

Segmenting Speech in Different Languages

"Imagine how hard it would be to read text if there were no gaps between words."

Are there phonological differences between languages? Anne Cutler reports on work between groups from six countries which are coming up with some answers.

THAT IS in a sense what perceiving running speech is like - there are no robust and reliable cues to where one word ends and the next begins. Consider the spectrogram on this page; it shows the utterance "This appears in MRC News". None of the boundaries between words are clearly marked; the words run into one another, and the only clearly defined gap in the speech signal actually represents the [p] sound in "appears".

In order to recognise an utterance, however, listeners have to match it against what they have in memory, and this means they must identify the individual units of which it is made up; one could not possibly store as a whole every utterance which might ever be spoken! This speech segmentation problem is

hard enough for listeners with utterances in the native language; it is of course even harder when the input is in a foreign language. (The familiar complaint is that speakers of foreign languages seem to be speaking too fast.)

Investigating how listeners perform speech segmentation, and whether phonological differences between languages bring about differences in the way we segment continuous speech, is the task of the project "Processing Consequences of Contrasting Language Phonologies", an international collaboration between groups from six countries: France (CNRS, Paris), Japan (Dokkyo University, Tokyo), Canada (University of Montréal), Belgium (Free University of Brussels), Spain (University of Barcelona) and the UK. The

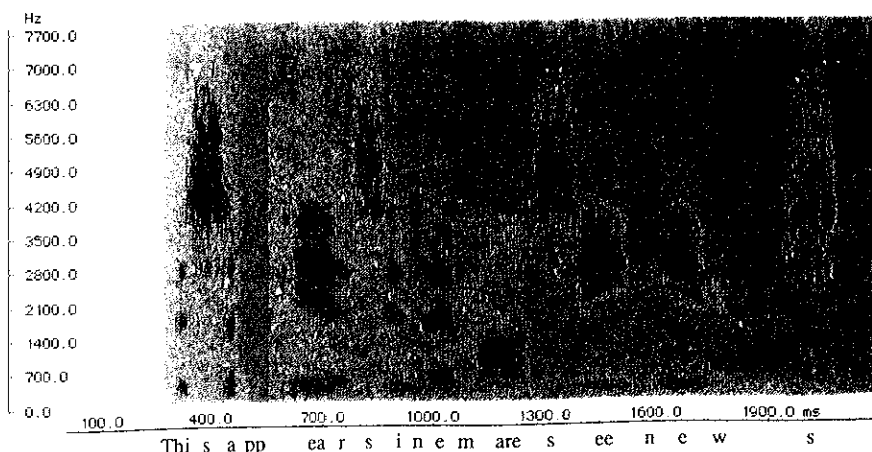


Figure 1. A speech spectrogram of the phrase "This appears in MRC News", produced by Dr G. Altmann and D. Young at the University of Sussex. The display represents frequency on the vertical axis against time on the horizontal axis, with greater energy represented by darker tone. The transcription is aligned as closely as possible with the corresponding sounds on the spectrogram.

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UK component includes researchers from two MRC units - the Applied Psychology Unit in Cambridge (Dr A. Cutler and Dr D. Norris) and the Cognitive Development Unit in London (Professor J. Morton) - as well as the University of Sussex (Dr G. Altmann).

"Contrasting Phonologies" is supported by the Human Frontier Science Program (HFSP), the international research support program formally established in 1989 to fund basic research into brain and biological functions (see box). So far, there have been four rounds of project awards: "Contrasting Phonologies" was one of 29 projects (from 235 applications) funded in the first round, in March 1990.

The mechanics of international collaboration

International consortia of academic collaborators come together in many different ways. Sometimes links are forged to meet the needs of a particular project. Sometimes - for instance in the European Community's ESPRIT program - collaborative associations are brokered by the funding agency. In the case of the "Contrasting Phonologies" team, the links preceded the project. The principal applicant of the project, Professor J. Mehler of CNRS Paris, had established collaborations and contacts with all five of the other groups. (His collaborations with members of the



Figure 2. A seven-month-old infant being tested in the speech perception laboratory at the MRC Cognitive Development Unit, London.

UK, Brussels and Montréal groups had already lasted more than a decade; the Barcelona and Tokyo links were somewhat more recent.) Other contacts also existed, for instance, Dr I. Peretz of the Montréal group had previously worked in the Brussels laboratory, while the author of this article and Dr T. Otake of the Tokyo group both studied at the University of Texas in Austin!

As can happen quite often with international grants, the amount awarded was a great deal less than the amount applied for. But other sources have provided some additional assistance. The consortium's initial meeting was held in Barcelona, and

was supported by the Spanish Ministry of Education and Science, and the region of Catalonia. At the end of the first year of the project the group met in Trieste for a workshop on contrasting phonologies, funded by the Scuola Internazionale Superiore di Studi Avanzati (SISSA) under its program "Trieste Encounters in Cognitive Science". In 1992 the meeting at the end of the second year was held at St Germain en Laye near Paris, and was supported by CNRS. In addition, the Brussels group has successfully obtained separate funding for its sub-collaborations: the Belgian "Commissariat Général aux Relations Internationales" has provided two small travel grants, one in collaboration with the British Council to support joint studies by the Brussels, Cambridge and Sussex groups, and another to support joint studies by the Brussels and Barcelona groups, while NATO has awarded a small grant for the joint Brussels-Montréal studies.

Human Frontier Science Program (HFSP)

THE HFSP is an international funding body set up following a Japanese initiative proposed at the Venice Economic Summit in 1987. The countries which take part in the management of the Program, and nominate members of the Board of Trustees, are the Management Supporting Parties (MSPs). The founding MSPs were the members of the seven Economic Summit countries: Canada, France, Germany, Italy, Japan, the UK, and the USA. The Commission of the European Communities was admitted as an MSP in 1990 and Switzerland in 1991. The Program has a £21m budget and Japan is the major contributor.

The aim of the Program is to promote, through international collaboration, basic research into the complex mechanism of living organisms, including man, and to make the results of the research available worldwide. To meet this aim, the Program sponsors research in two scientific areas: a) basic research for the elucidation of brain function, and b) basic research for the elucidation of biological functions through molecular level approaches.

The HFSP funds international collaborative research through three year research grants, long-term and short-term fellowships, and sponsoring international workshops. The Program is advertised widely in the scientific press in April/May. The 1994/5 deadline for research grants and long-term fellowships is 30 September 1994: there is no deadline for short-term fellowships and workshops which are processed throughout the year.

The MRC provides the lead UK representation on the HFSP, and is responsible for meeting the UK subscription of £350,000 per annum; it also represents, with the AFRC, the UK on the HFSP Board of Trustees.

Enquiries and requests for application forms and guidebooks for applicants should be addressed to the HFSP Secretariat at the following address:

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20 Place des Halles
67054 Strasbourg Cedex
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Cross-linguistic differences in processing speech

Studies from the Cambridge laboratory suggest that listeners can use the stress rhythm of English to help them solve the speech segmentation problem, while studies from the Paris laboratory suggest that for French listeners, the syllable can act as a segmentation unit. Cross-linguistic studies of English and French speech processing by these two groups, predating the present project, confirmed that speech segmentation procedures in English and French are fundamentally different. (This work was described in *MRC News*, No.39, in June 1988.) Now this line of research has been extended to Spanish, Catalan, Québécois, Dutch and Japanese. Cross-linguistic differences at this level of linguistic processing have been confirmed. Particularly interesting is a study of Japanese undertaken by the

Tokyo group in collaboration with the Cambridge and Paris groups. This suggested that Japanese listeners can use a subsyllabic unit called the mora in segmenting speech. English and French listeners presented with the Japanese speech materials responded quite differently, suggesting that mora-based processing is specific to Japanese listeners. In fact the French listeners segmented the Japanese speech by syllables, just as they segment French and English by syllables!

The result is interesting because it suggests a way of unifying all the language-specific speech segmentation findings. The mora is the unit of rhythm in Japanese (for instance in Japanese poetry), just as English rhythm is stress-based, while French has syllabic rhythm. In other words, across a phonologically quite diverse set of languages we see listeners relying on linguistic rhythm to help them solve the speech segmentation problem.

Why should this be so? It is possible that the answer lies in the earliest stages of language acquisition. Consider the infant's task in learning to distinguish meaning in the speech signals which occur in its environment. The segmentation problem is compounded by the fact that the infant has no existing store of meaningful units. The infant's task is, indeed, to build a vocabulary from scratch. On what basis can this process be started? Perhaps the characteristic rhythmic pattern of a language is sufficiently salient

to assist the newborn child in segmenting the continuous speech stream into discrete units.

To test this proposal, studies on this project are examining the newborn infant's discrimination of rhythmic regularities characteristic of different languages. In the Paris laboratory, infants can be tested within the first day or two of life. Slightly older infants are tested in the Cognitive Development Unit. As children are exposed to speech, we would expect them to lose their newborn impartiality towards the range of possible rhythmic structures, and begin to exhibit a preference for the rhythm of their own language.

A critical case is provided by bilinguals who have been exposed to two rhythmically different languages from birth. The most recent studies of the Cambridge and Paris groups suggest that maximally competent French-English bilinguals may have only one rhythmic segmentation procedure available to them - either the syllabic segmentation typical of French monolinguals, or the stress-based segmentation typical of English monolinguals. The "Contrasting Phonologies" consortium is studying bilinguals in three major bilingual cities - Brussels, Montréal and Barcelona - and hoping to establish the extent and the limitations of cross-linguistic differences in speech segmentation.

Dr Cutler is an HFSP grantholder at the MRC Applied Psychology Unit, Cambridge.



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