

COMMUNICATION AND ENGLISH LANGUAGE DOMINANCE IN  
THE INTERNATIONAL SCIENTIFIC PERIODICAL LITERATURE\*

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INTRODUCTION

Definitions

Science is regarded for the purpose of this paper as an international process through which universal knowledge is understood, discovered and invented. It stands distinct from technological or applied processes or from the discovery or creation of particular knowledge. Individuals who participate in the search for scientific knowledge come from social formations in which language is one of several constructs with the potential to create boundaries and thus to segment the scientific enterprise.

Science is necessarily based on national, regional and local institutions as well as particular international ones. These institutions may differ in the languages individuals in them use to communicate scientific information. Thus the individual scientist's language selection and language use form the basis for communication patterns (production and management norms and processes) which develop, or fail to develop. Thus general processes that result in particular kinds of language selection and language use become important foci for understanding scientific communication.

Such communication may involve both a particular language, which is needed to express something unique to that language and to the group of members which share it (e.g., English or German literature), or an international language to share the search for principles of, say, esthetics in literary evaluation. The language selection and uses that serve this latter enterprise will reach beyond local and national boundaries to include regional and international languages and will generate their own rather more international characteristics and conventions of communication.

Language selection is to be understood in this context as referring to choice of language, i.e., of endogenous, regional, or a language of wider communication, while language use is to be understood as referring to the discursal, stylistic and other characteristics of language used to express scientific content. Language use in particular languages may or may not exhibit the same characteristics.

Thus, science is normally a cooperative activity based on international communication networks which link a group of scholars into an invisible college that is held together by the exchange of scholarly thought, privilege, and much else (see Chubin 1985). It is also held together by the scholars' use of shared language and languages, which is our concern here. If the languages are not shared by the scholars, access to the means for the use of language(s) that give that individual access to the network can be through the use of hired translation skills. If direct individual access to colleagues or other scholars' writing is not available, then there is, at least, access mediated by information banks, abstracting services, information digests, etc. From this it is apparent that the individual scholar's links to networks both as a producer and user of texts/messages may be more or less direct and more or less personally interactive, whether with other scholars or with information specialists.

Scientists may participate in more than one network. The language demands placed on individuals as well as their solutions to the language demands may vary in each network. Networks may well coexist and overlap within the same area of study, field of work or discipline. A discipline is constituted in such a way that individual scholars from different networks share the same disciplinary journal outlets, compete for the same research grants, and employment opportunities, such as research in industry, teaching at universities, etc. and participate on occasion in the same international conferences.

#### Problem

The development of science and the training of scientists is facilitated when there is a high level of communication of scientific information (cf. Pool 1982:90). It is therefore a matter of some importance how science information is communicated and if there are barriers to communication, what these barriers are and how they may be overcome, especially in regard to the role that language plays in the science communication process. For the individual scientist, it requires energy to actively belong to a network of communicating scholars. Language differences that intervene between potential network members can form a significant additional obstacle to active participation in the kinds of information exchanges that maintain these invisible colleges of scholars. An understanding of how scientists communicate and the extent to which language is a barrier to communication might aid in the development of strategies to deal with the problem.

#### LANGUAGE AS A COMMUNICATION BARRIER

##### Language Bias in the Literature

English Language Dominance. The extent to which English is the dominant language in scientific communication can be seen from some surveys conducted on languages of articles contained in major abstracting services. For instance Wood (1967) found that nearly half the literature abstracted in Chemistry, Mathematics and Medicine was in a language other than English, while Biology,

Physics and Engineering abstracted about 20-25% in a non-English language (see Table 1). Wood predicted that

as the under developed areas (three quarters of mankind) catch up technologically..., it seems likely that the proportion of foreign language literature will increase rather than decrease. (1967: 117)

Language	Chemical Abstracts	Biological Abstracts	Physics Abstracts	Engineer Abstracts	Index Medicus	Math Reviews
English	50.3%	75.0%	73.0%	82.3%	51.2%	54.8%
French	7.3%	3.0%	4.0%	2.4%	8.6%	7.8%
Russian	23.4%	10.0%	17.0%	3.9%	5.6%	21.4%
German	6.4%	3.0%	4.0%	8.6%	17.2%	8.7%
Japanese	3.6%	1.0%	0.5%	0.1%	0.9%	0.7%
Chinese	0.5%	1.0%	0.1%	0.0%	0.4%	0.2%
Other	8.5%	7.0%	1.4%	2.7%	16.1%	6.4%

Table 1: 1965 Language Breakdown of Literature Indexed in Six Major Science Abstracting and Indexing Publications (Wood 1967: 119)

Baldauf and Jernudd (1983b) replicated this aspect of Wood's study using 1981 abstracts to determine if the changes Wood predicted had occurred. As Table 2 indicates, the proportion of articles in English has dramatically increased since 1965 while in general the proportion of articles in other languages has declined. In the two abstract databases which are most equivalent over the sixteen year period, Chemical Abstracts with CA Search and Mathematical reviews with MATHFILE, the use of English increased from 50.3% to 66.95% and from 54.8% to 69.3% respectively.

Language	CA Search	BIOSIS	INSPEC	MEDLINE	MATHFILE
English	66.9%	85.7%	84.6%	73.1%	69.3%
French	1.9%	2.1%	2.0%	4.0%	4.8%
Russian	12.7%	3.9%	3.8%	5.9%	18.1%
German	5.5%	2.5%	3.9%	5.5%	3.6%
Japanese	9.9%	1.9%	1.5%	3.0%	0.3%
Chinese	0.9%	0.2%	0.6%	0.7%	0.5%
Other	2.2%	3.6%	3.6%	7.8%	3.4%
TOTAL N	252,409	300,024	167,618	258,941	35,907

Table 2: 1981 Language Breakdown of literature Indexed in Five Major Science Abstracting and Indexing Publications (Baldauf and Jernudd 1983b)

Baldauf and Jernudd (1983b) also examined the database MATHFILE by language over a seven year period. While English language articles increased proportionally to the total for each year using 1973 as the base line year, Russian, German and Japanese language articles were relatively stable in absolute terms. This data suggests that while the English language is becoming proportionately more dominant in the scientific literature, there continues to be a large and relatively stable non-English language scientific literature. As the following section on database selectivity suggests, studies such as these which are based on databases are selective and often biased in favour of English language publications. Thus the extent of the non-English language literature is undoubtedly underestimated.

Language Selection within National Boundaries. The dimensions of the language problem are not just between English and non-English language using scientists. Scientists working in a particular language area also tend to cite more articles from their own language than do scientists from another language area. For example Louttit (1957) analyzed the citations taken from the 1952 issues of journals in psychology, chemistry and physics. As Table 3 shows English and German-speaking scientists made a high proportion of citations to work in their own language. For the French, the trends were more diverse, but nevertheless the French cited French language sources more frequently in their articles than did Germans or English speakers.

Language of Publication	Language of Citations %			
	English	German	French	Other
<b>PSYCHOLOGY</b>				
English	92.5	5.2	0.7	1.6
German	2.7	91.1	6.2	0.0
French	25.6	7.4	64.0	3.0
<b>CHEMISTRY</b>				
English	79.4	11.9	4.7	4.0
German	22.8	64.0	6.2	7.0
French	36.7	27.9	29.1	6.3
<b>PHYSICS</b>				
English	86.2	5.9	2.0	5.9
German	33.5	58.1	1.4	5.2
French	49.8	15.3	30.7	4.2

Table 3: 1952 Language of Citation by Language of Publication

To take another example, Lange (1985) has examined the language of citation for the theoretical sections of psychology journals in four countries. In the Russian journal, 10 percent of the articles cited were in English, in the two American journals 89.1 and 94.2 percent of the articles cited were in English, while in the two German language journals the percentage

of citations in English were 38 (GDR) and 69.4 (FRG).

In an other example with a somewhat different focus, twenty-six matched pairs of English-French articles from the International Journal of Psychology were examined. French language articles contained fewer references (459 to 618) than English language ones. Only 66% of the French language articles' references were in English while 96% of the English language articles' references were in English (Baldauf, 1986). In the period between 1969 and 1984, 78 external citations were recorded for the French language articles whereas 171 were found in SSCI for the English language ones. Eleven of the twenty-six French language articles had no external citations whereas only six of their English language counterparts suffered the same fate. Self citation rates were similar and accounted for an additional 18 and 22 citations in each group respectively (Baldauf & Jernudd, 1986). These data strongly suggest that there is a significant disadvantage in publishing a cross-cultural psychology article in French rather than in English, at least in terms of citations.

Large (1983) cites a number of other instances from German, Spanish and Soviet journals of the language-citation pattern of citation. However, this phenomena may apply only to scientists working in international languages. As we note later in this paper, the citation patterns of many Scandinavian Psychologists are not that different from their English speaking colleagues. These studies indicate that the universality of science which we often take for granted is undoubtedly segmented by language and language selection.

#### Database Selectivity

The relationship between scientist-writers and the world of publication has increasingly become subject to the ability of databases to register, sort, store and distribute their findings. However, databases are selective and Garfield makes it quite clear how this selectivity works for Current Contents and for the Social Science Citation Index. In order to keep costs down the editors of Current Contents and other ISI publications try to select the high impact journals. The "objective is comprehensive coverage of the world's most important journals" (1985, p. 6) from among all those available. This we are assured is a hard and painful process as editors and readers all believe that their favorite journal should be among those selected.

Garfield indicates how this selection policy is related to a consideration of geopolitical and language issues in the following quotation:

Another problem in journal selection is language. We do cover a large number of foreign-language journals. Here the presence of informative abstracts or summaries is essential. It is absurd for scientists in any country to expect colleagues abroad to be able to read all of the exotic languages in which original data can be reported.

Geographical representation is another consideration in adding foreign journals. Unless the journal is exceptional, we are unlikely to cover a publication that would be of interest to only a small region of the world. As mentioned in an article on Third World research (Garfield 1983), we know that the best papers from most developing countries are published in international journals. So, given the choice of two journals in the same area, we will choose the one with international representation. This may present a hardship to Third World publications trying to enter the international arena. (Garfield 1985, p. 8-9)

While we may take exception to calling languages other than English 'exotic' or to the self-fulfilling prophecy inherent in Garfield's statement that 'the best papers' are published in some journals, we must ask whether he is, as a matter of scientists' behaviour, right? What do such selective policies mean in practice? Byrne indicates that even a "novice on-line searcher in Australia [soon realizes] that not all Australian journals are indexed in any overseas database..." (1983, p. 10). In his article he demonstrates how a national literature can be 'lost' when searching for articles in databases. For example, in Australia, 16 Educational journals are published, but only 7 or 44% are listed in ERIC. In the area of language and literature the problem is even worse with only 5 of 16 titles or 31% being listed in the Arts and Humanities Index and 4 titles or 25% listed in the MLA Bibliography (Byrne 1983, p. 11-12).

The German-speaking parts of Europe provide another example of how major databases exclude information. The Zentralstelle für Psychologische Information und Dokumentation provides the most comprehensive documentation of German-language psychological literature in the world. Part of this service includes PSYINDEX, a German-English database of German-language psychological literature containing over 20,000 references since 1977, only about 10% of which are found in PsycINFO (Becker, 1984). Clearly PsychINFO is far less comprehensive in some areas and exhibits far more language bias than native English speaking researchers who rely on it would like to think.

While Garfield firmly believes that the databases published by the ISI cover nearly all the important, high impact scholarly work, many articles clearly are not covered. Increasingly, databases staff, rather than editors or scholars themselves are becoming gate keepers to what is communicated in the scientific community.

It is therefore already likely that the patterns of citation and inclusion of articles in a database has had an impact on the structuring of scientific communication, by reinforcing the use of English and publication in 'international' journals. National databases in communal-national languages (as e.g. Japan and Japanese) may to an extent balance the force of the American and/or internationally oriented databases, but the outcome of such balancing for national purposes of communication and control of knowledge is by no means clearly discernible.

## Approach

The examples cited in the previous sections indicate to us that language is a problem in scientific communication both within and amongst the invisible colleges of scholars and scientists. Scientific communication and the related problems of an ever increasing journal literature are being examined by the new field of scientometrics which has as its focus of concern the quantitative features and characteristics of science and science policy. Two major language oriented perspectives have emerged from a review of the literature in this field (Baldauf and Jernudd 1983b). First, that of the information specialist can be exemplified by Large (1983:ix) who claims that "the foreign-language barrier probably poses the biggest current obstacle to scientific communication," and proposes to solve the problem through computer-assisted translation. This suggests that the information specialist believes that the problem is one of access to information and adequate resources to do that job properly. Furthermore, individual scientists are the best judges of what constitutes good science.

Second, that of the information analyst who sees language and communication barrier as one which can be solved through a better allocation of resources. In this regard Garfield, who initiated and directs one of the world's major data bases of science information, has claimed that "the main problem today is information overload" and that this can be dealt with by identifying "the more significant, high-impact research within the mass of scientific literature" and by eliminating "25 percent of published material [that] is unwitting duplication" (Australian 1986). This suggests that the database editor believes the problem is one of increasing the quality of scientific content through selection at points of information transmittal.

We take another approach to this problem which is the one taken by linguistic scientometrics. We are interested in the wider aspects of language management, education and communication processes within the invisible colleges of scholars, but with an emphasis on individual choice, and language correction, and with explicit attention to variation, as aspects of the problem. The purpose in this approach is to seek an understanding of how language selection and use manifest themselves in various disciplines and what language correction procedures are being tried to solve such problems as may be recognized in the relevant networks and communities.

The processes of scientific communication occur in an environment which can conveniently be characterized as a multidimensional space of interaction between "components" of ways of speaking and writing. From the many possible components, the authors have chosen to focus on varieties of language and specifically on language selection for articles that have been published in internationally noted science periodicals. We have also examined the opinions of some scientists in selected disciplines and networks, as participants and as individuals engaged in at least some limited acts of language management directed at writing for publication. We have also relied on scientometric findings by some other investigators mainly concerned with periodicals as channels of communication.

The data collected by us strongly suggests that language selection poses a barrier to communication in science and that members of smaller language groups, those other than the international or major regional languages, bear most of the burden of communication imposed by the constraints on language selection. We feel this is true because non-English speaking scientists themselves have indicated (Jernudd and Baldauf 1987) that the burden of communication in English poses a significant language problem which may even amount to feeling subject to deliberate domination (Carvalho 1986:69). Let us now examine briefly some aspects of this problem from several different areas of scientific endeavour.

#### LANGUAGE SELECTION IN FISHERIES

In a study which looked at fisheries networks, Jernudd and Thuan (1983) found that information flow from the individual fisherman, wholesaler, shop keeper, and customer to the "scientist" is severely deficient and probably significantly hindered by the lack of a shared medium of communication (whether in "language", "discourse" or "terms") and a lack of institutional structures to enable such vertical communication to prosper. They found that there is even a lack of competence in endogenous ways of speaking by specialists. Groups of people who do not share an interest, indeed, who often stand in antagonistic relationships, find it difficult to form integrating networks of communication exchanges (cf. Lara 1986:95). Given the assembly-line nature of many tasks in contemporary society, communication gaps are likely to occur unless made an explicit goal.

In another study (Baldauf and Jernudd 1983a) a cross-sectional examination of the fisheries literature for 1978 was made to see how language selection patterns were related to communicating research information. An analysis of 884 articles, 75% of which were in English, indicated that despite the dominance of English as an international communicative medium, there was a strong national language usage pattern. National language usage was not confined to local fisheries problems, but cut across issues of international importance. For most of the articles the language of publication was directly predictable from the first author's country of residence. However there was a mismatch between these variables and about ten percent of the sample which indicated that there was language selection occurring and that individual cases needed to be studied. An interesting side light to this study was that English language publications were being abstracted significantly more quickly than non-English ones. This finding again emphasizes the importance of language selection for accessibility to the literature.

In an follow-up study of language use patterns of fisheries using the same database, the Aquatic Sciences and Fisheries Abstracts (ASFA), all the abstracts found under the subheading of "Fishable Stocks" were examined for a 32 month period to identify mismatches between the language in which the article was published and the language normally used in the country in which the author resided. For the 32 month period, 2215 articles were found of which 310 or 13.9 percent were classified as article



containing language-residence mismatches. These abstracts were then more closely examined to remove those authors whose choice of language of publication could probably be attributed to the 'required' use of English as a medium of wider communication in international forums. The remaining abstracts seemed likely to be a sample of those authors who had chosen to make a language of publication choice, and they formed the basis of our survey sample. An analysis of this survey data is currently under way.

#### LANGUAGE SELECTION IN CROSS-CULTURAL PSYCHOLOGY

Another approach to studying language selection is to look at the proportion of articles cited by authors in various languages to get a feeling for the languages authors read. For example, for the five years beginning in 1978, four journals concerned with cross-cultural psychology published 338 articles with 8,489 citations. "Ninety-seven percent of these articles were in English. Although citations were found in 16 languages, an English speaker with French, German, Spanish and Hebrew as additional languages could read 99.5% of the literature" (Baldauf, 1986, p.221).

This data suggests that in the field of cross-cultural psychology, the English language barrier is even greater than in most disciplines. Malpass, when examining the same articles but focusing on nationality, was able to report that when comparing author nationality in the Journal of Cross-Cultural Psychology for the years 1970-1979 and 1982-1984 that "there [was a significant] increase in the percentage of authors from Africa, East Eurasia, and South America, with a corresponding decrease in authorships from North America" (1985, p.4-5) in the latter sample. Whether this indicates there is an increasing participation by more non-native English speaking authors who are now publishing in JCCP compared with previous years is debatable. A study of JCCP articles for the years 1978-1982 found that only 102 of 325 authors who published in JCCP lived in non-native English speaking countries. All but ten of these were in English language situations or had developed clear and often multiple English language connections and/or language coping strategies (Baldauf, 1986). These studies suggest that without individual efforts to develop contacts, non-native English speakers face a real barrier to participation in the community of cross-cultural psychological scholars because of its English language domination.

#### LANGUAGE SELECTION BY SCANDINAVIAN PSYCHOLOGISTS

##### Journal Selection Issues

The structure of communication in Scandinavian Psychology we believe provides another illustration of the language selection problems and of patterns of language use found in the journal literature which scientists, from many multilingual nations where an international language is not spoken as a first language, face. Ulrich (1982) lists six Scandinavian journals with Psychology as their primary field of emphasis. Two of these periodicals are published in English and the other four in a Scandinavian language(s). The Scandinavian Journal of Psychology

(SJP), which is published in English, serves by implication as a major international outlet for Scandinavian psychologists. As a matter of policy, the SJP does not reprint articles including Scandinavian language articles originally published in other journals listed in Psychological Abstracts. Therefore, Scandinavian psychologists must, because of both journal policy and language constraints make language selection decisions and choose the audience they wish to reach.

Options for publication in psychology in Scandinavia are not only limited to the six periodicals located in Ulrich. An analysis of the curriculum vitae of 25 Scandinavian psychologists with a total of 846 publications revealed fifty-two distinct Scandinavian publication outlets and ninety-two 'international' outlets. Of the fifty-two Scandinavian outlets, eleven were judged by the authors to be 'final' publication outlets while the rest seemed to reflect publication for more 'popular' or collegial audiences (Jernudd and Baldauf 1987).

To document which languages were used by Scandinavian psychologists to participate in the international scientific communication process, Baldauf and Jernudd (1985) tabulated all the individual citations by authors publishing between 1979 and 1984 in SJP by language. While there is some variation over this five year period, nearly 94% of all articles cited are in English. The figure for self-citations is 95%. These article citation percentages are very similar to those found for the cross-cultural psychology journals examined in the previous section. A major difference, however, is that in the case of the JCCP only 38% of authors come from countries where English is not the native language whereas 88% of SJP authors come from similar countries.

The SJP data for 1984 represents a somewhat different picture of psychological studies in Scandinavia since the editors initiated a series of invited review papers to "afford the international scientific community valuable inroads to and surveys of Scandinavian research which might otherwise be difficult to obtain" (Larsen and Magnussen, 1984: 1). Four review articles were published in 1984. One article contains 116 of the 252, or 46% of the citations to Scandinavian language psychological literature for the 1979 to 1984 period. The editors go on to say that "psychological research in the Scandinavian countries has seldom been reviewed in depth, and never to an international public (1984: 1). These statements highlight another important aspect of the language problem. Communication is a two way process. Not only must Scandinavian psychologists make language decisions for themselves (and prior to that, decisions about direction of dissemination and reach), but psychologists in other countries must decide whether they believe the English language literature that is available on Scandinavian psychology adequately represents the Scandinavian repository of psychological information and knowledge.

#### Scandinavian Psychologists Views of Language Problems

These issues were addressed in another way by sending questionnaires out to a selected sample of Scandinavian Psychologists who had published an article in SJP (see Baldauf

and Jernudd 1985), twenty out of a total of 29 respondents offered comments in addition to answering specific items on our language use questionnaire. While eight of them gave answers that imply a degree of at least regret that a foreign language has to be used for some scientific communications, the remaining twelve simply described the conditions under which one rather than another language may be preferred. An interpretation of all the comments suggests three sets of reasons for language selection: (1) a set of general constraints, (2) a set that motivates preference for selection of Scandinavian languages, and (3) a set that motivates preference for the selection of an international language (see Jernudd and Baldauf 1987).

These constraints were confirmed by one of the questions in the questionnaire which asked whether the respondent normally publishes certain reports, articles or monographs in English and others in some other languages, and invited comments. A 'yes' response was given by two-thirds of the respondents. Thus, respondents introduced domain distinctions involving language selection. Taken together, this data suggests that "scientific" articles are written for an international audience and therefore in an international language -- in their case, English -- and that "popular", "reporting", and "debate" writings are produced for a domestic audience and therefore in a national language -- in their case the Scandinavian language of their literate community. The bibliographical details provided some additional information on language selection. First of all, we found that publishers of books, monographs and periodicals publish in English for an international audience when they are located in Scandinavia. Second, there is a hierarchy of periodicals published in Scandinavia as outlets for psychologists' writings that can be characterized as more or less internationally oriented as well as being more or less oriented to a broader readership than the disciplinary specialist. Thus, language selection is related to differences in intended audience or purport of the article as factors in variability in the periodical literature.

In the context of our questionnaire and bibliographical data, the detail that can be sifted out suggests that (1) it is only in Scandinavian-based publications that there is language selection: external publishing is done almost exclusively in English, and that (2) English is chosen for a larger number of articles in Scandinavian-based publications than Scandinavian languages. These English language publications are distributed across a number of different outlets, such as the Scandinavian Journal of Psychology (50%), contributions to various institutional report series (32%), dissertations, other Scandinavian English language internationally directed periodicals such as the Scandinavian Journal of Behavior Therapy, Acta Neurologica Scandinavica, etc., proceedings, a Festschrift and more or less specialist edited volumes and monographs. Interestingly, there are reports to the Swedish Defense Research Institute in English. Presumably the contents of these reports are directed mainly at a scientific specialist audience external to the Swedish-reading one or are routinely produced according to this audience's norms of scientific communication, or are written in English for other reasons (e.g., "prestige" is often cited as one such reason although here priority of registration in public of findings may

play a role).

There are of course also research reports and articles on original scientific work in Scandinavian languages. However, the "popular" category as used by the respondents would [incorrectly] exclude such content. One explanation for the discrepancy may well be a deliberate professional norm to go public in English and not in a Scandinavian language with findings in disciplinary work that are ready for collegial interchange and evaluation, quite regardless of whether preliminary, progress or simultaneous reporting takes place in Swedish to scientific-professional and/or other readers in the local, national and regional (here Nordic) networks. The fact that the Scandinavian Journal of Psychology coexists with the journal Nordisk Psykologi and other psychological journals is a direct outcome of balancing points of view on scientific communication in the profession. Professional news, administrative reporting and so on are naturally expressed in a Scandinavian language.

The data and examples presented in these sections raise the question of whether a general structure for language selection for communication within scientific disciplines can be generated. A model for language selection in scholarly communication will apparently have to accommodate differences between disciplines and the networks which constitute them in regard to language selection by kind of communicative act. It will also have to look at the type of language community from which the communication emanates and the range of individual language skills available to community members. Also, the influence of databases and other information filters will need to be acknowledged.

#### DEVELOPING A GENERAL MODEL

In an earlier section of the paper, we examined the nature of language as a barrier and some current strategies being used to cope with the problem. In each case, particular perspectives were utilized to evaluate science information exchange networks, but these perspectives were not made explicit. For one thing, there was no attempt to separate issues of production of texts and their correction from access to and use of scientific texts. Thus, neither approach, in our opinion, dealt adequately with the language related and text production aspects of the problem of scholarly communication, e.g., the issue of the individual scholar's problem of language choice within various constraints. Both approaches focused on the research product, whether on translating or editing it, to provide a service to scientists who it is assumed wish to access it. Linguistic Scientometrics, however, is process and individually oriented. We would argue that if one could understand the process by which the individual scientist makes choices, language correction procedures could be developed to improve communication, information exchange and presumably specific language "products".

In searching for a general process oriented model, we have proposed a number of factors that may be important. First, there is the TYPE of community in which the scientist lives, considering the pervasive characteristics of the communicative system and the degree of development of the endogenous language

in particular. Next there are the INSTITUTIONAL and NETWORK constraints within which a scientist lives and works. These factors can taken together predict the limits of individual freedoms of communicative selections or the DOMAINS of writing (and speaking) likely to be used. The factors influence language selection and create the basis for satisfying (if not optimizing) scientific communication outcomes for INDIVIDUALS. We would argue that corrective actions based in understanding a system would optimize communication within a scientific community. Each of these factors has been described in more detail in Jernudd and Baldauf (1987) and so we will only review them briefly here.

The sociolinguistic TYPE of language community determines dominant language selection in local, (normally) national and (sometimes) regional institutions, based on the conditions of the communication system in the society at large. It determines what languages individuals normally acquire in their life cycle and what languages they normally use.

In some countries the endogenous language may dominate for most communication while an international language may have special status for "foreign" communications. However, different political systems, in the two Germanys for example, may determine the language orientation (Russian - English) used by German scientists (Lange 1985). In post-colonial communities that are now modernizing, there may be a degree of transition from the previously colonially dominant exogenous language to general use of an endogenous language. Another possibility is that a regional language norm may rule language selection for reporting to regional organizations, in regional meetings, etc., i.e., Arabic. Although Arabic would normally be used for regional cooperative work in the Arab world, respondents to a survey of fisheries experts (Jernudd and Baldauf, mss) from around the world focusing on language selection for articles in periodicals, indicated that an exogenous language, normally English or French, is the usual language for all professional communication in this region.

These examples merely indicate the importance of TYPE. An important task is to develop a global typology that can be used as a criteria to analyze the particulars of communication system changes and to begin formulating the processes that form and reform it and that enable or disable language modernization (Jernudd 1987).

INSTITUTIONAL constraints in a particular field of science act as determinants of language selection and use. They serve as foci for behaviour towards ways of communicating, e.g., through formulation of policy, thus of constraint on selection of language. Institutions can be defined as meetings, organizations, research facilities, schools, journals, citation indices, databases, etc. The language policy for submission to and publication within that institution limits the author's options.<sup>2</sup> For example in the field of fisheries international organizations such as the ICES figure very prominently in European fisheries experts' replies to questionnaire data we have collected, and their matter of fact replies about language selection are that one can use French, but one uses English if one wishes to be read (and heard).

Thus, in a model, the INSTITUTIONAL framework determines language selection in the case of meetings, work with specific organizations, context of agency authorizing work, publications policy, and educational and other sectorial users of the pertinent content. It is a matter of empirical work to specify institutional characteristics, their force in shaping communicative behaviour, and their elasticity in responding to changing communicative circumstances or explicit demands.

It is also likely that the pull of international and regional norms of communication, together with a compartmentalization into specialized outlooks in contemporary society, channels many professionals away from broader engagement in their societies. This tendency towards disengagement maintains and sharpens the contrast between the "scientific" and the "popular" DOMAINS of science communication that we have previously mentioned. It is important to make explicit that selection of language necessarily implies choice also of language use (discoursal) strategies peculiar to the communicative conditions for which the selection is made. Communicative behaviours and ways of writing bundle together and are mutually interactive according to the DOMAINS of use. Institutions normally "set the terms" for these components of communication. There are few individuals who are free agents.

The NETWORK can be seen as a framework that also determines language selection and enables communication among specialized colleagues, as mediated by the institutional framework, and perhaps also networks that include research managers and funding agents. Professional interests, both in science and in the personal spheres of life, and also in terms of job security and standing in society may also define collegial networks.

If there are domestic periodicals and if there is a domestic readership of sufficient size, contributions to discussion and disclosure of fact may be made in a local or regional language. This may run counter to the common assumption among scientists, who avoid participation and even prior publication in local networks, that the more highly desirable specialized networks are only available supranationally and therefore through international languages. Funding and professional support NETWORKS can operate in either local, national, or international groups and language selection would be made accordingly.

INDIVIDUAL variation then is determined in part by the opportunity to acquire proficiency in languages of wider communication as well as local, national, and regional languages. There are also individual opportunities for choice of language and acquisition of competency that may be available to scientists in a number of different working situations.

Some specific examples of factors which may influence individual opportunities include an individual's political orientation; the "inherited" practices of disciplinary language use; the sources of availability of grants, and exchange opportunities; policy and practice concerning language use in journals and international organizations, international conferences etc.; the career orientation of the individual scholar; the community language situation (modernized, post-

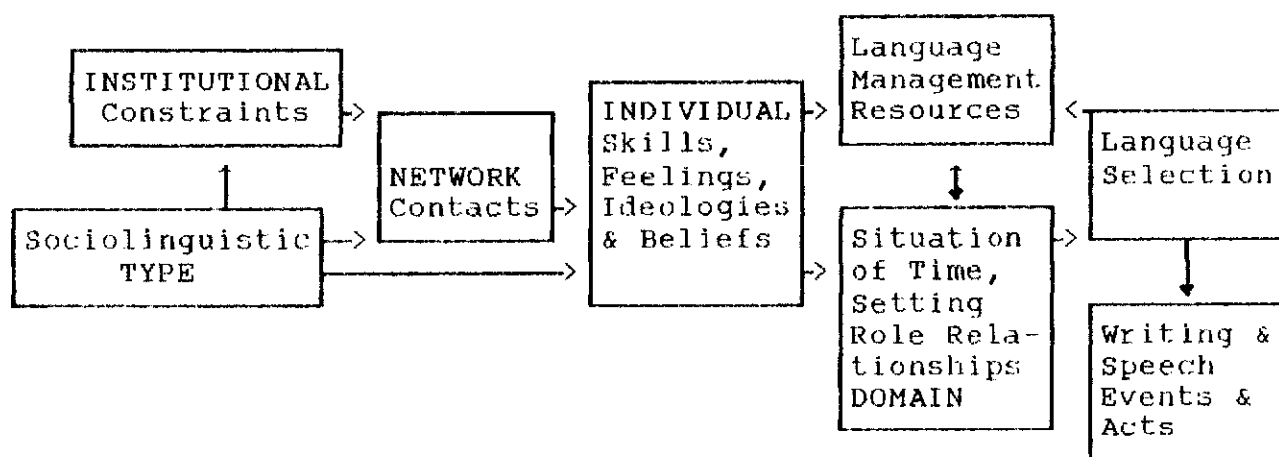
colonial, etc.) in which the scholar works, e.g.; and the status of languages other than the vernacular in education.

Of course, the availability of editing and translation services, which may render unnecessary development of individual ease of use of a wider communication language, through the degree of integration of the individual scientist in institutions and networks which demand use of particular languages, can be effected by individual decisions. This latter factor is interestingly reflected in responses to our questionnaire when a person, e.g., declares that since English is the language of European fisheries, s/he might as well write everything in English -- unless of course special reasons demand otherwise.

#### A Linguistic Scientometric Model for Science Communication

The preceding discussion illustrates that language selection for communication in a scientific discipline involves a number of variables. Figure 1 presents, from a linguistic scientometric perspective, an abstract representation of a model of the role of language in scientific communication.

FIGURE 1: Model of Language Selection in Scientific Communication



<Sociolinguistic Macro Level> <Individual> <Sociolinguistic Micro Level>

Briefly, the model suggests that the sociolinguistic TYPE of a community will at a minimum influence the individual skills that are developed, and that individual differences together with the pervasive characteristics of language use in the TYPE will contribute to determining language selection decisions. INSTITUTIONAL constraints and/or NETWORK contacts will often intervene between TYPE and the individual in selection decisions, as will the availability and use of language management resources (e.g., library and database services, translation services, language editors, etc.). The factors interact with the DOMAINS in which communication of scientific information can occur. Taken together we believe that a study of the model's components and their interrelationships will help us to better understand

the role language plays in the way scientific information is communicated.

### IMPLICATIONS FOR SCIENTIFIC COMMUNICATION<sup>3</sup>

A starting point in planning science communication would seem then to be a description of the present state of affairs and a projection of requirements for the satisfactory functioning of the ideal state through the joint participation in these processes by scientists, communication and language experts and by community representatives. The description would seek data very much in the manner exhibited in the previous sections of this paper. It would relate to the description of and take into account the processes whereby individual scientists generate and correct communicative behavior.

The apparent but theoretically unproven advantage of use of languages firmly grounded in one's community and especially of languages acquired and used as a matter of course for creative and social expression also for the purposes of science and work would have to be taken into account in the planning process. Acquisition and training in other languages must necessarily be seen against the backdrop of social, political, technological and other communicative relationships between the scientific networks and other networks. Planning fortunately decomposes into component choices by competing and cooperating interests. Thus, the planning process holds out a promise of self-improvement and the deliberate coordination and increased knowledge of what others do assist the system in realigning individuals within it.

#### Developing Individual Skills

When looking at procedures for developing individual skills, people's feelings, ideologies and beliefs are very important in guiding an individual's communicative behaviours while providing a basis for individual evaluations of others' ideologies, beliefs and suggestions -- including suggestions for changes in communicative skills, behaviour and environment. Full disclosure of information and full participation in planning and decision making processes provide the kind of platform and the cooperative socio-political goodwill which forms a basis for scientific and communicative goals being reached.

Services and training in the institution in which the scientist works and in the nation/community in which the institution resides greatly affect the ability of the individual scientists to work through and actually participate in generating texts and to function well in the scientific community in general.

Available services and training available often refer to different stages in the development of a scientist in his/her working life, and to different aspects of language. We can separate out for discussion and planning purposes such events as (a) the teaching of language skills in all their complexity in the schools, e.g., learning effective writing in one's native language or abstracting, and learning to write in a "foreign language" (cf. Barnes 1982), (b) the correction of language use



as a part of training scientists to make informed use of information systems, e.g., use of libraries and data bases, or to pay consistent attention to correctness of expression in reporting research (cf. Barrass 1978) or in answering examination questions, in the schools and at the specialized training institutions, and (c) the specialized teaching of language skills for scientific expression (e.g., all aspects involved in approaching the writing of a scientific article) and access to information in separate training sessions, e.g., scientific writing, terminology, ESP (cf. Swales 1971).

Of course, correction and acquisition may occur through participation and practice, rather than through overt management of correction, e.g., through trainees working as assistants, or through seminars. Furthermore, correction is inevitably present in all interaction (Neustupný 1978) and is communicated appropriately to a greater or lesser extent (collegially, in a non-threatening manner) so that individuals can take action on the basis of the overt evaluation and even seek suggestions for improvement. Modern technologies can greatly assist in the process of correction. Correction processes may differ in international scientific communication and in the popular, professional, etc. domains and acts of communication, between types of language communities, individuals and so on.

Scientists need a variety of language skills because like all people they participate in a variety of communicative situations. They require discourse that supports social skills in foreign languages for interaction with visitors and at conferences, they require writing skills, oral reporting skills etc. The study of a foreign language is not worthwhile unless it is undertaken with a great deal of commitment to excellence (Jernudd & Jo 1986:15). It is no easy task and it takes much time -- this also means that proper foreign language teaching is a very serious vocation that requires very specialized attention, significant allocation of resources and constant self-improvement by its practitioners. It may come as no surprise to this audience that a key American observer of the Japanese scientific and technical fields recently expressed surprise when he "learned that only about 400 Americans who are scientists or engineers are studying Japanese in the US." What may be surprising is that he continued his comment with: "Even that number sounded large to me." Why? Because he feels that "the serious professional study of Japanese is not for everyone... It should be undertaken only by those who are committed essentially to a lifelong interest in Japan, and in fact, the Japanese people and the Japanese culture." (Bloom 1986:38)<sup>4</sup>

The need for individual language skills will remain whether or not there are changes in the allocation of resources for work in science or for interpretation of science results. For one thing, the global scientific system is far beyond the reach of rational decision-making about resource allocation. Nevertheless, there is no question but that for one to do what another has already done is inefficient and for one to struggle to do what another can do easily is also inefficient, unless of course one attributes a value to the process of struggling, which is, e.g., the case in training. An obvious ideal solution to these dangers of inefficiency is to make systems of science information

available to individual scientists without encumbrance by individuals' language skills -- wherever they may be. What would be involved in this? What resource constraints or other considerations would shape the process of implementation of even a near universal agreement in principle of ideal availability? As for language, an obvious factor remains the continuing cost of making scientists acquire active and passive command of the small number of international languages that apparently are used to carry most of the pertinent information. Another would be the continuing cost of converting information from one language to another, and yet another would be the inculcation of language skills for "effective" production and reception of information, writing articles and reports which is the focus of this paper, but of course also including skills of use of information systems, especially data banks of various kinds. We have claimed above that language selection in producing texts and language selection for structuring data bases (etc.) are interrelated. In that light, a most modest proposal from a conference on increasing the visibility of work by Third World scientists would encourage editors of journals in other languages than English to have a title page in English to "facilitate the inclusion of their journal in international databases." (Moravcsik 1985:3, 13)

#### Understanding Networks will Help

Networks differ in whether and how their members wish to maintain exclusivity. They may rely on particular methods, particular content, selection of a particular language, and so on. For example, a Scandinavian Journal wishes to represent Scandinavian work, and therefore may only rarely accept submissions from the global scientific community. German psychologists are making extensive efforts to see that their publications are not further 'internationalized', but at the same time are providing better access to the German language materials through a German-English database on German psychological literature (Becker 1984). Further, one network may share one perspective on rules of evidence that does not allow them to accept articles in the network's journal from others with a different perspective. Networks need not but may of course be characterized by its members' residence in a given type of community with its dominant language (e.g., Francophonie, Weinstein 1985) or by its members' shared values (e.g., a working group on language rights that's being formed in 1987). Partly for these reasons, Moravcsik makes recommendations which urge a "study of the editorial practices in international scientific journals" (1986:3, 12-3).

After all, one of the comforts and perhaps even explicit purposes of a network is to allow an individual not to go elsewhere for approval, in search of relevant information etc. As a matter of fact, it could be suggested that it is within the network only that articles 'take on meaning', i.e., are embraced in such a way as to be evaluated, if positively, to be published, if negatively, to be corrected. In the harshest light, writing an article in English doesn't accomplish anything unless it's written in a particular way for the particular readership, including communication of membership in the network (Neustupný, personal communication) in the appropriate fashion, e.g., by a particular pattern of citation. It is indeed ever an assumption

on our part that there are strong interdependencies between all components of communicative situations (until specified to degree), e.g., it is in our opinion reasonable to assume that the selection of language interacts with development of content and style of presentation. It does not follow at all from the fact that a journal publishes mainly in English that the journal is 'an international scholarly journal' in some detached neutral sense -- the journal still represents a network of interests.

#### Developing Better Institutional Environments for Science Communication

The dominance of English is absolute, in specialist science communication, in most regions of the world. In fact, the amount of timely information available in English may increase in specialized scientific communication (cf. Bloom 1986:38 on Japan), further increasing the pressure from English which will inevitably incite reactions, in their own defense by users of languages other than English (cf. Fishman 1987: 46).

It's interesting how Scandinavian psychologists immerse themselves in English situations by spending a sabbatical or training year abroad. This kind of language acquisition can be institutionalized in different ways. Many Japanese companies, e.g., "fully support financially the assignment of some of their young employees to graduate schools in the US. One of the reasons for this, in addition to being exposed to high quality science and technology, is to improve their language capabilities." (Bloom 1986:40) The American Electronics Association is a US pioneer in this regard by "sponsoring language education through total immersion in Japanese for a handful of young engineering students... to working environments in Japan." (Bloom 1986:40) The cost for this is borne mainly by Japanese companies!

The fact that English was chosen for a Scandinavian Journal is interesting as an outcome of professional decision-making, yet, the individual scientists probably conduct most of their work (in the daily routine, in scribbling, in talking...) in their native Scandinavian language. The processes that produce such bilingual usage, multilingual when the fact of use of other languages in reading and sometimes writing is also taken into account, must be studied both at the level of institutional-professional decision-making about maintaining a regionally controlled periodical, at the level of institutional decision-making about the relationship of reports, training etc. to this and other communicative realities, and at the individual level of networking and language correction. A planning process for science communication could then be said to consist in harmonizing these many factors (individual and institutional interests etc.). Successful outcomes from a planning process depends on the engagement in it by representatives of all these interests, and on an iterative process of negotiation (Jernudd 1982).

#### SUMMARY AND CONCLUSIONS

The collection of all the data necessary to understand how all the variables identified contribute to the scientific communication process presents a formidable challenge. Given the

facts of uneven distribution of control and recognition -- of power and solidarities -- in favour of some journals, some databases and one language, English, there would seem to be no doubt about the perpetuation of the current state of affairs and the possibility of its aggravation unless, with regard to language at least, networks of scientists, institutions, communities or states deliberately act in ways that make possible the use of their (other) languages in science communication without hindering such international information exchange that further contributes to the success of their scientific enterprise. Awareness and the saliency of the communication issues among scientists themselves are preconditions for successful action and for meaningful relationships between scientists and others interested in the planning process.

There is a pressing need for the overall study and planning of the development of communication resources in science. As this paper suggests, this is a complex process which can only be slowly implemented. However, if steps are not taken, there is a danger that science in many parts of the world will become even more marginal (Arunachalam and Garg 1985) and that human resources in science will be wasted rather than developed.

#### NOTES

\* This paper was presented to the 12th Applied Linguistic Association of Australia/AILA Congress, Sydney, 17th August 1987. The paper is a review of research published by the authors on the topic since 1983. As such it relies heavily in some parts on previous work (see references).

<sup>1</sup> Language is of course not only an important variable to the author as a writer but also to the author as a consumer. Baldauf and Jernudd (1985) report that for the period between 1979-1983, there were 4049 citations by authors published in SJP. The fourteen most frequently cited journals, which provided 923 citations or 23% of the total, were published in English and twelve of the fourteen came from the United States or England. These figures indicate that, in terms of the volume of material to be read in a second language, there may be a serious language problem for Scandinavian psychologists.

<sup>2</sup> Although not an explicit topic of this paper, style conventions, covert organizational (i.e., discursal) conventions, and even the selection of content, limit both submission to and acceptance in periodicals. Clyne (1987) has described some differences in discourse patterns which sometimes act as a barrier to the exchange of scholarship between two related cultures. This area of language use requires further urgent and intensive investigation.

<sup>3</sup> Science communication involves a great many more activities than merely publishing articles in journals. It involves maintaining and storing data of all kinds, contributing and accessing data, reading articles, manuals and books, meeting and discussing with other scientists, and with donors, administrators and others. It also involves, because the social and communicative systems are intertwined, distributing research

resources, honours and positions, i.e., it involves communication for getting things done in an all-encompassing sense. There are many specialized information relationships, and among these, the one between the scientist and the stores of information is critical. These stores consist mainly of (a) libraries of articles, books and documents, (b) abstract files and services, (c) databases and (d) colleagues and assistants or information specialists. This accessing/reading relationship is fundamental to research and different in many regards from writing and contributing in other ways to information and information exchanges.

<sup>4</sup> "I think most Foreign Service Officers would agree with the statement made earlier by more than one person here that about 10 years of practice are needed before one begins to feel like he could reach the point of being an interpreter or translator. Even then, people are afraid to do either." (Bloom 1986:44)

<sup>5</sup> It is a misreading of this of paper to think that scientists and scholars rely on systematic and exhaustive literature searches. It is not the purpose of the authors' use of bibliographical information to imply that scientists and scholars also use it, in a commensurately intense fashion. The study of the demand for scientific and technical information is a whole enterprise by itself. Just because there's information made available in English from Japan, this doesn't mean that, for example, American scientists make use of it (Bloom 1986:39). The authors merely tap this kind of bibliometric/scientometric information to seek to understand language selection, using this data to gain insights into the functioning of science communication systems.

#### REFERENCES

- Arunachalam, S. and Garg, K.C. 1985. A Small Country in a World of Big Science: A Preliminary Bibliometric Study of Science in Singapore. Scientometrics. 8, 5-6: 301-313.
- Australian. 1986. Science index sparked off in laboratory flash. Computers. 8 April.
- Baldauf, R.B., Jr. 1986. Linguistic Constraints on Participation in Psychology. American Psychologist. 41: 220-224.
- Baldauf, R.B., Jr. and B.H. Jernudd. 1985. Aspects of language use in cross-cultural psychology. Australian Journal of Psychology. 38,3: 381-392.
- Baldauf, R.B., Jr. and B.H. Jernudd. 1985. Academic Communication in a Foreign Language: The Example of Scandinavian Psychology. Paper presented at 10th ALAA Congress, Brisbane.
- Baldauf, R.B., Jr. and B.H. Jernudd. 1983a. Language Use in the Fisheries Periodical Literature. Scientometrics. 5,4: 245-255. Errata Scientometrics 6,1: 67-69.
- Baldauf, R.B., Jr. and B.H. Jernudd. 1983b. Language of Publication as a Variable in Scientific Communication. Australian Review of Applied Linguistics. 6,1: 97-108.

- Barnes, G.A. 1982. Communication Skills for the Foreign-born Professional. Philadelphia: ISI Press.
- Barrass, Robert. 1978. Scientists Must Write: A Guide to Better Writing for Scientists, Engineers and Students. London: Chapman and Hall.
- Becker, J.H. 1984. German-language psychological journals: An overview. German Journal of Psychology. 8: 323-344.
- Bloom, Justin L. 1986. Summary conclusions and recommendations. In E.L. Brady (ed.), U.S. access to Japanese technical literature: Electronics and electrical engineering. Proceedings of a seminar held at the National Bureau of Standards, Gaithersburg, Md., June 24-25. Washington, D.C.: Government Printing Office.
- Byrne, A. 1983. How to lose a nation's literature: Database coverage of Australian Research. Database. 6,3: 10-17.
- Carvalho, Nelly. 1986. Transfert de technologie ou intervention et domination culturelle et linguistique? In C. Rondeau and J.C. Sager (eds.), TERMIA 84. Terminology and International Cooperation. GIRSTERM, Canada. Pp. 66-75.
- Chubin, D.E. 1985. Beyond invisible colleges: Inspirations and Aspirations of post-1972 social studies of science. Scientometrics. 7: 221-254.
- Clyae, M. 1987. Cultural differences in the organization of academic texts. Journal of Pragmatics. 11,2
- Fishman, Joshua A. 1987. Reflections on the current state of language planning. In Udaya Narayana Singh & R.N. Srivastava (eds.), Perspectives in language Planning. Calcutta, Mithila Darshan. Pp. 28-59.
- Garfield, E. 1985. Journal selection for Current Contents: Editorial merit vs. political pressure. Current Contents 18: 3-11.
- Garfield, E. 1983. Mapping science in the third world. Science and Public Policy 10,3: 112-127.
- Jernudd, B. H. 1987. Globalism and language. In Udaya Narayana Singh & R.N. Srivastava (eds.), Perspectives in Language Planning. Calcutta: Mithila Darshan. 11-27.
- Jernudd, B.H. 1983. Evaluation of Language Planning -- What has the Last Decade Accomplished? In Cobarrubias, J. & J. A. Fishman (Eds.) Progress in Language Planning. International Perspectives. Berlin, Mouton Publishers (Walter de Gruyter & Co.): 345-378.
- Jernudd, Björn H. 1982. Language planning as a focus for language correction. Language Planning Newsletter. 8,4:1-3.
- Jernudd, B. H. 1977. Prerequisites for a Model of Language Treatment. In Rubin, J., B. H. Jernudd et al. (Eds.) Language

- Planning Processes. The Hague, Mouton: 41-54.
- Jernudd, B.H. and Baldauf, R.B., Jr. 1987. Planning science communication for human resource development. RELC Regional Seminar, April.
- Jernudd, B.H. and Baldauf, R.B., Jr. ms. Aspects of language choice in the fisheries literature.
- Jernudd, Björn H. and Sung-hwan Jo. 1986. Bilingualism as a resource in the United States. In Robert B. Kaplan (ed.), Annual Review of Applied Linguistics. 6, 1985: 10-18.
- Jernudd, B.H. and Thuan, E. 1983. Control of language through correction in speaking. International Journal of the Sociology of Language. 44,
- Lange, L. 1985. Effects of Disciplines and Countries on Citation Habits. An Analysis of Empirical Papers in Behavioural Sciences. Scientometrics. 8, 3-4: 205-215.
- Lara, L.F. 1986. On the difficult path of terminology in Spanish-speaking countries. In C. Rondeau and J.C. Sager (eds), TERMIA 84. Terminology and International Cooperation. GIRSTERM, Canada. Pp. 66-75.
- Large, J.A. 1983. The Foreign Language Barrier. Problems in Scientific Communication. London, A. Deutsch.
- Larsen, S.F. and S. Magnussen (1984) Reviews of Scandinavian psychology: Editorial introduction. Scandinavian Journal of Psychology. 25: 1-4.
- Louittit, C.M. 1957. The use of foreign languages by psychologists, chemists and physicists. American Journal of Psychology. 70; 315.
- Malpass, R.S. 1985. Editor's notes. Journal of Cross-Cultural Psychology 16; 3-7.
- Moravcsik, M. J. 1985. Strengthening the Coverage of Third World Science: The Bibliographic Indicators of the Third World's Contribution to Science. Eugene, Oregon: Institute of Theoretical Science.
- Neostupný, J.V. 1978. Post-Structural Approaches to Language: Language Theory in a Japanese Context. Tokyo: University of Tokyo Press.
- Pool, J. 1982. Applying conceptual analysis in the 21st century: Design of a computerized system for global translingual communication. In Fred W. Riggs (ed.), The CONTA Conference. Frankfurt, Indeks Verlag. Pp. 85-99.
- Swales, John. 1971. Writing Scientific English. London: Nelson.
- Ulrich's International Periodicals Directory. 1982. A Bowker Serials Bibliography. New York and London.

Wood, D.N. 1967. The foreign-language problem facing scientists and technologists in the United Kingdom - Report of a survey. Journal of Documentation 23(2); 117-130.

Weinstein, B. 1985. Francophonie: Purism at the International level. Paper presented at Conference on "The Politics of Language Purism: A Rhetoric of Authentication". Honolulu, East-West Center. [Available RMC in ICC at East-West Center]