

Evaluating fast-acting compression in basic psychoacoustic and speech tasks

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Introduction

Multi-channel wide dynamic-range compression (WDRC) is involved in the signal processing schemes of most modern hearing aids. Commonly used non-linear gain prescriptions (e.g., DSL v5.0, NAL) do not make specific recommendations for other parameters of compression amplification, such as time constants or the number of processing channels. Currently, there is no consensus regarding optimal values of these parameters. Studies using speech recognition as an outcome measure have shown mixed results, partly due to the differences in testing conditions (e.g. overall input levels and signal-to-noise ratios), differences in individual cognitive abilities, and differences in available cues for speech recognition. The latter likely depend on the degree and configuration of the hearing loss. Here, a model of auditory processing (Jepsen et al. 2008, 2011) was used to compare linear and various compression schemes in terms of individual listener's performance in basic psychoacoustic tasks. These results were verified in aided psychoacoustic experiments. Further, speech recognition performance of the same group of hearing-impaired listeners with compressive and linear amplification was investigated.

Outcome measures

Psychoacoustics:

- Aided/unaided experiments and simulations in 3 kHz and 3.5 kHz: **Quality of forward masking** (simulated/75 dB SPL masked, signal at 1 and 4 kHz (Fig. 1))
- Spectral masking patterns**: narrowband 75 dB SPL masker at 1 and 4 kHz (Fig. 2)
- In HI only: **temporal masking curves (TMCs)** measurement for a behavioral SRT estimate at 1 and 4 kHz (Fig. 3, and 4)



Speech recognition:

- Dantale II (Wagener et al. 2003) sentences in ICRA7 noise -> expected negative SRTs
- GA1 (Jepsen et al. 2014) sentences vs. two competing talkers -> expected positive SRTs

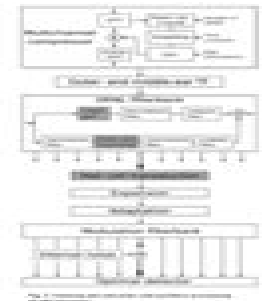
Auditory processing model and hearing-aid simulator

Hearing aid:

- Instantaneous attack, 10-ms release (AC)
- 24 channels, ERB-like
- Frequency- and level-dependent insertion gain based on NAL-NL1 (compression) or NAL-RP (linear amplification)

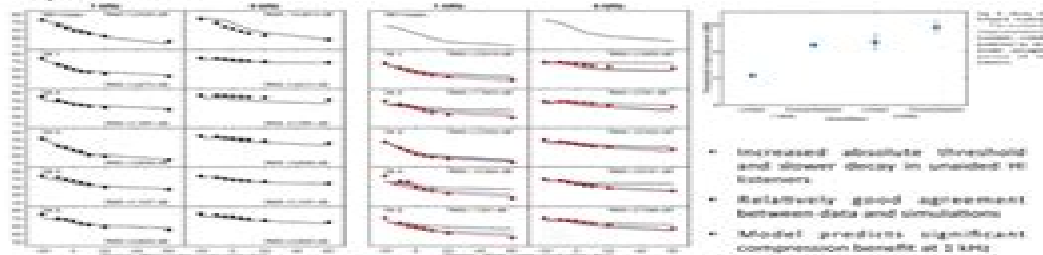
Auditory processing model:

- CASP model (Jepsen et al., 2008)
- Individualized based on the audiogram and the TMC data (Jepsen and Dau, 2011)

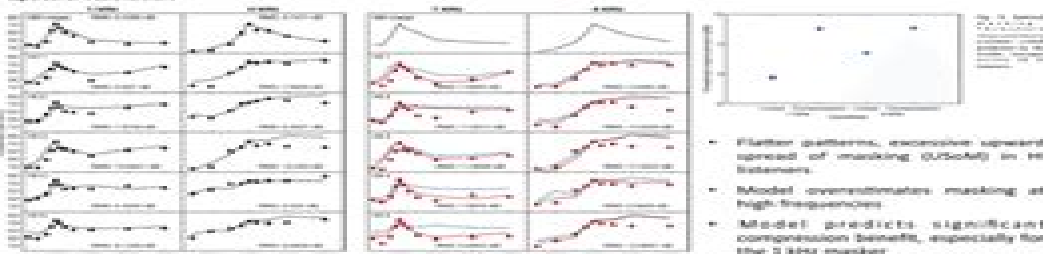


Psychoacoustic results

Temporal resolution



Spectral resolution



Speech intelligibility results



Related measures: SRTs

Significant effect of speech material

No effect of amplification type

Interaction trend: amplification type*speech material

Conclusions

Temporal resolution: with a short release time, compression can give listeners a slight benefit.

Spectral resolution: with a large number of channels a significant improvement is also seen in measures of spectral resolution.

Speech recognition: the relative benefits of compression vs. linear seem to depend on the choice of speech material, and therefore on the SNR range (positive vs. negative).

References

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Basic Experimentation in Psychoacoustics Alan M. Richards, 1976

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Howard, Jamie Angus, 2013-03-20 The acoustics of a recording space can have a real impact on the sounds you create and capture The book gives an essential grounding and understanding to how real music sounds behave and are perceived in real spaces With a clear and simple style Howard and Angus walk you through the theory the science of sound engineering and music production and the practical how to apply it to music spaces so create professional sound using real world examples and providing audio clips and recorded sounds to work with Updated throughout the new edition uncovers the acoustic application for today's recording industry The website is packed with audio clips questions and answers a calculation facility as well as links and resources

Acoustics and Psychoacoustics

David M. Howard, Jamie Angus, 2017-06-13 The acoustics of a space can have a real impact on the sounds you create and capture Acoustics and Psychoacoustics Fifth Edition provides supportive tools and exercises to help you understand how music sounds and behaves in different spaces whether during a performance or a recording when planning a control room or listening space and how it is perceived by performers listeners and recording engineers With their clear and simple style Howard and Angus cover both theory and practice by addressing the science of sound engineering and music production the acoustics of musical instruments the ways in which we hear musical sounds the underlying principles of sound processing and the application of these concepts to music spaces to create professional sound This new edition is fully revised to reflect new psychoacoustic information related to timbre and temporal perception including an updated discussion of vocal fold vibration principles samples of recent acoustic treatments and a description of variable acoustics in spaces as well as coverage of the environment's effect on production listening sonification and other topics Devoted to the teaching of musical understanding an accompanying website www.routledge.com/cw/howard features various audio clips tutorial sheets questions and answers and trainings that will take your perception of sound to the next level This book will help you Gain a basic grounding in acoustics and psychoacoustics with respect to music audio technology systems Incorporate knowledge of psychoacoustics in future music technology system designs as appropriate Understand how we hear pitch loudness and timbre Learn to influence the acoustics of an enclosed space through designed physical modifications

Psychoacoustics, Speech And Hearing Aids - Proceedings Of The Summer School And

International Symposium Birger Kollmeier, 1996-05-06 Recent advances in psychoacoustics and speech research have an important impact on our understanding of hearing impairment and the concepts of compensating hearing problems with modern hearing instruments This proceedings of the summer school and symposium give an introduction into the latest developments in this interdisciplinary area Tutorials of leading international scientists as well as more focused contributions of active researchers provide an excellent overview and a documentation of the state of the art The book is of interest for everybody involved in hearing research audiology and audio signal processing

Psychoacoustics Jennifer J.

Lentz,2023-11-27 Psychoacoustics Auditory Perception of Listeners with Normal Hearing and Hearing Loss Second Edition provides an overview of the field of psychoacoustics with a primary focus on auditory perception The book retains its focus on applications of psychoacoustics to clinical audiology and its modular organization with each chapter including relevant information around a specific topic Within each chapter acoustics physiology and perception by adult listeners with normal hearing and those with hearing loss as they relate to that topic are presented The influence of hearing loss on these general auditory abilities is discussed in every chapter Components of the book also include the role of psychoacoustics in audiological assessment and treatment The text is ideal for audiology students who intend on having a clinical career and need an understanding of both normal and impaired auditory perception It is intended to give students sufficient information to understand how the ear achieves auditory perception what the capabilities of the ear are and how hearing loss influences that perception It also provides students with a foundation for further study in the area and to apply psychoacoustic principles to diagnostic audiology and audiological rehabilitation New to the Second Edition 70 new figures to clarify some points and facilitate students understanding of the material New chapter that focuses exclusively on the perception by individuals wearing hearing aids and cochlear implants New section on the perceptual consequences of sensorineural hearing loss on everyday listening added to each chapter Revamped chapter on Psychoacoustics and Advanced Clinical Auditory Assessment now solely addresses elements within diagnostic audiology that are based on psychoacoustics with added content on tinnitus assessment automated B k sy audiometry retrocochlear and pseudohypacusis evaluation and the identification of dead regions Enhanced focus on inclusivity such as alternative versions of some demonstrations designed to be more accessible to individuals with hearing loss and a new section on the contributions of women and BIPOC scientists to the field of psychoacoustics Key Features Learning objectives and summaries begin and end each chapter to convey the goals of the text and review student comprehension Each chapter contains exercises designed to develop critical thinking about psychoacoustics Chapters include the following introduction relevant acoustics important physiological studies perception by normal hearing listeners and perception by listeners who have sensorineural hearing loss Emphasis on applied learning for more effective and efficient learning of the material Disclaimer Please note that ancillary content such as lab exercises are not included as published in the original print version of this book *Methods in Comparative Psychoacoustics* G.M. Klump,R.J. Dooling,Richard Fay,W.C. Stebbins,2013-11-11 Twenty five years ago Bill Stebbins presented the principles of animal psychophysics in an edited volume Stebbins 1970 describing an array of modern creative methodologies for investigating the range of sensory systems in a variety of vertebrate species These principles included precise stimulus control a well defined behavioral response and a rigorous behavioral procedure appropriate to the organism under study As a generation of comparative sensory scientists applied these principles our knowledge of sensory and perceptual function in a wide range of animal species has grown dramatically especially in the field of hearing Comparative psychoacoustics i e the

study of the hearing capabilities in animals using behavioral methods is an area of animal psychophysics that has seen remarkable advances in methodology over the past 25 years. Acoustic stimuli are now routinely generated using digital methods providing the researcher with unprecedented possibilities for stimulus control and experimental design. The strategies and paradigms for data collection and analysis are becoming more refined as well again due in large part to the widespread use of computers. In this volume the reader will find a modern array of strategies designed to measure detection and discrimination of both simple and complex acoustic stimuli as well experimental designs to assess how organisms perceive, identify and classify acoustic stimuli. Refinements in modern methodologies now make it possible to compare diverse species tested under similar if not identical experimental conditions. [Current Catalog](#) National Library of Medicine (U.S.), First multi year cumulation covers six years 1965-70. *Communication Acoustics* Ville Pulkki, Matti Karjalainen, 2015-04-30. In communication acoustics the communication channel consists of a sound source, a channel acoustic and/or electric and finally the receiver, the human auditory system, a complex and intricate system that shapes the way sound is heard. Thus when developing techniques in communication acoustics such as in speech audio and aided hearing it is important to understand the time-frequency space resolution of hearing. This book facilitates the reader's understanding and development of speech and audio techniques based on our knowledge of the auditory perceptual mechanisms by introducing the physical signal processing and psychophysical background to communication acoustics. It then provides a detailed explanation of sound technologies where a human listener is involved including audio and speech techniques, sound quality measurement, hearing aids and audiology. Key features: Explains perceptually based audio; the authors take a detailed but accessible engineering perspective on sound and hearing with a focus on the human place in the audio communications signal chain from psychoacoustics and audiology to optimizing digital signal processing for human listening. Presents a wide overview of speech from the human production of speech sounds and basics of phonetics to major speech technologies, recognition and synthesis of speech and methods for speech quality evaluation. Includes MATLAB examples that serve as an excellent basis for the reader's own investigations into communication acoustics interaction schemes which intuitively combine touch, vision and voice for lifelike interactions. **Ecological Psychoacoustics** John Neuhoﬀ, 2021-10-01. Ecological Psychoacoustics outlines recent advances in dynamic cognitive and ecological investigations of auditory perception and ties this work to findings in more traditional areas of psychoacoustics. The book illuminates some of the converging evidence that is beginning to emerge from these traditionally divergent fields providing a scientifically rigorous real world perspective on auditory perception, cognition and action. In a natural listening environment almost all sounds are dynamic, complex and heard concurrently with other sounds. Yet historically traditional psychoacoustics has examined the perception of static impoverished stimuli presented in isolation. Ecological Psychoacoustics examines recent work that challenges some of the traditional ideas about auditory perception that were established with these impoverished stimuli and provides a focused look at the perceptual

processes that are more likely to occur in natural settings It examines basic psychoacoustics from a more cognitive and ecological perspective It provides broad coverage including both basic and applied research in auditory perception and coherence and cross referencing among chapters *Acoustical Society of America* ,1976

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