Speaking of Science:
The Use by Australian University Science Staff of Language Skills[1]

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1. Introduction

Scientific endeavour is an international phenomenon that brings together those working in science through professional organisations, conferences, books, journals, and personal contacts to work on common problems and to share ideas and findings. Science is cumulative and thus, despite some rivalry among individuals, sharing and debating the nature of knowledge is essential to scientific progress. Communication and the languages of that communication are, therefore, critical to the proper functioning of scientific endeavour. Those outside the scientific communication links, for whatever reason, find it difficult to participate in cutting edge science. Languages form one possible barrier to individuals′ ability to participate fully in science (Baldauf and Jernudd 1983). As Kaplan and Baldauf (1997: 246f) have shown, this issue is of such national importance that a small number of nations (e.g. Japan, Saudi Arabia, Israel, Taiwan and Malaysia) have undertaken national strategies to solve the problem language poses for information access.
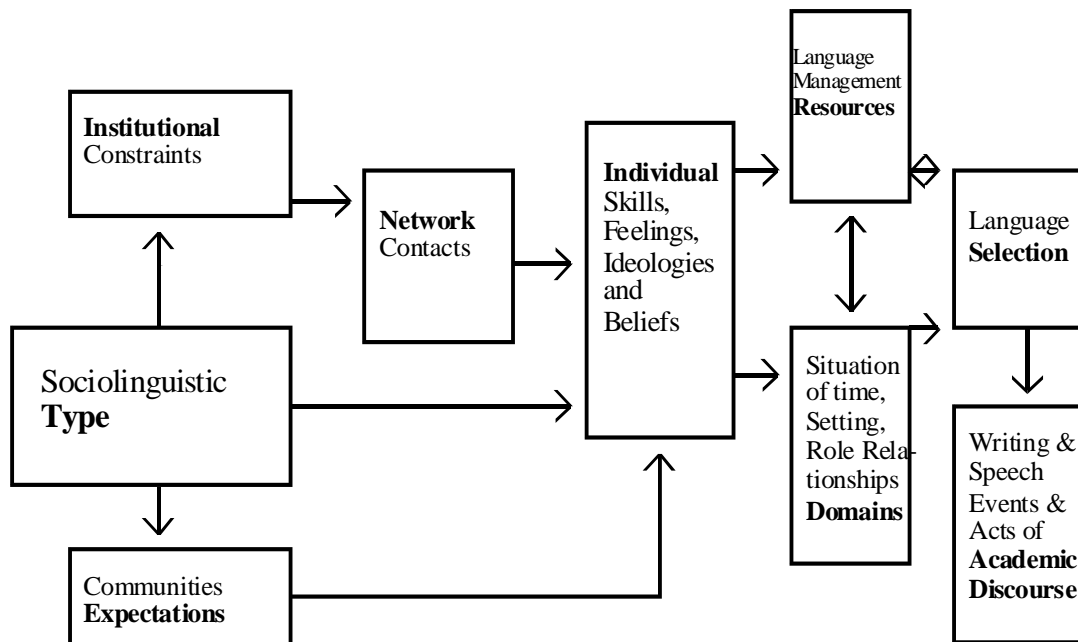
The languages used in scientific communication can be thought of as forming a linguistic ecology. Mühlhäusler (1996: 206-7) has defined such ecologies in terms of

> [...] structured relationships between [the linguistic] co-inhabitants and between the individual inhabitants and components of the ecological support system. [He goes on to argue that] the key property of any ecology is structured diversity [where] diversity is defined not so much in terms of numbers but in terms of the quality of the meaningful relationships. [...] The aim of ecological language planning is to sustain structural diversity.

The notion of a linguistic ecology suggests that a set of relationships exist between languages that are used to communicate and develop meaningful ways of interacting and which may vary across domains. In the domain of scientific communication, Ammon (1998) has shown the degree to which English has become the dominant international language of science (ELS) and, to a lesser degree, also the humanities. This raises questions about how the linguistic ecology of scientific communication has changed over the last few decades, what effect changes have had on various disciplines and individuals working in those disciplines, and what will the emerging (and stable?) ecology look like?

Jernudd and Baldauf (1987) have examined the specific problem of written scientific communication and have developed a hypothetical model that illustrates some of the ecological variables that influence *language selection* for communication[2]. Briefly, the model (Figure 1) suggests that the sociolinguistic *type* of community[3] 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 socio-linguistic *type* will contribute to determining language selection decisions. *Institutional* constraints and/or *network* contacts will often intervene between *type* and *individual* language selection decisions, as will availability and use of language management *resources* (e.g., library and database services, translation services, language editors, etc.). The various communities' *expectations* to which the individual belongs will also influence the language and text that the individual produces. The factors interact with the *domains* in which communication of scientific inform-ation can occur. These factors lead to *language selection*, which in turn have implications for the particular *discourse strategies* that are employed to produce the scientific communication (cf. Swales 1990). Taken together an understanding of the model's components and their interrelationships can help us to better understand the factors which influence language choice and the way in which scientific information is communicated.

← Macro Sociolinguistic Level→← Individual→← MicroSociolinguistic Level→
Figure 1. Model of Language Selection in Scientific Communication (Jernudd and Baldauf 1987: 172)

Thus, it is argued that language forms a potential communication barrier for many scientists which they must overcome if they are to actively participate in their field and interact with their colleagues. In this paper, the role, growth and dominance of English as the language of science (ELS) is briefly reviewed (as both a problem and a solution) before examining how ELS has impacted on some English speaking scientists in Sydney, Australia.

2. English as a language of wider communication

The reasons for the rise of English as a language of wider communication (LWC) for technology and science, industrialisation, international business, transportation, and world-wide communication are not hard to understand, although they are sometimes obscured by accounts which stress social, historical and political factors (Crystal 1997, Wallerstein 1995), rather than those related to economic and scientific motivation (Kaplan 1987, Grabe 1988, Kaplan and Baldauf 1997). The growth of English has not occurred because it is efficient or flexible, but rather as a

matter of historical accidents which have lead to the use of the language for these purposes. Although English has been spread as part of the British and American empires, it was the language of the elite and in most countries where it had spread, not the language of the home, of solidarity or of personal identity. Thus, military and political imperialism alone are insufficient bases for the phenomenal spread of English that we have seen since the end of World War II. Furthermore, other imperial languages such as Spanish and Russian have not become *lingua franche* in the same way that English has. What then explains the growth of English?

At the end of the Second World War, the United States was the only major industrialised nation whose industrial and educational infrastructure remained intact. The impetus provided by the war, post-war immigration and the cold war lead to the rapid expansion of higher education, the development of research universities and the development and use of the computer, first as a means for scientific data processing, but increasingly for information processing and retrieval. This co-occurrence of "military development, economic stability, research universities, R&D capacity, and the invention of computer networking" meant that the United States emerged as the greatest contributor to and user of the information pool (Kaplan 1987:139) and that that contribution was in English. As the major contributor to and user of the system, the United States effectively became the manager of the "information cartel" and provided its organisation. Thus, English became not only the language of science and technology, but the language of information management as well. It is no accident that most computer languages use English terminology and concepts.

This coincidental dominance of English, needs to be seen in the context of the nature of recent scientific research and its relationship to modern economies. Kaplan (1987:139) and Grabe (1988:66) describe this relationship in terms of six basic assumptions about science and information that can be summarised as follows:

- Scientific information is cumulative;
- The time from the discovery of new information to its application has decreased markedly;
- The rate of information increase is nearly exponential with the quantity doubling every four years and with the cycle length decreasing;
- A sophisticated management system is needed to handle this information growth;
- Much of the technical information available world-wide is available in English; and

- Countries must have access to this information if they are to be economically competitive.

Based on these historical circumstances and the economic and scientific need to access information, ELS came into being. The need to use and the continued use of English has become a self-fulfilling prophecy. English has become the language of political and social opportunity. It provides important cultural capital, access to information, and it is the language of the multinational political economy[4]. This need for English access has created a thriving English-as-a-second language market worldwide (Kaplan and Baldauf in press). Such has been the demand for English that non-native speakers of English now outnumber those for whom it is a first language. Evidence for the growth of ELS is reflected in the languages used in scientific journals and we now turn to a review of that work.

3. English as the language of science

One measure of the extent to which English has become the dominant language of science can be seen from some surveys conducted on languages of articles contained in major abstracting services. For instance, in an early survey 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 1965 data in Table 1). However, in the 1960's the idea that English might become the dominant language of science was still not clearly foreseeable. Wood predicted that "as the underdeveloped 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).

To test this hypothesis, Baldauf and Jernudd (1983) replicated that particular aspect of Wood's study using the articles abstracted in the 1981 issues of five science databases[5] to determine if the changes Wood predicted had occurred. However, as the 1981 data in Table 1 indicates, the proportion of articles in English dramatically increased, rather than decreased, since 1965 while in general the proportion of articles in other languages declined. Specifically, 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 as the language of publication increased from 50.3% to 66.95% and from 54.8% to 69.3% respectively.

A longitudinal study by Tsunoda (1983) that covered publications in mathematics, biology, chemistry, physics and medicine over the course of the century (1880 - 1980) shows that until after World War I, publication in English was roughly on an equal footing with French and German, but that from 1930 onwards English gained at the expense of the other two languages.

A further replication of Wood's study was undertaken to collect language of publication data from abstracts for 1988 from the same five databases as well as from Sociological Abstracts. Large increases were found in the numbers of articles being abstracted in four of the five databases, reflecting the growth in publication in these fields over the seven-year period. The proportion of articles published in English remained relatively stable, the proportions declined slightly in Biosis and CA Search, but increased in INSPEC, MEDLINE and MATHSCI. The proportion of publications in Russian also remained stable, but from a much smaller base[6]. The proportion of publications published in French and German both declined slightly, while those in Japanese and Chinese rose. Thus, much of the expansion in the science literature continues to come in the English language domain. Eight languages accounted for between 95.2 and 99.7 percent of the publications listed by these abstract services.

Table 1. Language breakdown for abstracted literature indexed in *six* databases[1] for *1965*,* 1981** and 1988.

Language	Chem	Biol	Engin	Med	Math	Socio
1965*						
English	50.3	75.0	82.3	51.2	54.8	
Russian	23.4	10.0	3.9	5.6	21.4	
German	6.4	3.0	8.6	17.2	8.7	
French	7.3	3.0	2.4	8.6	7.8	
Japanese	3.6	1.0	0.1	0.9	0.7	
Chinese	0.5	1.0	0.0	0.4	0.2	
Other	8.5	7.0	2.7	16.1	6.4	
Total N	-	-	-	-	-	

Table 1. Continued

Language	Chem	Biol	Engin	Med	Math	Socio
1981**						**1976**[2]
English	66.9	85.7	84.6	73.1	69.3	46.3
Russian	12.7	3.9	3.8	5.9	18.1	11.3
German	5.5	2.5	3.9	5.5	3.6	5.7
French	1.9	2.1	2.0	4.0	4.8	14.3
Japanese	9.9	1.9	1.5	3.0	0.3	7.1
Chinese	0.9	0.2	0.6	0.7	0.5	+
Spanish	0.2	0.7	0.3	1.2	0.3	+
Italian	0.2	0.6	0.5	1.6	1.3	+
Other	1.8	2.3	2.8	5.0	1.8	15.3
Total N	252,409	300,024	167,618	258,941	35,876	4,827
1988						
English	63.9	84.7	85.9#	75.6	71.1	82.4
Russian	11.2	3.8	1.9	6.1	18.2	1.1
German	4.5	2.4	3.1	4.1	2.0	4.8
French	1.2	1.9	1.4	3.2	3.4	3.4
Japanese	12.6	2.2	2.6	3.2	0.2	0.1
Chinese	2.5	0.5	1.1	0.8	3.2	0.0
Spanish	0.5	1.0	0.3	1.1	0.6	1.1
Italian	0.2	0.8	0.3	0.9	0.7	1.8
Other	3.0	2.2	3.0#	4.6	0.3	4.8
Total N	465,603	520,000	238,522	183,111	54,876	22,832

*Wood (1967:119), **Baldauf and Jernudd (1983: 99), +Not given separately,
included in other, #Estimate

[1] CA Search (Chemical Abstracts), BIOSIS (Biological Abstracts), INSPEC
(Engineering Abstracts), MEDLINE (Index Medicus), MATHFILE (Math Review),
Sociological Abstracts.
[2] Thogmartin (1980:6) 22.8 per cent sample of UNESCO *Bibliography' of Social
Sciences.* This is not a comparable source as it not a database and was selected as it
was likely to have more non-English citations.

Baldauf and Jernudd (1983) also examined the database MATHFILE
by language of publication 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 terms of absolute numbers of articles
published. Extension of this data through 1988 revealed similar trends –

growth occurring mainly in English with other languages remaining relatively stable. If this data is representative of other databases[6], it suggests that while the English language was becoming proportionately more dominant in the scientific literature, there continued to be a large and relatively stable non-English language scientific literature.

Of course, Wood's hypothesis may still have been right. The proportion of foreign literature may have increased during this period vis-à-vis English – although no data on this is available, but its representation in the abstracted database literature may have declined. Part of this decline can be attributed to the fact that some non-English language journals became English[8] or bilingual (often effectively becoming English only). Part of the decline is also undoubtedly due to the fact that abstracting services, when faced with an increasing literature and limited resources, have opted to select what they consider to be high impact international journals over journals from the Third World written in "exotic" languages (Garfield 1985: 8-9). University library research collections as well, contribute to how the literature is shaped and used. When faced with selecting from a growing list of 80,000 journals, and with shrinking budgets, libraries are having to become more selective. While journal material is still accessible by other means (e.g. on the internet[9], interlibrary loan), the loss of ability for academics to physically browse the literature directly means that different computer-based skills need to be developed to avoid loosing touch with the literature.

In the context of the previous section where Kaplan and Baldauf (1997) noted that database users control the information cartel, the move toward English language dominance reflects the dominance of English language users' contributions to the system and their need for highly relevant information for themselves. While databases are often treated as if they were representative of the world's scientific literature, they are not, nor with their present limitations are they likely to be. Since the large, well-known databases must be selective for practical reasons, database selectivity is a problem that all scientists must face[10]. The growth in coverage and number of databases over the last fifteen years may in part be a response to the need for access to the wider literature. Yet, most of these databases are in English[11].

4. 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) analysed the citations taken from the 1952 issues of journals in psychology, chemistry and physics. As Table 2 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 German or English speakers.

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).

Table 2: 1952 Language of citation by language of publication (Louttit 1957: 315)

Language of Publication	Language of Citations %			
	English	German	French	Other
PSYCHOLOGY				
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
CHEMISTRY				
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
PHYSICS				
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

In another 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). If

we use external citations as a measure of importance, 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 and Jernudd 1986). These data strongly suggest that language of publication provides differential access to and use of information. For those French authors there were significant disadvantages 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 phenomenon may apply only to scientists working in international languages. As Baldauf and Jernudd (1987) have noted, the citation patterns of many Scandinavian Psychologists are not that different from their English-speaking colleagues.

5. Business and language skills in Australia[12]

When examining a problem in one domain of language use, it can often be useful to examine that problem in other domains as the work in those domains may shed light on community and professional attitudes and trends on language use in society as a whole. Such trends may help to explain the milieu in which attitudes scientists have toward language have developed and may help to explain language use patterns. In Australia, economic rationalism has been the driving force behind many of the social and political changes that have occurred over the last decade, and so an examination of the use of language in business may be helpful in understanding the mix of attitudes toward language and culture held by many Australians.

Australia has changed dramatically in the last fifty years in its economic and social structure. Prior to World War II it was primarily a pastoral country, with very limited industry and an Anglo-Celtic monocultural and monolingual view of itself. World War II forced Australia to reexamine this heritage and the post war migration, mainly from Europe, was intended to develop Australia's industrial base. In the past twenty-five years Asian migration has added to the country's multilingual and multicultural diversity. While Australia's industrial and

services sectors of business have expanded since the war, its internal market is small and it needs to move more forcefully into the manufacturing and services sectors and/or export more to a wider range of markets.

In response to this growing ethnic diversity, Australia has developed a series of language policy statements since the early 1980s directed at meeting these national economic and social needs (Kipp, Clyne and Pauwels 1995, Lo Bianco 1990, Ozolins 1993). At the Commonwealth level, the *National Policy on Languages* (Lo Bianco 1987) was developed to help achieve four broad social goals: *equality* within a multicultural society, *economic* development and trade, *enrichment* of social and cultural life and *external* relationships. In 1991 this was followed by the *Australian Language and Literacy Policy*, in 1994 a National Asian Languages and Studies in Australian Schools Program (COAG 1994) and in 1996 the government took the first steps toward developing a national schools literacy policy (Lo Bianco and Freebody 1997). Progressively, each of these language and literacy policy documents has stressed the underlying theme of employment and economic development. State governments (e.g., Queensland) in framing their school language policies have also suggested economic motivations for their actions (Baldauf 1993, Djité 1994) and school systems and universities have been keen to export their educational expertise to countries in the region. Perceived economic benefit (economic rationalism) has been a major driving force behind these government language policies and the accompanying public rhetoric. In this context, increasingly universities are being seen as just another business with the need to be more productive; i.e. to teach more students with fewer staff and resources while at the same time doing more research and fund-raising consultancy work.

Business and industry interest in language, to the extent it has existed, has also been based on economic considerations although Australian companies have generally been inward-looking "passive exporters" (e.g., Stanley *et al.* 1990: 46)[13]. As engagement with language and cultural questions has grown nationally, two perspectives of how to deal with this business-sector language problem have emerged.

5.1. *Language, multiculturalism and economic outcomes*

From the "multiculturalist perspective" the challenge for business has been to change the culture of Australian industry to make it active and world-oriented with an understanding of the role that language and culture play in export markets. In a market which increasingly emphasises selling products from the secondary and tertiary sectors of the economy, more

interpersonal encounters with potential customers are required because individualised products are being marketed to individuals or small groups of customers and not, as with primary produce, in bulk quantities to government agents. These strategies require much more personal interaction with customers and a knowledge of their tastes and preferences. As many of these new customers are assumed to be non-English speakers, these changes have obvious policy implications. A demand should be created for second language and culture education and for the proficient and confident use of language skills since secondary and tertiary economic activities necessarily involve the need for diverse language and cultural competencies.

This scenario broadly describes one view of Australia as a multi-cultural country (see Clyne 1997). An analysis of the 1991 census data (Kipp, Clyne and Pauwels 1995) indicates that; 14.8 per cent of the population uses a language other than English (LOTE) at home. This figure possibly underestimates this potential language resource but reflects an increase from 12.3 per cent in 1976 and 13.6 per cent in 1986. However, there is often a gap between what many immigrants are able to contribute linguistically and culturally because either their English is not up to standard or the Australian authorities are unable to recognise their professional qualifications because they were obtained in another country and are not deemed to be equivalent. This means that Australia is not able to use the fullest extent the language and cultural resources these people bring.

Stanton, Aislabie and Lee (1992) have suggested that trade and commerce, tourism and small business are the three ways in which multiculturalism could contribute to economic objectives of the polity. However, they conclude that there is little direct evidence from the literature in any of these areas about the contribution that multiculturalism actually makes to economic performance. Stanton and Lee (1996: 510) go on to point out that Australian access and equity programs have long been part of multicultural policy and that such programs may provide economic outcomes. However, they seriously question any attempt to use "the contribution of cultural diversity to Australian export performance [as] one element of an attempt to establish an economic agenda as a part of Australia's multicultural policy."

5.2. *English as the language of business*

The alternative perspective suggests that, a foreign language is becoming less important for business and that trade and commerce can be developed around English as the language of business.

It is a deliciously Australian irony and so typical of our planning from the beginnings of white settlement that Australian governments should discover the economic importance of languages at the moment in our history when languages have never been less important on purely economic grounds. Exactly when the pendulum is swinging toward English among the educational and trading elites of Asia, for example, our Governments are concentrating their rhetoric on providing language courses of unspecified content and outcomes. The primary wish of these trading partners in language terms is to acquire English proficiency. (ALLC 1994: 9)

A summary of some twenty studies in this area by the ALLC (1994:33-50) suggests that while personal skills in a language other than English are useful for social intercourse and in marketing, many business people seem to feel that a command of another language is unnecessary for business purposes, other than for interpreters and translators who would be hired as part of the negotiation process.

For example, in a study by Stanley *et al.* (1990), two thousand companies nominated by Austrade were surveyed by questionnaire, with a 25% response rate, to try to establish what the relationship was between language other than English (LOTE) skills and export success. The survey found that there was generally a low level of awareness of the relationship between LOTE skills and export success, as evidenced by the fact that, while knowledge of LOTE skills ranked as least important in the survey, obstacles related to the lack of LOTE skills (knowledge of foreign markets) were rated as the most serious. Even when companies did recognise that LOTEs were important, they were not sure which might be important for their own purposes. Exporters viewed the following nine languages as being in demand: Mandarin, Japanese, Arabic, Indonesian, Korean, Thai, Spanish, German and French, roughly in that order.

In another report on trade with Latin America, Austrade expressed the view that:

It is difficult for Australian companies, particularly those which are fairly new to the export business, to get into a market like that. Their attitude is why go through all this hassle with...different languages...when they can go to closer markets such as South East Asia, New Zealand or whatever. " (SSCFADT 1992: 278-279).

In a third study interviews with 60 of the biggest export companies in New South Wales found that Japan, the United States, New Zealand, Papua New Guinea, the United Kingdom and Ireland were the companies' most important clients in 1988 in terms of income earned. By 1998, they expected Hong Kong, China and Thailand to join that list. This suggests that Australian exporters have a limited vision of what markets there might be for their products (Valverde 1992).

Although these companies represented the "exporters" and therefore were supposedly ones with some expertise in this area, most companies were represented by monolingual/ monocultural individuals with very limited notions of geographical and cultural differences (i.e., couldn't necessarily differentiate between countries in South East Asia and those in Oceania). Only two export managers said they had heard anything about the National Association of Australian Translators and Interpreters (NAATI)[14], and interpreters and translators were seldom used. Although there was a lot of interest shown in many of the issues presented in the survey, there was very little evidence of an awareness for the need for language and cultural skills.

Exporters suggested that Japanese, Chinese, French, Korean, Spanish, Indonesian and German were the main languages of the future. The survey also showed that these companies actually had multilingual employees fluent in many of these languages, except Japanese where the upper management was directly hired from Japan. Thus, attitude, rather than resources seemed to be a prime problem for these exporters; There was a belief that English is enough. Even when language skills were used, in only one case were these skills recognised by better pay.

This perspective from business suggests that views about language and culture in the Australian community are divided. Government policy has stressed the importance of languages as a resource, of multiculturalism as the Australian way of life and that Australia is a part of and increasingly a partner in Asia. However, despite the rhetoric there is little direct evidence that multiculturalism has substantial economic benefits. While the multiculturalists have been politically dominant for the last decade, it is clear from election results in the late 1990s (e.g. in Queensland) that some Australians have not been persuaded by this line of thinking and are feeling marginalised by it as it seems to exclude rural, "Anglo" and working class groups. Although Australian multicultural language policy has always been based on an "English plus" model, these views undoubtedly mean that many Australians believe that if it is important, it will be reported or written in English (i.e. the "plus" element of the policy is not essential).

6. Languages at Australian universities

How language is viewed in a community also depends on the availability of language to those who wish to learn it. Experience has

shown that most immigrant communities are unable to sustain their languages without further in migration. While the Commonwealth and States all have language policies which support the teaching of languages in schools, this support does not extend directly to universities. Under current policies by 2004, all students in years 3-10 are expected to study a language other than English in school. A number of reports have looked at language teaching in Australian Universities (Leal, Bettoni and Malcolm 1992, Bettoni and Leal 1994, Baldauf, *et al.* 1995, White, Baldauf and Diller 1997, Baldauf and Djité 2000) and all have found support for language teaching to be inadequate. In 1997 the 36 Australian universities offered 50 languages (not including Anglo-Saxon or Old English). The most frequently taught languages were Japanese (35), Chinese (26), Indonesian (23), French (21), Italian (16), German (14), Spanish (13), Classical Greek (11), Modern Greek (10) and Latin (10). Other languages offered at more than 3 institutions include Arabic, Hebrew, Hindi, Korean, Russian, Sanskrit, Thai and Vietnamese. Thirty-one languages were offered at only one or two institutions.

While the relatively large number of languages offered might suggest that language offerings in Australian universities are healthy, and in some instances growing (e.g. Japanese) when compared to previous years, this would be a mistaken assumption. Continuing cuts to university funding by the Commonwealth government has severely affected the Humanities in particular. In an economic rationalist environment, subjects with smaller numbers that are more expensive to teach are targeted for closure. Potentially, this places languages, and especially low candidature languages, in a precarious position.

Another major concern is the substantial staff attrition rate that pervades nearly all language departments in all universities. While specific language offerings may be the same in 1997 as, for example, 1994, often they are being taught with far fewer staff or with fewer contact hours. A related concern is the loss of senior academic language staff as they either retire or are forced to accept redundancy packages from beleaguered universities, and then are either not replaced at all, or replaced by non-tenured staff, often part-time lecturers or casual staff, leading to the loss of a whole generation of language specialists. An Academy of the Humanities study currently in progress estimates that nearly 100 full-time academic positions in languages have disappeared between 1996 and 1999.

Underlying this rather grim environment is a concern by many of the low esteem in which languages are held by university colleagues (often senior administrators); the lack of understanding of the complexity

involved in providing sound pedagogic language teaching; the lack of understanding by the community at large of the value of languages which one may argue is also a problem for governments with their sole emphasis on trying to 'cut costs'.

The present 'corporatist' climate in which universities are now seemingly forced to operate has taken a serious toll on language departments. It is questionable that without some alleviation of under-funding, under-staffing and under-resourcing which is the lot of most language departments in the late 1990s, that the broadly based teaching of languages will remain viable as a significant part of offerings at many universities.

The pressure that many language departments find themselves under is beginning to affect research and the ability to work with languages other than English. In the long term this will reduce the ability of Australian scientists to work in other languages and will reinforce the notion that English is the sole language of science.

7. Survey of Australian university science staff

It is estimated that Australia produces about three percent of the world's published research. The University of Sydney is the largest tertiary provider of languages in Australia, offering in 2000 some 34 languages[15] through its Faculty of Arts and over a hundred languages on a self-study basis through its Language Centre. The University has a multilingual and multicultural staff, many of whom are involved in cross-national research or have international connections. It is one of the major research Universities in Australia in terms of the amount of research funding it is able to attract each year and keeps a register of languages that staff are able to speak/use as a research tool. As such, one might expect that if Australian scientists were using languages other than English in their research work, evidence of this would be found here.

To examine the question of pro-active language use, as opposed to passive reading or citation use, by University Staff for research communication purposes, University of Sydney's *Research Reports* for 1981 and 1988 were examined to see what languages were being used for which purposes - to develop hypotheses about language other than English use. The five Faculty/Departmental groupings most similar to the areas examined in Section 3 (i.e. Chemistry/Biochemistry, Biological Sciences/Agriculture, Engineering, Medicine and Mathematics) plus the

Faculties of Arts (in two groups - languages and other) and Law were examined. These results are tabulated in Table 3.

Table 3: Number of citations by faculty group with non-English (NE) sources by year

Year	1981 Total[1]	1981 NETitle[2]	1981 NE Source	1988 Total	1988 NETitle	1988 NE Source
Chem/Biochemistry	73	0	1	208	0	11
BioScience/Agricul	136	0	0	213	0	0
Faculty Engineering	150	0	1	300	0	3
Faculty Medicine	548	2	13	1277	3	20
Mathematics/Stats	43	0	5	62	0	1
Faculty of Law	27	3	4	114	3	3
Faculty Arts-Langs	45	11	15	122	28	36
Faculty Arts-Other	198	14	16	455	10	14
Totals	1220	30	55	2751	44	88

[1]The number of published language events (books, chapters, articles, papers, reports) found in the University of Sydney *Research Report* for 1981 and 1988. No *Reports* have been published since 1990.
[2]Number of non-English titles listed.
[3]Number of non-English sources. These may be underestimated as it is not always possible to tell from the title whether the source is non-English. It may also include some English language journals published in non-English speaking countries. For example, Ammon (1998: 48) indicates that most science journals – using science in the broadest sense – published in Germany are now (almost exclusively) in English with an English title.

The data indicate that only a relatively small number of publication events[16] make use of a language other than English (LOTE). For 1981 only 30 titles and 55 Sources out of 1220 publication acts were in a LOTE. While the total number of publication acts had more than doubled by 1988 to 2751, the numbers of titles (44) and sources (88) remained constant except for those working in the Faculty of Arts where the languages departments had increased research and use of languages publication. Overall, German and French were the languages most frequently used with publication titles also in Chinese, Dutch, Finnish and Polish. In a further examination of the literature, 362 publications were identified as having a University of Sydney author in the 1973-1998 *Linguistics and Language Behaviour Abstracts* database. Of these only nine were written in a LOTE (7 in French and 2 in Italian). The seven authors involved (one of the

authors published three articles) were members of either the French or Italian Departments. For only one of the seven was the LOTE a second language.

An examination of the language-use events represented by these publications, suggests the following hypotheses about proactive non-English language use by Australian scientists:

- Personal language background (mother-tongue) may account for the use of a LOTE in some circumstances (Chinese, French, Italian and Polish examples)
- Co-author expertise (non-Sydney) may facilitate publication in a LOTE (German, Italian and Dutch examples)
- Discipline expertise in languages may encourage scientists to write in a LOTE (French, German and Italian examples)
- Some disciplines are more internationally and interculturally oriented than others (e.g.in the Faculty of Law, no papers from the Department of Law (Australian focus) were in a LOTE whereas a number of papers in Jurisprudence were (international focus))
- Some grant or project requirements may require the work to be published in a LOTE (a Chinese language example - possibly translated in the Peoples Republic of China)
- Transcripts of new language materials (e.g. publication of Aboriginal songs in the original language with Aboriginal co-authors)
- Articles about work in language, where the article and the source are primarily in English, but analyse a language text (e.g. a Welsh text; reviews of books in a LOTE)
- Research completed on a local topic and published in a local journal (e.g. on Pompeii, published in Italian)
- A few papers given overseas are in a LOTE (pre-print versions, e.g. ISA Papers)
- As journals become more English language oriented, it is increasingly difficult to tell whether a journal is solely in English or includes other language materials (e.g. Sudan Medical Journal, Pflügers Archiv, European Journal of Physiology, Electrochimica Acta)

Three additional language-related activities were noted in the data.

- Papers were presented all over the world in countries where a LOTE was spoken, with an apparent increase from 1981 to 1988, but in English (increased language contact)
- German and Dutch (in particular) publishers publish a lot of scientific material in English although their own language is not English

- There were a number of non-University of Sydney authors with non-typical Australian names (whatever that may be!) suggesting there may be a mentoring or English language facilitation process occurring with some overseas co-authors.

The results of this examination of publications parallel the database information discussed in Section 3, i.e. the number of publications and the use of English are increasing. For English language milieu speakers (at least at this site), the pro-active use of a language in scientific publication is very limited and becoming increasingly so in terms of the total number publications produced. The fact that science is cumulative and the major databases are in English and favour "international" journals means that this trend is likely to continue in the print media unless something is done to change the language ecology. However, the increased overseas (direct cross-linguistic and cross-cultural) contact may make English-speaking scientists more aware of language issues.

From a language planning perspective, these decisions represent 'unplanned' micro-language planning decisions (see Baldauf 1994, Kaplan and Baldauf 1997). While such decisions may not be as immediately interesting as the planned macro-language planning in Québec or the Baltic states, never-the-less when taken as a totality, they do have a major impact on language communities. In a world where individual rights and responsibilities are increasingly being stressed, it may be appropriate for language planners to look more to individuals to drive language change.

8. Implications for English speaking language communities

The studies cited in this paper indicate that the universality of science which is often taken for granted is undoubtedly segmented by language and language selection. While ELS has created an apparent communication channel for scientists, the data presented in this paper also indicates that the channel comes at a cost and that a language barrier for the communication of science information still exists. The language ecology of scientific communication is changing and this raises the question of "What can we do as scientists, sociologists, applied linguists or TESOL teachers to reduce the effects of this barrier – to make scientific communication more effective and more accessible to all scientists?"

First, the critical approach to language teaching, language planning and literacy is increasingly providing an important critique of the role that

particular language use and English play in creating language problems and language inequality. They suggest that modernist planning approaches to language planning and TESOL teaching may be inadvertently creating more problems and inequality than they solve. Luke, McHoul and Mey (1990), Tollefson (1991), Phillipson (1992) and Pennycook (1996) raise many of the issues central to the problem and the latter provides field exercises which may help English speakers to experience the language barrier. Being aware and sensitive to the problem is an important first step.

Second, for those working with TESOL students, especially those who aspire to become scientists, materials about the language barrier need to be explicitly made part of their curriculum. They need not only to understand how academic discourse works, but the politics of it as well. Swales (1990) provides a good introduction to these issues, while Barnes (1982) is more language teaching oriented.

Third, in a world that is becoming increasingly multilingual, there is a need for monolinguals, particularly monolingual English speakers because they symbolise the language barrier, to learn and actively use a language other than English, particularly in their role as scientists. One way to support the non-English literature is to subscribe to a LOTE journal or to publish an article in a LOTE (cf. Conseil de la langue français 1986, L'Heureux 1986)

Fourth, journals and their editors need to have a greater mentoring role generally, but especially in the case of second language authors. As this takes time and effort, it may mean that journals will need a different level of support from their sponsoring bodies and institutions, and that editorial boards will need to take on different functions. The need for language editors (e.g., *Scandinavian Journal of Psychology*) may need to be explored (*NAVF*, 1976).

Fifth, journals and presentations need to consider publishing abstracts of their articles or providing resumes of their presentations in languages other than the original (Lewin and Jordan 1981, Touraine 1998). For non-English language journals, having an English abstract available may be the difference between making it into a database or not. Ikushima and Tenopir (1988:118) report that "language of periodicals or summaries seems to be the most important single factor that determines whether Japanese scientific and technical literature is included in major English language databases". For English language journals, there is an obligation to our colleagues to provide access to our work.

Sixth, journals might also consider encouraging and publishing more reviews, especially those that collect their information cross-linguistically.

Good reviews provide better access to materials than abstracts. Gordon and Santman (1983) discuss the role of reviews and the language barrier. Larsen and Magnussen (1984) introduce a policy of in depth reviews as a way to bring Scandinavian psychology to the attention of psychologists world-wide.

Seventh, there is need for scientists, to be more collegial, to provide more mentoring, to do more collaborative work with authors who would not otherwise be able to publish, either through lack of experience, or a lack of linguistic skills (cf. Subramanyam 1983).

Eighth, English speakers in particular need to recognise the limitations of English bound databases (Smith 1979, Byrne 1983) and go beyond them to seek out materials in LOTEs. Not all important work is in English. This may mean using translation (van Bergeijk & Risseeuw 1980, Harris 1983).

Finally, there is a need be sure that our science information is being communicated, not just published (Manten 1980). This may mean finding more appropriate ways and outlets for our science communication. Chatelin and Arvantis (1989) document the changing habits of French soil scientists, who continue to publish in "local" journals, while presenting papers more frequently at meetings and congresses. Authors may need to consider a wider variety of publication outlets to take the problem of language into consideration. In this context, English speakers need to be sure when working in a non-English speaking situation, that appropriate and accessible "publication" of findings is available to that community.

There are undoubtedly other ways to create a more supportive language ecology for scientists in the era of ELS, but most important are the changes we make ourselves as scientists to foster more equity and access within the community of scholars.

9. Notes

1. Paper presented at the XIV World Congress of Sociology RC 25 Sociolinguistics symposium on the "Effects of the Dominance of English as a Language of Science (ELS) on the non-English Language Communities", Montreal, 29 July-3 August 1998.
2. For a variation on this model and an example of its use as a tool for understanding scientific communication, see Swales (1990: 104-105).
3. Jernudd and Baldauf (1987: 165) indicate that: "The sociolinguistic type determines dominant language selection in local, (normal) 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."

Many of the late 1980s examples given in that chapter have changed, but it might be said that the standard English-speaking type (e.g. the United States, Australia, New Zealand) is that English is seen to functions at all levels (local, national, regional and international) with only specialists (diplomats, some academics) learning other languages and with migrant languages supported or tolerated on a laissez-faire basis. In southeast Asia there is a growing 'English-knowing bilingualism' type developing, exemplified by Singapore, where English is increasingly becoming a mandatory second language for a wide segment of the population and where English is taking on some national (e.g., university education) functions.

4. While this paper focuses on the language problems that exist for individual scientists in their work, Tollefson (1991) points out some of the wider implications for ELS and ELWC. In particular, that the spread and dominance of English creates inequalities 1) between 'developed' and 'developing' societies and 2) within 'developing' societies. Luke, McHoul and Mey (1990) have raised some of the same issues, but in the broader context of language rather than English alone. (Also see Phillipson 1992 and Pennycook 1995)

5. The online data for each of these years is that "acquired" during that year and this matches the printed database. The number of citations in a database for any particular year is variable, as additional items are added to the database.

6. It will be interesting to see if Russian has declined significantly in the 1990s with the break up of the Soviet Union and the Russian Empire in Eastern Europe.

7. A comparison of the data presented for the five databases presented in Tables 2 and 3 suggests that we must be careful not to over generalise and to treat databases individually. For instance, the MATHSCI database is the only one not to show a growth in Japanese language publication.

8. For example France's prestigious Institut Pasteur, which has published *Les annales de l"Institut Pasteur* since 1887 (in French) decided in 1987 to henceforth publish only in English. It is now known as *Research in Microbiology* and has a circulation of about 1000. On the other hand, *Médecine-Sciences* (in French), which was founded in 1985, has gone from 200 to 4,200 paid subscribers. Thus journals, like individuals are making "market" decisions about how best to distribute their information (Anonymous [JC] 1989). Ammon (1996) notes that *Archiv für Kreislaufforschung* has changed into *Basic Research in Cardiology*, *Zeitschrift für Kinderheilkunde* into *European Journal of Pediatrics* or *Psychologische Forschung* into *Psychological Research.*

9. In 1999 the University of Sydney adopted a policy of preference buying from publishers / using journals from providers over the internet with no hard copy being held. Such holdings are cheaper to buy and store, and are now readily available in the hard sciences (but less so in the humanities and social sciences).

10. Byrne (1983) in a study of the Australian literature demonstrates that much of that literature is not referenced in any overseas database. Thus, even English language literature may be lost if it is view as being on only local significance. Many local journals therefore have overseas editors and may even include "international" in their title in their quest to stand out, and be included in the major databases.

11. There are of course databases like PSYNDEX, a German-English database of German-language psychological literature containing over 20,000 references

(1977-1984). Only about ten percent of these are found in PsychINFO (Becker 1984). See Ammon (1988) for a review of these issues related to German language publication.

12. Some of the material in this section is adapted from Kaplan and Baldauf (1997: 171-180).

13. A collation and critique of this literature (20 studies) can be found in ALLC (1994: 33-50).

14. NAATI is a long established accreditation body for interpreters and translators with considerable national standing (see Ozolins 1993).

15. These include Arabic, Akkadian, Aramaic, Balinese, Chinese (Mandarin), Chinese (Classical), Middle English, Old English, French, Old French, German, Modern Greek, Classical Greek, Classical Hebrew, Modern Hebrew, Hindi, Old Icelandic, Indonesian and Malay, Modern Irish, Old Irish, Italian, Japanese, Javanese, Javanese (Old), Korean, Latin, Russian, Sanscrit, Spanish, Syriac, Ugaritic, Thai, Welsh, Yiddish. (Portuguese and Vietnamese may be added in 2001.)

16. As we are not concerned with publication length, but with whether a language other than English was used or not, no weightings were given to books when compared to articles, papers, reports, etc.

17. The costs of participating in science are very real for some scientists. Chris Candlin reports being told by a colleague at the AILA Congress in Finland in 1996 that it would cost her a month's pay to get her article translated so it could be published (*AILA News*, 4, 2000, pg.1).

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