

## Commission for Linguistics and Communication Research

The Commission sees its main function in the application of theory for the systematic collection and analysis of long-term data on speech disorders and first-language acquisition in German as compared with other languages in a cooperation with national and international partners. The research involves interdisciplinary collaboration with psychology, medicine, special and therapeutic pedagogy, computer science and philology. Application-focused fundamental research is becoming of increasing importance alongside pure research. The language corpora created in this way form the basis for further theoretical and applied investigations within and outside the Academy.

### *1. Neurolinguistics*

The focus of interest in the field of neurolinguistics is the investigation of linguistic and cognitive skills in persons with acquired specific speech disorders (aphasia) following lesions in the left-hand side of the brain or with verbal communication disorders following lesions in the right-hand side of the brain. The concern interest of basic applied neurolinguistic research is to extend our knowledge about language processing in different tasks on the basis of longitudinal speech test and speech therapy data of individual aphasia patients and persons who have suffered damage to the right brain hemisphere. The main objectives of the analysis and the interpretation of the speech data obtained are the development of theoretical approaches and models of speech production and speech reception and the development of a theory of treatment.

The following research projects are within the neurolinguistic field of activity:

#### *Recovery of linguistic skills following a stroke*

The first part of this project implemented the link between basic research and the practical application of the research results. The recovery of the linguistic skills of individual aphasia patients was documented within the framework of intensive speech therapy. The evaluation of the extensive test and therapy data and publications about the results will form the focus of activities over the next few years, and will result in an internationally unique database.

In international collaboration, the effects of therapy, in particular their generalization in cases of

chronic aphasia patients in terms of speech-communicative behaviour will be analysed, with a particular focus on the transfer of the therapy of spontaneous oral speech production to the written language that is not the focus of speech therapy.

#### *Standardization of the pictorial stimuli of the Everyday Life Activities (ELA) series of photos*

If a realistic evaluation of the linguistic capacities of persons suffering from brain damage is to be made, it is first necessary to obtain comparative data about healthy speakers. For this purpose, a database of sentence production based on the ELA photo cards by healthy speakers of various age groups is being prepared.

The ELA photo series developed by the Commission for Linguistics and Communication Research consists of 3000 photo cards divided into three sets covering all relevant everyday activities, and is already being used internationally by a number of specialist groups. So far, data has been obtained, and has in part been transcribed, on 61 persons from Vienna aged between 60 and 95 using 413 selected photo cards. This project is to be continued with the recording and analysis of sentence production by healthy speakers of younger age groups and will also permit a comparison of the speech production of different generations.

#### *Text processing and text pragmatics in insult patients with damage to the left as compared with the right brain hemisphere – linguistic and cognitive functions*

This project examines experimental performance and malfunctions in text processing and text pragmatics with various text types, and the correlations with other cognitive performances, above all attention, memory, logical thinking, planning and problem solving. Partial results are already available on 28 patients. However, the sample must be increased considerably in order to form homogeneous subgroups and to obtain realistic descriptions of performance.

#### *Aphasic naming performance – simple nouns versus compound nouns*

The activation, recall and production of individual words is impaired in different ways with all aphasic syndromes. Corpora of naming errors from test and therapy sessions with English and German speaking aphasia patients are being analyzed and compared. The aim is to review and further develop the ad-

equacy of the explanation in two frequently applied models of word processing.

## 2. Child language

The focus of this field of research is on the question of how children acquire and develop the grammar of their first language. In the absence of comprehensive and systematic investigations of the acquisition of the grammar of Austrian German as a first language to date, the intention is to describe, analyze and interpret this issue on a sound theoretical basis. The initial concentration is to be on the fields of syntax, morpho-syntax and flectional morphology. The basis for the investigations is in the form of speech data from systematic long-term case studies of linguistically normal Austrian children aged from between 18 months and 5 that has been collected on a regular basis in the past and is to be extended in the future.

The major objectives of the investigations include both the identification of invariable features in the course of the acquisition of grammar and the recording of the possible bandwidth of individual variations. For this reason, the study involves not only systematically and individually observing the course of development of individual children, but in addition making inter-individual comparisons between different children acquiring Austrian German. This requires data from many long-term studies. In concrete terms, the investigations on the acquisition of the grammar of Austrian German are intended to create a basis for comparison on a linguistic and psycho-linguistic basis of methods for the diagnosis, assistance and therapy of abnormalities in speech development, i.e. delays and disorders in grammar acquisition.

The following research projects are planned within this focal area of research:

### *Acquisition of the grammar of Austrian German as a first language in comparison*

The child's acquisition of flectional morphology, morpho-syntax and syntax in Austrian German is to be examined in detail on the basis of data from long-term case studies. The central initial hypothesis is that the acquisition of grammar takes place according to autonomous principles of universal grammar. The language comparison focuses on Slav languages (primarily Croatian, but also Polish and Russian) in project-generated studies. The specific grammars of these languages provide a broad basis for comparison for the language-specific variations.

### *Cross-linguistic projects on pre- and proto-morphology in language acquisition*

An international collaboration in the form of intensive long-term studies focuses on an investigation of the early acquisition of morphology in German and a further 14 languages. In addition, there are sub-investigations of six languages. A new point of

emphasis is to be the acquisition of lexis. The results will also provide the basis for investigations of early second-language acquisition.

### *Flectional systems and their first-language acquisition*

The flectional systems of a dozen languages are described according to principles of natural morphology developed in Vienna, and their first-language acquisition examined in connection with the above-mentioned cross-linguistic project.

### *The linguistic and psycholinguistic foundation for the diagnosis of abnormalities in language development*

In contrast to the overemphasis on children's speech abnormalities such as articulation problems not infrequently found in speech assistance and speech therapy practice, this study investigates language development abnormalities in the field of grammar. The focus is on the development of grammar in mentally handicapped patients (e.g. Down's syndrome, Williams-Beuren syndrome).

A longer-term objective of the Commission's work is to provide a corresponding diagnostic instrument for Austrian German. The basis is a specially developed battery of tests (Schaner-Wolles 1995, Vienna Language Development Tests – WLDT) which has already been tested on a small group of normal children aged between 2 and 6. Using these tests, continuing cross-section studies are intended in the medium term to provide, analyze and document a larger corpus of elicited data.

## “Phonogram Archive” Institute

The Phonogram Archive was founded in 1899, and is a multi-disciplinary scientific acoustic archive whose historic inventories from 1899 to 1950 have been included by UNESCO as documents of exceptional value in the World Register of the Memory of the World programme.

Its function is to create or encourage the creation of scientific sound recordings so that they can be accessed, exploited and made available for scientific purposes. The core of the Institute's activity is in accessing, verifying the source and securing the research inventories donated to the Archive.

Research and developments in the field of audio-visual archiving constitute important supplements to the core field, and in particular include questions of the long-term stability of audio-visual data media, re-recording, the scientific and technically perfect reproduction of the contents of historic data media and their transfer to digital format, digital archiving and its long-term perspectives.

### *Videography*

While these traditional functions continue to remain essentially unchanged, they are being joined by videography as a result of the recommendations made following the first evaluation cycle (Medium-

Term Research Programme 1996–2000). It is being implemented in a three-stage plan on the basis of a feasibility study carried out in 1999.

- *Growth of the collection*

In the field of audio, growth will focus on the following aspects: *Vienna* (linguistic projects and documentation of selected chapters of cultural life), the systematic recording of the language of emigrant Austrians including aspects of contact linguistics (in particular in South America and Eastern Europe) and the systematic documentation of mechanical musical instruments.

In the video sector, priority is being given to the selective archiving of roughly 50 % of the around 2000 hours of video inventories already recorded at the Austrian universities and other research institutions, a task expected to take 8 years.

- *Recording, cataloguing, database*

It will continue to be a function of the Institute to transfer in entirety the earlier inventories to the database in the form of written “protocols”. The primary objective is to list all sub-collections and to make them available via the internet. It is hoped to store the video inventories by means of key frame presentation, in which an image for each scene is provided, thereby permitting a rapid visual overview of the contents.

- *Technology*

In the audio sector, archiving is entirely digital. It is hoped to install a digital bulk memory in 2001 to 2002, permitting not only access to the individual media but also the automatic review of the integrity of its data and allowing any regeneration that might be necessary. Given the urgent international demand for “small” digital bulk storage media, in particular inexpensive solutions for developing countries, this project has pilot character. In the medium term, the plan is to provide acoustic information about the inventory of the collection on the internet, although for legal reasons only short samples in highly data-reduced quality can be provided as an “acoustic catalogue”.

The video archiving is still initially being made on a specific video format (DigiBeta). Since a file format is about to be introduced for video signals and since the costs for the storing of large quantities of data are continually falling, digital archiving on the lines of the audio sector may become practical during the forecast period.

The efforts in the field of rerecording are to be continued, with the problem of sound recordings now being joined by those of video recordings. Successful copying of audio-visual data media depends on the sufficient physical and chemical integrity of the individual data media, which unfortunately is not the case. Consequently,

there is a need for a greater effort in conservation research with respect to audio-visual data media. The focus here is on an approximately reliable assessment of remaining life time.

- *Cooperation activities*

At national level, the successful collaboration over the last few decades within the Working Party of the Audiovisual Archives in Austria (AGAVA) is to be continued, guaranteeing the division of labour and the avoidance of duplication.

In the narrower scientific field, our partners include the Institute for Acoustic Research of the Academy of Sciences, the Technical University of Vienna, the Austrian Synthetics Institute (stability, assessment of remaining lifetime and rejuvenation of audio-visual data media) and the Federal Office for Historical Monuments.

At international level, the Phonogram Archive continues to collaborate with the technical bodies and the standard committees of the International Association of Sound and Audiovisual Archives (IASA), UNESCO (Memory of the World) and the Audio Engineering Society (AES), while there are also plans for collaboration in the future with the Society of Motion Picture and Television Engineers (SMPTE).

#### *Complete edition of the historic inventories 1899–1950*

The complete edition, begun in 1996, of the collection of inventories, which has now received a UNESCO award, is to be continued. The edition comprises the sound recordings on audio CD, reproduction of the protocols on CD-ROM, and written commentaries. Of the total of 17 series, four have already been published. The complete edition is not expected to be completed before 2010.

#### *Effects on personnel costs and infrastructure*

The proposed measures provide for an increase in personnel from currently 10 to 16 permanent posts by 2005. The increases concern a linguist for dealing with non-European speech recordings, staff to deal with the inclusion of videographic documents and the inclusion of the staff responsible for digital technology and the complete edition within the regular budget.

As an interim measure, additional premises close to the Institute have been rented and adapted for the start of the inclusion of videography. However, in the long term it will be necessary to concentrate the two parts of the Institute in premises of sufficient size in the course of the further development of the video sector and the necessary integration of the media.

Since it was founded, the Phonogram Archive has made a continuous contribution in terms of research policy, technology and organization to the

establishment and systematic improvement of audiovisual archives around the world with the aim of promoting the creation of an international network for the division of labour in the production, collection, storage and distribution of scientific audiovisual documents. The successful efforts on the part of the programme archive over the last few years have resulted in numerous cooperation projects in every continent, and are to be continued. This includes technical consultation work, training seminars, such as most recently for eastern European and south-eastern Asian archivists, together with joint field research with partner institutes for the purpose of the transfer of methodological and technical field research practices. The lobbying of international organizations (UNESCO, the European Commission) will be continued in the attempt to ensure adequate consideration of aspects of information storage in these organizations' information policy measures.

### Institute for Acoustic Research

The Institute for Acoustic Research pursues three main objectives:

1. Computational acoustics
2. Psycho-acoustics, phonetics, noise research (computational hearing)
3. Medical technology and acoustics (experimental audiology)

The Institute's software development for acoustic analyses, experimental process control and digital signal processing is part of the existing electro-acoustic laboratory system. In this way, the Institute for Acoustic Research provides a programme ranging from fundamental research to practical applications.

#### *Computational acoustics*

This aspect is still in development and comprises the theory and application of the digital simulation of sound projection and sound reflection, *inter alia* in the fields of mechanical engineering and construction. Examples are sound attenuation measures in tunnels, sound quality design and general issues concerning the creation of sound, noise emissions, noise immissions and noise forecasts. For the simulation of sound projection and reflection, it is planned to use a number of methods, the finite element method for internal problems, the boundary element method for indoor and outdoor problems and the ray tracing method for large volume indoor rooms such as concert halls. New digital questions result from the formulation of the problems in the field of timing and in the optimization of existing methods in terms of accuracy, computing time and memory requirements.

#### *Psychoacoustics, phonetics and noise research (computational hearing)*

This aspect deals with formally describable models and theories of the ear (cochlea models), of the

auditory system and the auditory processes, and their processing in psycho-physical functions. Psychoacoustics deals with perceptive questions of binaural hearing, pitch (spectral and virtual), timbre, focus, extent of fluctuation, roughness etc. Perception components such as those just mentioned constitute in particular the basis for loudness models. More complex auditory functions such as masking, temporal coherence and auditory streaming permit the investigation of more demanding perceptive processes in language and music. Cochlea models are currently undergoing a dramatic restructuring as a result of the discovery of oto-acoustic emissions in the ear, resulting in physiologically completely new points of view for psychoacoustics.

Direct applications of fundamental psychoacoustic research are to be found in the subjective assessment of noise sources, noise control, sound quality design, the generation of virtual acoustic rooms and in sonification and auralization. In addition, the Institute intends to continue the focal research area, introduced some time ago, of *semi-automatic segmentation of acoustic signals* by means of figure-background separation and content-related classification. For applications in the field of hearing loss, see the section on medical technology and acoustics.

In the field of phonetics, acoustic models of speech production are being used with great success to extract various speech parameters, in particular to calculate formant frequencies and the course of the fundamental frequency. In speech, too, prime importance is being given to the automatic segmentation of unrehearsed speech. Breath groups are automatically identified as a preliminary stage for segmentation and transcription. A process and rule catalogue is being prepared for the documentation of Austrian standard varieties (initially Vienna and the adjoining region of Lower Austria; Graz and environs). As further assistance to the work on speech recognition, it is proposed to make phonetic, phonological and dialectological descriptions of languages in the closer catchment area of Austria, whose phonology and phonetics have hitherto been insufficiently researched (e.g. Albanian, Turkish, Romanian, Bosnian, Serbian, Croatian). Currently, the Institute maintains a speech database containing around 400 speech samples in a wide variety of languages and capable of segmentation and annotation in whole or in part, depending on requirements.

Psycho-acoustic models and derived content-descriptive methods and analyses are also used in music. The Institute for Acoustic Research, in cooperation with various partners, is responsible for projects on performance practice and sound engineering, on the digitization, archiving, segmenting and annotation of music, on sound and music synthesis, on the restoration of historic sound recordings and on the development of teaching and learning aids in music education. Mention should be made in this context of the Institute's participation

in the HARMONICA project (Accompanying Action on Music Information in Libraries: PRO-LIB/HARMONICA I0453 – European Commission Libraries Programme), in which the Institute chairs the networking and digitization working party. In addition, the Institute acts as a partner in the DELOS project (Network of Excellence on Digital Libraries – European Commission Information Society Technology, IST-1999-12262) with the special topic of *Content analysis and metadata for music and music information*. This group of questions is in particular being pursued in the music industry in the field of MPEG-7 standardization (Moving Picture Experts Group: Multimedia Content Description Interface), and is intended to facilitate the storage, exchange and network access to music products.

*Medical technology and acoustics  
(experimental audiology)*

This area is characterized by extensive work in the field of neuropsychological models (neurograms, sound pressure level excess), models of auditory processes with hearing impairment and signal processing for hearing test methods for hearing impairment and cochlea implants. This is a field that will undergo considerable expansion in the future as a result of binaural hearing aids and bilateral cochlea implantation. The main advantages of binaural stimulation as compared with monaural stimulation are to be found in the inclusion of inter-aural runtime, phase, intensity and spectral differences that can be evaluated at brainstem level and separated into desired signal and interference noise with the help of localization cues. What is required is the development and validation of binaural test methods that both facilitate differential diagnosis in the clinic by means of improved topographic delimitation, and allow more elaborate approaches to treatment. Equally urgent is the optimum adaptation of the two speech processors working independently of each other in the case of binaural supply with cochlea implants in order to maintain a certain degree of directional hearing. The development of test methods suitable for children is absolutely new ground. In the case of the postlingually deaf, the improvement of speech comprehension is determined by means of the binaural intelligibility level difference (BILD). The test set-up currently installed for monaural cases involving the compression and increase of contrast of spectral peaks by means of masking is to be extended for use with binaural applications. It will also be interesting to see whether the improvement of speech expression following monaural cochlea implantation identified in collaboration with the clinic can be further increased by means of a binaural supply.

*Organizational structure*

The three areas listed above benefit from numerous theoretical and practical cross-links involving

considerable synergy effects. Directional hearing makes systematic use of results from the Institute's work in computational acoustics. These include for instance digital simulations of sound projection and sound reflection, and the generation of virtual acoustic rooms. Phenomena and test methods for localization and lateralization, such as binaural masking level differences (BMLD), binaural fusion, time intensity trading (in the case of lateralization), that have been the subject of long investigations on normal hearers in the field of psychoacoustics are for the first time being prepared for clinical use for the binaural support of sensory-neural hearing impairments. Finally, the joint development of software for all three areas forms a framework that imposes a clear definition of the interfaces of the individual projects at the level of the modelling algorithms, permitting a cumulative process of theory and hypothesis formation in both experimental design and test theory. The results of these studies are verifiable and available in the form of the software package S\_TOOLS (Intelligent Sound Processing Tools).

**Commission for Scientific Visualization**

Scientific visualization (*SciVis*) is one of the fastest-growing areas in computer science. The visualization of complex processes and the compressed and easily ascertainable representation of large quantities of data is an urgent need in almost all disciplines of medicine, the humanities, engineering and the natural sciences. The rapid development of increasingly powerful hardware and software is continuously extending the fields of application of visualization. In addition, the varied efforts and the progress made in the field of virtual reality have substantially expanded the possibilities and fields of application of scientific visualization (architecture, archaeology, medicine).

The Commission for Scientific Visualization was set up on January 1, 1999, with the aim of studying the fundamentals, methods and applications of scientific visualizations. In the fields of application, the focus is on questions of visualization in medicine and functions in the field of the historical sciences.

*Medicine*

The Commission's current activity continues to be large-scale data visualization, collaborative visualization and multidimensional vector visualization. A field of application in which all these topics play a major role is medical imaging. This work is to be continued and consolidated on the basis of the years of experience within the Commission in the field of medical data visualization. A number of cooperation projects are planned and are ready for submission to the various funding bodies:

1. BBangio – visualization of pelvis-leg-angio-spiral CT data for the rapid and reliable detection of arterio-stenosis

2. CoVoIVis – collaborative volume visualization over a volume-rendering, hardware-based client-server system
3. SIEVE – spatially immersive environment for volume exploration
4. MULTIMO – multimodal physiological data visualization combining CT, MRI, EEG and MEG sources
5. GIF – guided image visualization

The most powerful and flexible method for visualizing three-dimensional medical data records is volume rendering. This method can also be used to deal with geometrical objects if they have been prepared accordingly. The work in this sector is to be continued focusing on the following areas:

1. Development of new voxelization techniques for geometrical objects, stemming from an “intelligent” voxel concept (voxel with attributes), and implementation of the appropriate reconstruction techniques.
2. Hierarchic representation of volumetric data sets that increase the effective resolution of the data without impairing its quality.

The preparation of volume data is a time-consuming operation and constitutes the main obstacle to the routine use of three-dimensional methods in clinical practice. For this reason, the pre-processing, segmentation, registration and visualization techniques are to be improved and tested on large tomographic data sets as produced by high-resolution spiral CTs.

In addition, it is also planned to participate in the development of clinically applicable methods for diagnosing vascular calcification and aneurisms, since these give rise to pertinent and demanding visualization problems.

A long-term focus of the Commission’s staff is on trials for the visualization of brain activity measured by means of EEG. In this context, attempts are made to determine the degree of synchronization, i.e. interaction, of different areas of the brain using a number of linear and non-linear dimensions. The main topic in this sector is the investigation of the EEG in thought processes such as listening to speech and music, simultaneous interpreting, observing and remembering images, and spatial conceptualization. Fourier analyses have shown that the degree of cooperation between different areas of the brain changes in accordance with the task. These investigations are to be corroborated and extended using non-linear methods. At the same time, work is to be carried out on revealing “concealed”

information in time series obtained from bio-medical measurements and using it for prognostic and diagnostic statements. The role of external and internal interference from physiological systems on the maintenance and derivation of certain preferred conditions is to be studied.

The huge quantities of data in the form of sleep EEGs obtained within the framework of the now completed EU SIESTA project are to be used as the basis for more extensive and in-depth signal analyses. This also leads to problems for visualization, such as the possibility of presenting the results of signal analyses rapidly and clearly in topographic and in animated representations.

#### *Computer Aided Archaeology*

The visualization activities in this sector are still in their infancy, and are to be extended and consolidated. This field is currently developing very dynamically, and is also being met with a lively response in the mass media and the broad public. A starting point is a series of smaller bilateral cooperation projects with partners within the Academy (Institute for the History of Ancient Art: terrace houses at Ephesus, Höflein Villa, individual buildings at Carnuntum), and it is within this framework that a 3D reconstruction and presentation based on multimedia CD-ROM is to be created for use by the general public. An outwardly open, GIS-based archaeology-related data management and visualization system is to be developed, and, after an initial stage, the data and experiences already available are to be integrated in simulation and animation processes (such as earthquakes, drainage systems or lighting). This is a highly multi-disciplinary field of activities and requires the expertise and participation of archaeologists, architects, astronomers, physicists, geologists and computer scientists.

#### *Information visualization*

Scientific visualization is increasingly also becoming an instrument with a broad field of application. As a result, a number of new demands have arisen which can be subsumed under this heading. The issue involves the visual representation of large data collections, which need not, however, be of a scientific nature, e.g. customer stock, results of database queries or WWW searches. The Commission is to participate in and make its contributions to this development.