter of the article; generally should be taken from body of paper	-
*Ann. Stat.	Inst. Math. Stat., USA	1973 (vol. 1)			-
*J. Appl. Probab.	Appl. Prob. Trust, UK			For computer inf. retr.	-
J. Optimiz. Theory & Appl.	Plenum Publ. Co., USA		4-5	Important for indexg. - intl. & extl.	K
Math. Program.	N. Holl., Neth.	1977			

Subject/Journal	Publishers & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
<u>Astronomy</u>					
Astron. & Astrophys.	Springer Verl., W.Ger.	1969 (vol. 1)	≤ 5		-
Astrophys. J.	Am. Astron. Soc., USA	1973		(g, h)	K
<u>Physics</u>					
Nucl. Phys. (exper. papers)	N. Holl., Neth	1964		(c)	NK
Phys. Rev. C.	Am. Phys. Soc., USA			(c)	NK
<u>Chemistry</u>					
Ber.Bunsenges. Phys. Chem.	Verl. Chem., W.Ger.	1974			K (g)
J. Electrochem. Soc.	Electr. Soc., USA		3-5	To facilitate inf. retr. Avoid words in title & generic terms.	(K)
J. Solution Chem.	Plenum, USA	1972 (vol. 1)			K
Theor. Chim. Acta	Springer Verl., W.Ger.		≤ 5	For subject index g.	K
Z. Phys. Chem. (Wiesbaden)	Akad. Verl., W.Ger.		≤ 5	To be underlined in abstract	-

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Geology					
Comput. & Geosci.	Pergamon, UK				
Earth Surf. Proc.	Wiley, UK				K
Neu. Jahrb. Geol. & Palaontol.	Schweiz Verl., W.Ger.				
Pure & Appl. Geophys.	Birkhäuser Verl, Switz.	1977			K
Z. Dtsch. Geol. Ges.	Dtsch. Geol. Ges, W.Ger.	1970			
Biology & Life Sciences					
Acta Anat.	Karger. Switz.		3-9		-
Acta. Pathol. Microbiol. Scand.	Munksgaard, Denm.				-
Acta Virol.	Acad. Sci., Czech.	1974	3-6	For computer recall purposes	NK
Am. J. Physiol.	Am. Physiol. Soc., USA	1964	$\geqslant 3$	Not in title	NK
Anat. & Embryol.	Springer, W.Ger.	1968	$\leqslant 5$	Pref. MeSH	-
Ann. Microbiol.	Masson, Fr.			(Engl. & Fr.)	K
Ann. Immunol. (Paris)	Masson, Fr.			(Engl. & Fr.)	K
Arch. Hydrobiol.	Schweiz., W.Ger.				-
Arch. Microbiol.	Springer, W.Ger.		$\leqslant 10$	Indicating scope	

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Arch. Sex Behav.	Plenum, USA		4-5	Should express precise content. Are used for indexing - intl. & extl.	K
Biochem. Genet.	Plenum, USA		4-5	" "	K
Biochem. Physiol. Fflanz.	Fischer, E.Ger.		3-6	Indicate essential content. System. names	-
*Biometrics	Biometr. Soc., USA				(K)
*Biometrika	Biometr. Trust, UK		'some'		-
Blut	Springer, W.Ger.	1976	$\leqslant 5$	Pref. MeSH	
Brain Behav. Evol.	Karger, Switz.		3-9		K
Cell & Tissue Res.	Springer, W.Ger.				-
Clin. & Exp. Pharmacol. & Physiol.	Blackwell, UK		$\leqslant 10$	Required for indexing content of paper. Pref. MeSH. Alphabet. order.	-
Clin. Sci. & Mol. Med.	Blackwell, UK			Pref. MeSH	NK
Comput. Programs Biomed.	N. Holl., Neth.				-
Cytobiologie	Wiss. Verl., W.Ger.		$\leqslant 5$		-
Dermatologia	Karger, Switz.		3-9		(K)

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Ecology	Ecol. Soc. Am., USA	1974	6-12		K
Eur. J. Pharmacol.	N. Holl., Neth.		3-6	Pref. MeSH	K
Exp. Cell Biol.	Karger, Switz.	1977 (vol. 1)	3-9		
Exp. Parasitol.	Acad. Pr., USA			Should help to describe paper to non-expert readers. Taxon. names and larger categories (In contents list)	
Folia Biol., Praha	Acad. Sci. Bohem., Czech.				
Hoppe-Seylers Z. Physiol. Chem.	Gruyter, W.Ger.	1976			K
Hum. Hered.	Karger, Switz.		3-9		(K)
Hydrobiologia	Junk, Neth.			To incorporate in the lit. inf. lists	-
Bull. Inst. Pasteur	Masson, Fr.			(Engl. & Fr.)	-
J. Physiol. (Paris)	Masson, Fr.	1972	'limited'		Cl
J. Appl. Physiol.	Am. Physiol. Soc., USA		$\geqslant 3$	Not in title	(K)
J. Lipid Res.	Lipid Res., USA		$\leqslant 10$	(In contents list) To direct attentn. of readers & abstr. services to subjs. not in title	NK

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
J. Med.	PJD Publ., USA				
J. Mol. & Cell Cardiol.	Acad. Pr., UK	1973			K
J. Protozool.	Soc. Protozool, USA			Usable in subject index	(K)
Lab. Anim. Sci.	Am. Inst. Lab. Anim. Sci., USA		3-5		K
Lab. Invest.	Williams & Wilkins, USA				(K)
Med. Educ.	Blackwell, UK				
Med. Inf.	Taylor & Francis, UK		4-8		
Methods Inf. Med.	Schattauer, W.Ger.		ca.5	(Engl. & Ger.)(d)	
Nauyn Schmediebergs Arch. Pharmacol.	Springer, W.Ger.		5	Pref. Ind. Med.	-
Neuroendocrinology	Karger, W.Ger.		3-9	For indexing.	K
Pathol. Biol.	Exp. Sci. Fr., Fr.			For INSERM (syst. MEDLINE)	
Pflügers Arch.	Springer, W.Ger.		≤5	Pref. MeSH	K
Phytochemistry	Pergamon, UK		3-10	Identify most impt. subjs. To assist in comput. retr.	
Phytopathology	Am. Phyt. Soc., USA			Not in title or abstr.	
Plant Syst. & Evol.	Springer, Austr.		5-15	Taxa and probs. in form to be fed into data bank.	

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Planta	Springer, W.Ger.	1977	$\leqslant 6$	Characterising scope. Principal plant materials.	
Syst. Zool.	Soc. Syst. Zool., USA				
Vegetatio	Junk, Neth.		$\leqslant 10$	In lang. of MS and Engl.	
Wilhelm Roux Arch. Dev. Biol.	Springer, W.Ger.				
Clinical Medicine					
Acta Haematol., Basel	Karger, Switz.		3-9		K
Acta Psychiatr. Scand.	Munkagaard, Denmk.			Ind. Med. as guide Depict & characterize essentials.	-
Am. J. Clin. Pathol.	Lippincott, USA			Should be in title or abstract.	K
Am. J. Epidemiol.	Johns Hopk. Univ., USA			Pref. MeSH	NK
Am. J. Med. Sci.	Slack, USA		$\leqslant 10$		K
Ann. Endocrinol.	Masson, Fr.		3-4	(In French)	-
Arch. Fr. Pediatr.	Doin, Fr.				-
Biol. Neonate	Karger, Switz.		3-9		K
Calcif. Tissue Res.	Springer, W.Ger.		$\leqslant 5$	Pref. MeSH	K

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Chemotherapy	Karger, Switz.		3-9		K
Chir. Plast.	Springer, W.Ger.		ca. 4		
Diabetologia	Springer, W.Ger.		5-15		K
Digestion	Karger, Switz.		3-9	Provided by Edit. Board	K
Early Hum. Dev.	Elsevier, Neth.		3-6		
Epilepsia	Raven, USA		ca. 5	For abstracting services	
Eur. J. Clin. Invest.	Blackwell, UK	1970 (vol. 1)			K
Eur. J. Obstet. Gynecol. & Reprod. Biol.	Elsevier, Neth.		3-6	Not in title	
Eur. Surg. Res.	Karger, Switz.		3-9		K
Histopathology	Blackwell, UK		Small no.		
J. Appl. Physiol.	Am. Physiol. Soc., USA				NK
J. Maxillofac. Surg.	Thieme, W.Ger.				K
J. Neurosurg.	Am. Soc. Neurol. Surg., USA	1971	ca. 6	To aid indexing Pref. from Neurosurg. Biblio-Index	NK
J. Nutr.	Am. Inst. Nutr., USA		3-4	For subj. classification & indexing in the j.	K

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
J. Perinat. Med	de Gruyter, W.Ger.		≤ 10	Pref. MeSH	
Lab. Invest.	Williams, USA	1968	≤ 7	For coding & indexg.	(K)
Mater. Med. Pol.	Polona-Ruch, Pol.		3-12	MeSH	
Minerva Med.	Min. Med., Italy				K
Mol. & Cell. Endocrinol.	N. Holl, Neth.		3-6	Not in title	K
Nephron	Karger, Switz.		3-9	For indexing purposes	K
Nutr. & Metab.	Karger, Switz.		3-9	For indexing	K
Pediatr. Res.	Williams, USA			For indexing	
Pediatrics	Acad. Pediatr., USA			Under which the article should be indexed	K
Respir. Physiol.	N. Holl., Neth.				(K)
Scand. J. Clin. & Lab. Invest.	Blackwell, UK			Not in title. Pref. MeSH	K
Scand. J. Gastroenterol.	Universitetsforl. Norw.		3-12	From MeSH	K
Scand. J. Haematol.	Munksgaard, Denmk.		4-9	Pref. MeSH	(K)
Tex. Rep. Biol. & Med.	Univ. Texas, USA		3	Of ≤ 3 words. For indexg., e.g. MEDLARS, MEDLINE	K
Virchows Arch.	Springer, W.Ger.	1975	≤ 5	Pref. MeSH. For subj. indexing	-

Subject/Journal	Publisher & Country	Date key-words intr.	No. of key-words reqd.	Other instrns. or information	Subject index
Engineering					
AIAA J.	Am. Inst. Aer. & Astr., USA			'Index categories'	K
Ann. Rev. Autom. Progr.	Pergamon, UK			(e)	
Commun. ACM	Ass. Comput. Mach., USA	1968		(e)	–
J. ACM	" " " "			"	–
ACM Trans. Math. Software	" " " "			"	
Automatica	Pergamon, UK	1977			–
COMSAT Techn. Rev.	Commun. Satell. Gp., USA				
IEE J. Electron. Circuits & Syst.	Inst. Electr. Engin., UK				
IEE J. Solid-State & Electron Devices	Inst. Electr. Engin., UK				
J. Am. Concr. Inst.	Am. Concrete Inst., USA				NK
Eng. Synop.	Inst. Mech. Eng., UK	1977 (vol. 1)			K (f)
Proc. Inst. Electr. Eng.	Inst. Electr. Eng., UK	1970			NK
Software Pract. & Exper.	Wiley, UK				K
Geography					
Eiszeitalter & Ggw.	Hohenlohe, W.Ger.				

Notes :

MeSH Medical Subject Headings (listed in Part 2 of the January issue of Index Medicus)

* Keywords used by London School of Economics Information Retrieval System

Subject indexes : K using keywords; NK not using keywords; (K) partly using keywords; - none; Cl classified

(a) Also includes SfB and UDC classifications

(b) Has bibliography with keywords

(c) For nuclear reactions only. Special format - perhaps better considered as abstract

(d) Also includes UDC classification

(e) Also includes CR (Computing Review) categories

(f) Also has a subj. index not using keywords

(g) Keywords controlled

(h) Assigned by editor.

sciences a smaller proportion still. Journals with keywords in the social sciences were very few. They were mainly of a statistical character, as were those in mathematics, and are due to the London School of Economics Information Retrieval System (see Section 5.3). In the humanities, no examples were found. This distribution is in accordance with the general state of bibliographic control in the subjects, though chemistry might have been expected to rank as high as the life sciences. Perhaps general awareness of MEDLARS and MEDLINE, as compared with that of computerised systems in other subjects, is partly responsible. Certainly MeSH (Medical Subject Headings) was the most frequently quoted set of standard terms (see Table 5.1). The order also fits in with the commonly accepted differences in the ease of classifying and indexing in the subject areas. (The particular difficulties in the social sciences have been considered by Kyle (1958) and Foskett (1974), and in the humanities by Langridge (1976). Swift (1975) points out that 'Social science documents are open to different interpretations depending on the theoretical viewpoint employed by the interpreter.')

The dates of the first volumes to feature keywords were found for some of the journals, and are shown in the Table. The <u>American Journal of Physiology</u> was the first journal of those investigated to introduce keywords (1964), and may perhaps have started the fashion in the life sciences.

The analysis according to publisher and country of publication is hampered even more by lack of data on the sample. Publishers were certainly not consistent among their journals. Masson of France, Springer-Verlag of Berlin and S. Karger of Switzerland seem to be prominent, though this may be an effect of the Library's selection. American publishers do not appear to use keywords very much, and, of those that do, learned societies form a fair proportion.

5.3 FUNCTION OF KEYWORDS

When the instructions to authors as printed in the journal said anything about the function of the keywords this was noted. Generally, the statement is a rather vague reference to indexing, as 'important for indexing', 'for subject indexing', 'identifying the most important subjects', &c., sometimes with a reference to computerised retrieval, e.g. 'for computer recall purposes', and 'for computerised information retrieval'. Occasionally, keywords are seen as a supplement to the title, to alert readers and indexers to topics not included there, e.g. in the Proceedings of the National Academy of Sciences of the USA, Experimental Parasitology, and the Journal of LipidResearch. The degree to which keywords supplement rather than repeat information already in the title is examined in Section 5.6.

The indexing needs which the keywords are to meet are separated by some journals into internal and external (e.g. the Journal of Optimisation Theory and Applications, Archives of Sexual Behavior, and Biochemical Genetics). These journals do, in fact, use the keywords to form their subject indexes for each volume. However, as can be seen from Table 5.1, some of the journals which had keywords did not have a subject index at all. Others applied some degree of editorial standardisation to the keywords to produce a better subject index. In the Astrophysical Journal the keywords ('subject headings') appearing with the papers were supplied by the editors from an authority list printed with the subject index. In yet other journals, the subject index appeared only tenuously, if at all, to be based on the keywords printed with the papers. Keywords were introduced into applied statistics journals from 1972 onwards for the sake of the London School of Economics Computer Unit Information Retrieval System. This permits retrieval by keywords when provided by the author - otherwise only by title words.

Printed subject indexes for single volumes produced from authors' keywords may be moderately satisfactory. The user may need to consult all the postings of the required keyword to check for relevant papers, or the title or other keywords may be given to show the context. Inflexional variants and combined forms produce adjacent or almost adjacent entries and are easily spotted. However, for larger indexes cumulated for several volumes or covering many journals, inclusion of the context and standardisation become essential. Whilst in a KWIC title index a user may think of looking under singular, plural, compound, and adjectival forms of a word and under synonyms, he will not expect to have to do this in what looks like a conventional subject index. Cross references can provide only a partial answer: all possible connections cannot be catered for (as argued cogently by Wilson, 1968, ch. 6), and editorial effort in selection would be better spent on standardisation. In computer retrieval, searching for word fragments can get round some of the problems of variant and combined forms. However, text-searching is time-consuming and thus expensive, and it is much more ecconomical to use an inverted file with postings on standardised terms. Standardisation is also essential for post-coordinate systems using coincidence cards.

Some of the journals surveyed did suggest means of standardisation, especially the use of MeSH in the biomedical area. Texas Reports on Biology and Medicine actually suggested that the keywords were used by MEDLARS. In Section 5.7, I examine the extent to which authors' keywords are suitable for use by MEDLARS (and so in MEDLINE), and whether instructions to use MeSH terms are effective.

5.4 PRECOORDINATION IN KEYWORDS

Authors vary widely in the amount of precoordination they incorporate in their keywords. This is hardly surprising in the absence of clear indications of the functions of keywords. At one extreme is this example:

Leukapheresis/data processing

Platele tpheresis/data processing

Data processing in pheresis procedures

Computer program for pheresis

(Am. J. Clin. Pathol. 67 (1977) 241)

where each of the four keywords gives a fairly complete idea of the subject area of the paper (A computer program to record technical data in leukapheresis and plateletpheresis procedures). At the opposite extreme are the following:

Alanine

Gluconeogenesis

Glycerol

(Scand. J. Clin. & Lab. Invest. 67 (1977) 347)

where the subject is obtained only by taking all three together plus additional information about their relation (A method for the study of the in vivo gluconeogenesis from alanine and glycerol), and

Abundances

Nucleosynthesis

(Astrophys. J. 218 (1977) 253)

where the title was 'More on big-bang nucleosynthesis with nonzero lepton numbers'.

As a measure of the amount of precoordination, the mean number of words per keywords was determined in various journals. The values are given in Table 5.2.

TABLE 5.2. Coordination in keywords: number of words per keyword

Journal	No. of keywords in sample	Words per keyword Mean	S.D.
Am. J. Clin. Pathol.	188	2.00	0.97
Scand. J. Clin. & Lab. Invest.	215	1.89	0.97
Texas Rep. Biol. & Med.	50	1.90	0.70
Am. J. Physiol.	120	1.98	1.17
Astrophys. J.	91	2.03	0.58
Geol. Soc. Am. Bull.	110	1.66	0.78
Z. Naturforsch. B	120	1.93	0.69

The mean number of words (except for the Geological Society of America Bulletin) is close to two, despite differences in, or absence of, instructions. The standard deviation is lowest for the Astrophysical Journal, owing to the common format in the authority list of a noun plus a single-word modifier, or a class plus a member.

Whilst precoordination produces more informative entries for printed subject indexes, it is pointless for mechanised retrieval. Concepts can easily be coordinated with 'AND's in the search process. Coordination produces more different entries and longer entries, both of which increase storage space requirements. It requires more cards, or more positions on cards, in coincidence systems. Finally, it requires a user to guess the combinations in which his required concept might occur - or to check the whole set of descriptors for a required fragment.

Thus there is a conflict of interest between the use of keywords for subject indexes and for mechanised or semi-mechanised retrieval systems. Surely the concept of keywords is that they should be as free from precoordination as possible? Sometimes separation into single words might be misleading (e.g. of 'guinea pigs'), so a mean value of one word per keyword is not to be expected. However, the values of around two suggest that many keywords assigned by authors could be profitably split up into simpler components.

5.5 AUTHORS' CONSISTENCY IN KEYWORDS

I have emphasised the need for standardisation in keywords in Section 5.3. If authors are aware of this need, then each author would be expected to be consistent in his form of keywords in different papers. To see if this is so, the keywords of some papers forming numbered parts of a series were examined. Three difficulties in selecting the samples were that (a) series sometimes started before keywords were introduced, (b) papers in the series were often spread over different journals, some of which did not have keywords, and (c) long series often had such general titles that little overlap of keywords could be expected. The five examples selected are given below.

EXAMPLE 1. 'Aperture synthesis observations of galactic H II regions' in Astronomy and Astrophysics.

Part I	H II regions; cocoon stars; star formation; associations; mass ejection
Part II	H II regions; star formation; K 3-50; W 58; galactic radio source
Part III	Aperture synthesis radio observations; H II regions; star formation
Part IV	Radio observations; star formation; H II regions
Part V	H II regions; radio observations; NGC 2175
Part VI	Radio observations; structure of H II regions; star formation.

EXAMPLE 2. 'Interaction of plasma membranes with influenza virus' in Acta Virologica

Part IV	Plasma membranes; influenza virus; nucleotide triphosphatase activities
Part V	Influenza virus; plasma membranes; chick embryo cells; creatine phosphokinase
Part VI	Influenza virus; plasma membranes; adenylate cyclase
Part VII	Influenza virus; plasma membranes; chick embryo cells; 3', 5'c-AMP phosphodiesterase.

EXAMPLE 3. 'Thermal properties of alkali halides' in the <u>Journal of Solution Chemistry</u>

Part II Heat capacity; enthalpy of dilution; heat of dilution; relative apparent molal enthalpy; alkali halide; water; aqueous solution

Part III Apparent molal volume; apparent molal heat capacity; D_2O; heavy water; structural hydration; alkali halides

Part IV Volume; expansibility; compressibility; heat capacity; apparent molal quantities; alkali halide; urea; structural hydration; structure breaking

Part V Excess free energies; activity coefficients; osmotic coefficients; excess enthalpies; excess heat capacities; alkali halides.

EXAMPLE 4. 'The molecular structure of allenes and ketenes' in the <u>Berichte der Bunsengesellschaft für physikalische Chemie</u>

Part II Photoelektronenspektren; Absorptionsspektren; CNDO/S - Rechnung; Elektronenstruktur; Molekülstruktur

Part III Absorptionsspektren, sichtbar und ultraviolett; Elektronenstruktur; Molekülstruktur; Photoelektronenspektren; Substituenteneffekte

Part IV Magnetische Kernresonanz (chemische Verschiebung); Molekülstruktur; Stereoisomerie

Part V Magnetische Kernresonanz (chemische Verschiebung); Molekülstruktur; Substituenteneffekte.

Part VI	Absorptionsspektren, sichtbar und ultrviolett; Circulardichroismusspektren; Elektronenstruktur; optische Aktivität; Rotationsdispersion
Part VII	Magnetische Kernresonanz (Kopplungskonstanten); Molekülstruktur; Substituenteneffekte; Wellenfunktionen
Part IX	Absorptionsspektren, sichtbar und ultraviolett; Elektronenstruktur; Molekülstruktur; Photoelektronenspektren; Substituenteneffekte.

Example 1 shows the kind of inconsistency introduced by precoordination. In Parts I to V there is the keyword 'HII regions', but in Part VI it is replaced by 'structure of HII regions'. Part III has the highly coordinated term 'aperture synthesis radio observations' (the subject of the whole series), which is reduced to 'radio observations' in Parts IV to VI, while Part II mentions only 'galactic radio source'. Example 2 seems to contain a fairly consistent set of keywords. 'Plasma membranes' and 'influenza virus', forming the subject of the series, are constant throughout. Perhaps 'nucleotide triphosphatase activities' could have had 'activities' dropped, to correspond with the other enzyme names.

Part II of Example 3 has both 'enthalpy of dilution' and 'heat of dilution', which are synonymous - the subject index uses only the former. There is inconsistency through the series between the singular and plural forms of 'alkali halide', and of the thermodynamic functions. The term 'relative apparent molal enthalpy' in Part II seems excessively complex, compared with 'volume' in Part IV. The adjective 'excess' was not used in entries for Part V in the subject index.

In Example 4, there are no keywords corresponding to 'allenes' or 'ketenes'. The keywords are not, however, exclusive of title words, as each paper except Part VI had 'Molekülstruktur'. The omission of chemical substance names is part of the indexing policy of the Berichte der Bunsengesellschaft: entries are made only under physicochemical concepts. However, not all the keywords which appear with papers are used in the subject index, e.g. Circulardichroismusspektren, and CNDO/S-Rechnung. (The qualification 'sichtbar und ultraviolett' attached to 'Absorptionsspektren' is used in the subject index, though not 'Kopplungskonstanten' attached to 'Magnetische Kernresonanz'.)

In conclusion, this study of series of papers provides an illustration of the general shortcoming of including keywords with papers, namely the lack of guidance on their function, and so uncertainty about the specificity and form required. Almost any application of the keywords examined would require some editorial modification of them.

5.6 KEYWORDS AND TITLES

There are contradictions in the instructions to authors about whether keywords may include words in the title or not. For instance, the Proceedings of the National Academy of Science of the USA says that they may not, while the Journal of the American Statistical Society says that they may, and the American Journal of Clinical Pathology says that the keywords should be in the title or abstract. If the subject index is to be based on keywords alone, then obviously important words in the title should be included. They are the 'key' words describing the subject of the paper. However, if keywords are to supplement the title in contents lists (as in Experimental

Parasitology and the Journal of Lipid Research) or perhaps in KWIC indexes of titles, they evidently should not be words from the title. Despite this apparently clear dichotomy of function, there is not a clear division of authors' instructions according to the practice of the journal, and it seems doubtful whether the editors can have thought clearly about the function of the keywords.

A criticism which I have heard more than once of keywords is that they are too wide to be of much value in indexing. They are frequently the name of the branch of science to which the paper belongs, e.g. 'cosmology' (Astronomy & Astrophysics) and 'igneous petrology' (Bulletin of the Geological Society of America), or the name of a large class of entities, e.g. 'stars: individual' (Astrophysical Journal) and 'special stains' (American Journal of Clinical Pathology). Whilst these are not very useful as entries in a printed subject index, they are conceivably useful as modifiers in a postcoordinated search. This is presumably the justification for such vague keywords as 'instability' in the American Journal of Clinical Pathology 67 (1977) 180, and 'type I' in Astronomy & Astrophysics 60 (1977) 131.

To investigate the overlap between keywords and titles, fifty papers in each of three journals were examined. The journals chosen were the American Journal of Physiology, which says that keywords should not be taken from the title, Zeitschrift für Naturforschung B (covering inorganic and organic chemistry), which gives no guidance except for quantity, and the Geological Society of America Bulletin, which discontinued keywords in 1977, and so does not appear in Table 5.1. Its instructions said that keywords should 'help to index the paper in bibliographies or to identify the full subject matter of the paper'.

Each keyword in the papers was scored as one of the following, in decreasing order of preference: (a) exact match: when all the words in the keywords were found in the title (even if separated); (b) partial match: when a significant fragment in the keyword was found in the title, e.g. the keyword 'paleomagnetism' scored a partial match with 'magnetic' in the title, but 'glucose concentration' did not with 'fatty acid concentration'.

(c) equivalent: this was used for matches between words and corresponding symbols or abbreviations, e.g. 'sodium' and 'Na', matches between synonyms, e.g. 'preparation' and 'synthesis', and between nouns and adjectives which did not fall into (b), e.g. 'moon' and 'lunar'.

(d) and (e) broader and narrower terms. A thesaurus was not used for judging these, and they were restricted to well-defined hierarchies, as in chemical nomenclature and geographical divisions.

(f) no match.

The results were converted into mean percentages of keywords for each journal using the SDPP package on the Leicester University Computer. These are reported in Table 5.3.

TABLE 5.3. Overlap between keywords and titles

Journal	Words per title	Key-words per paper	Mean percentage: Exact match	Partial match	Equiv-alent	BT in title	NT in title	No match
Am. J. Physiol. 1977	10.7	5.1	5.5.	23.4	1.1	3.6	4.7	61.7
	(3.5)	(1.9)	(15.0)	(20.8)	(6.0)	(12.2)	(10.8)	(28.2)
Geol. Soc. Am. Bull., 1976	11.6	6.0	21.1	16.8	9.6	9.8	4.8	46.8
	(3.1)	(2.6)	(18.7)	(17.5)	(3.9)	(12.5)	(12.0)	(26.5)
Z. Naturforsch.B, 1975	8.8	3.4	36.8	7.7	13.4	3.6	10.6	27.8
	(4.4)	(1.0)	(31.6)	(17.1)	(22.7)	(15.0)	(19.0)	(28.6)

Note: standard deviations given in brackets

The proportion of exact matches is, as would be expected from its instructions, low for the American Journal of Physiology, but appreciable for the Geological Society of America Bulletin, and over one third for the Zeitschrift für Naturforschung. As a complement, over 60% of the keywords in the American Journal of Physiology did not match with the title, and so may usefully augment it, while less than 30% of those in the Zeitschrift für Naturforschung did not match, so that the keywords in that journal may peform a more complete indexing function. (For this difference, $t = 5.92$, $p < 0.001$.)

The number of keywords and title words per paper will obviously have an effect on the number of matches. The more words there are in the title, the greater their probability of including keywords. In retrospect, it might have been better to have selected journals where the numbers were more equal, but the intention was to look at areas with different terminological features (see Section 2.9).

The ratio of title words to keywords does not vary too much between the three journals, and, in fact, Zeitschrift für Naturforschung, which had the lowest ratio, had the highest percentage of matches.

A factor which will influence the proportion of partial matches is the number of words per keyword (or key phrase). If this number is high, the keyword is likely to score only a partial match rather than an exact one. As reported in Table 5.2, the mean number of words is almost equal for the American Journal of Physiology and Zeitschrift für Naturforschung but somewhat lower for the Geological Society of America Bulletin. Clearly this variation is not sufficient to account for the pattern of partial matches shown in Table 5.3.

The evaluation of broader/ narrower term matches goes only part-way towards testing the criticism of excessive broadness of keywords. In particular, a concept (such as faulting or entropy) was not regarded as a narrower term of the name of the discipline in which it is studied (geomorphology or thermodynamics). This was partly because of the difficulty of knowing where to stop, and partly because such relations are likely to be of little use in retrieval. However, the number of broader terms among keywords with respect to title words could be taken, at least for _Zeitschrift für Naturforschung_, as lending some wieght to the criticism.

Could titles be expanded to fulfil the function of keywords? In the case of the _American Journal of Physiology_, the mean number of keywords is 5.1, i.e. 10.1 words, of which 61.7%, i.e. 6.2 words, do not match with the title. To accommodate these, the title would need to be expanded to at least 16.9 words. (In fact more words would usually be needed to connect the keywords with existing words in the title.) For _Zeitschrift für Naturforschung_ the corresponding increase would be from 8.8 to 10.6 words, which is more feasible. The titles in that journal are, however, rather short for the subject area (c.f. Table 2.2).

5.7 KEYWORDS AND INDEXING SERVICES

Since MeSH is the most commonly quoted authority list for keywords, I decided to examine three medical journals to see how far the keywords supplied by the authors accorded with those assigned by the MEDLARDS staff. MeSH is printed in the first issue of _Index Medicus_ each year, and so should be available fairly easily to most medical authors. Apart from the terms on the published list, MEDLARS also assigns 'check tags' to papers giving information on the subjects of studies, e.g. 'cats', 'human', 'female', and 'adolescent', and certain forms of paper, e.g. 'comparative study', 'historical article'. These were not considered in with the descriptors. Descriptors are often qualified with subheadings, e.g. 'liver/metabolism' and 'prostatic neoplasms/diagnosis/pathology'. Such qualifiers were also disregarded in the comparisons. The descriptors assigned are of two types, 'print' and 'non-print' terms. The former constitute the headings under which the paper will appear in Index Medicus, while the latter appear only on the machine-readable files (Frankland, 1975). The former are indicated in the computer print-out by asterisks.

A search was conducted on the MEDLINE database using the BLAISE terminal in Leicester University Library. Three journals were selected by specifying their ISSNs: Texas Reports on Biology and Medicine, which says that the keywords are 'for indexing purposes such as MEDLARS ... and MEDLINE'; the Scandinavian Journal of Clinical and Laboratory Investigation, which says that 'keywords should not include words contained in the title' and 'where possible the keywords should be adjusted to MeSH'; and the American Journal of Clinical Pathology, which states that the 'keywords should appear in the title or abstract'. One year (1976) of Texas Reports was selected to provide a sample to check on its claims, and fifty papers were selected from the 1977 volumes of each of the other two journals. An offline print was ordered of the full forms of the records for each selection. The authors' keywords were then compared with the MEDLARS descriptors using the catgories (a), (b), (c) and (f) described in Section 5.6. The results are given in Table 5.4. For the two samples of fifty papers, the print and non-print MEDLARS descriptors were evaluated separately against the authors' keywords, and these results are given in Table 5.5.

To provide a comparison with a different subject area, a sample of thirty papers from the Astrophysical Journal, indexed by the staff at INSPEC (Information Services in Physics, Electrotechnology, Computers and Control) was obtained. Their indexing consists of controlled and free terms. The controlled terms are taken from a list which is probably not well known to athors, and they are used in the printed index. The free terms are usually taken partly from the title or abstract of the paper, and are available only in computerised retrieval. The results of comparing descriptors of each type with the keywords printed with the papers are entered in Tables5.4 and 5.5.

TABLE 5.4 Accuracy of authors' keywords: comparison of keywords with indexing services' descriptors

Journal	Sample size	Mean Keywords per paper	Mean % Exact match	Mean % partial match	Mean % equivalent	Mean % no match
Texas Rep. Biol. & Med.	17	2.94	56.8	19.1	1.9	22.1
		(0.73)	(24.1)	(25.7)	(7.8)	(22.7)
Am. J. Clin. Path.	50	3.76	28.1	33.1	4.8	33.9
		(1.48)	(29.7)	(30.0)	(11.8)	(28.2)
Scand. J. Clin. & Lab. Invest.	50	4.86	32.8	30.9	5.2	31.1
		(1.83)	(23.7)	(23.8)	(11.2)	(17.9)
Astrophys. J.	30	3.03	43.3	40.6	5.9	10.2
		(1.15)	(32.8)	(27.1)	(12.8)	(15.6)

NOTE: Standard deviations in brackets

TABLE 5.5 Adequacy of authors' keywords: comparison of indexing services' descriptors with authors' keywords

JOURNAL	Sample size	ALL DESCRIPTORS					PRINT DESCRIPTORS				
		Total per paper Mean	%Ex. Mean	% P. Mean	% Eq. Mean	% No Mean	Total per paper Mean	%Ex. Mean	% P. Mean	% Eq. Mean	% No Mean
Texas Rep. Biol. & Med.	17	9.18									
Am. J. Clin. Path.	50	5.88	18.5	30.0	6.4	45.2	3.00	28.0	38.4	5.0	28.6
		(2.64)	(21.6)	(24.8)	(12.1)	(25.7)	(1.17)	(32.5)	(34.1)	(13.1)	(28.4)
Scand. J. Clin. & Lab. Invest.	50	7.12	22.8	21.5	3.8	51.9	2.94	32.4	27.5	6.2	33.9
		(1.95)	(18.9)	(18.0)	(8.6)	(18.4)	(1.14)	(32.3)	(27.8)	(18.6)	(32.0)
Astrophys. J.	30	11.29	12.4	30.0	1.1	56.6	3.36	26.3	38.8	0	34.9
		(3.29)	(11.6)	(19.1)	(3.3)	(17.0)	(1.06)	(29.2)	(36.4)	(0)	(29.4)

NOTE. Standard deviations in brackets.

The proportion of authors' keywords which matched exactly with descriptors assigned by MEDLARS was significantly higher for <u>Texas Reports</u> than for the <u>American Journal of Clinical Pathology</u> ($t = 3.99$, $p < 0.01$) and the <u>Scandinavian Journal of Clinical and Laboratory Investigation</u>. The claim made in its instruction thus has some foundation. The partial matches arise partly from authors using their own forms instead of consulting MeSH (e.g. 'intermittent positive pressure ventilation' for 'intermittent positive pressure breathing'), but partly from the use of more precise terms than those in MeSH with elements (or words) in common (e.g. 'Citrobacter diversus' where MeSH has only 'Citrobacter'). The number of partial matches is appreciably lower for Texas Reports than for the American Journal and the Scandinavian Journal, which indicates more conformity with MeSH in Texas Reports.

Many of the 'no match' keywords may also be useful index terms outside the scope of MeSH, rather than the result of authors' negligence. Lancaster (1969) has shown that MEDLARS indexing is far from providing a perfect standard. In retrieval tests, almost 10% of all recall failures were due to indexer omissions.

Considering next Table 5.5, it can be seen that authors' keywords would provide only about 20% of MEDLARS descriptors correctly, and about 30% of the print terms. About half the descriptors (and a third of the print terms) did not correspond at all with authors' keywords. Authors' keywords thus provide a very inadequate source of descriptors for MEDLARS indexing. The only significant difference found between the American Journal and the Scandinavian Journal was for the proportion of keywords which were partial matches with MEDLARS descriptors ($\underline{t}$ = 1.96, p $\simeq$ 0.05 for all descriptors). The lower proportion in the Scandinavian Journal could be due to the instruction that keywords should be adjusted where possible to MeSH. The difference over whether keywords should include title words does not seem to affect significantly the proportion of keywords which match with descriptors.

The keywords in the Astrophysical Journal, or 'subject headings' as they are called, are listed at the beginning of the annual Subject Index. They are assigned to papers by the managing editor (personal communication). Quite a lot of the subject headings are rather wide, e.g. 'nebulae: general', 'stars:

individual', and 'abundances'. However, the keywords seem to match INSPEC descriptors about as well, and to be about as adequate as a source of descriptors, as the keywords of the medical journals were with respect to MEDLARS.

5.8 CONCLUSIONS

The functions of keywords suggested in instructions to authors could be divided into:

(a) internal

  (i) for compiling annual or culmulated subject indexes;

  (ii) for supplementing the title.

(b) external - for comprehensive bibliographies, including mechanised retrieval systems.

I have discussed how these different functions impose different requirements on the types of keywords. In particular:

(a) Subject indexes, and especially indexing for computerized systems, require a listing of all the important index terms for the paper, while supplementing the title requires only some of them.

(b) Precoordination is appropriate for printed indexes, but not for mechanised systems.

(c) All kinds of subject indexing, except perhaps for individual volumes, require standardisation of index terms.

Although instructions to authors do vary between journals, they do not seem to depend on intended functions in the way that would be expected. The number of keywords asked for varies from three to fifteen, without any apparent regard for function. Even when the instructions asked authors to take their keywords from an authority list, the correspondence between the authors' terms and those assigned by professional indexers from the list was poor. The authors' keywords would provide less than a fifth of the descriptors assigned by the indexing service, and less than a third of those used in their printed indexes.

To sum up, editors do not seem to have thought clearly about what they require of keywords, and appear rather bemused by the development of computerised retrieval. In the absence of clear instructions, authors cannot be expected to supply useful keywords. Not much notice is taken of existing authority lists, and the same list is unlikely to be appropriate for internal and external use. Professional indexers do not seem to find authors' keywords much help. (One at INSPEC told me that onlyrarely did they alert her to a topic not obvious from the title or abstract.) Thus the only function they may usefully have seems to be to provide quick subject indexes for individual volumes of a journal. When a journal does not use them for this purpose, I fail to see the point of including them.

C H A P T E R   S I X

REFERENCES

6.1 INTRODUCTION

Since so much work has been reported using citations (or references) for studying the scientific process and community, it may be as well to reiterate from the Introduction what is the scope of the study here. I am concerned only with the use of references for bibliographic control. Firstly I consider the ways in which they are so used, and the tools available to facilitate this. Then I examine the different ways in which references are given in journals, and how these practices affect bibliographic control. Next, some figures are given for the average number of references per paper in various subjects, broken down for experimental papers according to the sections of the paper. Literature on the purposes and types of citations is reviewed, and published studies on the relevance of citations and use of citation indexes are summarised. Finally, I draw some conclusions about the strengths and weaknesses of the use of references in bibliographic control.

On terminology, I take 'citation' to be an instance of referring in a text to another document, and 'reference' to be the details of the cited document, usually given in a footnote or in a list at the end of the paper. The same reference may be cited several times in a paper, and so could be said to correspond to several citations, but the word 'citation' is often used to mean a unique citation, and so becomes more-or-less equivalent to 'reference'.

References given in a research paper have traditionally been an important route to other material on the same topic, or on particular aspects of the paper. Wood and Bower's (1970) study of requests received at the National Lending Library was mentioned in Section 2.2.1. It showed that the most common source of references in biology and medicine was from other periodical articles. Line (1971) in his investigation of the information uses of social scientists reported that 59% of those asked said that they found bibliographies and references in books and journals to be very useful for locating references, and more than half thought that a citation index would be a good idea. Hakulinen (1974) found from 1840 replies that 32.8% of borrowings from the Karolinska Institutets Bibliotek arose from references in articles or books. In a fourth study, Van Styvendaele (1977) found from questionnaires given to borrowers of periodical literature from the Antwerp State University Centre that 27% of papers in the social sciences and 39% in science and technology were discovered from references in other papers.

In 1961, references were used as the basis of a new secondary service, the Science Citation Index (SCI) which enables one to find what papers during the period covered have cited a given paper. Whereas the reference list of the given paper enables a searcher to go backwards to find earlier related papers, the citation index enables him to go forward to later related papers. In 1973, a a citation index was started to cover the social sciences, and in 1977 the Arts and Humanities Citation Index was launched.

Hakulinen (1974) found that only 11 loans out of 1840, or 0.6% were for references found from SCI. Van Styvendale's (1977) results indicate that of the references obtained from abstracting and indexing journals (which constituted 33.5% of all references in science and technology and 14.5% in social science), 21.6% were from SCI and 4.5% from the Social Science Citation Index. The relative level of use of these indexes thus appears to be rather low, but they may be important in particular kinds of searches.

Various advantages have been claimed for the use of citation indexes as compared with other retrieval tools, especially by Garfield who has been mainly responsible for developing them. Firstly, a searcher does not need to rely either on descriptors assigned by an indexer (Davies, 1966), or on words chosen by authors for their titles. (However, a title-word index is also available to find an entry point, mainly intended for nonspecialists.) If the searcher knows one or more papers relevant to the required topic, then he can refer to the citation index and see what later papers have cited each original paper. Those which cite more than one paper known to be relevant (i.e. are strongly 'bibliographically coupled') stand a high chance of being relevant themselves. When they have been checked, these additional papers can be used as starting points for further searching. Davies (1966) asserted that this process allows more user interaction than does computer searching (presumably in batch mode).

The avoidance of any dependence on subject words means that citation indexing can link literature on a new specialism together before the specialism has acquired a fixed terminology, and that it can be used in subject areas where terminology is characteristically soft (Salton, 1968, p. 379). Many papers in philosophy are criticisms of earlier papers or books, and a citation index is more likely to be helpful in bringing the argument together than is a subject index with citations arranged under descriptors. Garfield (1955) pointed out that citation indexing makes it possible to eliminate uncritical citation of fraudulent, incomplete or obsolete data by alerting users to criticisms of earlier papers. Some studies of the frequency of such 'negational' references are reviewed in Section 6.4.

Weinstock (1971) gives examples of necessary research questions which can be answered by using a citation index:

1. Has this basic concept been applied elsewhere?
2. Has this theory been confirmed?
3. Has this method been improved?
4. Is there a new synthesis for this old compound?
5. Have there been errata or correction notes published for this paper?

Tukey (1962) stressed the importance of browsing, as opposed to specifically searching for information. If a tool for focussed access and easy browsing is to be slow to go out of date, it should depend on relationships rather than classification. Tukey held that the useful way of classifying a field changes surprisingly rapidly, but the relationship of one article to another changes relatively little. Garfield (1964) has also claimed that the citation index provides the scientist with useful leads towards an <u>unspecified</u> information objective in his day-to-day research. He gave an example of how the use of <u>SCI</u> could have alerted an author claiming the discovery of a new method for analysing peptides to a previous paper which reported it. The two papers had four references in common. Any one of these could have been checked in <u>SCI</u> and would have led to the first paper. Garfield suggested that editors and referees might insist that certain standards of literature search be met before accepting a paper.

Tukey (1962) further pointed out that, as the volume of scientific literature increases exponentially, so does the number of people needed to evaluate it. The problem can be solved by using the judgments of authors, as indicated by their references, which should bear the sanction of referees and editors.

Another advantage claimed for citation indexes (Lester, 1977, p. 14) is that they enable one to identify the most highly cited papers in the retrieved set, which, from one point of view, are the most important papers. In fact, the more often a paper is cited, the higher the probability of retrieving it during 'cycling'. Other retrieval tools (except perhaps reviews) give no direct indication of the importance or impact of a paper.

Cleverdon (1970) pointed out that a citation index retrieves a different subset of relevant documents from other retrieval systems, so that if each gives 60% recall the use of the two together may increase this by about 85%.

On the level of the tool, rather than the technique, Garfield (1976c) has stressed the value of SCI as a unified index to science, and stated that the Social Sciences Citation Index would have been integrated with it but for economic and practical constraints. The independence of indexing terminology is a significant factor in facilitating such a unified index. However, from the practical point of view, one might point out that another factor is that only 2,655 source journals are covered by SCI (in 1977), as compared with 8,458 in Biological Abstracts and over 14,000 in Chemical Abstracts. The limitation to this relatively small number of journals is justified by the Institute for Scientific Information (Weinstock, 1971) in terms of Bradford's (1948) law. This states that a small percentage of journals account for a large percentage of the significant articles in any given field of science. Garfield (1972) reported that only 25 journals are cited in 24% of all references on the SCI database, 152 journals are cited in 50% of references, and only about 2000 journals are cited in 85% of all references. More than 75% of the abstracts in Chemical Abstracts, in fact, come from 8% of the journals it covers (Wood, 1966). De Solla Price (1965) has claimed that 80% of all scientific articles occur in about 1000 journals. (The number may have grown somewhat since then.)

6.2 FORMS OF REFERENCES

References in research papers began as a special kind of footnote, and so were marked in the text like other kinds of footnotes. The earliest system seems to have been lower-case letters, as in Archaeologia from 1778 to 1910. Asterisks, daggers, double daggers, tramlines, &c., were used in the Philosophical Magazine from 1798 to the 1930's and in e.g. the Transactions of the Royal Historical Society from 1875 to 1883 and the Geographical Journal from 1893 to 1932. Possibly for ease of printing and typing, or because a page may have more references than the number of symbols available, the use of these devices has now been limited to footnotes proper, or been discontinued altogether.

A speaker at a medical technical editors' workshop held by the British Medical Journal and ELSE (British Medical Journal, 1977) reported that he had found 33 different styles of references in use by 52 journals. For references to journal articles, some of the possible options are:

(a) reference in the text by author and date (the 'Harvard' system) or by numbers (superscript or in brackets);

(b) references at the foot of each page or at the end of the paper;

(c) numbering consecutively through the paper or (if placed at the foot of each page) on each page;

(d) inclusion or noninclusion of the title of the cited article;

(e) giving the title of the cited journal in full or in abbreviated form;

(f) giving the year before or after the volume number;

(g) inclusion or noninclusion of the issue number and/or month of the issue;

(h) the use or nonuse of such abbreviations as 'et al.', 'op. cit.', 'ibid.', 'loc. cit.', and 'v.s.'

(i) inclusion or noninclusion of the final page number.

There are also various possibilities over minor matters such as whether authors' initials come before or after the surname (which can be different for the first author), the punctuation and the use of bold-face and italic type. Ellis (1972) calculated that there were 2632 different possible permutations of the variables he identified.

Many of these differences have no effect on the information content of the reference (though it is, of course, essential that volume, part and page numbers be identifiable). Their chief significance lies in the inconvenience to authors and typists of having to prepare their manuscripts differently for different journals, especially when a paper is rejected by one journal and then submitted to a second with different conventions (Paton, 1973; O'Connor, 1978).

6.2.1 Author-date vs. numbered citation

The principal dichotomy is between the author-date citation and the numbered citation. Besides their different form in the text, they lead to a different arrangement in the list of references. In the author-date system, the list is normally alphabetical by the surname of the (first) author, while in the numbered system references may be put at the foot of each page or listed at the end of the paper in order of citation. A compromise arrangement was put forward at the ELSE-CIBA Foundation workshop in November 1977 (O'Connor, 1978), whereby authors would always be allowed to submit their reference lists arranged alphabetically by author, and if the editor wanted a numbered system he would number the references as listed and insert these numbers in the text. However, 'some editors could not bring themselves to accept ... non-sequential numbering in the text'.

For information content, the Harvard system has the edge over the numbered system, in that readers can see in the text the author and date of the work being cited, which may help in weighing the information quoted from it. It may also enable the reader to recognise references which he knows already without having to turn to a separate reference list. A great advantage from the author's point of view (and a deciding one for the present author) is that additional references can be put into the text at any stage without upsetting the numbering. The

Harvard system can easily be adapted to refer to particular pages in a book, by giving author, date and page number in the brackets, with a single entry for the book in the reference list. Using the numbered system a different number has to be given, and a separate entry made, for each page referred to. Disadvantages are that (i) giving the author and date takes up more space in the text (especially as compared with e.g. [1-5] in the numbered system), (ii) anonymous contributions, such as editorials, are awkward to cite, and (iii) if one finds an interesting reference in the reference list it is less easy to trace where it was cited in the text than if references are numbered sequentially. Inglis (1978) claimed that putting the author and date in the text is unsightly, and may be embarrassing when an author cites his own work, and Garfield (1968) claimed that it is faster to find a reference in a numbered list.

The practice in the journals previously sampled in Chapter 3 for author details is shown in Table A.1. It is summarised for some subjects in Table 6.1.

There seem to be two factors influencing the choice of system. Firstly, the numbered system seems to be preferred in the more mathematical subjects, including biochemistry, whereas the author-date system is preferred in the life and social sciences. Secondly, the numbered system is preferred in the humanities, probably because it can be used for footnotes too, which are often not distinguished. Indeed, references are sometimes put into the form of a note, e.g. 'See A. Friis, _Alderman Cockayne's Project and the Cloth Trade_ ...' (_English Historical Review_, 1977), and

TABLE 6.1 Reference systems used by journals in various subjects

(Sample size = 10)

Subject area	Journals with author-date system	Journals with numbered system	Journals with references at foot of each page
Mathematics	0	10	0
Physics	3	8	0
Chemistry	0	10	1
Biochemistry	2	8	0
Botany	8	1	0
Zoology	10	0	0
Medicine	3	7	0
Engineering	1	9	0
Psychology	8	2	0
Economics	4	6	1
Politics	1	9	7
Sociology	7	4	1
History	0	10	10
Philosophy	1	9	8
Literature	0	10	8

comments may be made on the reference, e.g.

> _Leviathan_, ch. VI. The definition of courage, even if one recognises it as an emotion or 'passion' in Hobbes's phrase, is plainly faulty. (_Philosophy_, 1976)
>
> PL 125, col. 1041. Here Hincmar quotes, without attribution, from Augustine, Ep. 185. (_English Historical Review_, 1977)

In such cases it is obviously useful to have the notes printed on the pages where they apply, so that the parenthetical matter can be read without needing to turn to another page. However, it is annoying to the reader to have to keep going from the text to footnotes, and may interrupt the train of thought, so I consider that footnotes should be worked into the text wherever possible.

Positioning the references at the foot of each page means that there is no complete list for the paper in one place, and so must make the task of citation indexers more difficult. When sources are cited several times in a paper, which is especially common in history, either arbitrary abbreviations are introduced (e.g. POPC for Proceedings and Ordinances of the Privy Council of England, ed. N.H. Nicolas (Record Commission, 1834-7) - English Historical Review, 1977), or use is made of op. cit., loc. cit., etc., much to the inconvenience of the reader. A further argument against giving references as footnotes is the extra trouble caused to the printer, and so extra costs (Inglis, 1978). One may therefore hope that with increased awareness of the bibliographical importance of references the footnote system will die out.

Hills (1971) in her study of the 168 most-cited British scientific journals found that only 8 had the references at the foot of each page, all of which were in the field of chemistry. (Six of these have now changed.) One journal, the New Scientist, had references in full in the text. Fifty-nine of the journals used a numbered system, 113 used the author-date system, and 5 used both. Her results also show the author-date system to be more popular in the life sciences (e.g. it was used by 55 journals out of 60 in medicine and 20 out of 23 in biology) than in the physical sciences (e.g. all journals in chemistry used the numbered system, as did 7 out of 9 in engineering and metallurgy). These seem to show the same tendencies as my results.

6.2.2. Titles of cited papers

Table 6.2 shows the cases where the titles of cited papers were not given. Since references have been shown to be an important means of information retrieval, and titles in the subject areas concerned are amongst the most informative, it seems that the extra space which would be taken up would be well justified. Stoldal and Gordon (1974) considered the full title of the cited articles to be 'often the most useful and informative part of the reference list' and Cawkell (1968) wrote that 'of all the symbols provided in a complete reference, an explicit title provides the best clue for a reader concerning the relevance of a cited article. Kwok (1975) reported that frequency-selection from the words of the title and cited titles gave a compact document representation with a high concentration of indicative words.

In Hills' (1971) sample, 67 of the 167 journals always gave the titles of cited papers, and 16 sometimes did. Only one journal out of 11 in physics, and none out of 20 in chemistry always gave titles of cited papers, whereas 31 of 60 journals in medicine always did, and 3 more sometimes did. (Perhaps omission of titles of cited papers is more common in British medical journals, as sampled by Hills, than in American ones, which my sample mainly comprised. Both the British Medical Journal and the Lancet omit them.)

TABLE 6.2 Journals which did not give titles of cited papers (Sample size = 10)

Subject area	No. of journals not giving titles of cited papers
Mathematics	1 (sometimes)
Physics	9 + 1 (sometimes)
Chemistry	10
Biochemistry	9
Botany	1 + 1 (sometimes)
Engineering	1 + 1 (sometimes)

TABLE 6.3 Incidence of abbreviation of journal titles in references (Sample size = 10)

Subject area	Journal titles in full	Journal titles abbreviated	Practice variable
Mathematics	1	9	
Physics	0	10	
Chemistry	0	10	
Biochemistry	0	10	
Botany	1	9	
Zoology	3	7	
Medicine	0	10	
Engineering	2	7	1
Psychology	7	3	
Economics	7	3	
Politics	10	0	
Sociology	9	1	
History	6	2	2
Philosophy	8	0	2
Literature	7	3	

6.2.3 Abbreviation of journal titles

The incidence of abbreviation of journal titles in references is shown in Table 6.3.

Some journals specify standards for abbreviating journal titles in their instructions to authors. This may be the World List of Scientific Periodicals (e.g. in Man, Annals of Botany and the International Journal of Heat and Mass Transfer), or a well-known abstracting journal in the subject, such as Mathematical Reviews (e.g. in the Journal of Economic Theory, Annals of Statistics, and Advances in Mathematics) or Chemical Abstracts (e.g. in Annals of Biochemistry and Archives of Biochemistry and Biophysics). Abstracting services are less well-known in the humanities, and practice on title abbreviation tends to be rather haphazard. Authors may abbreviate titles of well-known journals but not others, or they may abbreviate only certain words in the title, e.g. Zschr. f. Geschichtswissenschaft (in Historische Zeitschrift). In English literature, three of the journals sampled - English Studies, Essays in Criticism and ELH - used initials for some journals. These journals, e.g. JEGP: Journal of English and Germanic Philology and PMLA: Publications of the Modern Language Association of America, have the initials given on the title page or cover. (ELH, a Journal of English Literary History, has only the initials.)

Hills (1971) found that the title was abbreviated always in 146 of 167 British scientific journals, and sometimes in 7 more. Sixty-two journals used the abbreviations given in the World List, and ten more did except for the use of capital letters.

Like omitting the titles of cited papers, abbreviating journal titles is a way of saving space, and typing and printing costs. All journals in my sample which omitted the titles of papers also used abbreviated journal titles.

There seems to be little point in striving for consistency in journal title abbreviations for its own sake. The main concerns are that the abbreviations should be recognisable (at least in a catalogue) and unambiguous. Sheppard (1928) added that it should also be indicative of the language of the original. Library catalogues of serials usually require the user to know the exact form of the title, including prepositions which are eliminated in the abbreviated form. Locating the entry on the basis of an abbreviated title can therefore sometimes be quite time-consuming. (For example, to find 'Arch. Mech.' the user may need to look under Archiv fur ..., Archives de ..., Archives for ..., Archives of ..., Archivium ..., etc.) No doubt authors often think that their sources are sufficiently well known to readers for them instantly to recognise the abbreviations (e.g. Ber., as formerly used in the Journal of the Chemical Society, was readily identified by chemists as the Berichte der deutschen chemischen Gesellschaft), but with cross-disciplinary studies becoming increasingly popular this is no longer the case.

The use of British Standard 4148 Part 2: 1975 for abbreviating title words on an individual basis may sometimes lead to ambiguity, e.g. Ann. Phys. could stand for Annales de Physique, Annalen der Physik, or Annals of Physics. In such cases, B.S. 4148 Part 1: 1970 requires the addition of a place name - Ann. Phys. (Paris), Ann. Phys. (Leipzig) and Ann. Phys. (N.Y.), respectively. However, unless authors consult a large indexing service's source list, or the World List, they may not be aware of instances where confusion could arise, and there is always the danger of ambiguities arising in the future. The World List used fuller forms of some abbreviations at the beginnings of titles, e.g. Ann. Phys., Annls Phys., and Annln Phys. for the above titles. It is thus not in accordance with the International Standard 833-1973, or its British version B.S. 4148: 1970-75.

Lorphèvre (1948) declared himself 'adversaire de toutes les abréviations. Elles font gagner un peu de temps au bibliographe, mais elles font perdre 10 ou 100 fois plus de temps aux malhereux chercheurs, qui doivent reconstituer des assemblages de lettres n'ayant parfois aucune signification apparente.'

A conference of medical editors in 1968 (Ellis, 1972) almost unanimously approved the practice of giving journal titles in full. The British Medical Journal accordingly adopted this in April 1969. The decision may account for the relatively high proportion of full titles found in medicine by Hills. Another conference of medical journal editors (Lancet, 1979), however, agreed to give titles of cited papers, but to abbreviate journal titles according to Index Medicus. This so-called 'Vancouver style' is to be adopted by 19 journals, including the British Medical Journal.

In conclusion, there do seem to be good arguments for giving journal titles in full, but, in view of the time and costs caused to authors, typists, editors and printers by using the full forms, one can have considerable sympathy with those journals (especially review journals) which choose to abbreviate them. It is hoped that this sympathy may be extended to the present author.

6.2.4 Part numbers and dates of parts

No journals in Hills' (1971)sample gave part numbers or dates of parts in references. I found a few journals only in the humanities and social sciences which sometimes gave part details, e.g. Social Problems and the International Social Science Journal. Since journals are usually bound in volumes and the parts are not easily distinguishable, these data are normally irrelevant. They are, however, essential for journals which begin pagination from 1 in each issue (e.g. Scientific American), and they are useful for finding articles in unbound periodicals, especially if the page numbers are not indicated on the spines of the issues.

6.2.5 Accuracy of references

In information retrieval using a citation index, the references given in a paper act, in effect, as rather specific index terms to it. For example, 'Lederberg J., 63, Nature 198, 428' is essentially equivalent as an index term to 'euphenics' (Weinstock, 1971). Whereas minor errors in free index terms (e.g. spelling mistakes in title words) or even controlled index terms (e.g. singulars for plurals) can be spotted fairly easily and may not have a serious effect, errors in references are generally not obvious, and may mean that the source cannot be traced. Apart from the simple relation between volume number and year which obtains for many journals, and the author index to a volume which links authors to page numbers, there is little redundancy in a reference.

Disquietingly high error rates in references have been reported in the literature. Terry (1965) examined the 46 entries given in SCI for an author in the field of quantum theory.

Eleven of them had some error in the page, volume or year, and one cited the wrong journal. These errors were not the fault of SCI, but were present in the original papers. Martyn (1965) also found errors in references when using SCI in the fields of biology and chemistry, but the proportion was very much lower than that found by Terry. He considered that checking every reference in a paper was an impossible task for the compilers of SCI, and placed the responsibility on authors, referees and editors.

In the early days of SCI, citations appeared exactly as in the original paper as regards athors' names, issue numbers, journal titles, etc. (except for a few standard abbreviations such as J for 'Journal') (Martyn and Gilchrist, 1968). This led to separate entries for the same paper - e.g. under SNAPE, SNAPE, F, AND SNAPE FJ (Martyn, 1965). Thompson (1918), in using the 1974 SCI to trace papers by G.E.P. Box found duplication due to:

1. Incomplete titles of journals
2. Incorrect spelling of journal titles
3. Incorrect journal titles (e.g. 'Society' for 'Association')
4. Variations in abbreviation of journal titles
5. Incomplete bibliographical details
6. Variations in bibliographical details (issue/date)
7. Incorrect bibliographical details (e.g. wrong page number)
8. Combinations of the above
9. Omission of one or more initials of the author.

He quoted a letter from T.H. Rosen of the Institute of Scientific

Information indicating that they had an algorithm for title unification using attributes which 'include the first four characters of the author's last name, the first character of the journal title, and the volume, page and year of the journal.' The number of variants appearing in SCI does now seem to have been reduced, but they are still quite noticeable for some authors.

Fondin (1976) looked at 1811 references given in articles in three French political and economic journals. Of these, he claimed that 254 were unsuitable for citation indexing because 70 (3.9%) had no date, 93 (5.1%) were anonymous, and 91 (5%) referred to a source 'incompatible avec le système de recherche'. One awaits with interest reports on searches using the Social Sciences Citation Index and Arts and Humanities Citation Index.

6.3 NUMBERS OF REFERENCES

6.3.1 Experimental study

In Chapter 4, the structure of thirty experimental papers in each of ten journals was examined in some detail. To gain a further insight into the use of external information in such papers, the numbers of references in each of the four sections of the papers were counted. (The Journal of Chemical Physics, which was included in the abstracts study only for a special comparison, was eliminated from this study.) The mean numbers for each journal are given in Table 6.4. The total number of references per paper does not equal the sum of the mean numbers for each section because the same reference may appear in more than one section. The mean numbers of references per 100 words of text were also calculated, to compensate for the different lengths of the various sections.

The total number of references per paper was counted for two further journals, the English Historical Review and Philosophy, and for the 1947 and 1962 volumes of some of the other journals. French and German physical chemistry journals were also included.

By far the greatest mean number of references per article was found in the English Historical Review. History must, however, be counted as a special case, because most of the references are to 'source material' such as manuscripts, letters, minutes of committees, law reports, etc., rather than to other research papers. (When there are many references to a series of sources it is difficult to decide what constitutes a distinct reference. The practice of the Arts and Humanities Citation Index was therefore followed.) Whereas in other subjects the mean number of references per paper gives a rough idea of the mean number of times that a paper in that subject is cited (though the distribution is highly skew - see e.g. Garfield, 1964), this is not the case in history, as source material does not cite research papers. However, each reference, to source material or to other papers, constitutes a distinct entry point in the citation index, so there are far more for historical papers than for papers in other subjects.

History apart, the journal containing most references per paper was the Journal of Pharmacology and Experimental Therapeutics, and those with fewest were Language and Speech and Philosophy (where some of the references might also be regarded as 'source material'). This distribution is probably due largely to the volume of work published in each area, pharmacology having many journals with many papers in each, while language and philosophy have relatively few journals and few papers. An additional factor may be that, because of the lower use of current awareness and

TABLE 6.4 Mean numbers of references per paper, and parts of papers, in various journals (sample size = 30)

Journal	Mean refs. per paper	Mean refs.				Mean refs./100 words			
		Intr.	Exp.	Res.	Disc.	Intr.	Exp.	Res.	Disc.
1973									
J.C.S. Faraday Trans. I	21.9	8.1	2.8	4.4	12.7	2.69	0.83	0.62	1.10
	(8.4)	(4.6)	(2.5)	(4.7)	(6.6)	(1.11)	(0.74)	(0.63)	(0.53)
J. Phys. D	17.2	8.2	2.0	2.3	8.1	2.43	0.32	0.35	0.85
	(9.4)	(4.9)	(2.2)	(2.7)	(7.7)	(1.21)	(0.31)	(0.33)	(0.59)
J. Pharmacol. & Exp. Ther.	28.8	9.5	4.8	2.0	20.0	3.72	0.47	0.23	1.93
	(15.5)	(7.3)	(3.8)	(2.7)	(13.5)	(5.05)	(0.21)	(0.30)	(1.79)
Lancet	16.8	7.6	3.0	1.0	8.0	3.59	0.76	0.21	1.43
	(9.3)	(5.2)	(2.9)	(1.6)	(5.8)	(3.00)	(0.98)	(0.35)	(1.06)
Ann. Bot.	19.2	10.3	2.3	2.0	9.2	3.50	0.69	0.21	1.34
	(10.3)	(9.1)	(2.3)	(2.8)	(4.6)	(1.89)	(0.71)	(0.28)	(0.55)

Journal	Mean refs. per paper	Mean refs.				Mean refs./100 words			
		Intr.	Exp.	Res.	Disc.	Intr.	Exp.	Res.	Disc.
Anim. Behav.	19.3	10.4	2.3	2.0	9.9	2.68	0.39	0.18	0.99
	(11.5)	(5.3)	(1.9)	(3.7)	(8.7)	(1.75)	(0.33)	(0.35)	(0.69)
J. Soc. Psych.	14.0	9.8	1.9	1.0	3.6	1.98	0.33	0.17	0.66
	(5.6)	(5.3)	(2.6)	(1.2)	(3.7)	(1.12)	(0.53)	(0.21)	(0.61)
Sociometry	19.9	14.8	1.9	1.4	5.0	1.72	0.25	0.14	0.60
	(9.6)	(8.3)	(2.1)	(1.8)	(4.4)	(0.95)	(0.29)	(0.17)	(0.39)
Lang. & Speech	11.4	6.3	2.4	0.7	3.6	1.23	0.40	0.15	0.45
	(7.7)	(5.3)	(2.0)	(0.8)	(3.9)	(0.79)	(0.31)	(0,21)	(0,45)
Engl. Hist. Rev. (1977-78)	59.6								
	(27.9)								
Philosophy	6.1								
	(6.9)								

Journal	Mean refs. per paper	Mean refs.				Mean refs./100 words			
		Intr.	Exp.	Res.	Disc.	Intr.	Exp.	Res.	Disc.
J. Chim. Phys.	18.7	6.8	2.6	3.4	8.9	2.56	0.80	0.64	0.71
	(17.6)	(5.3)	(1.9)	(4.7)	(8.5)	(2.92)	(0.61)	(0.78)	(0.33)
Z. Phys. Chem. (Leipzig)	16.8	4.8	3.1	2.8	8.5	2.55	1.34	0.80	1.27
	(8.0)	(6.3)	(2.5)	(2.9)	(4.7)	(2.39)	(1.23)	(0.98)	(0.87)
Z. Phys. Chem. (Wiesbaden)	20.1	9.3	2.6	3.6	9.1	4.09	0.73	0.65	1.22
	(11.4)	(6.4)	(2.1)	(4.4)	(7.4)	(2.92)	(0.59)	(0.91)	(0.85)
<u>1962</u>									
Trans. Faraday Soc.	15.9	6.0	3.0	2.5	8.1				
	(8.0)	(4.3)	(3.3)	(3.1)	(5.8)				
Ann. Bot.	17.4	8.1	2.9	2.0	8.6				
	(9.4)	(6.5)	(4.3)	(2.3)	(6.5)				
J. Soc. Psych.	8.9	5.6	1.8	2.3					
	(6.5)	(5.4)	(2.6)	(2.1)					

Journal	Mean refs. per paper	Mean refs.				Mean refs./100 words			
		Intr.	Exp.	Res.	Disc.	Intr.	Exp.	Res.	Disc.
Sociometry	11.4	6.8	2.3	1.5	2.4				
	(5.2)	(5.2)	(2.0)	(1.4)	(3.0)				
<u>1947</u>									
Trans. Faraday Soc.	14.3	6.1	1.6	3.2	6.2				
	(6.8)	(4.6)	(1.3)	(4.4)	(4.4)				
Ann. Bot.	13.7	4.9	2.5	2.7	6.7				
	(8.2)	(4.7)	(2.1)	(2.9)	(6.5)				
J. Soc. Psych.	8.0	3.2	1.1	0.9	3.7				
	(6.4)	(3.6)	(1.4)	(1.2)	(5.1)				

NOTE: Standard deviations given in brackets

information retrieval services in the humanities, authors are less aware of related work.

The sections of the paper in which most references were made were the introduction and discussion. The relative numbers in the two sections help to support the remarks made in Section 4.6.4 that in the social sciences the contribution of the study to that area of knowledge is set out in the introduction, and once the results are known there is little more to discuss. In the natural sciences, on the other hand, the significance of the findings for the specialty concerned is considered in the discussion. Thus the numbers of references in the discussion sections of papers in Language and Speech, the Journal of Social Psychology, and Sociometry are low compared with those in the natural sciences. The density of references per hundred words was always significantly higher in the introduction section than in the discussion section (e.g. $t = 4.7$, $p \simeq 0.001$, for Language and Speech). Thus references are generally referred to briefly in introductions, but dealt with in more depth in discussions.

The numbers of references in the experimental section were lowest in the Journal of Social Psychology and Sociometry, and these journals are also among the lowest for density of references in that section. The number was highest in the Journal of Pharmacology and Experimental Therapeutics, and the density was highest in J.C.S. Faraday Transactions. These results accord with the remarks made in Section 4.6.2 that there seems to be more use of previously reported methods in the natural sciences, whereas the description of the method in psychology papers tends to be peculiar, and described in great detail.

All the journals had an average of at least 0.7 references per paper in the results section, confirming that this section is used for more than just reporting the results of the experiment. The number was greatest in J.C.S. Faraday Transactions. Physical chemistry does not usually require the long 'observational' type of results section which occurs in the life sciences, and the actual experimental results are usually in the form of tables or graphs. Thus the text is likely to contain a fair amount of comparison with other work, leading to a relatively high density of references. In the life and social sciences, the results section is mainly composed of observations made during the experiment being described, and so has a relatively low density of references.

The only significant differences found between the numbers of references in the British, French and German physical chemistry journals were (i) the Zeitschrift für physikalische Chemie (Leipzig) had significantly fewer references per paper than did J.C.S. Faraday Transactions, especially in the discussion sections; and (ii) the Zeitschrift für physikalische Chemie (Leipzig) had significantly fewer references per paper than did the Zeitschrift für physikalische Chemie (Wiesbaden) ($t = 2.74$, $p \simeq 0.01$), with the main difference in the introduction sections. The reason for the low number of references in the East German journal may be that the authors (mainly from communist and third-world countries) have less access to the literature, or perhaps are working in less active fields.

The Transactions of the Faraday Society, Journal of Social Psychology, and Sociometry showed significant increases in their numbers of references between 1962 and 1973, principally in the introduction and discussion sections. It seems unlikely that the advent of citation indexes was responsible for these increases. (The Social Science Citation Index did not commence until 1973.) A more likely explanation is the increase in the volume of published work relevant to each new paper. This is especially the case in the social sciences, where there may also be a development towards greater formalisation as a science, with more effort to relate new studies to earlier experiments and theories, rather than reporting them in isolation. (In the 1947 sample, five papers in the Journal of Social Psychology had no references in their introductions. In the 1973 sample, none did.)

To some extent, the citation of increasing numbers of references in a specialism may be self-perpetuating. Once one author cites several early papers, subsequent authors will also be aware of these, and may cite them too.

6.3.2 Comparison with previous work

Two previous studies have looked at the distribution of citations among the sections of experimental papers. Bertram (1972) suggested that the amount of information cited varies significantly with the section in which the citation is made. From studying the citations made in fifty papers in each of the Journal of Organic Chemistry and the Journal of the American

Chemical Society for 1966, she found that citations from the introduction tend to refer to the whole of the cited articles (setting the present study in context) citations from the experimental section are likely to refer to small bits of material (methods and techniques), and citations from the results and discussion sections tend to cite sentences or paragraphs of the cited articles (which the findings of the citing paper confirm or contradict). Her results indicate that, on average, 3.5 citations were made in the title or introduction, 2.2 in the experimental section, and 5.2 in the results and discussion sections of the papers. These figures are rather lower than I found for the physical chemistry journal, Transactions of the Faraday Society, but show roughly the same distribution.

Voos and Dagaev (1976) were also concerned with whether there is a difference in the value of a citation depending on where in the body of the citing article it occurs. They looked at the first two and the twenty-ninth and thirtieth of the '1970 papers most frequently cited from 1970-73' (Garfield, 1973). Articles 1, 2 and 29 were in the biomedical field. On average about 55% of references to them were in introductions, 10% in experimental sections, and 35% in results and discussion sections. Since there were no controls, it is hard to know what to make of these findings. My results showed that the proportions of citations made in introductions were about 26% in the Journal of Pharmacology and Experimental Therapeutics, 38% in the Lancet, and 43% in Annals of Botany, so the highly-cited papers would seem to receive their citations more often in introduction sections than do other papers.

Several earlier studies have reported values for the numbers of references per paper in different areas. Kaplan (1965) found that for journals published by the Chemical Society and the American Chemical Society the mean was 18.7 references per paper in 1961, while for the Lancet and the British Medical Journal it was only 4.4. He commented: 'It is not yet clear why there should be approximately four times as many references per article in a chemical journal as in a medical one ... . It is ... possible that the observed differences are due to different normative standards for citations in the medical and chemical fields.' The value for chemical journals fits in with my results for the Transactions of the Faraday Society, but Kaplan's values for the medical journals are considerably lower. I can only assume that he included all kinds of articles in these journals (e.g. leading articles, 'new inventions', 'medical education', 'points of view', and 'annotations'), rather than just experimental studies as I did. Papers in experimental medicine (e.g. those of the Journal of Experimental Pharmacology and Experimental Therapeutics) are certainly not inferior to those in chemistry for numbers of references.

Some figures for the Journal of Bacteriology were given by Kull (1965). In 1950, the mode of the number of references was 6-7 (14%), though the bulk of papers cited considerably more. In 1963, the most common values were 12 (12%) and 16 (11%). Many cited over 30 and one cited 63. Kull commented that, at about 30 references per printed page, this represented a considerable amount of space devoted to references.

Meadows (1967) noted that between 1934 and 1964 there was an increase of about 50% in the references per paper in the Monthly Notices of the Royal Astronomical Society, which was only partly explicable by the increase in the average length of the papers.

Xhignesse and Osgood (1967) were concerned principally with the citations within a network of 21 psychological journals. These increased by 69% from 1950 to 1960, while the total number of articles published rose by 50%. (With the birth of new journals during that period, though, the total amount of potentially citeable literature must have grown by more than this.) In 1960, the average number of references per paper was 11.6. The journal with least was the Journal of Clinical Psychology with 5.8: the Journal of Social Psychology had 10.3, which is somewhat higher than my value of 8.9 in 1962 for experimental papers only. (The journal used to carry review-type papers with considerably more references on average.)

An investigation of eight American journals concerned with communication research (Parker et al., 1967) showed a median of 8.4 references per paper in 1950, 9.4 in 1955, and 15.2 in 1960 and 1965. Meadows (1974) suggested that increases in most areas seemed to be levelling off at around 15 references per paper, though the limit depended on both the subject area and the length of the paper. The results in Table 6.4 suggest that this figure may have been premature.

As regards differences between journals published in different countries, Garfield (1976) reported that, while the average number of references per article over all journals in the 1974 Science Citation Index was 13.1, for articles from

French journals it was 8.8, and for articles from German journals it was 15.7 (Garfield, 1976a). For articles from the 73 East European journals (which did not include Russian ones) the average was 8.6 (Garfield, 1976b). These values are, of course, dependent on the particular journals included in Science Citation Index, and especially on the proportion of review articles.

6.4 THE SIGNIFICANCE OF REFERENCES

Some journals now include instructions to authors on limiting their number of references. The American Journal of Physiology stipulates that 'references must be limited to directly pertinent published works or papers that have been accepted for publication. Usually this is achieved with a total number of less than thirty.' The American Journal of Obstetrics and Gynecology encourages authors to limit their references to 16, and the Annals of Internal Medicine states that references should in general not exceed one per 100 words of text. The Journal of Pharmacology and Experimental Therapeutics instructs that 'Except in extraordinary circumstances, no more than four references should be cited in support of any given point.'

The idea of imposing a limit on the citation of other documents raises the question of why references are given at all. Weinstock (1971) wrote that 'Scientific tradition requires that when a reputable scientist or technologist publishes an article, he should refer to earlier articles which relate to his theme. These references are supposed to identify those earlier researchers whose concepts, methods, apparatus, etc. inspired or were used by the author in developing his own article. Some specific reasons for using citations are as follows:

1. Paying homage to pioneers
2. Giving credit for related work
3. Identifying methodology, equipment etc.
4. Providing background reading
5. Correcting one's own work
6. Correcting the work of others
7. Criticising previous work
8. Substantiating claims
9. Alerting researchers to forthcoming work
10. Providing leads to poorly disseminated, poorly indexed or uncited work
11. Authenticating data and classes of fact - physical constants etc.
12. Identifying original publications in which an idea or concept was discussed
13. Identifying the original publication describing an eponymic concept or term as e.g. Hodgkin's disease, Pareto's law, Friedel-Crafts reaction
14. Disclaiming work or ideas of others
15. Disputing priority claims of others.'

Davies (1970) claimed that such a rationalised view of reference giving is about as relevant to what really happens in science as the philosopher of science's concern with induction, deduction, hypothesis, theory and law. He held that the process of giving a reference is frequently wayward, dishonest or self-centred. For example, an author may try to lay claim to having had an idea first, show off how widely read or up-to-date he is, 'kick someone in the teeth' by omitting to refer to his relevant paper, or spike criticism by a glowing reference to a potential critic. He pointed out that just because an author cites a references it does not mean that he has seen it - references may be 'accumulated by accretion'. He suggested that the number of references given in papers in Nature could be reduced from 25 ± 10 to 5 ± 3 without impeding science and with a saving of money. May (1967) took the view that as authors would choose their citations to serve their own scientific, and political and personal goals, 'in the long run there can be no substitute for good indexing, abstracting and analysis.'

Davies went on to ask why, with such an idiosyncratic background to references, it was necessary to bother with them at all. 'Practising insiders know how a paper fits into the main-stream of science and references are wasted on them. The intelligent outsider ... is presumably sufficiently intelligent to write to us if he wants to know more.' I suspect that this division of readers into 'insiders' and 'outsiders' may be an oversimplification. There is, fortunately, the occasional innovative paper which is not merely borne along in the mainstream of science, but stands at the confluence of two or more streams, some, perhaps, rather quiet at that stage. Also, do authors really want to offer reading lists on demand to enquirers? It could be argued that outsiders should approach a new subject area through textbooks or reviews, but the traditional reference list of a relevant paper provides a more specific and up-to-date bibliography.

Some attempts have been made to analyse the functions of references in samples of research papers. Moravcsik and Murugeson (1975) used four factors:

1. Conceptual (i.e. theory) or operational (i.e. tool)
2. Organic (i.e. really needed for the paper) or perfunctionary (i.e. merely acknowledging previous work).
3. Evolutionary (i.e. building on the cited paper) or juxtapositional (i.e. giving an alterantive to it)
4. Confirmative or negational.

Some references were classified as 'redundant', when other references made the same point. Moravcsik and Murugeson analysed the references given in 30 papers on theoretical high energy physics in the Physical Review in these terms. About 50% of the references were conceptual, 60% were organic, 60% were evolutionary, 87% were confirmatory, and 31% were redundant. Chubin and Moitra (1975) used a slightly different breakdown, and compared theoretical with experimental papers and papers with letters. They classified about 50% of references as 'affirmative-essential', 45% as 'affirmative-supplementary', and 5% as 'negational'.

Cawkell (1977) tried to analyse the references made in articles in Nature in the same terms. He found it most difficult to identify 'perfunctionary' or 'redundant' references. He quotes as an example 'binds to the tryptophan operator and blocks transcription(5-10)'. On examining the six articles, 5 to 10, he found that they seem to build on each other, and so were all deservedly cited.

The coming of the <u>Science Citation Index</u> and later the <u>Social Sciences Citation Index</u> facilitated the branch of research known as 'citation analysis'. This research is largely used for putting things in order, which 'things' may be journals, papers, authors, or the organisations to which authors belong. Martyn (1975) has reviewed some of the objections to the results of such exercises, and the precautions which ought to be taken. Recognition that papers may be cited in a 'perfunctionary' way - i.e. acknowledged as related studies, rather than used - or even 'negationally' is also an important consideration. Some authors have suggested that the use of citations to evaluate authors will lead to abuse of the referencing system - for example:

> If citation indexing becomes a basis for promotion and tenure [of college and university staff], for grants and fellowships, the implications for one's own footnotes are clear. In the marketplace of ideas, the footnote is the unit of currency; to footnote an author is to cast a vote for his tenure or grant. One should therefore be judicious in his footnoting: footnote friends and don't footnote enemies. The most likely consequence will be an inflation of citations; as the important of being footnoted becomes increasingly clear, each author will footnote more people - to gain their friendship and their footnotes in return. The average

number of citations per author will creep up, and the standards will have to be revised to reflect the new footnoting practices.
(Wiener, 1974)

How far such practices have led to the increase in the average number of citations per paper in recent years, and to the need for editorial limitation on numbers of references as quoted earlier in this Section, would be hard to judge. As shown in Table 6.4, there have been significant increases during the period 1962-1973, but these have taken place in social science journals too, which were not covered by citation indexing until 1973.

As mentioned in Section 6.1, I am not concerned with the information about scientific status or processes which can be drawn from citation indexes, but only with their use in bibliographical control. Some authors have suggested that the introduction of citation indexes would lead to more attention being given to this function of references. De Solla Price (1964) considered 'now that citations to previous work have become a valuable tool for literature indexing, referees and editors should reject bibliographies that are either insufficient or padded', and Cleverdon (1965) wrote: 'Perhaps the time is coming when editors of scientific journals should take the same active steps to obtain a high quality of citing as many have recently been doing for abstracts and titles.' Margolis (1967) considered that 'Extended use of citation indexing may well lead to general improvement of standards, as a result of editorial policy and recognition of moral obligations on the part of the authors. But a more realistic motive ... could be the author's self-interest in feeding the index with relevant information so that he may reach his readers. He knows that his article may be overlooked if it does not cite pertinent literature.' (The level of use of citation indexes found in the studies reported in Section 6.1 suggests that this is not a serious danger at present.)

Martyn (1975) considered that citations for frivolous reasons, such as citations of likely referees, and references to 'Alice in Wonderland' (one of which he made himself), are relatively few in number, so that 'at the very least, it is safe to say that when a item is cited, the citing author has heard of the reference and believes it to be sufficiently relevant to the topic of his work, or to a statement or remark contained in it, to be worth citing'.

As illustrated in Weinstock's list in Section 6.1, 'negational' references are far from irrelevant in information retrieval, and 'redundant' references in a paper are probably all relevant too; indeed, they may help to speed the process of assembling references using a citation index or reference lists. Neither Moravcsik and Murugeson (1975) nor Chubin and Moitra (1975) seem to have needed a category 'frivolous'. Perhaps the most important question about the use of citation indexing is what is the effect of references relevant only to a 'statement or remark' in the paper, rather than to its entirity. Cleverdon (1964) wrote: 'Most of the references which an author cites are not directly relevant to the main theme of the paper, and the results is that a high proportion of the papers to which one is referred will be of no interest.' (At that time the Science Citation Index did not give the titles of citing papers, and the searcher had to go to the original to judge its relevance. This has now been made good by the inclusion of the Source Index.) The value of including titles in references lists was stressed in Section 6.2.2.

Bertram's (1972) figures give some data relevant to the complementary problem: how much of the cited paper is relevant to the citing paper? Of the 1084 citations made in fifty papers in chemistry, 42% referred to the whole theme of the cited paper, 45% to part of it, and 13% to particular words in it. As mentioned in Section 6.3.2 citations from the introduction were most likely to refer to the whole of the cited paper (75%). Some further data are given in Barlup's study below.

6.5 EXPERIMENTS ON THE RELEVANCE AND USE OF CITATIONS

Some opinions on the usefulness of citations and citation indexes were reviewed above. In this section, some experimental studies reported in the literature are discussed which bear on the value of citation indexes as tools for information retrieval.

Waldart (1964) compared the use of the 1964 Science Citation Index (SCI) and seven conventional abstracting and indexing services in compiling a bibliography on lasers. A single reference was used as the entry point to SCI, and 'cycling' was not employed. Only Applied Science and Technology Index and Solid State Abstracts contributed a higher proportion of unique references than SCI. It took 380 minutes to find 124 references from the conventional sources and 120 minutes to produce 40 from SCI - about 3 minutes per reference in each case.

Martyn (1965) started with a bibliography of 1094 references on the semiconductor properties of gallium, covering 1950 to April 1964. Of these, 49 were dated 1964, and 22 (45%) appeared as source items in the first three quarterly issues of the 1964 SCI. (Eight more were in the annual issue, bringing the coverage up to 61%.) All 1094 references were used as entry points, and 163 were recorded by SCI as having been cited. Fifty-five of these led to relevant references only, 80 to 'noise' references only, and 28 to both. Altogether, 83 led to 20 out of the 22 source items, and 67 additional references in January-April 1964 were retrieved. Of these, 36 were probably not relevant, 27 were possibly relevant, and 4 were definitely relevant. The 'signal-to-noise ratio' was thus 24:63, or about 2:5. The references which were not relevant to the topic of gallium as a semiconductor were generally relevant either to gallium or to semiconductors alone. Many of them could have been 'filtered out' using their titles.

Kessler (1965) made a detailed comparison of how 334 papers in a 1958 volume of Physical Review formed related groups according to (a) the analytic subject index (ASI) of Physical Review, and (b) bibliographic coupling (BC). Papers are said to be 'bibliographically coupled' if they share at least one common reference. Groups formed by BC showed high correlation with those of ASI, and groups formed by ASI correlated more or less with those formed by BC, depending on the 'logical size' of the ASI category. (ASI's divisions are pragmatic, to achieve fairly equal expectations, rather than logically-based.)

Judging by ASI, the coupling strength (measured by the number of references in common) is a measure of the relatedness between pairs of papers. The study did not, however, result in any judgment of the value of either method for any specific application.

A study of the performance of <u>SCI</u> for a specific search, viz. papers on haemorrhagic fevers was conducted by Ghosh (1967). He started with an arbitrary paper from the twelve listed in 'Work done in India on viral and rickettsial infections of vertebrates - a bibliography', 1967. After cycling (33 searches) and looking at other papers by authors of interest, 65 references were retrieved. These included 13 on haemorrhagic fevers (5 in the bibliography under 'haemorrhagic fevers') and 11 relating to haemorrhagic fevers (8 in the bibliography under other headings). Thus 41 were irrelevant, giving a high level of noise (63%), but also five relevant references not in the bibliography were found.

Spencer (1967) prepared a bibliography on thalidomide using <u>Chemical Abstracts</u> and <u>Index Medicus</u> for 1956-64. This took 14.6 hours. Using a known relevant reference and cycling (with a review article as the starting point for the second run), a search was carried out in SCI for 14.6 hours. For the first 8 hours, SCI yielded more references than did <u>Index Medicus</u> or <u>Chemical Abstracts</u>. Each service produced a high number of unique references - <u>Chemical Abstracts</u> 48, <u>Index Medicus</u> 196, and <u>SCI</u> 203. Of all the 632 references found, 110 were in <u>Chemical Abstracts</u>, 370 in <u>Index Medicus</u>, and 367 in <u>SCI</u>. 434 references were missing from <u>Chemical Abstracts</u> and 145 from <u>Index Medicus</u> because of their selective coverage of journals. (<u>SCI</u> covers all articles in its selected journals.)

A rather simplistic study was carried out by Huang (1968). He compared forward searches (i.e. from cited to citing papers) in the 1965 _SCI_ and searches using the subject indexes for 1965 of the _Bibliography of Agriculture_, _Biological Abstracts_, _Chemical Abstracts_ and _Index Medicus_. He chose three topics in genetics: an emerging research interest with a concentrated citation pattern, a topic with a number of papers over several years scattered among citations, and a topic of more extended scope with many papers. He started with 5, 7 and 16 references respectively for the three searches. Not surprisingly, in view of the simple search strategy, the searchers using _SCI_ were much quicker in all cases, but only for the first topic produced more unique relevant references. For the second topic, it did not retrieve any, and for the third it retrieved only 62, as opposed to 160 from the subject indexes. A backward search (i.e. from citing to cited papers) was also carried out for the second topic. This produced 107 unique references in the first round, and an estimated 343 unique references in the second round. Huang concluded that backward searches without the elimination of 'noise' at each step will soon retrieve an overwhelming number of irrelevant references. The 'noise' arises from authors citing references for units of information in the papers other than the information for which the backward search is being done.

Barlup (1969) investigated the relevance of citing articles in a rather original way. She gave each of 25 members of Washington University School of Medicine copies of up to 10 works which cited a paper they had written (traced using SCI 1964-7). Of the 161 articles evaluated, 43% were said to be 'very closely related' in subject content to the cited article, 29% 'directly related', 22% slightly related, and 5% not related at all. (1% were in languages which the medics could not understand.) The subjects were asked to evaluate the relevancy of the papers first from their titles alone. The titles of 18% of the papers suggested that they were not related, but 6% were, in fact, 'directly related'.

6.6 CONCLUSIONS

Citation indexing involves using the references given by a paper as its descriptors. This has the advantages that (i) the descriptors are author-assigned, so further human indexing is not needed; (ii) it cuts across disciplines; and (iii) it avoids problems of semantics in compiling and using the indexes. Kessler's (1965) comparison of the conventional subject indexing of Physical Review with groups formed by bibliographical coupling showed that there was a fair correlation between the two.

Like other bibliographical information, references tend to be less abundant in the social sciences and humanities than in the sciences. Historical papers, which tend to cite large numbers of 'source documents' are, however, an exception. There seems to be little information available so far on the use of references in the social sciences and humanities for information retrieval, but, since citation indexing gets round the difficulty of applying index terms in areas with 'soft' terminology, it seems to offer a promising approach. As papers in philosophy are often comments on, or criticisms of, earlier papers or books, citation indexing may be valuable there, as also in literary criticism.

The mean number of references per paper has been increasing from 1947 to the present, not only in the sciences but also in the social sciences. Some journals are now suggesting limits on the number of references. Many journals give instrustions about the form, content and order of data in referreces. The numbered system seems to be preferred except in the life and social sciences. The titles of cited papers are valuable pieces of information which are often omitted, especially in chemistry and physics, and there are arguments for giving journals titles in full. More guidance seems to be needed, however, on the circumstances in which references are required, especially as they now affect citation indexes.

A particular problem with using citations for information retrieval seems to be that some relate to the whole of the citing paper, and others to only part of it. Similarly some citations are to the whole of the cited paper, and some are to part of it. Searches can thus retrieve a large number of irrelevant references, or 'noise'. The frequency of references to the whole, or part, of cited articles apparently varies according to the section of the paper in which the citation is made. Some indication in citation indexes of the type of citation might be useful. (This information would presumably have to be given by the author - e.g. by 'starring' some of the items in his reference list.)

C H A P T E R   S E V E N

THE TRADITIONAL BIBLIOGRAPHIC ELEMENTS IN THE AGE OF COMPUTERIZED INFORMATION RETRIEVAL

7.1 INTRODUCTION

Conclusions regarding the individual bibliographic elements have been given at the ends of the relevant chapters, and it is not intended to repeat them here. This chapter is concerned with the common trends observed in the elements, an appraisal of their changing functions, and a consideration of possible developments in the future.

7.2 LENGTH AND NUMBERS OF ELEMENTS

Evidently, the longer a bibliographic element is, the more information it can carry. If titles of, say, thirty words in length are considered acceptable, then they can carry appreciably more information about their papers than can titles of ten words. Similarly, the longer an abstract, the more detail it can contain about the method and findings of the study. Most of the elements investigated in this thesis increased significantly in length or number since 1945. Increases were found in title lengths, abstracts lengths, and numbers of references, and keywords have been introduced since that date. Acting counter to such trends is the increased pressure on space, partly due to the increasing number of papers being submitted, and partly to economic factors, i.e. rising costs and falling subscriptions. This pressure has led to, or been used to justify, some space-saving measures which hinder information retrieval - e.g. omission of titles of cited papers, and limiting abstracts to one language only - and to instructions to authors to limit the length or number of bibliographic elements - e.g. title lengths (Section 2.1) and numbers of references (Section 6.4). Of course, greater length of bibliographic elements leads to increased costs and space problems for the secondary services which employ them. It was shown in Section 4.11 that abstracts written by abstracting services tend to be significantly shorter than those written by the authors.

The ideal balance between information content and brevity will obviously occur at different points for different purposes. It may not matter very much on a computer database whether titles are ten words long or fifty - they are usually handled in the same way as abstracts for searching. However, titles of fifty words would be inconvenient to scan on contents pages, as in Current Contents, and would lead to unsatisfactory entries in KWIC indexes, where most of the title would be missing.

The present system of recording references, where no distinction is made in a reference list between references to papers on the same subject as the citing paper and those to papers which support perhaps only a small part of it, leads to many undesired papers being retrieved from a citation index (Section 6.5). However, for the reader of the citing paper, presumably the more references the better. It will usually be fairly obvious from the text what the connection is with the paper, and if the title of the cited paper is given that will help even more. (I have suggested in Section 6.6 that this particular problem could be eased by distinguishing the directly related references with a symbol - rather like the 'central concept indicator' of MEDLINE.)

The variety of applications, and conflicts between the interests of primary and secondary services, mean that it is difficult to recommend lengths or numbers of bibliographic elements.

7.3 THE NEW FUNCTIONS OF THE BIBLIOGRAPHIC ELEMENTS

It looks as though, in the future, secondary services are going to have to rely even more heavily on the bibliographic elements provided by the primary journal, rather than supplementing them with their own. Cleverdon (1979) has pointed out that, at present, the cost of intellectual indexing by secondary services is justified mainly by its requirement when producing printed products. If the time comes when mechanised databases supplant the printed product, then this cost will no longer be justified, and the producers will rely on the available abstracts.

The point was made in Section 2.2.3 that, as far as computerised information retrieval goes at present (as well as for some printed indexes), titles serve merely as sources of individual index words. The same is true of abstracts (Section 4.12.6). Individual words can be combined with great facility to produce compound searches (e.g. (MONKEYS OR CHIMPANZEES) AND (LSD OR CANNABIS)) but automatic linguistic analysis is far from the point where computers can exploit the syntactic relationships expressed in the title or abstract between the terms. The only refinement which is possible on most systems is to scan the records retrieved to find those where the individual words are adjacent, or in the same sentence.

As computerised retrieval grows in importance, therefore, will the need for titles and abstracts disappear, and their place be taken by a list of keywords? This could be much more efficient, since duplication between title, abstract and keywords could be avoided. Words which are uninformative but relatively rare, and so not on stop lists, could also be eliminated. The study reported in Chapter 5 suggests that the quality of keywords given in primary journals is rather low. (A reviewer in Newsidic (1979) even criticised keywords given in the Journal of Information Science.) In the absence of clear guidance, some authors give only very general keywords, while others given highly coordinated terms. In writing abstracts, however, authors will necessarily use terms as specific as the subject of the paper (except when they occasionally avoid duplication between the title and abstract by referring, e.g. to 'the title compound').

7.4 CONSIDERATIONS OF VOCABULARY

One of the greatest difficulties in searching 'free text' (i.e. words in titles and abstracts) as opposed to 'controlled language' (i.e. words from an indexing thesaurus) is that of coping with broader and narrower terms. When a document is indexed by an indexer, a notation can be employed which represents the way in which the terms fit into a hierarchy, e.g. U.D.C. or MeSH Class Numbers. When searching, therefore, it is possible to search under a broad term and pick up all documents indexed with narrower terms under that term. Using free text, however, one is dependent on the presence of both broad and narrow terms being present in the title or abstract (Section 2.6.3). If papers mention only particular places in the United States in their abstracts and titles, but do not use 'United States' or 'America', then one cannot find them all when searching for, say, the occurrence of uranium in the United States.

If authors could be relied on to give broader words in a keyword list, as well as those at the level of specificity of the subject of the paper, then perhaps a keyword list alone would suffice for machine searching. Authors' current performance, however, does not give rise to much optimism about this possibility. At present, abstracts often supply broader or narrower terms for words in the title, e.g.

> 'The Suisnish layered dyke' (title)
> 'A minor picritic body at Suisnish Point, Isle of Skye, is described' (abstract: Mineral Mag., 1976)

and

> 'Adrenergic and serotonergic receptor binding in rat brain after chronic desmethylimpiramine treatment' (title)
> 'The effects of chronic administration of the tricyclic antidepressant agent desmethylimpiramine ... were studied' (abstract: J. Pharmacol. Exp. Ther., 1979)

The abstract in the first example gives a more general place-name, 'Isle of Skye', and that in the second example gives the type of drug, 'antidepressant'. Thus abstracts seem to provide a more reliable source of index terms than do lists of keywords. It would be a good idea if more instructions to authors stressed the value of including both broad and narrow terms in titles and abstracts.

Even if keyword lists adequate for indexing purposes were provided, a coordinated statement of the subject of the paper would still be needed for display, to select the probably relevant documents from those retrieved. This is most conveniently the title. However, users generally prefer to have the abstracts (even if their value for selection, compared to that of titles, is questionable - Section 4.12.5), so the combination of abstract-plus-title seems preferable to keywords-plus-title.

There are two areas in partuclar where a hierarchical code would be of great assistance for searching. The first is the time period covered in historical papers. This could be done by indexing a paper covering several hundred years by each century, e.g. 1763-1914 as D18, D19, D20 (using a D prefix to denote a date code), and shorter periods by each decade, e.g. 1914-1945 as D191, D192, D193, D194. This would enable papers to be retrieved covering any period which overlapped, or was contained within, the period sought. For example, searching for D18? should retrieve all documents pertaining to the nineteenth century. Such a coding system should be simple enough for authors to apply themselves, and the codes could be given in or after the title or abstract.

The second area where a hierarchical notation would be valuable is geographical location. This would avoid problems of synonyms or near-synonyms such as United Kingdom, Great Britain and British Isles, and also permit searches to retrieve papers on parts of the area specified in the search profile.

For example, papers on Leicester, Lincolnshire and London could all be retrieved when searching for England. Since such coding would require consultation of a fairly extensive schedule, it would probably have to be applied by the editor, or by the secondary service.

It was pointed out in Section 6.1 that retrieval based on citation gets round problems of vocabulary. When going from a paper to papers in its reference list, one may be able to pick out papers on the same subject and papers on broader subjects by the way they are cited in the text. This is facilitated when titles are given in the reference list. However, when using a Citation Index to go from cited papers to citing papers, there is no way of telling their relative specificities, except from their titles given in the Source Index.

7.5 BIBLIOGRAPHIC CONTROL IN DIFFERENT SUBJECTS

One object of this thesis (Section 1.2) was to compare bibliographic practice and potential in different subject areas. My general conclusion is that subjects seem to lie in much the same order for provision of each of the bibliographic elements. Thus, papers in chemistry had the longest titles; the nomenclature used in chemistry allows meaningful fragmentation and so assists in generic searches; authors' addresses were always given; abstracts were always present and tended to be relatively long and informative; some journals had authors' keywords; and chemical papers had a relatively large number of references. At the other extreme, papers in philosophy had the shortest titles, and these were frequently metaphorical rather than literal; the terminology is 'soft'; authors' addresses were rarely given, and even affiliations were sometimes absent; abstracts were rare; no examples of authors' keywords were found; and philosophical papers had the fewest references per paper. As argued in Section 2.5.2 the poor provision for bibliographic control in philosophy may not, at present, matter too much to philosophers. The number of papers published per year is small compared with that in the sciences, and the research results are of less immediate practical or economic significance. This may be partly behind the bibliographic practices of philosophical writing.

The social sciences are in an intermediate position. Their research results are becoming of increasing practical importance, with the growing attention to social matters in central and local government and in industry. In their papers, practitioners are increasingly attempting to present a scientific appearance to their research. The layout of experimental papers is taking on the traditional introduction-method-results-discussion form of the natural sciences, abstracts and author details are being set out as in scientific papers, and more references are being given. As these trends develop, so the tools used for information retrieval in the natural sciences will become increasingly effective in the social sciences.

Various bibliographic practices used in the sciences and sometimes in the social sciences could be extended into the humanities. Titles could be made longer, and if authors wish to use 'clever' ones they could be backed up by more factual subtitles. Abstracts can be written for philosophical and historical papers, as shown by some isolated examples. There seems no reason why author details could not be given more fully, and presented in the same way as in the sciences. References can be used for retrieval at least as effectively as in the sciences - perhaps especially so for critical papers.

The major reservation about improved bibliographic control in the social sciences and some areas of the humanities is concerning their terminology. I have suggested how indexing by place and by time might be improved, and this would enable certain kinds of searches in history to be done quite efficiently. Proper names, such as those of people and of literary works, should be reasonably easy to search for in English literature, history and philosophy, though the value of giving such names in full and unambiguous forms needs to be stressed to authors (Section 2.8.1). However, the abstract nature of the phenomena studied in philosophy, and often in the social sciences, together with the variety of viewpoints existing, seem likely to prevent standardisation of terminology in the near future at least. This is bound to hinder information retrieval techniques using free text such as titles, abstracts and uncontrolled keywords.

Now that citation indexes and on-line databases have become available in the social sciences and humanities, it should hopefully not be too long before experimental studies of their effectiveness are available.

A P P E N D I X

TABLE A1.

Information about authors and reference systems

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. system
Philosophy								
Analysis	Blackwell	UK	b	M	e	-	-	ne/f, T, J
Br. J. Philos. Sci.	Br. Soc. Phil. Sci.	UK	b	A	e	-	-	ae, T, J
Inquiry	Universitetsforl.	Norw.	b	M	b	-	-	ne, T, J
J. Philos.	J. Philos.	US	e	A	e	-	-	(n)f, T, J
Mind	Mind. Ass.	UK	b	A	e	-	-	nf, T, J
Philosophy	Camb. U.P.	UK	b	M	e	B	-	nf, T, J
Am. Philos. Q.	Blackwell	UK	b	M	e	-	-	nf, T, J
Rev. Fil. Neo-Scol.	Univ. Catt. Sacro Cuore	It.	b	M	b	-	-	nf, T, (J)
Kant-Stud.	de Gruyter	W. Ger.	b	M	-	-	B	nf, T, J
Rev. Metaphys. & Morale	Soc. Fr. de Phil.	Fr.	e	M	-	-	-	nf, T, (J)
Psychology								
Acta Psychol.	N. Holl.	Neth.	b	A	b	-	-	ae, T, J
Br. J. Psychol.	Camb. U.P.	UK	b	S	b	-	-	ae, T, J
J. Soc. Psychol.	J. Press	US	b	M	b	-	e	ne, T, -

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. system
J. Behav. Ther.	Pergamon	UK	b	M	b	-	f	ae, T, -
Am. J. Psychol.	Univ. Illinois Pr.	US	b	M	b	-	(e)	ae, T, J
Br. J. Soc. & Clin. Psychol.	Camb. U.P.	UK	b	M	e	-	e	ae, T, J
Child Dev.	Soc. Res. Child Dev.	US	b	A	b	-	f	ae, T, J
Int. J. Psychol.	Dunod	Fr.	b	A	b	-	-	ae, T, J
J. Res. Pers.	Acad. Pr.	US	b	A	b	-	f	ae, T, J
Neuropsychologia	Pergamon	UK	b	M	b	-	b	ne, T, -
Sociology								
Br. J. Sociol.	Routledge	UK	b	M	e	e	-	ne, T, J
Int. Soc. Sci. J.	Unesco	Fr.	b	M	f	f	-	ae/ne, T, J
Man	R. Anthrop. Inst.	UK	b	S	b	-	-	ae, T, -
Sociol. Rev.	Univ. of Keele	UK	b	M	e	-	-	ne, T, J
Am. J. Sociol.	Univ. Chicago P.	US	b	A	b	B	-	ae, T, J
Human Relat.	Plenum	US	b	M	b	e	-	ae, T, J
Social Probl.	Soc. Social Prob.	US	b	M	b	-	-	ae, T, J

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. system
Social Res.	New Sch. Soc. Res.	US	b	A	E	E	-	nf, T, J
Sociol. & Soc. Res.	Univ. S. Calif.	US	b	A	b	-	-	ae, T, J
Sociometry	Am. Soc. Ass.	US	b	A	b	B	-	ae, T, J
Politics								
Polit. Sci. Q.	Acad. Pol. Sci.	US	b	A	f	f	-	nf, T, J
Am. Polit. Sci. Rev.	Am. Pol. Sci. Ass.	US	b	A	b	B	-	nf, T, J
Foreign Aff.	Council For. Rel.	US	b	A	f	f	-	nf, T, J
Polit. Q.	Polit. Q.	UK	b	S	f	f	-	nf, T, J
Int. Aff.	R. Inst. Int. Aff.	UK	b	M	B	B	-	nf, T, J
Polit. Sci.	Univ. Wellington	NZ	b	M	b	-	-	ae, T, J
Br. J. Int. Stud.	Longman	UK	b	M	B	B	-	nf, T, J
Europa Arch.	Verl. Int. Pol.	W. Ger.	b	A	f	(f)	-	ne, T, J
Polit. Vierteljahrschr.	Westdeut. Verl.	W. Ger.	b	A	-	-	-	ne, T, J
J. Polit.	S. Pol. Sci. Ass.	US	b	A	B	B	-	nf, T, J
Economics								
Economica	Lond. Sch. Econ.	UK	b	M	b	-	-	ae, T, J
J. Econ. Theory	Acad. Pr.	Belg.	b	A	b	-	b	ne, T, -

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. system
J. Publ. Econ.	N. Holl.	Neth.	b	M	b	-	b	ae, T, J
Rev. Econ. Stud.	Econ. Anal.	UK	b	M	b	-	-	ne, T, J
West Econ. J.	W. Econ. Ass.	US	b	M	b	-	-	ne, T, -
Int. Econ. Rev.	Wharton Sch.	US	b	M	e	-	-	ne, T, J
Finanzarchiv	Mohr	W. Ger.	b	A	-	-	-	nf, T, J
Econ. J.	Camb. U.P.	UK	e	A	e	-	-	ae, T, J
Econometrica	Econ. Soc.	UK	b	S	e	-	-	ne, T, J
Am. Econ. Rev.	Banta	US	b	M	f	-	-	ae, T, -
Mathematics								
Proc. Am. Math. Soc.	Am. Math. Soc.	US	b	M	e	-	e	ne, T, -
Ann. Stat.	Inst. Math. Stat.	US	b	M	b	-	e	ne, T, -
J. Symb. Logic	Ass. Symb. Log.	US	b	M	e	-	e	ne, T, J
Ann. Math.	Princetown Univ.	US	b	S	e	-	-	ne, T, -
J. London Math. Soc.	London Math. Soc.	UK	b	S	e	-	e	ne, T, -
Adv. Math.	Acad. Pr.	US	b	M	b	-	b	ne, T, -
Acta Math.	Nørlund	Swed.	b	N	b	-	-	ne, T, -
J. Math. Pures Appl.	Gauthier-Villars	Fr.	b	M	e	-	e	ne, (1), -

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. System
J. Reine & Angew. Math.	de Gruyter	W.Ger.	b	M	e	-	e	ne, T, -
J. Algebra	Acad. Pr.	US	b	M	b	-	b	ne, T, -
<u>Physics</u>								
J. Chem. Phys.	Am. Inst. Phys.	US	b	M	b	-	b	ne, -, -
J. Phys. (London)	Inst. Phys.	UK	b	N	b	-	b	ae, -, -
Philos. Mag.	Taylor & Francis	UK	b	S	b	-	b	ae, -, -
Phys. Rev.	Am. Phys. Soc.	US	b	S	b	-	b	ne, -, -
Surf. Sci.	N. Holl.	Neth.	b	S	b	-	b	ne, -, -
Z. Phys.	Springer Verl.	W. Ger.	b	N	b	-	e	ne, -, -
Ann. Phys.	Barth	E. Ger.	b	N	b	-	e	ne, -, -
J. Acoust. Soc. Am.	Acoust. Soc. Am.	US	b	M	b	-	b	*ne/ae, (T), -
J. Phys. (Paris)	Comm. Publ. Fr. Phys.	Fr.	b	N	b	-	b	ne, -, -
Physica	N. Holl.	Neth.	b	N	b	-	b	ne, -, -
<u>Chemistry</u>								
Acta Chem. Scand.	Chem. Socs. Scand.	Denmk.	b	M	b	-	b	ne, -, -
Bull. Soc. Chim. Fr.	Masson & Cie	Fr.	b	S	f	-	f	ne, -, -
Chem. Ber.	Verlag Chem.	W. Ger.	b	A	b	-	b	nf, -, -

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. System
J. Am. Chem. Soc.	Am. Chem. Soc.	US	b	M	b	-	b	ne, -, -
J. Chem. Soc. Faraday Trans.	Chem. Soc.	UK	b	M	b	-	b	ne, -, -
J. Inorg. & Nucl. Chem.	Pergamon	UK	b	S	b	-	b	ne, -, -
J. Org. Chem.	Am. Chem. Soc.	US	b	M	b	-	b	ne, -, -
J. Organomet. Chem.	Elsevier Seq.	Switz.	b	S	b	-	b	ne, -, -
Tetrahedron	Pergamon	UK	b	S	b	-	b	ne, -, -
Z. Phys. Chem. (Leipzig)	Acad. Verl.	E. Ger.	b	A	b	-	f	ne, -, -
<u>Biochemistry</u>								
Anal. Biochem.	Acad. Pr.	US	b	M	b	-	b	ne, -, -
Arch. Biochem. & Biophys.	Acad. Pr.	US	b	M	b	-	b	ne, -, -
Biochemistry	Am. Chem. Soc.	US	b	M	f	-	f	ae, -, -
Biochim. & Biophys. Acta	Elsevier	Neth.	b	M	b	-	b	ne, -, -
Biochem. J.	Biochem. Soc.	UK	b	A	b	-	b	ae, -, -
Eur. J. Biochem.	Springer Verl.	W. Ger.	b	A	b	-	e	ne, -, -
Biochimie	Soc. Chim. Biol.	Fr.	b	M	b	-	b	ne, -, -

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. System
J. Biol. Chem.	Am. Soc. Biol. Chem.	US	b	A	b	-	b	ne, -, -
J. Histochem. & Cytochem.	Williams & Wilkins	US	b	M	b	-	b	ne, T, -
Phytochemistry	Pergamon	UK	b	M	b	-	b	ne, -, -
Botany								
Ann. Bot.	Acad. Pr.	UK	b	N	b	-	b	ae, T, -
Am. J. Bot.	Bot. Soc. Am.	US	b	M	b	-	b	ae, T, -
Ber. Dtsch. Bot. Ges.	Fischer Verl.	W.Ger.	b	M	b	-	e	ne, (T), -
Bot. J. Linn. Soc.	Acad. Pr.	UK	b	S (fem)	b	-	b	ae, T, J
Bot. Jahrb.	Schweiz. Verl.	W.Ger.	b	M	e	-	e	ae, T, -
Bryologist	Am. Bryol. & Lichen Soc.	US	b	M	f	-	f	ae, T, -
J. Exp. Bot.	Oxf. Univ. Pr.	UK	b	S	b	-	b	ae, -, -
Physiol. Plant.	Scand. Soc. Plant Physiol.	Denmk.	b	M	b	-	b	ae, T, -
Planta	Springer Verl.	W.Ger.	b	S (fem)	b	-	b	ae, T, -
Watsonia	Bot. Soc. Br. Is.	UK	b	N	b	-	-	ae, T, -

Subject/ Journal	Publisher	Country	Author's name	Xian. names	Author's affil.	Author's biogr.	Author's address	Ref. system
<u>Zoology</u>								
Am. Zool.	Am. Soc. Zool.	US	b	A	b	-	b	ae, T, -
Acta Zool.	Stat. Naturv. Forsk.	Swed.	b	M	b	-	e	ae, T, -
J. Amin. Ecol.	Blackwell	UK	b	S	b	-	b	ae, T, J
J. Exp. Zool.	Wistar	US	b	M	b	-	b	ae, T, -
J. Insect Physiol.	Pergamon	UK	b	S	b	-	b	ae, T, -
J. Molluscan Stud.	Graham	UK	b	S	b	-	b	ae, T, J
Ecol. Entomol.	R. Entomol. Soc.	UK	b	S	b	-	-	ae, T, J
J. Zool.	Zool. Soc.	UK	b	S	b	-	(b)	ae, T, -
Physiol. Zool.	Univ. Chicago Pr.	US	b	M	b	-	b	ae, T, -
Zool. Anz.	VEB Gustav Fischer Verl.	E. Ger.	b	M	b	-	e	ae, T, -
<u>Medicine</u>								
J. Am. Med. Assoc.	Am. Med. Assoc.	US	b	A	f	-	f	ne, T, -
J. Exp. Med.	Rockerfeller Univ. Pr.	US	b	M	b	-	b	ne, T, -

Subject/ Journal	Publisher	Country	Author's name	Xan. names	Author's affil.	Author's biogr.	Author's address	Ref. system
J. Pharmacol. & Exp. Ther.	Williams & Wilkins	US	b	M	b	-	f	ae, T, -
Lancet	Lancet	UK	b	S	b	-	(b)(e)	ne, -, -
Zentralbl. Bakteriol.	Fischer Verl.	W. Ger.	b	S	b	-	e	ae, T, -
Am. J. Surg.	Dun-Donnelley	US	b	M	f	-	f	ne, T, -
Eur. J. Cancer	Pergamon	UK	b	S	b	-	b	ne, T, -
J. Nerv. & Ment. Dis.	Williams & Wilkins	US	b	M	f	f	f	ne, T, -
Ann. Endocrinol.	Masson	Fr.	b	N	b	-	b	ne, T, -
Virchows Arch.	Springer	W. Ger.	b	S	b	-	b	ae, T, -
<u>Engineering</u>								
AIAA J.	Am. Inst. Aeronaut.& Astronaut.	US	b	S	b	f	-	ne, T, J
Trans. ASME	Am. Soc. Mech. Engin.	US	b	N	b	-	-	ne, T, J
Automatica	Pergamon	UK	b	S	f	-	f	ne, T, -
IEEE Trans.	Inst. Electr. & Electron. Eng.	US	b	A	f	e+	f	ne, T, -

Subject/ Journal	Publisher	Country	Author's name	Xan. name	Author's affil.	Author's biogr.	Author's address	Ref. system
Proc. Inst. Mech. Eng.	Inst. Mech. Eng.	UK	b	N	b	-	-	ne, T, (J)
Int. J. Heat & Mass Transfer	Pergamon	UK	b	S	b	-	b	ne, T, -
J. Mec.	Gauthier-Villiers	Fr.	b	S	f	-	f	ne, T, -
J. Fluid Mech.	Camb. Univ. Pr.	UK	b	S	b	-	-	ae, T, -
Solid-State Electron.	Pergamon	UK	b	M	b	-	b	ne, -, -
Meas. & Control	Inst. Meas. & Control	UK	b	N	f	-	f	ne, (T), -
Literature								
Engl. Stud.	Swets & Zeit.	Neth.	e	M	e	-	-	fn, T, I
Mod. Lang. Rev.	Mod. Hum. Res. Assoc.	UK	e	M	e	-	-	fn, T, J
Essays Crit.	Editors	UK	b	M	e	-	-	ne, T, I
J. Mod. Lit.	Temple Univ.	US	b	A	b	-	-	fn, T, J
Mod. Philology	Univ. Chicago	US	b	M	e	-	-	fn, T, J
Am. Lit.	Drake Univ. Pr.	US	b	M	b	-	-	fn, T, J
Bibl. Hum. & Renaissance	Libr. Droz	Switz.	e	S	e	-	-	fn, T, J
Crit. Lett.	Inst. Graf. It.	It.	b	A	-	-	-	fn, T, J

Subject/ Journal	Publisher	Country	Author's name	Xian. names	Author's affil.	Author's biogr.	Author's address	Ref. system
Dtsch. Viertel-jahrschr. Lit. & Geist.	Metzler	W. Ger.	b	A	-	-	b*	fn, T, J
ELH	Johns Hopk. Pr.	US	b	A	e	-	-	ne, T, I
History								
Past & Present	Past & Present Soc.	UK	e	A	e	-	-	nf, T, -
Hist. J.	Camb. Univ. Pr.	UK	b	M	b	-	-	nf, T, J
Econ. Hist. Rev.	Econ. Hist. Soc.	UK	b	M	e	-	-	nf, T, (J)
J. Am. Hist.	Org. Am. Hist.	US	b	M	f	f	-	nf, T, J
J. Econ. Hist.	Econ. Hist. Ass.	US	e	M	e	-	-	nf, T, J
Soc. Hist.	Univ. Ottowa	Can.	b	A	f	-	-	nf, T, J
Hist. Z.	Oldenbourg Verl.	W. Ger.	b	A	-	-	B	nf, T, (J)
Byzantinische Z.	Beck Verl.	W. Ger.	b	S	-	-	b*	nf, T, -
Cah. Hist.	Com. Hist. Cent. Est	Fr.	b	M	e	-	-	nf, T, J
Speculum	Med. Acad. Am.	US	b	S	e	-	-	nf, T, J

<u>KEY</u>

b	at beginning of paper
e	at end of paper
f	footnote
B	at beginning of issue
E	at end of issue
*	place name only
( )	sometimes given
+	with photograph
–	not given

Christian names:

A	always given
M	given in most papers
S	given in some papers
N	never given

References:

n	numbered
a	arranged by author
T	title of cited paper given
J	full journal title given
I	initials of journal title given

R E F E R E N C E S

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