

Concept to The Alive Language

Jaba Tkemaladze¹

¹Director of Research, Longevity Clinic, Inc, Georgia

E-mail: jtkemaladze@longevity.ge | ORCID: <https://orcid.org/0000-0001-8651-7243>

Citation: Tkemaladze, J. (2025). Concept to The Alive Language. Longevity Horizon, 1(1).

DOI: <https://doi.org/10.5281/zenodo.14688792>

Abstract

The Living Language Hypothesis proposes that language functions as a dynamic, living system capable of resisting informational entropy. This hypothesis suggests that language is not a passive tool for communication but an active, evolving entity that interacts with its speakers, shaping their psyche, physiology, and consciousness. Just as biological organisms consume energy to counteract entropy, language is sustained through speech acts performed by individuals, ensuring its ongoing adaptation and complexity. These speech acts, influenced by factors such as genetics, age, and culture, contribute to the continuous evolution of language, fostering its resilience and dynamism. Central to this hypothesis is the role of phonemes, the building blocks of language, which evolve to accommodate the physiological and cognitive capabilities of speakers. The interaction between language and its speakers influences both individual identity and collective cultural development. This paper explores the implications of the Living Language Hypothesis for understanding language acquisition, phonemic diversity,

and the transformative power of language in shaping human experience. By viewing language as a living entity, this hypothesis offers new insights into the profound relationship between language, thought, and society.

Keywords: living language; speech acts; phonemes; informational entropy; language evolution; cognitive development

Introduction

All living beings possess a unique ability to counteract entropy, bringing stability within their respective species. Language, as one of the most significant cultural mechanisms, resists entropy through the development of vibrational structures and speech acts.

From the earliest stages of evolution, humans have used language as a tool for transmitting information and influencing the consciousness of their social environment. Language, in its diversity, impacts not only thought but also the development of the psychophysical potential of individuals.

If language is viewed as a system of codes, its phonemic structure becomes a critical

factor. The types and combinations of phonemes differ across linguistic systems, directly influencing the ease of language acquisition and cognitive abilities.

Starting with the notion that every spoken language has a finite number of phonemes, one can observe how these sounds are distributed within languages and how this distribution impacts individuals. Phoneme frequencies vary not only by language but also by factors such as age, gender, and genetic predisposition. For instance, the phonemes a child is exposed to in infancy differ significantly from those used in adulthood, contributing to the development of distinct cognitive and emotional patterns.

The question of which natural mechanisms influence phoneme frequency formation remains open. However, advances in linguistic analysis, combined with artificial intelligence, allow researchers to track such phenomena. This tracking can reveal the subtle effects of phoneme distribution on cognition and personality development.

When considering language as a living system, it becomes clear that it is not static but dynamic, constantly adapting to its speakers. Languages with a greater diversity of phonemes tend to exhibit higher vitality, as they foster richer cognitive and emotional interactions among their speakers. On the other hand, languages with fewer phonemes might face challenges in maintaining their vitality and adaptability.

The vibrational structures of language influence not only individual cognition but also collective consciousness. Languages with a balanced distribution of phonemes can create harmonious social interactions, while imbalances in phonemic structure

might contribute to communication barriers or misunderstandings.

One key aspect of phoneme studies is their frequency ranking within a language. Ranking phonemes by frequency involves analyzing large corpora of spoken or written texts to determine which sounds occur most frequently. For example, in languages like Georgian, vowel-dominant phoneme distributions shape unique rhythmic and cognitive patterns, distinct from languages with consonant-heavy distributions.

The importance of phoneme frequency goes beyond linguistics, extending into fields like psychology, neuroscience, and even sociology. Phonemes affect how individuals process information, form emotional connections, and interact within their social environment. Understanding these patterns offers valuable insights into the interplay between language and human behavior.

Another fascinating aspect is the potential universality of certain phoneme patterns. Across different languages, some phonemes are acquired earlier by children, suggesting an inherent ease of production and perception. These "universal" phonemes could hold clues to the fundamental structures of human communication and cognition.

The hypothesis of a "living language" suggests that languages actively influence their speakers, shaping their psyche, physiology, and consciousness. This proactive relationship underscores the need for comprehensive studies of phoneme frequencies and their impact on individuals.

With the advent of modern computational tools, it has become possible to analyze

phoneme distributions with unprecedented accuracy. Programs like Hyperbola, developed specifically for linguistic analysis, enable researchers to count phonemes in large corpora and compare distributions across languages. Such tools open new avenues for exploring how phonemes contribute to the vibrational and cognitive aspects of language.

Phoneme frequency studies also have implications for language preservation and revitalization. Languages with rich phonemic diversity are better equipped to adapt to changing social and cultural environments, ensuring their continued vitality. Conversely, languages with reduced phonemic inventories may struggle to maintain their relevance and functionality over time.

The introduction of phonemic data into interdisciplinary research offers exciting possibilities. By integrating linguistic, psychological, and computational approaches, researchers can uncover the mechanisms through which language shapes human experience. This integration can also inform language education, helping learners acquire new languages more effectively by tailoring instruction to their cognitive and phonemic predispositions.

Ultimately, the study of phoneme frequencies bridges the gap between the physical and cognitive dimensions of language. It reveals how the smallest units of speech carry profound implications for individual and collective development. As we continue to unravel the mysteries of phonemic influence, we gain deeper insights into the essence of language as a living, dynamic force within human societies.

In conclusion, understanding phoneme frequencies is not merely a linguistic endeavor but a multidisciplinary challenge with far-reaching implications. By exploring the vibrational and cognitive dimensions of language, we can unlock new perspectives on the role of language in shaping the human psyche and fostering social harmony.

Methods and Materials

The International Phonetic Alphabet (IPA)

The International Phonetic Alphabet (IPA) is a standardized system of phonetic transcription designed in the 19th century to precisely represent the pronunciation of languages. Its primary goal was to assign a unique symbol to every distinctive sound or phoneme in human speech, ensuring clear differentiation between sounds that distinguish one word from another. The IPA remains the most widely recognized example of phonetic transcription, enabling linguists to document and analyze the sound structures of languages worldwide. The concept of the IPA was first popularized by Otto Jespersen through a letter to Paul Passy of the International Phonetic Association. Developed in the late 19th century by notable figures such as A.J. Ellis, Henry Sweet, Daniel Jones, and Passy, the IPA sought to standardize the representation of spoken language. Before its creation, inconsistencies in traditional orthographies across languages led to confusion in pronunciation, impeding effective linguistic analysis. The IPA was envisioned as a universal system that would eliminate these inconsistencies, replacing

the multitude of transcription systems that existed at the time.

The IPA was first published in 1888 and has undergone several revisions during the 20th and 21st centuries to accommodate new linguistic insights and emerging needs. The International Phonetic Association maintains responsibility for the alphabet, regularly updating its chart to reflect advancements in phonetic research. At its core, the IPA relies primarily on Roman symbols. Additional characters are borrowed from other scripts, such as Greek, and modified to align with the Roman style. Diacritical marks are used extensively to capture subtle phonetic distinctions, including vowel nasalization, length, stress, and tonal variation.

The IPA is versatile, allowing for both broad and narrow transcription. For example, English contains a single /t/ sound as perceived by native speakers, necessitating only one symbol in broad transcription. However, when employing narrow transcription, diacritical marks can indicate slight variations in the articulation of /t/ in words like "tap," "pat," and "stop." These distinctions highlight differences in aspiration or voicing that are imperceptible to the untrained ear but crucial for precise phonetic analysis. The IPA has found applications across a wide range of disciplines, from linguistics and speech therapy to singing and language education. Linguists use the IPA to document the phonetic structures of endangered languages, enabling the preservation of linguistic diversity. Speech therapists rely on the IPA to diagnose and treat speech disorders, using its precise symbols to target specific articulatory challenges. Singers also adopt the IPA to master the pronunciation of foreign-language lyrics,

ensuring accurate and expressive performances.

Despite its widespread adoption, the IPA has not achieved universal usage. Its implementation varies significantly between regions, with greater acceptance in Europe compared to the Americas. This discrepancy stems partly from educational traditions and the perceived complexity of the system. Another challenge lies in the adaptation of the IPA to the needs of specific languages. While the IPA provides a comprehensive framework, some languages require additional symbols or diacritics to capture unique phonetic features. These modifications can introduce inconsistencies, complicating the universal applicability of the system. Furthermore, the IPA's creators originally intended it as a tool for both linguistic research and practical education. However, its complexity can deter non-specialists, limiting its accessibility to a broader audience. This challenge underscores the need for simplified training materials and greater integration of IPA instruction into language education curricula.

The International Phonetic Alphabet represents a monumental achievement in the standardization of phonetic transcription. By assigning unique symbols to every phoneme, it enables the precise representation and analysis of spoken language, fostering greater understanding of linguistic diversity. Although it faces limitations in universal adoption and accessibility, the IPA remains an indispensable tool for linguists, educators, and other professionals. Its continued development and application will undoubtedly play a vital role in the

preservation and study of the world's linguistic heritage.

Shannon-Weaver Theorem

The Shannon-Weaver Theorem, sometimes referred to as the Shannon-McMillan-Breiman Theorem, is a foundational concept in information theory. It establishes that if a text exhibits a certain statistical structure, it can be considered to contain information or meaning. This theorem has profound implications for understanding how information is encoded, transmitted, and interpreted within various systems, including language. At the core of the Shannon-Weaver Theorem lies the concept of entropy. In information theory, entropy is a measure of uncertainty or surprise within a message. When applied to a text, it quantifies the average degree of unpredictability in extracting symbols from the text. In simple terms, entropy describes how much "surprise" is embedded in the sequence of symbols.

If the symbols within a text appear with equal probability, the entropy is at its maximum. This means there is no discernible structure or pattern, and the text is highly unpredictable. Conversely, if a text exhibits structure or patterns, its entropy is reduced. This reduction occurs because some symbols or combinations of symbols appear more frequently than others, making the text more predictable and less uncertain. The theorem posits that texts with lower entropy contain more concentrated or "compressed" information compared to texts where symbols are distributed randomly. For example, a meaningful sentence in a natural language contains patterns that reflect the rules of grammar, syntax, and semantics, which reduce its entropy. These

patterns make it easier for a receiver—whether human or machine—to interpret the text and extract information.

Random sequences, on the other hand, lack structure and are harder to compress or interpret. For instance, a string of random characters such as "xqzprk" has higher entropy and contains little usable information compared to a coherent phrase like "The sun rises in the east." In the context of language, the Shannon-Weaver Theorem provides valuable insights into how information is encoded and transmitted. Texts that exhibit structure and regularity—such as grammatical sentences—tend to have lower entropy and higher information content. This aligns with the observation that human languages evolve to balance efficiency and redundancy. Efficiency ensures that messages are transmitted accurately, while redundancy provides a safeguard against noise or distortion during communication.

For example, in English, certain letter combinations like "th" or "qu" are more common than others, reflecting the statistical structure of the language.

This predictability reduces entropy and facilitates faster processing by the brain or computational systems. The Shannon-Weaver Theorem also addresses the optimal encoding of information. It states that there is an ideal way to encode information such that it can be transmitted with minimal loss and maximum efficiency, given the constraints of the communication channel. This principle is widely used in data compression algorithms, where patterns in the data are identified and exploited to reduce file sizes without losing critical information.

Languages, as systems of communication, exhibit similar principles. They use recurring patterns and structures to encode information compactly while maintaining clarity and meaning. This efficiency is particularly evident in spoken language, where constraints such as time and processing capacity necessitate concise yet effective communication.

One of the theorem's key insights is the relationship between structure and meaning. The presence of patterns in a text often indicates the presence of meaning or information. In language, these patterns can include grammatical rules, phonemic distributions, or semantic associations.

For example, the phrase "Colorless green ideas sleep furiously" follows grammatical rules but lacks semantic coherence, illustrating how structure can exist without clear meaning. Conversely, a meaningful sentence—even if syntactically complex—conveys information more effectively because its structure aligns with shared linguistic conventions.

The Shannon-Weaver Theorem has applications far beyond linguistics. In fields such as cryptography, it helps measure the unpredictability of encryption keys and the strength of security systems. In neuroscience, it provides insights into how the brain processes and stores information, revealing parallels between neural activity and information-theoretic principles. Similarly, in artificial intelligence and machine learning, the theorem guides the design of algorithms that detect patterns and predict outcomes based on data inputs.

Understanding the relationship between entropy and information has practical implications for both human and machine communication. For instance, language learning can benefit from insights into which patterns and structures reduce entropy, making certain languages or aspects of language easier to acquire.

In computational linguistics, tools such as text summarizers and machine translation systems leverage the principles of the Shannon-Weaver Theorem to identify and preserve meaningful structures while discarding irrelevant information. Speech recognition systems also use entropy calculations to distinguish between likely and unlikely sound patterns, improving their accuracy.

Additionally, the theorem underscores the importance of redundancy in communication. While redundancy may seem inefficient, it serves a crucial role in mitigating errors and ensuring that messages remain intelligible even in noisy environments. This principle is evident in languages, where synonyms, repetition, and contextual cues provide multiple pathways for understanding.

The Shannon-Weaver Theorem is a cornerstone of information theory, offering profound insights into the relationship between entropy, structure, and meaning. By quantifying the uncertainty within a text, it provides a framework for understanding how information is encoded and transmitted in language systems. Its implications extend beyond linguistics, influencing fields as diverse as data compression, neuroscience, and artificial intelligence.

As we continue to explore the interplay between structure and meaning, the Shannon-Weaver Theorem remains an invaluable tool for unraveling the complexities of communication and information processing.

The Living Language Hypothesis

The Living Language Hypothesis presents a novel perspective on the nature of language, suggesting that it functions as a living entity capable of resisting informational entropy. This idea explores the dynamic relationship between language and its speakers, emphasizing how language evolves, adapts, and actively interacts with individuals to shape their psyche, physiology, and consciousness.

Language as a System That Resists Entropy

In a biological context, all living organisms counteract entropy by consuming energy from their surroundings, allowing them to maintain their structure and functionality. Similarly, language resists informational entropy by utilizing speech acts performed by its speakers. These acts provide the necessary "nourishment" for language to evolve and sustain itself. Paradoxically, even as language resists entropy, it accumulates complexity through the interaction of its components, much like a living organism.

This hypothesis draws parallels between language and biological systems, where seemingly disparate elements harmoniously interact to create a unified whole. Just as

differentiated cells in an organism arise from a single progenitor and coexist harmoniously, diverse phonemes and linguistic structures emerge within a language, enabling it to function effectively as a communication system.

The Role of Speech Acts

Speech acts play a fundamental role in sustaining and developing language. Each act of communication reinforces the language system by encouraging the speaker to engage in internal dialogue. This internal process feeds the "living entity" of language, enriching its vibrational and informational structure. In this way, speakers become both the creators and the maintainers of their language.

Different speakers bring unique characteristics to their interactions with language, influenced by factors such as genetics, age, and cultural context. These differences contribute to the accumulation of entropy within the language system, forming statistical structures that are still not fully understood. The diversity among speakers ensures that language remains dynamic and adaptable, fostering its evolution over time.

Phonemes as the Building Blocks of Language

At the core of any spoken language lies the phoneme, the smallest unit of sound capable of distinguishing meaning. The distribution of phonemes within a language does not arise naturally but evolves to accommodate the physiological and cognitive capabilities of its speakers. For example, the phonemic distribution in a language is influenced by factors such as

age, gender, and genetic lineage, resulting in variations in speech patterns across different groups.

A clear example of this phenomenon can be observed in the Georgian language. Infants are exposed to simple phonemic patterns like “agh-u,” schoolchildren to “ai-ia,” and adults to more complex patterns such as “a-ie.” These evolving patterns shape the cognitive and emotional states of speakers throughout their lives, reflecting the adaptive nature of language.

Language as a Proactive Force

The Living Language Hypothesis asserts that language is not merely a passive tool for communication but a proactive force that influences its speakers. Languages with a greater number of phonemes and more frequent usage of these phonemes tend to foster higher birth rates, longevity, and overall well-being among their speakers. In this sense, language functions like a nurturing gardener, actively shaping the psychophysiological characteristics of its community.

Moreover, the hypothesis suggests that language integrates individuals into its structure, altering their consciousness and behavior to align with its vibrational patterns. This proactive relationship highlights the profound impact of language on human development, shaping not only individual identities but also collective cultural and social dynamics.

Humans and Non-Human Communities

The transformative power of language becomes evident when comparing humans raised in linguistic communities to those raised in non-linguistic environments. A person raised among speakers of a language develops a distinct psyche, body structure, and consciousness compared to an individual raised in isolation or among animals. Similarly, deaf-mute individuals who lack exposure to written or spoken language exhibit unique cognitive and emotional characteristics, further illustrating the integral role of language in shaping human experience.

Phonemic Diversity and Its Implications

The hypothesis emphasizes the significance of phonemic diversity within a language. Languages with a rich array of phonemes exhibit greater adaptability and resilience, enabling their speakers to navigate complex social and environmental challenges. Conversely, languages with limited phonemic inventories may struggle to sustain their vitality and relevance over time.

Phonemic diversity also influences the ease with which individuals acquire language. For example, languages with simpler phonemic distributions may be easier for young children to learn, while more complex languages may require greater cognitive effort. This relationship between phonemic structure and language acquisition underscores the interplay between biological and cultural factors in linguistic development.

Language as a Living System

By viewing language as a living system, the hypothesis challenges traditional notions of language as a static and purely symbolic construct. Instead, language is seen as an active participant in human evolution, capable of shaping and being shaped by its speakers. This dynamic interplay ensures that language remains a vital and adaptive force within human societies. For instance, the hypothesis proposes that languages with higher phonemic richness and structural complexity encourage cognitive and emotional growth among their speakers. This growth, in turn, reinforces the vitality of the language, creating a positive feedback loop that sustains the system over time.

Future Directions and Research Implications

The Living Language Hypothesis opens new avenues for interdisciplinary research, bridging fields such as linguistics, psychology, anthropology, and evolutionary biology. By exploring the mechanisms through which language influences human development, researchers can gain deeper insights into the fundamental nature of communication and its role in shaping human societies.

Potential areas of investigation include:

1. **Phonemic Distribution Studies:** Analyzing the distribution of phonemes across different languages and their impact on cognitive and emotional development.
2. **Language Acquisition Research:** Investigating how phonemic

complexity affects language learning in children and adults.

3. **Cultural and Biological Interactions:** Examining the interplay between genetic factors and linguistic structures in shaping individual and collective identities.
4. **Language Preservation Efforts:** Understanding the role of phonemic diversity in maintaining linguistic vitality and exploring strategies for revitalizing endangered languages.

The Living Language Hypothesis offers a transformative perspective on the nature of language, highlighting its role as a living, dynamic system that actively shapes and is shaped by its speakers. By resisting informational entropy and fostering cognitive and emotional growth, language emerges as a central force in human evolution and cultural development. This hypothesis not only deepens our understanding of language but also underscores its profound impact on the human experience, paving the way for new discoveries in the study of communication and human potential.

Software

The program "Hyperbola" was created, which allows for the counting of symbols of Georgian (Georgian script does not require IPA) / IPA letters in texts placed in a single catalog. The program is distributed under the MIT license and can be downloaded from the following address: <https://github.com/djabbat/Hyperbola>

Material and Representation

The distribution of phoneme rank-frequency (distributions) concerns the distribution of phonemes in a language according to the frequency of their occurrence. These distributions can reveal knowledge about the phonological structure of the language as well as its typological characteristics. For comparison, English and Georgian texts have been counted and analyzed. No large texts converted into IPA in English were found. Therefore, in order to determine phoneme rank-frequencies, Adam Kilgarriff's non-lemmatized frequency list for the British National Corpus was used, correlated with Carnegie Mellon University's pronunciation dictionary. The first is used as a phonetic dictionary, while the second, as a corpus, is weighted by the relative frequencies of each word's phonemes. To determine the phoneme rank-frequencies for the Georgian language, the so-called Mtskhetian Holy Scripture was used. Since Georgian script does not require IPA conversion, the program "Hyperbola" created by me was used. This software fully counts and aggregates both Georgian and IPA letters in texts.

The least frequent phoneme is assigned the rank 1, the second least frequent phoneme is assigned the rank 2, and so on. The frequency of each phoneme in the language is typically counted through the analysis of a large corpus of spoken or written text. This can be done manually (as was done earlier) or by using computational methods. After phonemes are ranked by frequency, the data is displayed on a graph, typically with the rank of each phoneme on the y-axis and the frequency on the x-axis. This forms the

rank-frequency distribution curve. The resulting curve can reveal significant information about the phonological structure of the language. For example, some languages may have a distribution where a small number of phonemes occur very frequently, while the majority of phonemes occur rarely. Other languages may have a more even distribution of phoneme frequencies.

Of particular interest is the sequence of the first phonemes in terms of rank. There exists a notable correlation between the ease of acquiring sounds and their representation in different languages. Human beings possess an innate, though not fully understood, mechanism that helps individuals avoid complex sounds. Children's language acquisition studies have demonstrated that phonology is learned in a logical sequence, with children first acquiring the sounds that are easier and more frequently used in their environment.

This process is significant because it highlights how the distribution of phoneme rank-frequency is structured in a language system, which reflects both the linguistic simplicity and the adaptability of a language to its speakers. The process of acquiring sounds begins with the phonemes that are simpler to articulate and perceive. This is evident in the way children first learn the most frequently used and simplest sounds of their native language, gradually expanding to more complex ones as their cognitive and physical abilities develop.

This sequence of sound acquisition is not random but follows a predictable pattern, which has been observed across various languages. Thus, phoneme rank-frequency

distribution, which refers to the frequency at which certain phonemes occur in a language, plays a crucial role in the structure of language systems. Furthermore, there is a general tendency in different populations to favor the use of phonologically simpler elements while avoiding more complex sounds. This phenomenon is rooted in the cognitive and physiological limitations of human speakers and listeners. In terms of language acquisition, sounds that are easier to produce and perceive are more likely to be retained and used, while those that are more difficult tend to be avoided or altered in some way.

This tendency toward simplicity in language reflects the human desire for efficiency in communication. What is considered "easy" or "difficult" to perceive and produce is not arbitrary but is influenced by genetic factors and the individual's physiological capabilities. For instance, languages across the world demonstrate varying levels of complexity in their phonetic systems, and these differences can be traced to genetic predispositions. People's ability to produce and perceive certain sounds is influenced by genetic factors that shape the structure of their vocal apparatus and auditory processing abilities. As a result, phonetic rank-frequencies are not random occurrences within a language but are shaped by these genetic influences, which guide the way in which certain sounds are favored over others.

Phonetic rank-frequency distributions can reveal a great deal about the structure and nature of a language. For example, some languages feature a distribution in which a small number of phonemes occur very frequently, while the majority of phonemes

are rare and occur infrequently. In contrast, other languages may have a more balanced distribution of phoneme frequencies, with no particular phoneme standing out as overwhelmingly common or rare. These patterns provide insight into the phonological structure of a language, offering a glimpse into the linguistic preferences and cognitive processes of its speakers.

The influence of these phoneme distributions extends beyond linguistic theory and into the practical effects they have on speakers. Languages with a higher frequency of simpler, more common sounds may be easier for children to acquire and may require less cognitive effort for speakers and listeners. On the other hand, languages with more complex phonetic systems may present greater challenges for acquisition and comprehension, both for native speakers and for second-language learners.

One particularly interesting aspect of phoneme rank-frequency distributions is the first phonemes in a language's sequence. The order of phonemes in terms of their rank-frequency has significant implications for language acquisition and phonological analysis. In many languages, the most common phonemes are simple sounds that are easy to produce, such as vowels or simple consonants like "p," "m," and "t." These sounds are often among the first to be acquired by children, reflecting their simplicity and frequency in speech. As a language progresses, less common and more complex phonemes, such as those found in consonant clusters or more intricate vowel sounds, appear later in the phonological sequence. The study of phoneme distribution forms is not only

phonological structure of the language, such as whether it follows a more uniform distribution or if certain phonemes are disproportionately frequent.

Letter	Percentage
s	17.5%
n	9.5%
g	8.5%
b	7.0%
h	6.5%
m	5.5%
q	5.0%
o	4.8%
t	4.5%
c	4.0%
f	3.8%
e	3.5%
i	2.8%
d	2.2%
o	1.8%
g	1.5%
b	1.5%
d	1.5%
a	1.5%
h	1.5%
f	1.5%
j	1.5%
e	1.5%
h	1.5%
s	1.0%
h	1.0%
d	1.0%
s	1.0%
k	0.8%
o	0.8%
j	0.8%
j	0.8%
x	0.5%
j	0.5%
d	0.5%
e	0.5%
a	0.5%

This horizontal bar chart displays the percentage of words in the 1000 most frequent words in English. The y-axis lists 1000 words, and the x-axis shows percentages from 0.00% to 12.50%. Red bars indicate the percentage of words in the 1000 most frequent words, while blue bars indicate the percentage of words in the 1000 most frequent words in the 1000 most frequent words.

Word	Percentage (%)
a	11.50
n	7.00
r	6.80
t	6.50
i	6.20
s	4.80
o	4.20
k	3.80
e	3.50
m	3.20
z	3.00
p	2.80
au	2.50
v	2.20
w	2.00
u	1.80
b	1.60
h	1.50
A	1.40
f	1.30
at	1.20
o	1.10
h	1.00
o	0.90
p	0.80
n	0.70
f	0.60
j	0.50
g	0.40
d3	0.30
tr	0.20
au	0.10
u	0.05
e	0.02
ai	0.01
3	0.00

In some languages, such as those with a high degree of phonemic simplicity, the curve may show a steep drop-off, where a few phonemes account for the majority of occurrences, and the rest of the phonemes are used far less frequently. This kind of distribution suggests that speakers of these languages tend to rely on a small number of phonemes for most of their communication. In contrast, languages with a more even distribution may exhibit a flatter curve, indicating a more balanced use of various phonemes.

© Under [CC BY-NC-ND 4.0 International License](#) | [Longevity Horizon](#), 1(1). ISSN: 088-4063

whereas Georgian places greater emphasis on consonantal sounds, which are more complex and varied in their articulation. These differences in phonetic distributions reflect the distinct phonological structures of the two languages, as well as the differing cognitive and physiological processes involved in their production and perception.

To illustrate these points, Picture 1 and Picture 2 provide visual representations of the phoneme distributions in English and Georgian. In these diagrams, the frequency of vowels is shown in red, while consonants are shown in blue. The visual comparison highlights the contrasts between the two languages, particularly in the balance between vowels and consonants and the overall frequency distribution of phonemes.

In conclusion, the form and distribution of phonemes in world languages are shaped by a combination of cognitive, physiological, and genetic factors. Phoneme rank-frequency distributions provide a window into the linguistic structure of a language, revealing patterns of simplicity, complexity, and cognitive adaptation. These distributions are not random but are influenced by the human need for efficient communication, and they offer valuable insights into how languages function, evolve, and are acquired by speakers. By examining phoneme distributions, linguists can deepen their understanding of the phonological characteristics of languages and the ways in which they shape the human experience of communication.

Discussion

The Living Language Hypothesis introduces an innovative way of viewing language, positioning it as a living, dynamic entity that

actively resists informational entropy. This hypothesis emphasizes the idea that language is not simply a passive tool for communication but rather an active force that shapes human consciousness, physiology, and behavior. By suggesting that language evolves, adapts, and interacts with its speakers in profound ways, this theory opens up new avenues for understanding the intersection between linguistics, biology, and psychology. In this discussion, we will explore the key aspects of the Living Language Hypothesis, its implications for human development, and the potential for future research.

At its core, the Living Language Hypothesis suggests that language functions similarly to biological systems in its resistance to entropy. In biology, living organisms resist entropy by consuming energy from their environment, thus maintaining their structural integrity and functionality. Language, likewise, resists entropy through the speech acts of its speakers. These speech acts—conversations, storytelling, teaching, and more—serve as the "nourishment" that keeps language alive, evolving, and relevant. Through these acts, language grows and sustains itself, much like a living organism. The paradox here is that, while language resists entropy by remaining functional, it also accumulates complexity over time through the interaction of its components.

The comparison between language and biological systems is crucial. In biological organisms, cells that were once undifferentiated develop into specialized forms to perform unique functions, yet they all contribute to the overall health and functionality of the organism. Similarly, phonemes and linguistic structures, while

diverse, work together to form a functional communication system. This metaphor not only highlights the complexity of language but also suggests that its components are interdependent, each playing a vital role in sustaining the whole. In this sense, language is not static but rather a living, breathing entity that constantly adapts and evolves in response to the needs and behaviors of its speakers.

Speech acts are central to the survival and development of language, according to the Living Language Hypothesis. Every act of communication—whether verbal, written, or non-verbal—reinforces the language system by providing it with energy and information. This process fosters an internal dialogue within the speaker, which in turn nurtures the language itself. Each individual contributes to the language's growth, shaping and being shaped by it. The unique characteristics of each speaker—such as genetics, age, and cultural context—add layers of complexity and diversity to the language, ensuring that it remains dynamic and adaptable over time.

Furthermore, this diversity in speech acts means that language cannot be reduced to a simple, fixed set of rules. It evolves through the interactions of its speakers, each bringing their own experiences, emotions, and cognitive processes to bear on the language. The accumulation of entropy within the language system, resulting from these individual contributions, forms complex statistical structures that reflect the richness and diversity of human communication. This ongoing process of evolution ensures that language remains relevant, resilient, and capable of adapting to the changing needs of its speakers.

Phonemes, the smallest units of sound capable of distinguishing meaning, are fundamental to the structure of language. The distribution of phonemes within a language is not arbitrary but evolves to accommodate the physiological and cognitive capabilities of its speakers. The arrangement of phonemes reflects both biological factors—such as vocal tract anatomy and auditory processing abilities—and social factors, such as cultural practices and communicative needs.

In languages like Georgian, phonemic distributions evolve across the lifespan. Infants first encounter simple phonemic patterns, such as “agh-u,” which reflect the physiological limitations of their vocal apparatus. As individuals mature, they gain access to more complex phonemic structures, such as “ai-ia” in childhood and “a-ie” in adulthood. These evolving phonemic patterns shape not only the language itself but also the cognitive and emotional development of speakers. The process of acquiring and internalizing these phonemic patterns shapes how individuals perceive the world, think, and interact with others. This relationship between phonemic structure and cognitive development highlights the adaptability of language and its role in shaping human identity.

The Living Language Hypothesis proposes that language is not merely a passive tool but a proactive force that actively shapes the lives of its speakers. According to this hypothesis, languages with a greater variety of phonemes and more frequent use of these phonemes contribute to higher birth rates, longevity, and overall well-being among their speakers. In this sense, language functions as a nurturing force that helps individuals thrive, similar to how a

gardener cultivates and shapes the growth of plants.

Language's proactive nature also extends to its role in shaping the consciousness and behavior of its speakers. The vibrational and informational structure of language interacts with the minds and bodies of its speakers, influencing their psychological states, physical health, and social dynamics. In this way, language becomes a force that aligns individuals with its rhythms and patterns, creating a shared cultural and social fabric that binds a community together. This active relationship between language and its speakers highlights the profound impact that language has on the development of individual and collective identities.

The transformative power of language becomes especially apparent when comparing humans raised in linguistic communities to those raised in non-linguistic environments. Individuals raised in linguistic environments develop distinct cognitive, emotional, and physiological characteristics compared to those raised in isolation or among animals. This phenomenon underscores the role of language in shaping human development, from basic cognition to complex emotional and social interactions.

For example, individuals raised without exposure to language—such as deaf-mute individuals who lack access to spoken or written language—exhibit unique cognitive and emotional characteristics. Their ability to think abstractly, understand complex social dynamics, and communicate with others is limited, illustrating the essential role that language plays in human experience. These comparisons emphasize that language is not simply a tool for communication but a fundamental force that

shapes the very essence of human existence.

Phonemic diversity plays a critical role in the adaptability and resilience of a language. Languages with a rich array of phonemes are more flexible and capable of meeting the diverse communicative needs of their speakers. Conversely, languages with fewer phonemes may struggle to sustain their vitality over time. The ability of a language to adapt to the needs of its speakers is closely linked to its phonemic inventory, as a wider range of phonemes allows for greater precision and expressiveness in communication.

Phonemic diversity also affects language acquisition. Simpler phonemic distributions may be easier for young children to learn, while more complex phonetic systems may require greater cognitive effort. This relationship between phonemic structure and language acquisition underscores the interaction between biological and cultural factors in linguistic development.

The Living Language Hypothesis offers exciting possibilities for interdisciplinary research in fields such as linguistics, psychology, anthropology, and evolutionary biology. Future research could explore how phonemic distribution influences cognitive and emotional development, investigate the role of language in shaping individual and collective identities, and examine the impact of phonemic complexity on language acquisition across different age groups. Additionally, research could focus on language preservation efforts, particularly in revitalizing endangered languages and understanding the role of phonemic diversity in sustaining linguistic vitality.

The Living Language Hypothesis offers a transformative perspective on language, viewing it as a living, dynamic system that shapes and is shaped by its speakers. By resisting informational entropy and fostering cognitive and emotional growth, language emerges as a central force in human evolution and cultural development. This hypothesis not only deepens our understanding of language but also underscores its profound impact on the human experience, offering new directions for research and exploration.

Conclusion

The Living Language Hypothesis presents a radical rethinking of language, positioning it as a dynamic, living entity capable of resisting informational entropy. By framing language in this way, the hypothesis not only challenges traditional views of language as a static tool for communication but also elevates it to a central role in shaping human identity, consciousness, and social dynamics. Language is not merely a medium for transmitting information but an active force that evolves, adapts, and influences its speakers in profound and far-reaching ways. Through the exploration of its key elements—speech acts, phonemic distribution, and language as a proactive force—the hypothesis opens new avenues for understanding the interplay between biology, culture, and communication.

One of the central concepts of the Living Language Hypothesis is the analogy between language and biological systems. Just as living organisms consume energy to resist entropy and maintain their structure, language survives and thrives through the acts of communication performed by its speakers. These speech acts act as the

“nourishment” for the language, ensuring its evolution and sustainability over time. While language resists entropy, it does so by accumulating complexity, as the diverse contributions of its speakers interact and shape the language in ever-evolving ways. This comparison highlights the interdependence of language’s components—phonemes, syntax, and cultural context—which, when combined, form a cohesive and adaptive system capable of meeting the communicative needs of its speakers.

The role of speech acts cannot be overstated. Each interaction with language—whether spoken, written, or non-verbal—reinforces the language system, enriching its structure and ensuring its continued relevance. The diversity of speech acts, driven by factors such as genetics, age, and culture, guarantees that language remains dynamic and adaptable. This diversity contributes to the accumulation of entropy, which, paradoxically, strengthens the language, allowing it to develop in new and unexpected directions. In this sense, speakers are both the creators and the sustainers of the language, actively shaping and being shaped by it.

Phonemes, the building blocks of language, play a critical role in the development of both individual identity and the broader linguistic system. The distribution of phonemes within a language is not arbitrary but rather reflects the physiological and cognitive capabilities of its speakers. Over time, phonemic patterns evolve, shaping not only how individuals communicate but also their cognitive and emotional states. For instance, as children grow, their language abilities become more complex, with

phonemic structures becoming increasingly sophisticated. This progression is integral to the development of human consciousness, emphasizing the role of language in shaping thought and perception. The evolving phonemic patterns in a language are not merely a reflection of biology but a product of cultural transmission, demonstrating the intricate relationship between the two.

Another key insight of the hypothesis is that language is not simply a passive tool for communication but a proactive force that actively influences its speakers. The structure of a language—its phonemic richness and frequency of use—has the power to shape the psychological and physiological characteristics of its speakers. For example, languages with a greater variety of phonemes may promote cognitive flexibility and emotional resilience, encouraging higher levels of well-being and longevity among their speakers. This insight underscores the profound impact of language on human development, shaping not only individual identities but also collective cultural and social dynamics.

Furthermore, the hypothesis suggests that the phonemic diversity within a language is vital to its adaptability and resilience. Languages with a rich array of phonemes are better equipped to handle the complexity of social and environmental challenges. In contrast, languages with fewer phonemes may struggle to maintain their relevance over time. The diversity of phonemic structures within a language allows it to evolve and adapt, ensuring that it remains relevant to the needs of its speakers.

The Living Language Hypothesis also draws attention to the transformative power of

language by comparing humans raised in linguistic environments to those raised in non-linguistic contexts. Individuals who grow up in linguistic communities develop distinct cognitive, emotional, and social characteristics that are shaped by their exposure to language. In contrast, those raised in isolation or without access to language exhibit unique cognitive and emotional profiles. This underscores the idea that language is not merely a tool for communication but a fundamental force that shapes the very nature of human existence.

As we look to the future, the Living Language Hypothesis offers exciting possibilities for research in various interdisciplinary fields. Linguistics, psychology, anthropology, and evolutionary biology can collaborate to explore the mechanisms through which language influences human development. Studies could examine how phonemic distributions shape cognitive and emotional development, how language acquisition varies based on phonemic complexity, and how language interacts with genetic factors to shape individual and collective identities. Furthermore, the hypothesis highlights the importance of preserving phonemic diversity, particularly in the context of endangered languages, as it plays a critical role in maintaining linguistic vitality and adaptability.

In conclusion, the Living Language Hypothesis provides a transformative perspective on language as a living, dynamic system that not only facilitates communication but also shapes the lives of its speakers. By resisting entropy, accumulating complexity, and fostering cognitive and emotional growth, language emerges as a central force in human

evolution and cultural development. This hypothesis offers profound insights into the nature of communication and human potential, paving the way for further research and discovery in the fields of linguistics, psychology, and beyond. By embracing the idea of language as a living system, we gain a deeper appreciation for its power to shape the human experience and the world we inhabit.

References:

1. de Saussure, F. (2011). Course in general linguistics. Columbia University Press.
2. Chichinadze, K., Lazarashvili, A., & Tkemaladze, J. (2013). RNA in centrosomes: structure and possible functions. *Protoplasma*, 250(1), 397-405.
3. Chichinadze, K., Tkemaladze, J., & Lazarashvili, A. (2012). A new class of RNAs and the centrosomal hypothesis of cell aging. *Advances in Gerontology*, 2(4), 287-291.
4. Chichinadze, K., Tkemaladze, J., & Lazarashvili, A. (2012). Discovery of centrosomal RNA and centrosomal hypothesis of cellular ageing and differentiation. *Nucleosides, Nucleotides and Nucleic Acids*, 31(3), 172-183.
5. Chichinadze, K., Tkemaladze, D., & Lazarashvili, A. (2012). New class of RNA and centrosomal hypothesis of cell aging. *Advances in Gerontology= Uspekhi Gerontologii*, 25(1), 23-28.
6. Chichinadze, K. N., & Tkemaladze, D. V. (2008). Centrosomal hypothesis of cellular aging and differentiation. *Advances in Gerontology= Uspekhi Gerontologii*, 21(3), 367-371.
7. Jaba, T. (2022). Dasatinib and quercetin: short-term simultaneous administration yields senolytic effect in humans. *Issues and Developments in Medicine and Medical Research Vol. 2*, 22-31.
8. Kipshidze, M., & Tkemaladze, J. (2024). Abastumani Resort: Balneological Heritage and Modern Potential. *Junior Researchers*, 2(2), 126–134. doi: <https://doi.org/10.52340/jr.2024.02.02.12>
9. Kipshidze, M., & Tkemaladze, J. (2024). Microelementoses - history and current status. *Junior Researchers*, 2(2), 108–125. doi: <https://doi.org/10.52340/jr.2024.02.02.11>
10. Kipshidze, M., & Tkemaladze, J. (2023). The planaria *Schmidtea mediterranea* as a model system for the study of stem cell biology. *Junior Researchers*, 1(1), 194–218. doi: <https://doi.org/10.52340/2023.01.01.20>
11. Kipshidze, M., & Tkemaladze, J. (2023). Comparative Analysis of drugs that improve the Quality of Life and Life Expectancy. *Junior Researchers*, 1(1), 184–193. doi: <https://doi.org/10.52340/2023.01.01.19>
12. Kipshidze, M., & Tkemaladze, J. (2024). Balneology in Georgia: traditions and modern situation. *Junior Researchers*, 2(2), 78–97. doi: <https://doi.org/10.52340/jr.2024.02.02.09>
13. Lezhava, T., Monaselidze, J., Jokhadze, T., Kakauridze, N., Khodeli, N., Rogava, M., Tkemaladze, J., ... & Gaiozishvili, M. (2011). Gerontology research in Georgia. *Biogerontology*, 12, 87-91. doi: 10.1007/s10522-010-9283-6. Epub 2010 May 18. PMID: 20480236; PMCID: PMC3063552
14. Matsaberidze, M., Prangishvili, A., Gasitashvili, Z., Chichinadze, K., & Tkemaladze, J. (2017). TO TOPOLOGY OF ANTI-TERRORIST AND ANTI-CRIMINAL TECHNOLOGY FOR EDUCATIONAL PROGRAMS. *International Journal of Terrorism & Political Hot Spots*, 12.
15. Prangishvili, A., Gasitashvili, Z., Matsaberidze, M., Chkhartishvili, L., Chichinadze, K., Tkemaladze, J., ... & Azmaiparashvili, Z. (2019). SYSTEM COMPONENTS OF HEALTH AND INNOVATION FOR THE ORGANIZATION OF NANO-BIOMEDIC ECOSYSTEM TECHNOLOGICAL PLATFORM. *Current Politics and Economics of Russia, Eastern and Central Europe*, 34(2/3), 299-305.
16. Tkemaladze, J. (2025). Concept to The Eternal Youth. *Longevity Horizon*, 1(1). doi: <https://doi.org/10.5281/zenodo.14681902>
17. Tkemaladze, J. (2025). Achieving Perpetual Vitality Through Innovation. doi: [10.13140/RG.2.2.31113.35685](https://doi.org/10.13140/RG.2.2.31113.35685)
18. Tkemaladze, J. (2025). Concept to The Curing All Diseases. *Longevity Horizon*, 1(1). <https://doi.org/10.5281/zenodo.14676208>

19. Tkemaladze, J. (2025). Strategic Importance of the Caucasian Bridge and Global Power Rivalries. doi: [10.13140/RG.2.2.19153.03680](https://doi.org/10.13140/RG.2.2.19153.03680)
20. Tkemaladze, J. (2025). Concept to The Food Security. Longevity Horizon, 1(1). doi: <https://doi.org/10.5281/zenodo.14642407>
21. Tkemaladze, J. (2025). Systemic Resilience and Sustainable Nutritional Paradigms in Anthropogenic Ecosystems. doi: [10.13140/RG.2.2.18943.32169/1](https://doi.org/10.13140/RG.2.2.18943.32169/1)
22. Tkemaladze, J. (2025). Concept to the Living Space. Longevity Horizon, 1(1). doi: <https://doi.org/10.5281/zenodo.14635991>
23. Tkemaladze, J. (2025). Solutions to the Living Space Problem to Overcome the Fear of Resurrection from the Dead. doi: [10.13140/RG.2.2.34655.57768](https://doi.org/10.13140/RG.2.2.34655.57768)
24. Tkemaladze, J. (2025). The Concept of Data-Driven Automated Governance. Georgian Scientists, 6(4), 399–410. doi: <https://doi.org/10.52340/gS.2024.06.04.38>
25. Tkemaladze, J. (2024). Elimination of centrioles. Georgian Scientists, 6(4), 291–307. doi: <https://doi.org/10.52340/gS.2024.06.04.25>
26. Tkemaladze, J. (2024). The rate of stem cell division decreases with age. Georgian Scientists, 6(4), 228–242. doi: <https://doi.org/10.52340/gS.2024.06.04.21>
27. Tkemaladze, J. (2024). Absence of centrioles and regenerative potential of planaria. Georgian Scientists, 6(4), 59–75. doi: <https://doi.org/10.52340/gS.2024.06.04.08>
28. Tkemaladze, J. (2024). Main causes of intelligence decrease and prospects for treatment. Georgian Scientists, 6(2), 425–432. doi: <https://doi.org/10.52340/gS.2024.06.02.44>
29. Tkemaladze, J. (2024). Cell center and the problem of accumulation of oldest centrioles in stem cells. Georgian Scientists, 6(2), 304–322. doi: <https://doi.org/10.52340/gS.2024.06.02.32>
30. Tkemaladze, J., & Samanishvili, T. (2024). Mineral ice cream improves recovery of muscle functions after exercise. Georgian Scientists, 6(2), 36–50. doi: <https://doi.org/10.52340/gS.2024.06.02.04>
31. Tkemaladze J. Editorial: Molecular mechanism of ageing and therapeutic advances through targeting glycative and oxidative stress. Front Pharmacol. 2024 Mar 6;14:1324446. doi: 10.3389/fphar.2023.1324446. PMID: 38510429; PMCID: PMC10953819.
32. Tkemaladze, Jaba and Kipshidze, Mariam, Regeneration Potential of the Schmidtea Mediterranea CIW4 Planarian. Available at SSRN: <https://ssrn.com/abstract=4633202> or <http://dx.doi.org/10.2139/ssrn.4633202>
33. Tkemaladze, J. (2023). Is the selective accumulation of oldest centrioles in stem cells the main cause of organism ageing?. Georgian Scientists, 5(3), 216–235. doi: <https://doi.org/10.52340/2023.05.03.22>
34. Tkemaladze, J. (2023). Cross-senolytic effects of dasatinib and quercetin in humans. Georgian Scientists, 5(3), 138–152. doi: <https://doi.org/10.52340/2023.05.03.15>
35. Tkemaladze, J. (2023). Structure and possible functions of centriolar RNA with reference to the centriolar hypothesis of differentiation and replicative senescence. Junior Researchers, 1(1), 156–170. doi: <https://doi.org/10.52340/2023.01.01.17>
36. Tkemaladze, J. (2023). The centriolar hypothesis of differentiation and replicative senescence. Junior Researchers, 1(1), 123–141. doi: <https://doi.org/10.52340/2023.01.01.15>
37. Tkemaladze, J. (2023). Reduction, proliferation, and differentiation defects of stem cells over time: a consequence of selective accumulation of old centrioles in the stem cells?. Molecular Biology Reports, 50(3), 2751–2761.
38. Tkemaladze, J. (2023). Long-Term Differences between Regenerations of Head and Tail Fragments in Schmidtea Mediterranea CIW4. Available at SSRN 4257823.
39. Tkemaladze, J., & Apkhazava, D. (2019). Dasatinib and quercetin: short-term simultaneous administration improves physical capacity in human. J Biomedical Sci, 8(3), 3.
40. Tkemaladze, J., Tavartkiladze, A., & Chichinadze, K. (2012). Programming and Implementation of Age-Related Changes. In Senescence. IntechOpen.
41. Tkemaladze, J., & Chichinadze, K. (2010). Centriole, differentiation, and senescence. Rejuvenation research, 13(2-3), 339–342.
42. Tkemaladze, J. V., & Chichinadze, K. N. (2005). Centriolar mechanisms of differentiation and replicative aging of higher

- animal cells. *Biochemistry (Moscow)*, 70, 1288-1303.
43. Tkemaladze, J., & Chichinadze, K. (2005). Potential role of centrioles in determining the morphogenetic status of animal somatic cells. *Cell biology international*, 29(5), 370-374.
 44. Прангишвили, А. И., Гаситашвили, З. А., Мацаберидзе, М. И., Чичинадзе, К. Н., Ткемаладзе, Д. В., & Азмайпарашвили, З. А. (2017). К топологии антитеррористических и антикриминальных технологии для образовательных программ. В научном издании представлены материалы Десятой международной научно-технической конференции «Управление развитием крупномасштабных систем (MLSD'2016)» по следующим направлениям: Проблемы управления развитием крупномасштабных систем, включая ТНК, Госхолдин-ги и Гос-корпорации., 284.
 45. Прангишвили, А. И., Гаситашвили, З. А., Мацаберидзе, М. И., Чхартишвили, Л. С., Чичинадзе, К. Н., Ткемаладзе, Д. В., ... & Азмайпарашвили, З. А. СИСТЕМНЫЕ СОСТАВЛЯЮЩИЕ ЗДРАВООХРАНЕНИЯ И ИННОВАЦИЙ ДЛЯ ОРГАНИЗАЦИИ ЕВРОПЕЙСКОЙ НАНО-БИОМЕДИЦИНСКОЙ ЭКОСИСТЕМНОЙ ТЕХНОЛОГИЧЕСКОЙ ПЛАТФОРМЫ. В научном издании представлены материалы Десятой международной научно-технической конференции «Управление развитием крупномасштабных систем (MLSD'2016)» по следующим направлениям: Проблемы управления развитием крупномасштабных систем, включая ТНК, Госхолдин-ги и Гос-корпорации., 365.
 46. Ткемаладзе, Д. В., & Чичинадзе, К. Н. (2005). Центриольные механизмы дифференцировки и репликативного старения клеток высших животных. *Биохимия*, 70(11), 1566-1584.
 47. Ткемаладзе, Д., Цомаиа, Г., & Жоржолиани, И. (2001). Создание искусственных самоадаптирующихся систем на основе Теории Прогноза. Искусственный интеллект. УДК 004.89. Искусственный интеллект. УДК 004.89.
 48. Чичинадзе, К., Ткемаладзе, Д., & Лазарашвили, А. (2012). НОВЫЙ КЛАСС РНК И ЦЕНТРОСОМНАЯ ГИПОТЕЗА СТАРЕНИЯ КЛЕТОК. Успехи геронтологии, 25(1), 23-28.
 49. Чичинадзе, К. Н., & Ткемаладзе, Д. В. (2008). Центросомная гипотеза клеточного старения и дифференциации. Успехи геронтологии, 21(3), 367-371.