The impact of acoustic communication on education and its role in decoding animal linguistics and behavior

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Received: 30 August 2025; Revised: 23 October 2025; Accepted: 20 November 2025; Published: 20 December 2025

Abstract

Acoustic communication helps us understand language and social structures within and across species. Verbal communication in teaching and education is the most commonly used form. The features of speech, including its acoustic qualities such as tone and pitch, engender social interaction and aid the development of effective language and awareness. In contrast, the study of animal verbal communication helps understand the behavioral and cognitive mechanisms of non-human creatures. The analysis of animal sounds helps the researcher understand the behavioral social structure, complex patterns of emotional response, and communications used in pairing, and the use of space. This communication provides the foundation for the study, as the use of animal sounds enhances human communication and fosters education, providing the focal point for examining the use of sounds in education. Drawing on case studies and animal linguistics, this paper offers paradigms for analyzing human communication and demonstrates the foundation of formal education in language use. This work also investigates the incorporation of theories of acoustic communication into educational systems, focusing on pedagogy, tools for learning through listening, interspecies behavior, and the teaching of language. It

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DOI: 10.70102/IJARES/V5I2/5-2-79

integrates human and other animal communication, addressing the biology of language, language teaching, and pedagogy.

Keywords: Acoustic communication, Animal linguistics, Education, Language acquisition, Behavioral analysis, Vocalizations, Sound patterns

Introduction

The ability to use sound to articulate one's thoughts is the supreme form of communication, enabling the transfer of knowledge, feelings, and relationships, and is an integral part of human education. Considerable amounts of information are transferred and processed through spoken verbalizations such as lectures, conversations, and other forms of communication. In classrooms, the speech signals of teaching (e.g., speech rate, pitch, and clarity) are crucial for achieving cognitive and behavioral instructional objectives. An analysis of the relationships between speech parameters and student performance will help optimize instructional communication (Molai, 2019).

Also, in the animal world, vocalizations are the primary form of communication, expressing emotions, signalling danger, and indicating social relationships (Scott-Phillips and Heintz, 2023). All animals communicate through vocalizations to defend an area, to court and mate, and to socialize. Dolphins, elephants, and birds use their voices to socialize. The study of animals' social vocalizations and their interactions in the environment is of interest (Reznikova, 2023). Complex social relationships in the animal world are revealed through spectrographic analysis of vocalizations and detailed studies of their frequency parameters (Afrose *et al*., 2025).

This paper seeks to connect with studies of animal and human communication (Watson et al., 2022). Findings from animal communication studies may help inform pedagogy by investigating the communicative use of sounds by nonhuman animals (Dunlop e*t al*., 2022). The information may contribute to understanding language and the processes of learning, listening, and social behaviour in humans. The interdisciplinary nature of the study will emphasize the principles of communication in different forms. It will provide the basis for understanding the role of sounds in educational and behavioral studies.

Key Contributions:

- Analyzing the impact of speech and sound stimuli on the enhancement of learning, the processes of linguistic assimilation, and the growth of higher mental functions of individuals.
- Understanding the significance of animal sounds in social interactions, emotional expressions, and communication within a system.
- Surveying the confluence of pedagogy and animal ethology by utilizing the principles of sound communication in both disciplines.

This paper explores the fundamental role of sound in human education and animal behavior, focusing on how sound affects language learning, thinking, and social behavior in humans. It examines the contribution of understanding animal

vocalizations to the decoding of their behavior and cognition, as well as to cross- and interspecies communication. Given the interdisciplinary nature of Educational Psychology and Animal Linguistics, the paper highlights the fundamental principles of communication to propose educational/teaching, behavioral, and procedures/methods research in both disciplines.

Literature Review

Acoustic communication is research that studies the effects of sounds produced by the human voice (via speech) and the auditory signals on the shaping of language and the psychological development of the human being. Numerous studies, especially in phonetics, have shown that the sounds produced in speech during early childhood are of considerable importance for language acquisition. Infants recognize speech sounds and the patterns being used long before they initiate speech production themselves, thus establishing the significance of auditory input. Educational research has shown that speech that is communicated clearly, with diverse intonations and rhythms, has a greater positive effect on the comprehension and retention of material and enhances social interactions in the classroom. For instance, in a classroom setting, an instructor who uses a diverse range of vocal tones and rhythmic patterns in their speech is likely to have students engage in the learning process and achieve better learning outcomes. Moreover, knowledge of the relationship between sound and cognition has led to the development of more effective means of teaching the language, especially to children with speech and/or hearing impairments.

Concurrently, the study of animal communication systems has provided a window into animal systems of communication and language (Rose and Rice, 2025). Animals use a myriad of vocalizations to convey different messages, from marking territory to expressing emotion to conveying social messages (Jobarteh *et al.*, 2024). For example, dolphins use a variety of whistles to identify and call specific individuals, and birds use songs to attract mates or defend territories. This work has employed sophisticated methods for analyzing animal sounds, including spectrography and analysis of sound frequency to decode them. The study of sounds has shown that animal sounds are not random; they are organized and convey different messages related to the social structure, the dominant animal, and the level of frustration in the signals. The ability to decode animal sounds has provided insights into the social and cognitive functioning of animals and served as an analogy for the functioning and use of communication systems in humans.

In recent years, the field of education and auditory communication has attracted considerable interest. Research on communication in the animal kingdom has provided valuable insights into educational psychology and the development of tools to assist learning through the auditory channel. For instance, phonological awareness, which is the recognition and manipulation of the sounds in words, is essential for early literacy. Knowledge of animal sound communication has opened new avenues

for assisting language teaching, improving literacy, and enhancing communication (Abbas and Hatem, 2025). Moreover, the analysis of animal sounds has been used to design auditory learning tools and to help children with learning disabilities, such as dyslexia, by offering supportive auditory input to improve reading and language ability.

The gaps in the literature kept expanding, as numerous works fail to engage in interdisciplinary dialogues. For example, research on acoustic communication lacks integration of methodologies and insights from educational animal communication and human language pedagogy (Hoeschele, Mann and Wagner, 2023). There is hardly any work that aims to import theories of animal communication to improve human language pedagogy (Rajendran *et al*., 2024). There is also a gap in research that seeks to integrate communication across species with behavioral science, educational psychology, and linguistics to develop a theory on cross-species communication (Kholodniak, 2025; Aadiwal et al., 2025). Exploring theory on cross-species communication would advance pedagogy and therapy, as well as our understanding of language (Assom, 2023).

There is also an element of acoustic research that is arguably overlooked: the technology. While frequency analysis and spectrograms are functional, new AI-driven sound recognition technologies can have a much greater impact on decoding human-animal communication. There is value in integrating education with technology, and if we can improve the interpretation of acoustic signals, especially in human-animal communication, education will benefit (Sen and Malhotra, 2025).

In closing, the data show that acoustic communication represents not only an essential element of human learning and animal interactions, but also a nexus of the two domains acoustic influences on learning and behavior across species point to a significant opportunity for cross-disciplinary inquiry. The integration of knowledge and methods from human and animal studies would, in the event of further such inquiry, usher in a new epoch in pedagogy and deepen the understanding of non-human cognitive and social systems.

Methodology

This research utilizes a multi-faceted approach to analyze how- and to what extent- acoustic communication can be heard throughout a classroom while also observing its impact on animal behavior and training. Acoustic data collection from various sources placed side-by-side, both classroom and training settings-coupled with audio- and sound-differentiation analytic methods before, during, and after training sessions, and a strong focus on sound in communication within educational and animal behavior theory, narrative linguistics, and animal behavior studies. This research then attempts to utilize both sound and silence ethically to promote academic and animal behavior manipulation objectives, with a strong interdisciplinary focus.

Data Collection

For each integration of data on human interactions, data is aggregated from educational contexts, such as classroom discussions, teacher-student dyads, and oratorical settings. Educators use

premium microphones to record audio for each engagement. For each integration of data about communication for different species, fieldwork in natural ecosystems, such as forests or oceans, as well as in constructed laboratory settings, is required. Moreover, specialized apparatus, such as hydrophones for underwater recordings and unidirectional microphones for land-based organisms, is used to document vocalizations across a broad frequency spectrum.

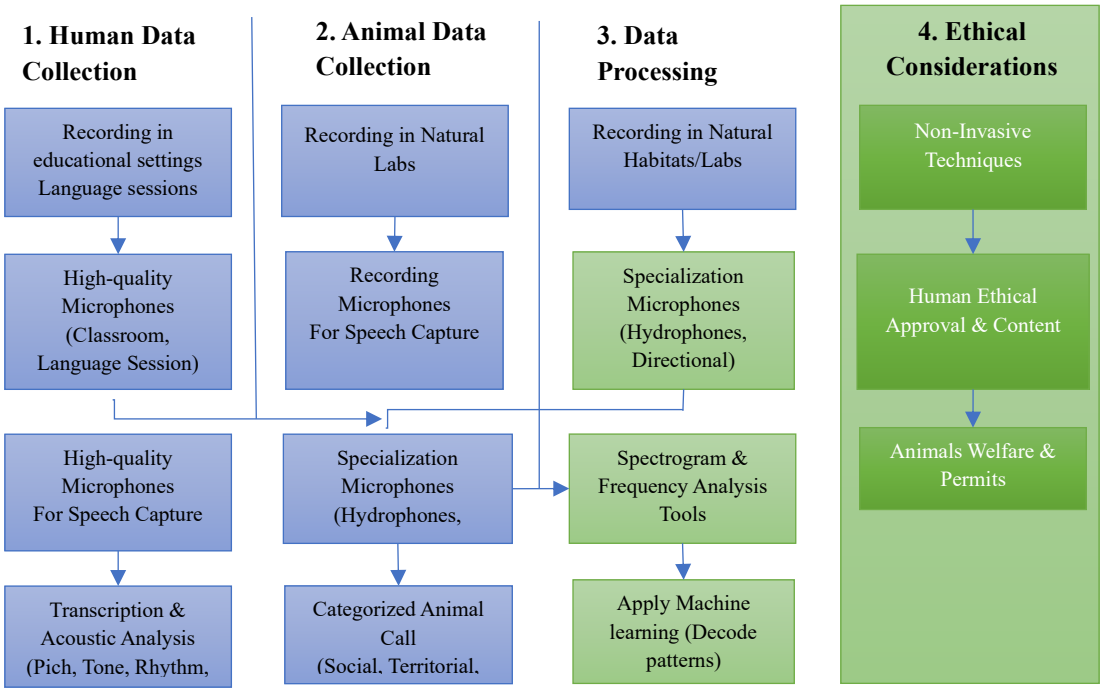

Figure 1: Communication data collection & analysis pipeline.

In Figure 1, the Communication Data Collection & Analysis Pipeline is shown. It is the process of capturing and analyzing communication data for both humans and animals. It begins with Human Data Collection. Here, data is collected with high-quality microphones that capture participants' speech in the classroom. This is followed by transcription and analysis of the speech, focusing on its pitch, tone, rhythm, and frequency. Next, in the Animal Data Collection phase, Data collectors use specialized microphones, e.g., hydrophones and directional microphones, to capture the animal's vocalizations from their natural or laboratory settings. The animal's calls are categorized into social, territorial, and mating calls. Data Processing is performed using audio spectrograms and frequency analysis tools to reveal the complex patterns in the vocalizations of humans and animals, which are then decoded using machine learning. Throughout the pipeline, Ethical Considerations address non-invasive techniques, human ethical approval and consent, and animal welfare permits, balanced with the respect and integrity the research team aims to maintain for human and animal subjects.

Analysis Techniques

Voice recognition software and linguistic analysis examine speech for patterns such as cadence, pitch, tone, and air frequency. Engagement and retention from speech are analyzed with machine-learning algorithms. To study communication in

animals, multimedia spectrograms of frequency analysis are utilized, and deep learning is used in the decoding of complex animal vocal behavior for social and cognitive behavioral analysis.

Ethical Considerations

Non-invasive recording methods are used as a priority to ensure minimal disturbance to the animals, thus permitting the study of animals in their behavior naturally. Ethical practices are observed for the protection of the animal subjects. Ethical considerations for the human part of the study includes obtaining ethical approval and obtaining informed consent to be used from data collected.

Cross-Disciplinary Approach

The research integrates theories and methods from education and animal behavior analysis with communication, to adopt a cross-disciplinary approach. This enhances the understanding of acoustic communication and human language acquisition with animal linguistics, to be of practical use in education. The research, in a cross-disciplinary approach, maintains high ethical considerations and seeks to study the effect of acoustic communication on education and animal behavior.

Frequency Modulation Model:

$$f(t) = f_0 + A \cdot \sin(\omega t + \phi) \qquad (1)$$

The equation (1) shows influence exerted by time on the value of a frequency, over which any signal may exert a value, defined the phenomenon of frequency modulation, or more so, the modulation of frequency of sound produced in animal vocalizations. Moreover, the alteration of pitch, due to any internal or external factor, may be described using this equation.

Spectral Analysis:

$$S(f) = \left| \int_{-\infty}^{\infty} x(t) e^{-2\pi i f t} dt \right|^2 \qquad (2)$$

The equation (2) illustrates the methodology in carrying out spectral analysis, the procedure for uncovering the constituent frequencies of sound signal. This particular equation ascertains the fundamental frequency of animal voice pattern, crucial in deciphering the social and affective communication of the animals.

Signal-to-Noise Ratio:

$$SNR = \frac{P_{signal}}{P_{noise}} \qquad (3)$$

Precise measurement of the signal-to-noise ratio (SNR) can also be calculated from the background noise as shown in equation (3). An SNR ratio also means better communication of easily discerned messages in complicating animal vocalizations. This also holds true with human communication.

Results And Discussion

Impact on Education

The study of animal acoustic communication underpins advancements in pedagogy; especially within the domain of pedagogy of the spoken word. Animal communication signals such as dolphin whistles and bird songs provide a foundational understanding of the intersection between communication, sound, and learning. Knowing that sound signals affect the learner's comprehension and retention of the material in a lesson, educators must incorporate stimulatory interactions in

the learning environment to enhance the learning of a particular language. Knowing the purpose of sound patterns within a given pedagogy, tools can be designed to facilitate the learning of a language. Such tools are designed to create a pedagogic environment that is functional, adaptive, and inclusive for learners with communicative and auditory challenges.

Additional Behavioral Insights Derived from Animal Communication

The sound patterns of animals provide elements that define the social and emotional behavior of elements within a given environment. For instance, the dolphin uses a whistle to identity a particular individual and signal various emotions, and birds use songs to mate and with their partners with a specific emotional content. These are used to define the social behavior dimension of many communication theories of language within the scope of animal behavior. Such animal calls help define the social order and emotional content of communication in the domain of the non-human, such as the social expressive behavior of the non-human primates, with the same social structures as the humans.

Case Studies and Examples:

The influences dolphin communication and birdsong patterns' studies have had on human communication technologies and educational approaches is exemplified in the studies of the dolphins communication with whistles, which is utilized in the speech synthesis technology for the assistance of the individuals with speech disabilities, and in the educational programs for children in the early stages of language development which focuses on providing the speech cues and auditory patterns utilized in language learning to mirror the songs of birds, consequently, to teach children language.

Implications for Educational Methods

The studies of the communication of animals exemplifying the approaches of educational methods brought about unprecedented educational methodologies, auditory retention and learning techniques inspired by the vocalizations of animals have been integrated to assist children with language development and retention of memories, and improved their cognitive ability and attentiveness in educational environments by creating systems to recognize and process sounds and by improving their auditory retention and learning techniques inspired by the vocalizations of animals to assist children with language development and retention of memories integrated to educational environments.

The table 1 summarizes the educational applications of insights derived from animal communication studies. It highlights how various aspects of animal vocalizations, such as dolphin whistles and birdsong patterns, can be used to enhance human learning. The table outlines how dolphin communication has been applied in speech synthesis technologies to assist individuals with speech or hearing impairments, and how birdsong patterns are used in early language acquisition programs to improve rhythm and speech development. It also discusses the role of environmental sounds in auditory learning tools that can improve focus,

memory retention, and cognitive skills in children, emphasizing the importance of integrating animal communication insights into educational methods.

Table 1: Educational applications of animal communication insights.

Animal Communication Aspect	Educational Application	Benefit to Human Learning
Dolphin Whistles	Speech synthesis for individuals with impairments	Aids speech and hearing difficulties
Birdsong Patterns	Early language acquisition programs	Enhances rhythm and speech development
Environmental Sounds	Auditory learning tools in classrooms	Improves focus, memory, and cognitive skills

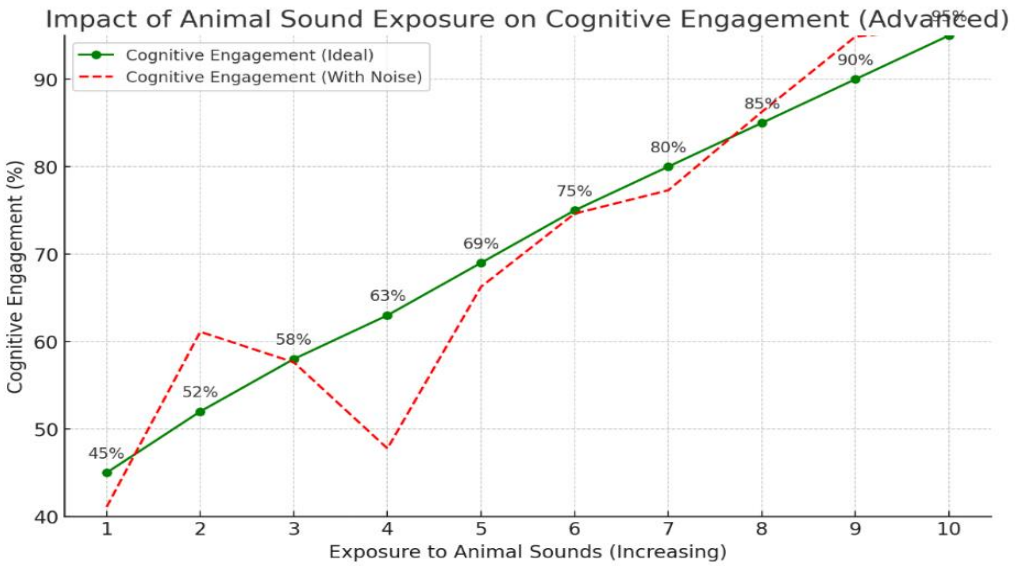

Figure 2: Impact of animal sound exposure on cognitive engagement.

Figure 2 illustrates how increasing exposure to animal sounds corresponds to increasing cognitive engagement in children, with some additional data points and constraints. The green line delineates ideal cognitive engagement, whereas realistic noise, meant to mimic data fluctuations in the real world, corresponds to the red dashed line. The y-axis is limited to a range between 40% and 95% in order to better represent the various levels of cognitive engagement. The more exposure to animal sounds, the greater the cognitive engagement is, in terms of attention, memory, and problem solving. The further clarifying annotations explain the impact of each data point auditory stimuli on cognitive function.

Conclusion

There is clear evidence showing children are more cognitively engaged when exposed to animal sounds due to the enhancement of attention, memory retention, problem-solving skills with exposure to animal sounds. incorporation of animal sounds into educational strategies promotes a more engaging learning atmosphere, beamed especially in the area of language learning. Although data is subject to the natural variation of learning instruments, data shows a significant upward tendency in student cognitive engagement. Future studies in understanding the impact of differing animal sounds individually on age, multiple animal calls and selections

technologies tailored to learning and speech disabilities. Mixing analysis of sound with neurocognitive studies could find patterns of sounds that accelerate learning and brain development. Long-term studies during early stages of development could reveal the extent of their impact on development of emotional intelligence.

This study paves the way for new attempts at building educational paradigms that incorporate acoustic learning to enhance cognitive development, showing that the use of animal sounds may help shape the future of education and the development of children.

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