What Does a Newborn Say? A Comprehensive Review of Neonatal Vocal Communication and Meaning

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ABSTRACT

Neonatal vocalizations represent the earliest form of human communication, preceding the emergence of structured language. Traditionally viewed as reflexive or distress-driven outputs, these sounds are now recognized as acoustically structured, functionally flexible, and communicatively meaningful. This review synthesizes current evidence on neonatal vocal behavior, including crying, protophones, and affective vocalizations, with emphasis on their physiological basis, communicative intent, and developmental implications. Advances in acoustic analysis and neurodevelopmental science suggest that neonatal vocalizations constitute a primitive yet organized "vocabulary" reflecting internal states, early cognition, and social engagement. Understanding this early communication system has significant implications for clinical assessment, early diagnosis of neurodevelopmental disorders, and optimization of caregiver–infant interaction.

INTRODUCTION

Human neonates are born into a complex sensory and social environment, yet lack conventional linguistic tools to communicate. Despite this limitation, they possess a sophisticated repertoire of vocal signals that function as their primary means of interaction. These early sounds—ranging from cries to cooing-like vocalizations—are not random but represent structured outputs shaped by neurobiological, physiological, and environmental influences [1].

Historically, neonatal vocalizations were interpreted predominantly as reflexive responses to discomfort or physiological imbalance. However, contemporary research challenges this reductionist view, demonstrating that infant vocalizations encode distinct acoustic features corresponding to specific emotional and physiological states [2]. Moreover, these vocalizations exhibit variability, individuality, and adaptability, indicating a level of communicative complexity previously underestimated [3].

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The concept of a "neonatal vocabulary" has thus emerged, referring to the spectrum of vocal expressions through which infants convey needs, emotional states, and early forms of social intent. Importantly, this vocabulary is dynamic, evolving rapidly in response to neural maturation and caregiver interaction [4].

Search Methodology

This narrative review was conducted to synthesize current evidence on neonatal vocal communication, with a particular focus on the concept of "neonatal vocabulary," acoustic characteristics, communicative intent, and clinical implications.

A comprehensive literature search was performed across multiple electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar, to identify relevant studies published up to 2025. Additional sources were identified through manual screening of reference lists of key articles to ensure completeness.

The search strategy combined Medical Subject Headings (MeSH) and free-text terms, including: *"neonatal vocalization," "infant cry," "protophones," "early vocal development," "cry acoustics," "neonatal communication," "preterm infant cry,"* and *"functional flexibility."* Boolean operators ("AND," "OR") were used to refine the search and improve specificity.

Studies were included if they met the following criteria: (1) involved human neonates or young infants, including preterm populations; (2) examined vocalizations such as crying, cooing, or protophones; (3) explored acoustic, neurodevelopmental, behavioral, or clinical aspects of vocal communication; and (4) were published in peer-reviewed journals in English. Both original research articles and high-quality reviews were considered. Experimental, observational, longitudinal, and computational studies were included to ensure a multidisciplinary perspective.

Exclusion criteria included studies focusing exclusively on non-human vocalizations without translational relevance, articles lacking primary or analytical data, conference abstracts without full text, and publications not available in English.

Data extraction focused on study design, population characteristics, type of vocalization analyzed, methodological approach (acoustic, neurobiological, or computational), and key findings related to communicative meaning and developmental implications. Given the heterogeneity of study designs and outcomes, a narrative synthesis approach was adopted rather than meta-analysis.

This methodology enabled a comprehensive and integrative evaluation of neonatal vocal behavior, encompassing physiological, developmental, and technological dimensions, thereby supporting the conceptual framework of neonatal vocalizations as an early, structured form of human communication.

Concept of Neonatal Vocabulary

The term "neonatal vocabulary" does not imply language in the linguistic sense, but rather a structured system of vocal signals that convey meaning within specific contexts. This system includes cries, vegetative sounds, and protophones, each serving distinct communicative functions [5].

Unlike fixed signaling systems observed in many non-human species, human neonatal vocalizations demonstrate functional flexibility, meaning that similar sounds can occur across different contexts and emotional states [6]. This flexibility is considered a foundational feature of human language evolution, enabling the later development of symbolic communication.

Furthermore, neonatal vocalizations are individually distinctive, allowing caregivers to recognize their infant's cry among others. This individuality suggests that vocal production is influenced by both biological predisposition and early environmental interactions [7].

Types of Neonatal Vocalizations

Crying: The Core Distress Signal

Crying is the most prominent neonatal vocalization and serves as a primary survival mechanism. It functions to alert caregivers to physiological needs such as hunger, pain, discomfort, or illness [8].

Acoustic analysis reveals that cries are not uniform; they vary in fundamental frequency, intensity, and temporal structure depending on the underlying cause. Pain-related cries, for example, are typically higher in pitch and more abrupt, whereas hunger cries show rhythmic patterns with gradual escalation [9].

From an evolutionary standpoint, crying acts as an honest signal of fitness, ensuring that caregivers respond preferentially to infants in greater need [10]. Importantly, cry characteristics

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have also been linked to neurological integrity, making them valuable clinical indicators [11].

Protophones: The Earliest "Speech-like" Sounds

Protophones are non-cry vocalizations such as cooing, vowel-like sounds ("aagoo," "ooo"), squeals, and growls. These sounds occur frequently during states of calm alertness and are not strictly tied to distress [12].

Unlike crying, protophones exhibit functional flexibility, appearing across a range of emotional contexts. This suggests that they are not merely reflexive but represent early forms of voluntary vocal exploration [13].

What do protophones actually "mean"?

Protophones do not convey fixed meanings like words, but they serve several critical communicative and developmental functions:

- Exploratory signaling: Infants experiment with their vocal apparatus, producing sounds that help develop control over pitch, airflow, and articulation[12]
- Social engagement: Sounds like "aagoo" often occur during interaction with caregivers, signaling readiness for engagement
- Positive affect or comfort: Many protophones are associated with relaxed states, indicating well-being rather than distress
- Foundation of language: These sounds represent the earliest building blocks of speech, eventually evolving into canonical babbling [13].

Thus, a sound like "aagoo" may not mean a specific need, but it reflects comfort, curiosity, and readiness for interaction—essential precursors to language.

Table 1: Protophones in Neonates—Types, Acoustic Features, and Communicative Meaning

Protophone Type	Typical Sound Pattern	Acoustic Characteristics	Behavioral Context	Communicative Meaning / Interpretation	Developmental Significance
Quasi-vowels (Cooing-like sounds)	"aagoo", "ooo", "aaah"	Low pitch, vowel-like, smooth phonation, low intensity	Calm alert state, social interaction, post-feeding	Signals comfort, contentment, readiness for interaction	Early control of phonation; precursor to vowel production in speech [12,23]
Fully Resonant Nuclei (Expanded vowel sounds)	Prolonged "aaa", "eee"	Stable phonation, clearer resonance, increased duration	Awake, relaxed, often during caregiver engagement	Indicates sustained attention and positive affect	Reflects maturation of vocal tract control and respiratory coordination [12]
Squeals	High-pitched "eee!", shrill vocal bursts	High fundamental frequency, variable duration, abrupt onset	Excitement, stimulation, sometimes overstimulation	Expression of heightened arousal or excitement	Expands pitch range; supports prosodic development [30]
Growls	Low-pitched "grrr", rough sounds	Low frequency, irregular phonation, creaky voice quality	Exploration, self-stimulation, sometimes frustration	Vocal experimentation; may reflect mild discomfort or curiosity	Demonstrates control over vocal fold tension and variability [12]
Marginal babbling (early consonant-like sounds)	"ma", "ba", "na" (not fully formed)	Incomplete consonant-vowel transitions, variable timing	Late neonatal period to early infancy	Emerging intentional vocal play	Transition toward canonical babbling and speech development [24]
Vegetative sounds	Grunts, sighs, cough-like sounds	Irregular, low-intensity, non-resonant	Feeding, sleeping, physiological adjustments	Reflects internal physiological states rather than social intent	Baseline vocal activity; supports respiratory-vocal coordination [5]
Yells / Vocal bursts	Loud "ah!", abrupt sounds	Increased intensity, sudden onset, variable pitch	Frustration, demand for attention	Early signaling of need without full distress cry	Bridge between protophones and structured crying [17]

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Emotional and Affective Vocalizations

Neonatal vocalizations encode emotional states through variations in acoustic properties such as pitch, rhythm, and intensity [14]. Even in the first days of life, infants demonstrate sensitivity to emotional expression in vocal sounds [15].

For example:

- High-pitched, tense cries → distress or pain
- Soft, rhythmic vocalizations → comfort or drowsiness
- Irregular, intense vocal bursts → overstimulation

These affective signals enable caregivers to interpret infant needs rapidly, forming the basis of early emotional communication and bonding [16].

Distress Signals: What Does a "Distress Cry" Mean?

Distress vocalizations are among the most critical components of neonatal communication. They represent a multidimensional signal integrating physiological, neurological, and emotional states [17].

A distress cry typically reflects:

- Physiological imbalance (hunger, hypoxia, temperature instability)
- Pain or discomfort
- Neurological stress or immaturity

Acoustic features of distress cries—such as increased pitch variability and intensity—correlate with the severity of distress and underlying neurophysiological activation [18].

Importantly, these cries are not merely outputs but are designed to evoke caregiver response, forming a feedback loop essential for survival and development [19].

Table 2: Cry *vs* Protophone *vs* Early Babbling

Feature	Crying	Protophones	Early Babbling (Transitional Stage)
Primary Function	Survival signaling (distress, need)	Exploration + social engagement	Intentional vocal practice
Examples	Wailing, pain cry, hunger cry	"aagoo", cooing, squeals, growls	"ba", "ma", "da" (incomplete forms)
Emotional Association	Strongly negative (distress-linked)	Neutral to positive (flexible)	Increasingly intentional and interactive
Acoustic Features	High pitch, intense, abrupt onset	Variable pitch, smoother contours	Rhythmic, emerging consonant-vowel patterns
Functional Flexibility	Low (context-specific)	High (context-independent)	High (goal-directed)
Neurological Control	Brainstem-dominant	Brainstem + emerging cortical modulation	Increasing cortical control
Behavioral Context	Hunger, pain, discomfort	Calm alertness, interaction, self-play	Social imitation, vocal experimentation
Caregiver Response	Immediate, urgent	Interactive, reinforcing	Conversational turn-taking begins
Developmental Role	Ensures survival	Foundation of speech	Direct precursor to language
Clinical Relevance	Marker of distress and pathology	Marker of neurodevelopment	Predictor of language acquisition

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Neurobiological Basis of Neonatal Vocalization

Neonatal vocal production is governed by a hierarchical neural system involving the brainstem, limbic system, and emerging cortical structures [20].

- The brainstem regulates basic cry generation and respiratory patterns
- The limbic system modulates emotional tone
- The cortex contributes to variability and early voluntary control

Emerging evidence suggests that the foundations of vocal behavior begin prenatally, with fetal vocal-like movements and neural preparation for postnatal communication [21].

Preterm vs Term Neonatal Vocalization

Preterm infants exhibit distinct vocal characteristics compared to full-term neonates. These include:

- Higher pitch variability
- Reduced melodic complexity
- Altered temporal patterns [22]

These differences reflect neurological immaturity and may persist into later development. Importantly, early cry characteristics in preterm infants have been associated with language and behavioral outcomes at later ages, highlighting their prognostic significance [23].

Caregiver–Infant Interaction and Vocal Feedback

Neonatal vocalizations are embedded within a dynamic caregiver–infant interaction system. Caregiver responses—such as talking, singing, and soothing—shape infant vocal behavior through reinforcement and feedback mechanisms [24].

Early vocal exchanges contribute to:

- Attachment formation
- Language acquisition
- Neurodevelopmental regulation

Studies in neonatal intensive care settings emphasize the importance of parental vocal contact, particularly for preterm infants, in promoting developmental outcomes [25].

Acoustic Structure and Technological Advances in Cry Analysis

Advances in acoustic science have significantly enhanced our understanding of neonatal vocalizations, demonstrating that infant cries are highly structured signals rather than random outputs. Acoustic parameters such as fundamental frequency (F0), formant structure, duration, and temporal variability provide objective markers of physiological and emotional states [26]. These measurable features allow differentiation between types of cries, including pain, hunger, and discomfort, with increasing precision.

Recent developments in computational modeling and machine learning have further revolutionized this field. Algorithms such as support vector machines and extreme gradient boosting have demonstrated high accuracy in classifying neonatal cries based on acoustic features [27]. These approaches not only validate the structured nature of neonatal vocalizations but also offer potential for automated clinical screening tools, particularly in resource-limited settings.

Multimodal analyses integrating acoustic data, body movements, and neurophysiological signals have provided deeper insights into the relationship between vocal expression and brain function [28]. Such integrative approaches reveal that cry characteristics correlate with neural activation patterns, reinforcing the concept that neonatal vocalizations are biologically meaningful outputs reflecting internal states.

Furthermore, emerging neural network–based models are capable of identifying subtle acoustic signatures in preterm infant cries, enabling early detection of atypical developmental trajectories [29]. These technological advances position neonatal vocal analysis as a promising non-invasive biomarker for neurological and developmental assessment.

Review of Literature

The study of neonatal vocal communication has evolved from descriptive observations to a multidisciplinary field integrating developmental neuroscience, acoustics, evolutionary biology, and computational science.

Early foundational work established crying as a biologically driven signal essential for survival, emphasizing its role in eliciting caregiver response [8,10]. Subsequent research expanded this perspective by demonstrating that cries are acoustically differentiated and encode specific physiological and emotional states [9,14].

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Table 3: Summary of Key Studies on Neonatal Vocal Communication

Author (Year)	Study Design	Population	Focus Area	Key Findings	Clinical / Conceptual Relevance
André et al. [1]	Observational acoustic analysis	Preterm infants	Vocal repertoire	Preterm infants exhibit diverse vocal patterns beyond crying	Supports existence of structured neonatal "vocabulary"
Bonafos et al. [2]	Comparative acoustic study	Preterm vs term neonates	Cry characteristics	Preterm cries differ significantly in pitch and structure	Marker of neurodevelopmental immaturity
Bornstein et al. [3]	Neurobiological study	Infants & caregivers	Maternal response to cry	Cry triggers consistent neural responses across cultures	Reinforces biological importance of cry signals
Chang et al. [4]	learning study	Neonatal cry datasets	Cry classification	High accuracy in classifying cries using AI models	Potential for automated diagnostic tools
Chittora & Patil [5]	Acoustic analysis	Neonates	Cry signal properties	Cry signals have measurable acoustic features	Objective assessment of infant distress
Elmlinger et al. [6]	Developmental study	Infants	Social feedback	Vocal learning shaped by caregiver interaction	Highlights importance of caregiver–infant loop
Filippa & Kuhn [8]	Clinical guideline	NICU infants	Parental vocal contact	Vocal interaction improves developmental outcomes	Supports NICU intervention strategies
Furlow [9]	Evolutionary analysis	Human infants	Cry signaling	Cry acts as an "honest signal" of fitness	Evolutionary basis of neonatal communication
Gustafson et al. [10]	Observational study	Neonates	Individuality of cry	Cries are unique to individuals	Enables caregiver recognition
Hou et al. [11]	Neurodevelopmental study	Neonates	Emotional perception	Newborns detect vocal emotions early	Early emotional communication capacity
Jhang & Oller [12]	Longitudinal study	Infants (0–3 months)	Functional flexibility	Vocalizations occur across contexts	Key precursor to language
Laguna et al. [14]	Multimodal study	Neonates	Cry + neuro signals	Cry correlates with brain and behavioral signals	Integrated understanding of distress
Lingle et al. [16]	Review	Multiple species	Distress vocalization	Cry defined by acoustic and functional properties	Theoretical framework of crying
Long et al. [17]	Observational	Infants	Social vs endogenous vocalization	Vocalizations occur even without stimuli	Suggests intrinsic drive for vocalization
Manigault et al. [18]	Cohort study	Preterm infants	Cry & outcomes	Cry features predict developmental outcomes	Early biomarker potential

Marschik et al. [19]	Review + computational	Infants	Early verbal functions	Vocal patterns linked to neurodevelopmental disorders	Screening relevance
Narayanan et al. [21]	Experimental	Fetal/neonatal models	Prenatal vocal-ization	Vocal behavior begins prenatally	Communication roots before birth
Oller et al. [24]	Experimental	Infants	Functional flex-ibility	Vocal flexibility is uniquely human	Basis of language evolution
Oller et al. [23]	Observational	Infants	Protophones	Protophones dominate early vocal output	Key building blocks of speech
Papaeliou et al. [25]	Acoustic study	Infants	Emotional vocal patterns	Acoustic variations reflect emotions	Emotional decoding possible
Shinya et al. [28]	Longitudinal	Preterm & term	Cry frequency	Predicts later language acquisition	Prognostic significance
Shinya et al. [29]	AI-based study	Preterm infants	Cry feature extraction	Neural networks detect subtle cry patterns	Advanced diagnostic potential
Soltis [30]	Review	Human infants	Cry signaling	Cry communicates multiple needs	Multifunctional com-munication system
Van Manen [31]	Qualitative study	Neonates	First cry	First cry has symbolic and clinical meaning	Philosophical + clinical relevance
Wang et al. [32]	Narrative review	Neonates	Cry significance	Integrates physiological and clinical roles	Holistic understanding

The concept of functional flexibility, introduced in developmental vocalization research, marked a paradigm shift by highlighting that infant vocalizations are not rigidly tied to specific contexts [6,13]. This flexibility distinguishes human infants from many non-human species and is considered a key precursor to language development.

Research on protophones further reinforced this view, demonstrating that non-cry vocalizations dominate the infant vocal landscape and serve as foundational elements for speech [12]. Longitudinal studies have shown that early vocal patterns, including pitch variability and melodic complexity, are predictive of later language acquisition and cognitive development [30].

Comparative studies between preterm and full-term infants have revealed significant differences in vocal characteristics, with implications for neurodevelopmental outcomes [22,23]. Additionally, evidence indicates that neonatal vocalizations are influenced by prenatal development, suggesting that the roots of communication begin before birth [21].

More recent studies have explored the neurobiological and emotional dimensions of neonatal vocalization, demonstrating that infants are sensitive to vocal emotions and capable of expressing affective states through structured acoustic patterns [15,31].

The integration of artificial intelligence and signal processing has further advanced the field, enabling large-scale analysis and classification of vocal data [27,29]. Collectively, the literature supports the notion that neonatal vocalizations constitute a complex, structured, and meaningful communication system, rather than a simple reflexive behavior.

Clinical Implications

Understanding neonatal vocal communication has profound implications for clinical practice, particularly in neonatology and developmental pediatrics.

First, cry characteristics can serve as early indicators of neurological integrity. Abnormal features such as high-pitched cries, reduced variability, or atypical patterns may signal underlying conditions including hypoxic–ischemic injury or neurodevelopmental disorders [11,32].

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Second, vocal analysis offers a non-invasive diagnostic tool for assessing infant well-being. With the integration of machine learning technologies, automated systems may soon assist clinicians in real-time interpretation of neonatal cries, improving early detection and intervention [27].

Third, interventions targeting caregiver–infant vocal interaction have demonstrated significant benefits. Structured parental vocal engagement, particularly in neonatal intensive care units, has been associated with improved physiological stability and neurodevelopmental outcomes [25].

Additionally, the recognition of vocal individuality underscores the importance of personalized caregiving, where caregivers learn to interpret the unique vocal patterns of their infant. This enhances bonding and responsiveness, contributing to optimal developmental trajectories.

Interpretative Framework: What Does a Newborn Really "Say"?

Although neonates do not possess symbolic language, their vocalizations convey meaningful information that can be interpreted within a structured framework.

Neonatal vocalizations communicate:

- Physiological needs: hunger, pain, discomfort
- Emotional states: distress, calmness, arousal
- Social intent: readiness for interaction, engagement
- Developmental status: neurological maturity and integrity

Crying represents an urgent, high-salience signal requiring immediate caregiver response, whereas protophones reflect exploration, comfort, and early social communication [12,13]. Distress cries, in particular, function as biologically optimized signals designed to maximize caregiver attention and ensure survival [19].

Thus, a newborn does not "speak" in words but communicates through a multidimensional acoustic system, where variations in pitch, rhythm, and intensity encode meaning. This system represents the earliest form of human language, bridging the gap between reflexive behavior and intentional communication.

CONCLUSION

Neonatal vocalizations represent a sophisticated and dynamic system of early human communication. Far from being mere reflexive outputs, these sounds are structured, meaningful, and developmentally significant. The concept of a neonatal vocabulary provides a valuable framework for understanding how infants convey needs, emotions, and emerging social intent.

Advances in acoustic analysis, neurodevelopmental research, and artificial intelligence have transformed our ability to decode these early signals, opening new avenues for clinical application and research. Importantly, neonatal vocal behavior serves as both a window into the developing brain and a foundation for later language acquisition.

Recognizing and interpreting what a newborn "says" is therefore not only essential for caregiving but also for advancing neonatal and developmental medicine.

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Conflict of Interest

The authors declare no conflict of interest.

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Ethical Approval

Not applicable, as this is a narrative review of previously published literature.

Author Contributions

Fajia Farhath conceptualized the study, performed literature synthesis, and drafted the manuscript. Arohi Gupta contributed to critical revision, interpretation of data, and final approval of the manuscript.

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