Life Sciences Research Report 5

Theodore H. Bullock

Editor

Recognition of Complex Acoustic Signals

Dahlem Konferenzen

The goal of the Dahlem Workshop on Recognition of Complex Acoustic Signals:

To understand the nature of biologically significant acoustic signals and their recognition by organisms and machines.

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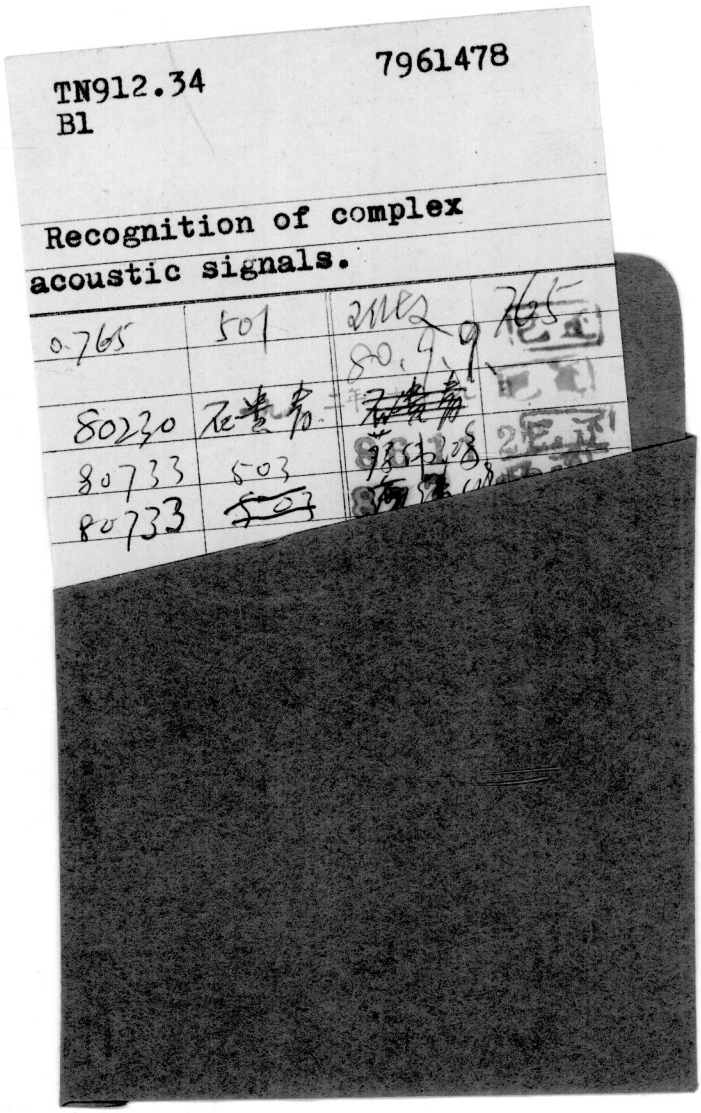

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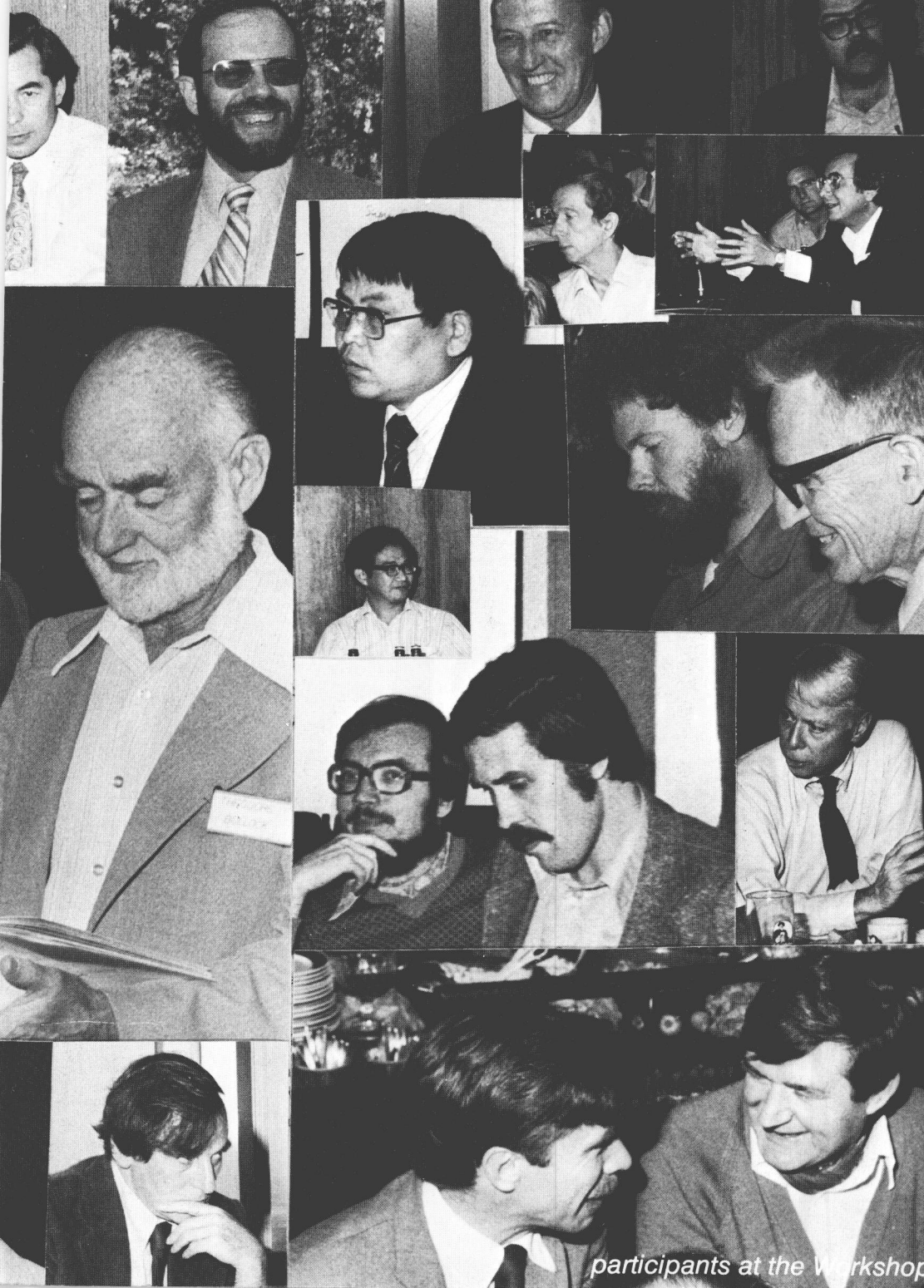

participants at the Workshop

Report of the Dahlem Workshop on
Recognition of Complex Acoustic Signals
Berlin 1976, September 27 to October 2

Theodore H. Bullock
Editor

Recognition of Complex Acoustic Signals

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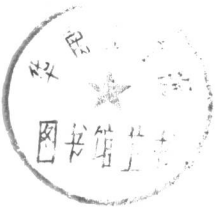

Progress in Auditory Recognition: A Case Study on How the Brain Works (Introduction)

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Progress in understanding how the nervous system processes natural acoustic stimuli is interesting enough in its own right and for the spin-offs of practical value that it triggers. But I see it as having an even wider significance. In our present eager search for insight into how that wonderful organ, the brain, the pinnacle of evolution, really works, it would be enormously valuable to find even fragmentary answers for a sensory modality like audition. To be sure, the intimate physiology of vision is generally said to be well in advance of auditory physiology. But this very situation is evidence that we cannot transfer everything learned in one modality to others; and hence, that audition is a case study of its own that may shed new light on the larger problem.

Progress there has been, even measured in the few years since the publication of F.G. Worden and R. Galambos (1972) on "Auditory Processing of Biologically Significant Sounds" (Neurosciences Research Program Bulletin, 10). However, it is not only for that reason that a new workshop and book are timely.

"Sound patterns are the most successful signals for communication in the animal kingdom. They offer special advantages for orientation and have evolved into the most elaborate communication system: human speech". With this thought,

G. Neuweiler and H. Scheich proposed a workshop with a new mix of workers, including specialists on human speech, animal communication, physiology, development, and even machine recognition of acoustic signals. With such a mix, brain mechanisms are not the universal center of interest, and the enthusiasm of the first paragraph reveals my bias more than that of the group that was convened in Berlin in the autumn of 1976.

The proposal by Neuweiler and Scheich for a new mix continues:

> Sound which is highly structured in the time and frequency domain poses special problems to any recognition mechanism. Since vocalizations have this quality, new and stimulating insights are to be expected and have been gained from brain mechanisms which process them.
>
> The technical use of acoustic signals in orientation and communication has gone a course from simple to increasingly complex applications. The need for efficient systems, for instance in automatic speech processing, directs the interest to principles which successfully operate in organisms. An interaction of biological and technical approaches at this stage is highly suggestive.
>
> Modern behavioral sciences have documented an overwhelming repertoire of minutely differentiated vocalizations. Behaviorists have shown the communicative significance of fine variations in acoustic signals for species and individual recognition and for many aspects of social interactions and adaptation to environmental peculiarities.
>
> This body of evidence and state of knowledge in bioacoustics which is derived from a comparison of species should be integrated into the concepts of all disciplines concerned with acoustic signal analysis.

Dahlem Konferenzen, following review, decided to mount such a meeting in their special style. This meant that specialists in the various topics were selected by an advisory committee and invited to write background papers. These were distributed to all participants several weeks before the meeting. Written questions and comments on them were distributed just before the meeting and initiated the discussions. All sessions, both small-group and plenary, were informal, without lectures. Each group met several times, and a rapporteur in each drafted a chapter for the book as a result. While these group reports have been scrutinized by the members of the groups, as well as the editor, and the final versions altered as a result of the

feedback, they remain essentially the product of the rapporteurs. Background papers were likewise revised as a result of feedback at the workshop and on subsequent drafts.

A number of participants stayed on at the end of the workshop for an additional session to consider how a scientific study of the biological mechanisms underlying the analysis of complex sounds could aid our understanding of hearing and language disorders. The session devoted most of its time to a consideration of the underlying nature of disorders of hearing and language before moving on to consider implications for present and future methods of diagnosis and the rehabilitation of the deaf. A condensed report of this seminar appears at the end of this volume.

The integration of the whole and realization of the goals can be, understandably, only partial; it would be unrealistic to expect too much. Nevertheless, the Dahlem Workshop achieved a high water mark of sustained contact and intensive communication between these specialized groups of people who speak different jargons, though working in intimately related areas. And one did see positions reformulated, and usage of terms sharpened. We can hope that among these groups and the readership of this book some of the ideas for new research will take root.

Although keenly interested, the writer is not a specialist in the field of the workshop. This may have been a reason that he was asked to chair the organizing committee and, later, to draft this introduction and edit the manuscripts. He felt the need of a specialist and is therefore very much indebted to Henning Scheich for giving each chapter an additional proficient reading.

Diversity in approach, working model, and strategy strike the eye as one reads such a collection. It is impressive how widely disparate the conceptual systems are, without the necessity of actual disagreement. This is certainly a sign of

the early stage in our understanding. I take it also as a sign of health for the science and an augury of a better chance for creative breakthroughs than if everyone had been influenced by a common point of view. Communication, to be sure, is more difficult when elementary words such as "feature" mean quite different things to different workers, even in the same field, requiring extra hours to establish mutual understanding. An effort of will is often required to show respect for the other worker's strategy, which may be based on a different set of priorities, hunches, and compromises.

To me, however, these problems are the high level challenges of our profession and are distinct from the technical level challenges of how to make a measurement. The beautiful thing about science is its subjectivity. In spite of Gunther Stent's dire prediction about the end of art, one art form that will continue to thrive is science, because it has rules to govern its creative flights.

In this workshop we began by taking for granted the disparities in frames of reference and in the vivid personal observations that represent reality. We did not bemoan the divergence in jargon or in perception of what "the real question" is. The group, by the act of conjoining, accepted the tasks of reading in advance background papers quite afield from their normal habitats, formulating comments and questions in a common language, and working together in long sessions toward a new synthesis.

The resulting group reports capture, of course, only a portion of the achievements. These will be judged by some readers mainly by the statements of what can be said about what we think we know. Others will see the achievements in the statements of issues and leanings; still others will see them in the opportunities underlined for new work. Concepts, issues, and strategies are inseparable ingredients in the chapters that follow, representing as they do, a kind of public thinking-out-loud.

My fellow participants worked hard but were put to shame in this dimension by the skillful staff of Dahlem Konferenzen. We gratefully acknowledge their dedication, patience and thoughtfulness and these qualities plus an insightful expertise in how to incite scientists to confer creatively in our genial leader, Silke Bernhard.