Communication acoustics and electrical-hearing performance: Can artificial intelligence be of help?*

Jens Blauert* 

Ruhr-Universität Bochum, 44780 Bochum, Germany

Received 13 September 2023, Accepted 30 September 2023

Acoustic or electrical-hearing skills are indispensable for auditory communication. However, sensory auditory perception alone is not sufficient for effective communication. We know from cognitive psychology that:

People do not react according to what they hear, but rather react to what they hear is meaning to them in their current action-specific, emotional, and cognitive situation—a much more complex process than just sensory perception.

This means that, in addition to the form of the signal streams that arrive at the listeners, their function, i.e., the meaning they convey, is of utmost behavioral significance.

From semiotics, we learn that all communication with and within the environment occurs via signal streams that denote specific meanings. These meaning-bearing signal streams are called “signs” in semiotics. Signs are often classified according to their level of abstraction [1], namely as indices, icons, or symbols. Indices are understood immediately, e.g., the cracking sound of a fire. Icons contain significant attributes of specific meanings, neglecting irrelevant details, e.g., the characteristic siren sound indicates an emergency vehicle. Symbols are signs whose meaning must first be learned, e.g., Morse-code beeps, which stand for letters or numerals.

To communicate meanings, it is necessary to code the signal streams sent to the listeners into clearly identifiable signs.

The proposal made in this short communication is now as follows: Instead of leaving it to the listeners to extract meanings from the corrupted signals that they receive, we leave the meaning extraction to an artificial intelligence (AI) system, in other words, a meaning recognizer that works on the uncorrupted acoustic signal streams.

Meaning recognizers are currently a major topic of AI research, and their performance is rapidly increasing. For limited sets of meanings, such systems are already readily available, such as the AI-supported spoken-language-dialog systems Alexa (Google) or Siri (Apple). Even for un-constrained sets of meanings, such systems make rapid progress, powered by self-learning systems with increasing “world knowledge”, e.g., the generative pre-trained transformer systems ChatGPT (OpenAI) or Bing (Microsoft).

Also, meaning recognizers are not limited to speech sounds as input signals. They can be trained to deal with sounds of different type (noise recognizers). Further, sensor-output signals can be recognized, interpreted and then communicated in an application-related manner via auditory symbols (Hearcons) as instructions for action, e.g., for navigation purposes.

To explore these ideas further, answers to the following questions are helpful. The reader is invited to consider them:

Would
• in electrical hearing, augmented auditory reality enhance interaction with the environment?
• artificial-intelligence software that automatically assigns meaning to speech-signal streams (meaning recognizers), be helpful in electrical hearing?
• auditory signs that denote meaning (indices, icons, symbols) improve the communication performance when transmitted via carrier signals tailored to the individual’s available communication channels?

If we want to convey meaning, it is instrumental to code them into signs, in other words, into uniquely identifiable perceptual entities that denote specific meanings.

In this context, it is advantageous to optimize the streams of signals that are interpreted by the receivers as signs in such a way that the best possible match is achieved with the specifications of the specific transmission channels that are available to each listener. And these can be very limited indeed, e.g., in cases where cochlear implants do not work adequately, or with brainstem implants.

One possible implementation of this idea could be to present listeners who hear electrically with an augmented auditory virtual environment that includes computer-generated or at least computer-modified auditive signs. Of course, the listeners should be aware that a computer is talking, as this will modify their interpretation of the meanings of the signs. By the way, such behavior is also common in the “real” world. People interpret the speech of a child

* Short Communication – based on a keynote address at the 7th Munich LMU Hearing-Implant Symposium 2022
*Corresponding author: jens.blauert@rub.de

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.
differently from that of an adult, and that of a layperson differently from that of an expert.

Given this situation, it is worth keeping in mind that in auditory communication audition and cognition always go together! (Fig. 1).

Simplifying the auditory world in electrical hearing with a strong focus on the meaning, i.e., the function, would thus improve the performance of electrical hearing, particularly in complicated cases.

Consequently, it is indispensable to increase our efforts in exploring the cognitive aspects of electrical-hearing performance. There is no doubt:

For proper communication, it is the MEANING that ultimately counts!

References