NEWSLETTER

CENTRE FOR ACOUSTIC SIGNAL PROCESSING RESEARCH (CASPR)

January 2026

The Centre for Acoustic Signal Processing Research (CASPR) is a research centre at the Section for Artificial Intelligence & Sound, Department of Electronic Systems, Aalborg University, Denmark. CASPR is supported by the Demant Foundation, Oticon A/S, and Aalborg University.

AALBORG UNIVERSITY

If you are interested in learning more about the research and teaching taking place in CASPR, check our webpage here.

Or, reach out to:

- Prof. Jan Østergaard
- Prof. Zheng-Hua Tan
- Prof. Jesper Jensen

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CASPR

Centre for Acoustic Signal Processing Research

RESEARCH IN CASPR

ABOUT CASPR

CASPR is conducting research related to advanced statistical signal processing solutions for assistive listening. The research finds direct use in communication devices such as hearing aids, helmets, headphones, cochlear implants, ear monitor, ear pieces, diagnostic equipment, etc. However, the envisioned research also finds use in related areas such as robust speech/speaker recognition, brain computer interfaces, acoustic event detection, etc.

CASPR will navigate in a rapidly changing technological landscape: we envision a near future, where the technological landscape allows very different, and better, hearing assistive devices than are known today.

The scientific scope of CASPR encompasses:

- Signal processing for hearing assistive devices that use multiple modalities such as sound, vision, EEG, and other body signals.
- Advanced signal processing concepts in closer symbiosis with the user in order to e.g., automatically adapt to the user's needs.
- Beyond audibility. Restore audibility, increase intelligibility, decrease listening effort.

SCIENTIFIC DISCIPLINES OF CASPR

Machine Learning

- Deep Neural Networks
- Automatic Speech Recognition
- Multimodal Biometric
- Brain-Computer Interfaces
- Big Data

Information and Communication Theory

- Information in the brain and the auditory system
- Streaming of sound
- Compression of sound
- Wireless acoustic sensor networks

Statistical Signal Processing

- Speech processing
- Signals in noise
- Spatial signal processing
- Multimodal signal processing
- EEG signal processing
- Processing of body worn sensor data

Signal Processing and Perception

- Signal processing that compensates auditory system
- Signal processing that complements auditory system

TEACHING IN CASPR

CURRENT COURSES RELATED TO CASPR

CASPR is heavily involved in teaching and education at B.Sc., M.Sc., PhD., and Postdoc level in disciplines that are relevant to the scientific scope of CASPR:

- Machine learning, Master and PhD courses.
- Deep learning, Master and PhD courses.
- Self-Supervised Learning, PhD course.
- Reinforcement Learning, PhD course.
- Introduction to Information Theory in Neuroscience, PhD course.
- CASPR Seasonal Schools on Signal Processing for Hearing Assistive Devices.
- Information and coding theory, Master course.

DURING FALL 2025, CASPR WAS INVOLVED IN THE FOLLOWING STUDENT PROJECTS

- Project title: “Quantifying speech comprehension using Large Language Models”
  Student: Sif Bjerre Lindby
  Education: Mathematical Engineering - joint 9/10th semesters long-thesis and 4+4 PhD
  Supervisors: Profs. Jan Østergaard, Zheng-Hua Tan, Jesper Jensen

- Project title: “Speech Enhancement using Speech Large Language Models”
  Student: Nikolai Lund Kühne
  Education: Mathematical Engineering - joint 9/10th semesters long-thesis and 4+4 PhD
  Supervisors: Profs. Zheng-Hua Tan, Jan Østergaard, Jesper Jensen

- Project title: “Sound Bubbles for Neural Multi-Channel Speech Enhancement”
  Student: Nicolaj Boelt Pedersen
  Education: Computer Engineering (AI, Vision, and Sound) - 9th semester project
  Supervisors: Niels Overby (Oticon and AAU), Svend Feldt (Oticon), Jesper Jensen (AAU and Oticon)

- Project title: “Multimodal learning for understanding human behavior”
  Students: Andreas Peter Juhl Hansen, Jeppe Roden Münster, Simon Bock Segaard.
  Education: Mathematical Engineering, Master thesis project with University of Southern California.
  Supervisors: Zheng-Hua Tan (AAU)

CASPR RESEARCH IN FOCUS

PHD PROJECT: QUANTIFYING SPEECH COMPREHENSION USING LARGE LANGUAGE MODELS

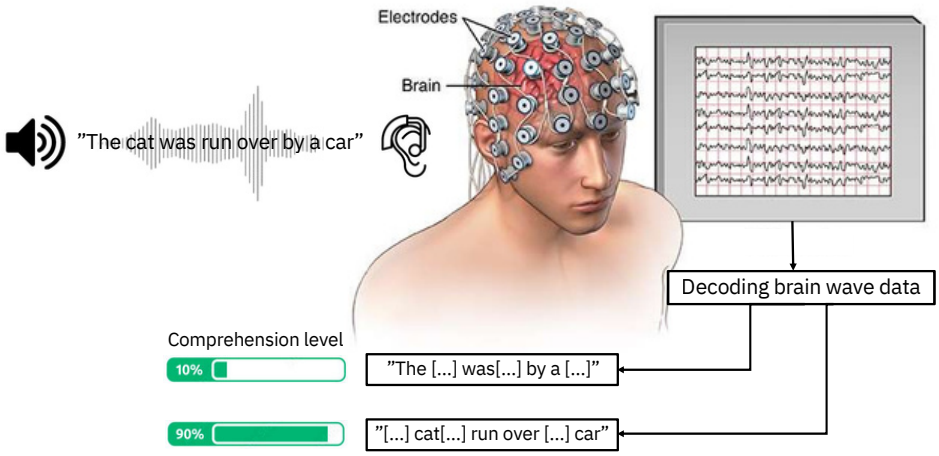
PhD researcher: Sif Bjerre Lindby
Start date: 01.09.2024
Supervisors: Profs. Jan Østergaard, Zheng-Hua Tan, Jesper Jensen

PROJECT SUMMARY

Over the years, much research has gone into various aspects of listening effort and speech intelligibility. However, very little has been established about comprehension, how it can be quantified, or even universally defined. While listening effort and speech intelligibility, to some degree, reflect comprehension, they do not provide the full picture. For example, you could have the same intelligibility level (50%) in two different scenarios, as seen in the figure below. In the first scenario, comprehension is low; the intelligible words provide no useful information for extracting meaning. In the second scenario, although intelligibility is the same as before, all the important information is now provided, and thus, meaning can easily be extracted; comprehension is high. Hence, an operational definition of comprehension could be that **getting the right words right matters.**

The ultimate goal of the research is to derive a metric that can be used to quantify speech comprehension directly from brain wave data. This is hypothesized to be possible by employing multimodal large language models and using both brain wave data and the speech data from which the brain wave data is generated as input, and transforming both into the same semantic vector space.

My current stage of research is concerned with statistical analysis of meaning as reflected by brain wave data extracted from meaningful and meaningless speech. My work shows that the lack of syntax in speech increases information loss in the brain significantly, and furthermore, that there are significant measurable differences in how the brain behaves when exposed to meaningful and meaningless speech. These results act as a stepping stone in answering our hypothesis as described above.



NEWS

- Profs. Jesper Jensen (left), Jan Østergaard (middle), and Zheng-Hua Tan (right) have received a total of DKK 14.752 million from the William Demant Foundation. The funding will be used to establish and continue operating the Center for Acoustic Signal Processing Research (CASPR).

  The purpose of CASPR is to drive and develop new, advanced methods for audio processing, especially with the aim of supporting people with hearing challenges. The researchers work with statistical signal processing and AI technologies that can improve the listening experience in devices such as hearing aids, headsets, and earpods.

  Wait for more detailed information in the upcoming newsletter!

- Profs. Jan Østergaard (middle) and Zheng-Hua Tan (right) each received DKK 4.5 million from Villum Foundation's Synergy programme for new interdisciplinary research projects.

  Prof. Jan Østergaard (middle) and Ass. Prof. Daniel-Ioan Stroe from the Department of Energy will combine signal processing, machine learning and acoustics to develop a method that can "listen" to the inside of a battery. By sending sound through the battery and analysing how it changes over time, the researchers aim to create a three-dimensional soundscape that reveals the battery's condition.

  Prof. Zheng-Hua Tan (right) and Ass. Prof. Sanshui Xiao from DTU will combine artificial intelligence with advanced 2D materials to develop compact, chip-integrated sources of quantum light, a technology that plays a key role in future secure communication, precision measurements, and quantum computing.

- Prof. Zheng-Hua Tan (right) has initiated a research collaboration with Tore Wulf and Suman Singha from the National Center for Climate Research at the Danish Meteorological Institute (DMI). The project, jointly funded by DMI and the Pioneer Centre for AI, supports PhD candidate Emil Haaber Tellefsen. The team will investigate self-supervised learning for Synthetic Aperture Radar (SAR)–based Earth observation, with a particular focus on applications that benefit Danish society.

- Prof. Zheng-Hua Tan (right) will serve as a TPC Co-Chair for the 53rd IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP-2028), Tokyo, Japan, 28 May - 03 June 2028.

NEWS
Continued

- Panagiotis (Panos) Apostolidis (pictured) started as an industrial PhD in CASPR and Oticon on Sept. 1, 2025. The research project is entitled, “Hearing Aid Systems Based on User-in-the-Loop Model”. Supervisors are Zheng-Hua Tan (CASPR), Jan Østergaard (CASPR), Svend Feldt (Oticon), and Jesper Jensen (CASPR, Oticon).

- PHD COURSE: INTRODUCTION TO INFORMATION THEORY IN NEUROSCIENCE
  ECTS: 2.0
  Date/Time: 22., 23., 24. April 2026

  Description: In this course, we introduce key concepts from information theory and their applications in neuroscience. The course provides a gentle introduction to the foundations of information theory:
  what it is and how to apply it on real-world physiological data. Core topics include: entropy, mutual information, information divergence, transfer entropy, directed information, and partial information decomposition.
  Our main emphasis will be on directed information measures, which are powerful tools for uncovering statistical relationships in time-series data such as EEG data. As examples, we demonstrate the tools on EEG data with applications to auditory attention decoding and epileptic seizure analysis.
  Through hands-on exercises, you will gain practical experience by applying the methods to different datasets including your own physiological recordings.

  Prerequisites: Basic courses on statistics and probability theory.
  Fee: The PhD course is free of charge for PhD students
  Course link: https://phd.moodle.aau.dk/course/section.php?id=29927
  Lecturer: Prof. Jan Østergaard, (jo@es.aau.dk)

- PHD COURSE: MACHINE LEARNING
  ECTS: 3.0
  Date/Time: 20, 22, 24, 27 and 29 April, 2026

  Description: This course offers a comprehensive introduction to machine learning, with the goal of elucidating fundamental methods and their theoretical underpinnings, while also addressing practical machine learning problems such as pattern recognition, prediction, clustering, and generative modeling.

  Topics will include:
  Supervised learning methods: logistic regression, support vector machines, neural networks, KNN, and decision trees.
  Unsupervised learning and clustering methods:
  K-means, GMMs, EM algorithm, and PCA. Deep learning methods: DNNs, LSTMs, CNNs, GANs, and Transformers. Probabilistic graphical models. Reinforcement learning.

  Prerequisites: Basic probability and statistics theory, linear algebra and programming skills in Python.
  Fee: The PhD course is free of charge for PhD students
  Course Link: https://phd.moodle.aau.dk/blocks/vitrina/detail.php?id=2865
  Lecturer(s): Prof. Zheng-Hua Tan (zt@es.aau.dk)

PUBLICATIONS

CONFERENCE PAPERS

1. “Investigating the Effect of Sentence-Level Syntactic Structure on Information Loss in the Human Auditory System”, Sif Bjerre Lindby, Jesper Jensen, Zheng-Hua Tan, Jan Østergaard. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
2. “Exploring Resolution-Wise Shared Attention in Hybrid Mamba-U-Nets for Improved Cross-Corpus Speech Enhancement”, Nikolai Lund Kühne, Jesper Jensen, Jan Østergaard, Zheng-Hua Tan. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
3. “Quantization-Based Score Calibration for Few-Shot Keyword Spotting with Dynamic Time Warping in Noisy Environments”, Kevin Wilkinghoff, Alessia Cornaggia-Urrigshardt, Zheng-Hua Tan. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
4. “DSPAST: Disentangled Representations for Spatial Audio Reasoning with Large Language Models”, Kevin Wilkinghoff, Zheng-Hua Tan. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
5. “Ranking the Impact of Contextual Specialization in Neural Speech Enhancement,” Peter Leer, Svend Feldt, Zheng-Hua Tan, Jan Østergaard, Jesper Jensen. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
6. ·“Beamforming using Virtual Microphones for Hearing Aid Applications,” Mojtaba Farmani, Svend Feldt, Jesper Jensen. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
7. ·”A Text-To-Text Alignment Algorithm for Better Evaluation of Modern Speech Recognition Systems”, Lasse Borgholt, Jakob Havtorn, Christian Igel, Lars Maaløe, Zheng-Hua Tan. ICASSP, Barcelona, Spain, 4-8 May 2026 (Accepted).
8. ·“Handling Domain Shifts for Anomalous Sound Detection: A Review of DCASE-Related Work”, Kevin Wilkinghoff, Takuya Fujimura, Keisuke Imoto, Jonathan Le Roux, Zheng-Hua Tan, Tomoki Toda. DCASE, Barcelona, Spain, 29-31 October 2025.
10. “Learning Robust Spatial Representations from Binaural Audio through Feature Distillation”, Holger Severin Bovbjerg, Jan Østergaard, Jesper Jensen, Shinji Watanabe, Zheng-Hua Tan. IEEE Workshop on Applications of Signal Processing to Audio and Acoustics (WASPAA 2025), October 12-15, 2025, pp. 1-5.
11. “Multivariate Phase Synchrony and Auditory Attention Decoding for Speech and Music”, Asjid Tanveer, Jesper Jensen, Zheng-Hua Tan, Jan Østergaard. ICBEB, 19-21 September 2025, Prague, Czech Republic, vol. 195, p. 01001.
12. “Spatial Covariance Estimation for Sound Field Reproduction Using Kernel Ridge Regression”, Jesper Brunnström, Martin Bo Møller, Jan Østergaard, Toon van Waterschoot, Marc Moonen, Filip Elvander. EUSIPCO, Palermo, Italy, 8-12 September 2025.
13. “Analysis and Extension of a Near-End Listening Enhancement Method Based on Long-Term Fractile Noise Statistics”, Filippo Villani, Wai Yip Geoffrey Chan, Zheng-Hua Tan, Jan Østergaard, Jesper Jensen. Interspeech, Rotterdam, The Netherlands, 17-21 August 2025, pp. 783-787.
14. “Intelligibility Prediction for Time-Modified Speech Signals Using Spectro-Temporal Modulation Features”, Aymen Bashir, Haolan Wang, Amin Edraki, Wai-Yip Chan, Jesper Jensen. Interspeech, Rotterdam, The Netherlands, 17-21 August 2025, pp. 5478-5482.
15. “xLSTM-SENet: xLSTM for Single-Channel Speech Enhancement”, Nikolai Lund Kühne, Jan Østergaard, Jesper Jensen, and Zheng-Hua Tan. Interspeech, Rotterdam, The Netherlands, 17-21 August 2025, pp. 5148-5152.

PUBLICATIONS

JOURNAL PAPERS

1. “MambAttention: Mamba with Multi-Head Attention for Generalizable Single-Channel Speech Enhancement,” Nikolai Lund Kühne, Jesper Jensen, Jan Østergaard, Zheng-Hua Tan. IEEE Transactions on Audio, Speech and Language Processing, 2026 (Accepted).
2. “Head-Steered Channel Selection for Hearing Aid Applications Using Remote Microphones, Vasudha Sathyapriyan, Michael S. Pedersen, Mike Brookes, Jan Østergaard, Patrick A. Naylor, Jesper Jensen. IEEE Access, Vol. 13, pp. 201478-201491, 2025.
3. “Binary Estimator Selection Methods for Hearing Aids With a Remote Microphone”, Vasudha Sathyapriyan, Michael S. Pedersen, Mike Brookes, Jan Østergaard, Patrick A. Naylor, and Jesper Jensen. IEEE Access, Vol. 13, pp. 159610-159627, 2025.
4. “A Steered Response Power Method for Sound Source Localization With Generic Acoustic Models”, Kaspar Müller, Markus Buck, Simon Doclo, Jan Østergaard, Tobias Wolff. IEEE Transactions on Audio, Speech and Language Processing. Vol. 33, pp. 4004-4019, 2025.
5. “Continuous and Overall Attribute Evaluation of Spatial Audio Reproduction Systems with Spatially Dynamic Content”, Pia Nancy Porysek Moreta, Søren Bech, Jon Francombe, Jan Østergaard, Steven van de Par. Journal of the Audio Engineering Society, 2025 (Accepted).
6. “A Survey of Deep Learning for Complex Speech Spectrograms”, Yuying Xie, Zheng-Hua Tan. Speech Communication, vol. 175, 2025
7. “Distributions and Direct Parametrization for Stable Stochastic State-Space Models”, Mohamad Al Ahdab, Zheng-Hua Tan, John Leth. IEEE Control Systems Letters, vol. 9, pp. 444-449, 2025.