

The Ear as a Communication Receiver
English translation of
Eberhard Zwicker and Richard Feldtkeller
Translated from German by Hannes Musch, Soren Buus, and Mary Florentine
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Preface to the Translation

The Ear as a Communication Receiver is the translation of the second edition of the German text *Das Ohr als Nachrichtempfänger* by Eberhard Zwicker and Richard Feldtkeller. Since its publication in 1967, the book has been referenced extensively in journals published in English, but it was never translated in its entirety into this language. This is not to say that the book was only accessible to German-speaking readers. In 1981, *Das Ohr als Nachrichtempfänger* was translated into French. Today, more than 30 years after its original publication in German, the Acoustical Society of America makes available an English edition.

Our aim was to produce a translation whose language is easily understood by the contemporary reader. We preserved many of the stylistic features of the original text such as the frequent use of the active voice. However, at times we opted for a loose translation in recognition of the fact that technical writing styles are different in German and English and change over time. It is our hope that our translation does the authors' original text justice.

An explanation is in order regarding the "List of Symbols, Units, and Definitions," which begins on page xviii. Zwicker and Feldtkeller used a consistent notation in the book, which Zwicker has maintained throughout his many papers. Following Zwicker's recommendation, we decided not to translate the acronyms and abbreviations used as qualifying subscripts to many symbols, but kept the original German forms intact. We hope that becoming familiar with Zwicker's use of symbols in this book will allow the reader with only rudimentary knowledge of German to decipher Zwicker's other works. In our opinion, this justifies the inconvenience of the often not-intuitive subscripts. There are some exceptions to this rule, however. We did change the subscripts to those symbols that were in direct conflict with the intuitive English acronyms or abbreviations. For example, we changed the original notation for lower cutoff frequency, f_u , (untere Grenzfrequenz) to f_l in order to avoid confusion with the upper cutoff frequency. Another such change was Grenzfrequenz (cutoff frequency), f_g , which was changed to f_c . The upper cutoff frequency (obere Grenzfrequenz), f_o , became f_u . The notation for the width of a critical band (Frequenzgruppe) in the German text, (fG) , was replaced by the more intuitive (fCB) . The same logic holds for the level within a critical band, LG , which became LCB . Finally, we deviated from the notation in

the German text by introducing the symbol z_m when referring to melodic pitch. In the original text, both the critical-band rate, measured in Bark, and the melodic pitch, measured in mel, are referred to by z . While the scales are proportional to one another the authors made a point of distinguishing between (see Section 34). This distinction is now reflected by the use of two different symbols.

The figures in this book are reproductions of the original ink drawings and photographs. We translated the labels on graphs and schematics where necessary, but left the figures otherwise untouched.

We would like to gratefully acknowledge the help of many individuals. Foremost we would like to thank Tilmann Zwicker for advice, encouragement, and help in the many organizational aspects of this seemingly everlasting project. We thank Hugo Fastl and Helmut Fleischer for their help with the figures. We are grateful to Andrew Oxenham, Monica Robinson, and the late Dixon Ward for their comments and advice on the early drafts. Finally, we would also like to thank the Acoustical Society of America, especially its Publication Committee, and the gracious and efficient staff at the editorial office.

Hannes Musch, Soren Buus, and Mary Florentine
Boston, December 1998

Preface

Are there hearing sensations that obey universal laws, which are independent of the listener? This question is justified by the often-held assumption that people's experiences are highly individual. However, it has been shown experimentally that reports about certain sensations tend to agree among individuals with different personalities. Because people tend to agree about them, it is possible to predict them. One example is the perception of color. It is predictable by the well-developed theory of the color triangle.

Listeners with normal hearing agree about many hearing sensations. Their reports are so similar that the opening question can be posed more narrowly. For which hearing sensations is it possible to use the outcome of subjective observations in listening experiments to derive laws that predict the relation between a sensation and the sounds that evoked it?

This book is a contribution to the search for answers to these and related questions. These questions are relevant to communication technology, because telephones and radios serve to transmit speech and music. For communication systems to be cost effective, they must aim at transmitting only parts of the signal that are relevant to the purpose of the system and, most importantly, only parts that are perceivable by the listener.

In reviewing the literature to find reliable and satisfying answers to our questions, we realized that many aspects of hearing were described either incompletely or not at all. We were also unable to compile a list of auditory sensations that could be quantitatively related to acoustic stimuli. This was the state of affairs about 20 years ago, when we began our own experiments. Research associates, Ph.D. candidates, and students helped us in the development of experimental methods and equipment. The range of hearing sensations that our experiments could assess increased steadily and grew to describe many psychoacoustic results that, we believe, are of more or less fundamental relevance.

After ten years we believed we had finished the first chapter of our research. The results we had obtained at that time were summarized in the first edition of this book, which was published in 1956. Even then we felt it was necessary to coin new terms such as "masked threshold," "critical band" and "loudness reduction."

The results of our investigations have been replicated and extended in many laboratories. Our own research focused on understanding loudness which we deemed particularly important because noise abatement is only possible on the basis of reliable loudness measurements. We also studied intensively

the sensations evoked by rapidly varying sounds. After another ten years of even more intense research, we now present the new results together with the earlier results. Many of the newer results were published previously in independent papers.

This is how we arrived at the second edition of our book. We hope that it better lives up to the ambitious title of the first edition. The style of the present edition is a combination of a progress report and an introductory text to the field of psychoacoustics. The majority of the material presented results from research at the Institut für Elektrische Nachrichtentechnik at the Technische Hochschule Stuttgart. This approach entails some risk of giving a one-sided view of the field. To provide a more complete view, material based on research from other laboratories has been included in some places.

The contents of Sections 70 (Phase Shifts of Complex-Tone Components) and 71 (Delay Distortion) has not been published anywhere else. The same is true for parts of Sections 78 (Post-Masking) and 79 (Pre-Masking).

We did not include any citations in the text to not disrupt the flow of the arguments. Rather, all citations are collected at the end of the book. Due to lack of space even these sections provide only examples of relevant papers. The authors ask for understanding of this limitation.

This edition includes only very few sections from the first edition, and even they are heavily edited. The inclusion of the chapters on the dynamic properties of the auditory system made it necessary to add in the beginning of the book two chapters that detail the physics of the sounds and sound fields used in the experiments.

Altogether, the size of the book grew to three times the original. As in the first edition, it was necessary to coin new terms to make the text more concise: "incitation" and "excitation," "partial loudness," "specific loudness," "ratio loudness," "pre-masked threshold" and "post-masked threshold," "masking index," and "signal-to-noise intensity ratio at threshold."

Results of binaural experiments, which give insight into the way our two ears work together, are not included in this book. Likewise, areas of auditory research that are not yet completely understood have been excluded.

The material and the form of presentation were chosen to address four groups of readers:

1. The book is intended to be a "school of hearing" for the communication-electronics engineer who is involved in the design of reproduction systems for speech and music. The design goal might be to develop better telephone systems or loudspeakers. To this end, we would like to provide an understanding of how the auditory system performs as a receiver and as a measurement device. It is also important to learn what degradations of the reproduced signal go unnoticed by the ear and to use this knowledge in the specification of the system's performance requirements.

2. The book may serve as a source of information about mathematics and physics to sensory psychologists and, in particular, psychoacousticians. This knowledge provides a basis for interpreting the experimental results presented in this book and understanding the universal models that we have come to appreciate as valuable and useful tools for describing various properties of the auditory system.

3. The book may prompt otologists to repeat experiments performed in normally hearing listeners with hearing-impaired individuals. This may lead to new diagnostic tools. The book may spark musicians' interest in psychoacoustics. Although composition and musical performance are affected only indirectly by the properties of hearing they play an important role. We would like to acknowledge that Dr.-Ing. D. Maiwald, Dipl.-Ing. E. Terhardt, and Dipl.-Ing. W. Weinschenk provided valuable help in the preparation of this book. The figures were prepared by Ms. Hinterwalder. We also would like to thank the publisher, S. Hirzel Verlag, and especially Mr. Plohm, for accommodating all our wishes.

E. Zwicker and R. Feldtkeller
Stuttgart, fall of 1966

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With communications, the receiver is the individual (or group) to whom a message is directed, and it requires a certain responsibility to get it right. A Receiver's Role in Clear, Effective Communication Is an Important One. Protect Yourself Better Knowing What Goes Wrong in Conversations. Share. Flipboard. Email. Print. Robert Kneschke / EyeEm/Getty Images. The Ear As a Communicatio has been added to your Cart. Add to Cart. Buy Now. Barack Obama's new memoir. Listen to the highly anticipated memoir, "A Promised Land". Free with Audible trial. click to open popover. Enter your mobile number or email address below and we'll send you a link to download the free Kindle App. Then you can start reading Kindle books on your smartphone, tablet, or computer - no Kindle device required. Apple. In communication models, the participantsThe senders and/or receivers of messages in a communication encounter. are the senders and/or receivers of messages in a communication encounter. The transmission model of communicationDescribes communication as a linear, one-way process in which a sender intentionally transmits a message to a receiver. describes communication as a linear, one-way process in which a sender intentionally transmits a message to a receiver. Richard Ellis and Ann McClintock, You Take My Meaning: Theory into Practice in Human Communication (London: Edward Arnold, 1990), 71. This model focuses on the sender and message within a communication encounter.