Wah Academia Journal of Society, Culture and Policy 1-2 (September, 2026) 29 - 36

WAJSCP

https://wajscp.com/index.php/journal/index

WAH ACADEMIA
JOURNAL OF SOCIETY, CULTURE AND POLICY

Original Article

Assessing English Phonological Accuracy Across LLM-Based Chatbots

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Article Info

Article history:

Received 7 Jul 2026

Received in revised form

17 Sep 2026

Accepted 19 Sep 2026

Available online 30 Sep 2026

Keywords: English Phonology, Generative Phonology, Language Learning Technology

Abstract

English is the most widely spoken language of the time. Thus, learners, regardless of language backgrounds, increasingly seek at least basic proficiency in it. Since spoken English is its most common form of use, understanding its phonological features and processes proves indispensable. With the growing use of machines for linguistic exercises, large language model (LLM)-based chatbots have become popular tools for language learning. However, their phonological accuracy has received limited scholarly attention. This study, therefore, investigates the accuracy of selected LLM-based chatbots across specific phonological features and examines systematic patterns of errors in their outputs. Using a descriptive qualitative research method, grounded in Chomsky and Halle's (1968) Generative Phonology, a total of 71 responses from each of six notable LLM-based chatbots were purposively sampled and thematically analyzed. Findings reveal that the chatbots demonstrate high competence in English phonology but lack complete reliability. Given the chatbots' dissimilar levels of competence, Claude achieves the best overall performance, while Copilot records the lowest. Although the sampled chatbots generate outputs that apply underlying phonological rules, their inaccuracies indicate limitations in consistently representing abstract phonological structures. The researcher thus recommends cautious use of chatbots' phonological outputs and regular improvement of training data by developers. In all, the study provides insights for users of the sampled chatbots learning English phonology and for developers seeking to improve the phonological accuracy and reliability of these systems.

Introduction

Learning English is an active process in the 21st century. According to Destari and Anis (2026, p. 157) note, English is now perceived as "a medium for participation in global discourse, intercultural interaction, and knowledge exchange." Everybody wants to attain a basic fluency in its use, especially in reading, speaking, listening (and understanding) and writing. However, in the digital age where machines and gadgets perform many household and office chores, language acquisition has also been revolutionized (Tsvetkova, 2025, p. 129). Chatbots are particularly deployed in this learning context. As evidence of this, Annamalai et. al. (2023, p. 6) confirm that "learners are satisfied with the gratification provided by educational Chatbots."

These chatbots are designed to replicate human intelligence (Abd-El-Salam & Youssef, 2026, p. 3) and therefore are trained for thorough productivity. Chatbots are in sizes, each performing according to its capacity, training it receives, and data it is fed. Thus, the most popular chatbots of the time are powered by language models (LMs). These LMs are in small, medium and large sizes (Zhou, 2025, p. 83). The large language model-based chatbots are the most efficient in language learning and are thus preferred by linguists, language learners and academics. Highlighting the role of large language models in chatbots, Dam et al. (2024, p. 1) affirm that "LLMs have become instrumental in powering their conversational capabilities and facilitating human-like interactions."

According to Arslan and Karaca (2025, p. 85), "LLMs are developed through training on various datasets at different stages." Given the inefficiencies of LLM-based chatbots, particularly those resulting from their training data and probabilistic language generation, users encounter inconsistencies in their linguistic outputs when these systems are deployed in language learning. Thus, Panagiotidis (2024, p. 114) proposes that "ways should be sought to reduce biased information to exclude the possibility of returning false answers." Given the importance of mastering the phonological aspect of English especially in a nonnative environment or an independent class without

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https://doi.org/10.63954/d6ypgd41
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a teacher, students engage LLM-based chatbots in deciphering the complexities of English Phonology, but however, get unsatisfactory or incorrect responses sometimes. Xiao et al. (2024, p. 1) identified "the potential reinforcement of biases and stereotypes" among the obstacles. This is not so surprising, as chatbots and their versions differ in functions, and these are improved over time.

Gutiérrez (2023, p. 188) notes that ChatGPT's responses are inaccurate sometimes, and that "99% of AI-powered chatbots are currently only capable of answering simple questions." Given the possibility of getting incorrect responses on prompts given to chatbots to address English phonological instructions, this study has the following objectives:

i. To evaluate the phonological accuracy of LLM-based chatbots in English across segmental, phonotactic, and stress-related features.
ii. To identify and analyze systematic patterns of phonological errors in the chatbots' outputs.

Review of the Literature

❖ **English Phonology**

Phonology is the systematic study of the sound system of a language. Crystal (2018, p. 248) adds that the study includes the general properties of such systems. The word 'phonology' originated from the two Greek words Phōnē (meaning sound, voice, or speech) and Logia (meaning the study of). According to Yule (2023, p. 104), "Phonology is concerned with the abstract or mental aspect of the sounds in language rather than with the actual physical articulation of speech sounds." English Phonology examines English phonemes (the smallest contrastive units of sound), allophones (variant pronunciations of phonemes that do not alter meaning), syllable structure (how words are grouped into syllables), stress (the prominence placed on syllables), intonation (the rise and fall of the voice), phonotactics (the rules governing possible sound combinations), and other phonological processes. Herawani and Dewanti (2026, p. 3) emphasize that Phonology involves identifying "the sounds that do not occur in that language."

According to Carley et al. (2018, p. 33), "When learning to pronounce a new language…the most important sounds are the ones that can change the meaning of words." Given the importance of clarity in spoken discourse, learners of English seek to understand the basic aspects of English phonology to improve their knowledge, spoken fluency, and mutual intelligibility. Similarly, Coupé et al. (2009, p. 143) note that "phonological systems are randomly composed," indicating that languages possess distinct sound systems that may create challenges for non-native speakers. Consequently, owing to differences between languages and the influence of mother-tongue interference, learners often struggle to grasp the concepts and complexities of English phonology. Kelly (2000, p. 4) notes that "we can learn to use our speech organs in new ways in order to produce learnt sounds in a foreign language, or to lose sounds from our own language which are not appropriate in the foreign language," although this ability diminishes after childhood. For instance, an English sound that does not exist in a non-native speaker's language may prove difficult to produce accurately. Similarly, Crystal (2018, p. 380) observes that "The most noticeable feature of the English spoken throughout South Asia is its syllabic rhythm...which can be a source of comprehension difficulty for those used to a stress-timed variety, especially when speech is rapid." The same is the case with a speaker whose language is syllable-timed trying to be fluent in English, which is stress-timed. Thus, accents and phonological backgrounds interfere with speakers' phonological output.

Article Highlights

- Purpose: Tests six LLM chatbots' accuracy in English phonology (segmental, phonotactic, stress features) and identifies error patterns.
- Method: Qualitative study grounded in Generative Phonology; 71 responses sampled from each of six chatbots.
- Performance: Chatbots showed high but imperfect accuracy; Claude best (98.59%), Copilot worst (76.06%).
- Errors: Systematic, not random—favor American English, confuse spelling with sound, rely on training-data patterns.
- Conclusion: Chatbot phonology is probabilistic, not fully rule-governed; use outputs with caution.

However, high fluency in spoken English is attainable through careful study of correct English pronunciation, attentive listening, and regular speaking practice. In this regard, Yanush (2025, p. 58) notes that "as students become more comfortable with what they know, they can pay closer attention to the quality of what they are using." Such increased attention to language quality facilitates phonological accuracy, whereby sounds (phonemes) are produced correctly, stress is placed on the appropriate syllables, and the appropriate intonation is used. Phonological accuracy can be contrasted with phonological models, whereby speakers have the option of mastering native-speaker standards or adapting to interlocutors or the immediate context.

❖ **Components of English Phonology**

The phonological inventory of English varies across regional varieties. As Salmanova (2026, p. 197) observes, "The late twentieth and early twenty-first centuries have witnessed significant phonological change in many varieties of English." Specifically, Standard British English (Received Pronunciation, RP) comprises approximately 44 phonemes whereas General American (GA) consists of about 39. Each comprises approximately 24 consonants. As Dabouis (2026, p. 4) notes, "Vowels are significantly more variable across varieties than consonants." While RP comprises approximately 20 vowels, GA consists of approximately 15. The 24 consonants include /b/, /d/, /f/, /g/, /h/, /k/, /l/, /m/, /n/, /p/, /ɹ/, /s/, /t/, /v/, /w/, /z/, /ŋ/, /ʃ/, /tʃ/, /ʒ/, /θ/, /ð/, /j/, and /dʒ/. Other dialects, including their sound systems, may also "emerge as standard, owing to the size and influence of the users" (Ndububa, 2025d, p. 7).

The vowels further comprise twelve monophthongs (single sounds) and eight diphthongs (pairs of vowels produced as one sound in a syllable). In RP, the monophthongs include /æ/, /aː/, /ə/, /ʌ/, /ɒ/, /ɔː/, /e/, /ɜː/, /ɪ/, /iː/, /ʊ/, and /uː/, while the diphthongs are /aʊ/, /aɪ/, /eɪ/, /ɔɪ/, /əʊ/, /eə/, /ɪə/, and /ʊə/. However, Wells (2019, p. vii) argues that "the existing descriptions of standard British English pronunciation, known as RP, are outdated." General American lacks the centring diphthongs /ɪə/, /eə/, and /ʊə/, but instead treats them as vowels followed by the rhotic consonant /ɹ/. GA also includes rhotic vowels such as /ɝ/ and /ɚ/, to reflect its rhotic pronunciation. There are also triphthongs, which are generally analyzed as specific diphthongs combined with a schwa (/ə/). The triphthongs include /aɪə/ as in fire, /ɔɪə/ as in lawyer, /aʊə/ as in hour, /eɪə/ as in player, and /əʊə/ as in lower.

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According to Ambalegin (2026, p. 61) "Different phonemes are different categories of sounds." Failure to produce or identify these sounds (phonemes) results in pronunciation or segmental errors, such as omitting a sound, as in pronouncing ask the same way as axe, or adding a sound, such as pronouncing the w in allowance. Problems with identifying phonemic symbols may also result in incorrect phonemic transcription of words, which is a common difficulty encountered by language students. Some phonemes sound alike or have similar articulatory features. Dabouis (2026, p. 4) confirms that "Vowels are significantly more variable across varieties than consonants." Although learners may encounter challenges in familiarizing themselves with phonemes and contrasting them, Merrita et al. (2026, p. 331) emphasize that "learners must improve their pronunciation competence to enhance their communicative and speaking abilities." Regular engagement in phonemic transcription, interpretation, and practice will, however, address these challenges.

Creating possible English syllables and words follows a set of phonological rules. This is called phonotactics. The rules guide the formation and combination of phonemes into syllables. Ambalegin (2026, pp. 62 - 63) explains some other rules which often function to simplify pronunciation.

In English phonotactics, certain combinations are permissible, while others are not. For instance, the phonemes /s/ + /t/ + /r/ can be combined in a syllable, as in strong /strɒŋ/. However, the phonemes /b/ + /k/ + /v/ cannot be combined in a syllable. English phonotactics also governs how sounds are positioned within a syllable. This also determines how many vowels or consonants may occur in the initial, medial, or final positions of a syllable. As Fromkin (2017, p. 249) explains, "phonological rules exist to ensure that the surface or phonetic forms of words do not violate phonotactic constraints." Thus, while English allows a cluster of up to three consonants in the initial position of a syllable, as in strong /strɒŋ/ and stray /streɪ/, it does not allow four consonants to cluster in the initial position. Additionally, English commonly allows a cluster of up to four consonants in the word-final position, as in junction /dʒʌŋkʃn/, prompts /prɒmpts/, texts /teksts/, and twelfths /twelfθs/. In the medial position of words or syllables, there may be clusters of up to four or five consonants, as in bedspread, campground, promptness, spendthrift, and temptress, each of which has four word-medial consonant clusters, and in compound words such as single-breasted and single cream, which have five medially clustered consonants.

Another significant component of English Phonology is the suprasegmental features (also called prosodic features). These are features that affect syllables, words, phrases, or utterances. They are called suprasegmental because they "normally stretch over more than a single segment – possibly a syllable, a complete word or phrase, whole sentences, or even more" (Collins and Mees, 2013, p. 129). Stress is a significant suprasegmental feature. In English Phonology, syllables are stressed according to a fixed set of rules, although there are exceptions. Ali suffixes or word endings often determine the stress patterns of most English words, they "may or may not affect the stress pattern of their base" (Dabouis, 2026, p. 9).

Intonation is another prosodic feature that contributes to meaning, just as stress does. While stress operates at the syllable level, intonation operates at the utterance level. According to Wells (2006, p 11), "The most obvious role of intonation is to express our attitude and emotions." There are two main intonation patterns: falling and rising. Of these, falling intonation is the more common pattern as it is used in most everyday utterances. Sentences that typically take falling intonation include imperatives, declaratives, wh-questions, and statement-like interrogatives. Rising intonation is mostly used when asking for confirmation or a response from the interlocutor, as in polar (yes/no) questions, tag questions, and listings. Interestingly, Yule (2023, p. 528) notes that "the use of rising intonation at the end of statements has been described as an aspect of gendered speech attributed to women in the United States."

❖ Large Language Models and Chatbot Performance

In the digital age, learning is facilitated by computers and smart devices. AI tools are at the forefront of this technological advancement. Given chatbots' ability to "simulate human-like conversations, provide immediate feedback, and facilitate continuous learning beyond the classroom" (Rasmita et al., 2026, p. 170), users increasingly employ them for academic studies and intellectual activities. This is fostered by the pre-training and regular updates of the chatbots by their developers. Chatbots are powered by language models which serve as the engines of their linguistic performance. Language models (LMs), Panagiotidis (2024, p. 106) notes, are "trained to perform probability distributions on words, which enables them to understand and generate human language." The various sizes of LMs (small, medium, and large) and their distinctive components determine the level of efficiency and performance of chatbots. More specifically, Arslan and Karaca (2024, p. 74) explain that the ability of Large Language Models to conduct in-depth analyses determines their language comprehension capabilities. Building on these advancements, Dam et al. (2024, p. 1) note, "LLM-based chatbots have set new standards in the AI community." Consequently, they have become among the most popular chatbot systems today. Among them are ChatGPT, Gemini, Copilot, Perplexity, Grok, Claude, etc.

Despite the impressive and often brilliant responses generated by large language model-based chatbots, they have weaknesses, which are traced to the quality and size of the data on which the language models are pre-trained. According to Arslan and Karaca (2025, p. 84), "LLMs acquire cross-linguistic understanding and contextual knowledge primarily from the datasets on which they are trained." The data may be insufficient, inaccurate, or biased, leading to unasked-for responses. However, other factors, such as user prompts, fine-tuning, external knowledge access, and developer policies, also shape chatbot responses.

Two key players in the development of these chatbots are the programmers and the users (Ndububa and Ugoala, 2025c). The programmers design and pre-train them with data and may update the pre-training data from time to time. According to Dam et al. (2026, p. 14), "Chatbots' responses are shaped by the input they receive. This involves providing additional information to help chatbots adapt to users' preferences. This is also called fine-tuning. Chat context and user prompts also play significant roles in fine-tuning chatbots (Ndububa and Ugoala, 2025b).

Large Language Model-based Chatbots and English Phonology

Large Language Models are powerful linguistic tools whose efficiency depends on their size and capacity (parameters). As Arslan and Karaca (2025, p. 86) note, "A larger number of parameters enable models to achieve superior results in language understanding, reasoning, and various tasks." Consequently, chatbots powered by these models play significant roles in language-related studies and tasks. As such, users engage them in language learning and translation. However, chatbots excel only in languages on which their underlying language models have been trained and may fail or hallucinate when handling linguistic tasks involving languages for which they lack adequate training. As Xi

et al. (2023, p. 13) caution, "LLMs may generate content that conflicts with the source or factual information."

According to Panagiotidis (2024, p. 107), "When properly trained on multilingual data, LLMs can handle and produce text in multiple languages." Owing to their models' extensive exposure to English, LLM-based chatbots thus support numerous aspects of English language learning and teaching (Mahmud, 2026, p. 114), including English phonology. They can answer questions, identify, transcribe, and interpret phonemic symbols, as well as perform a wide range of other phonological tasks. Rasmita et al. (2026, p. 169) notes that the chatbots achieve these through "creating more interactive and student-centered learning environments."

Theoretical Framework

This study is grounded in Generative Phonology (GP) by Noam Chomsky and Morris Halle (1968). GP assumes that underlying representations (phonemic or abstract forms) are transformed by systematic phonological rules into surface representations (phonetic forms). Generative Phonology also explains acceptable combinations of sounds in English and rules that guide stress placement. These rules are considered to determine whether the investigated chatbots address the study objectives. Noting that phonological phenomena are systematic rather than random, Chomsky and Halle (1968, p. 60) affirm that "Any ambiguity or inexplicitness in the statement of rules must in principle be eliminated." Thus, chatbots' phonological representations must unambiguously follow established English phonological patterns.

According to Al-Hindawi and Al-Aadili (2018, p. 7), "generative phonology is well-known because it has become a standard theory against which most other work in phonology has been measured and evaluated." Although GP has strengths that support this study, it also has weaknesses. These include paying less attention to speech production and perception, as it primarily focuses on abstract representations and rules. It is also unable to explain how chatbots generate responses since it is a linguistic theory rather than an artificial intelligence theory. However, despite these weaknesses, this theory is best suited to this study because it helps determine whether the phonological information produced by chatbots is accurate according to English phonology.

Methodology

This study adopts a descriptive qualitative research design which is considered most appropriate for assessing and describing data. The sampled LLM-based chatbots (ChatGPT, Claude, Copilot, Gemini, Grok and Perplexity) were selected because of their popularity. Default versions of the chatbots were used as these are the versions first available to users. The following are the versions of the sampled chatbots: ChatGPT (version 1.2026.181(6), based on GPT-5.5), Claude Sonnet 5 (version 1.260625.30(26062530)), Copilot Smart (version 30.0.440630001(440630001)), Gemini 3.5 Flash, Grok 4.3, and Perplexity (version 2.91.1).

The chatbots were given the same prompts and under the same conditions for consistency and fairness. The prompts were purposively designed and to support accurate interpretation by the chatbots. The chatbots were tested on the segmental, phonotactic, and stress-related features of English phonology. For the segmental aspect, the chatbots were prompted to provide IPA phonemic transcriptions, represent syllabic consonants, and identify silent letters. To assess their knowledge of English phonotactics, the chatbots were required to produce specific consonant clusters based on structure and position. To test their competence in English stress-related features, the chatbots were requested to assign primary stress, place word stress, and interpret emphatic stress.

Data Presentation and Analysis

In this section, the sampled chatbots' responses are thematically and purposively presented in tables exactly as generated. The chatbots are listed alphabetically rather than according to significance. Incorrect responses are starred for emphasis. Data analysis follows the study objectives and theoretical framework.

Table 1. British Phonemic Transcriptions of Words with Syllabic Consonants Produced by Chatbots

Test Item	ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
needle	/ˈniːdl/	/ˈniːdl/	/ˈniː.dl/	/ˈniːdl/	/ˈniː.dəl/	/ˈniːdəl/
metal	/ˈmetl/	/ˈmetl/	/ˈmet.əl/	/ˈmetl/	/ˈmet.əl/	/ˈmetəl/
table	/ˈteɪbl/	/ˈteɪbl/	/ˈteɪ.bl/	/ˈteɪbl/	/ˈteɪ.bəl/	/ˈteɪbəl/
button	/ˈbʌtn/	/ˈbʌtn/	/ˈbʌt.n/	/ˈbʌtn/	/ˈbʌt.ən/	/ˈbʌtən/
lesson	/ˈlesn/	/ˈlesn/	/ˈles.ən/	/ˈlesn/	/ˈles.ən/	/ˈlesən/
listen	/ˈlɪsn/	/ˈlɪsn/	/ˈlɪs.ən/	/ˈlɪsn/	/ˈlɪs.ən/	/ˈlɪsən/

The chatbots were prompted to transcribe the six words listed under the 'Test Item' column. The final syllables of the words contain syllabic consonants in standard British English pronunciation. This means that the final syllable is produced with a consonant functioning as its syllable nucleus instead of with an intervening vowel. However, syllabic consonants are more commonly represented in the phonemic transcription conventions of standard British English. Although such consonants are also realized in many American English varieties, American dictionaries often phonemically transcribe them with an accompanying schwa. ChatGPT, Claude, and Gemini correctly represented the syllabic consonants, whereas Grok and Perplexity did not, inserting a schwa (ə) before the final consonant.

Copilot shows inconsistent observation of the syllabic consonants. Thus, it represented needle, table, and button without schwas, while inserting schwas in the transcriptions of the other three words. Consequently, Grok and Perplexity seem to favour transcription conventions commonly associated with American English in this task.

Table 2. Chatbot Responses to the /bj/ Consonant Cluster Elicitation Task

ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
beauty	beauty	beauty	Beautiful	beauty	beauty
beautiful	beautiful	beautiful	Bureau	beautiful	bureau
beautify	bureau	bureau	Billion ★	bureau	bugle
bugle	tribute	buoyant ★	Bugle	bureaucracy	butane
bureau	abuse	buyer ★	Rebuke	butane	beautiful
buick	fabulous	beyond ★	Ambulance	bijou ★	bewail ★

The chatbots were prompted to list six English words in which the consonant /j/ immediately follows the consonant /b/. ChatGPT and Claude performed this task excellently, making no mistakes in any of their examples. Copilot's first three examples, as listed vertically, are correct, while its last three examples are incorrect. Looking at the following transcriptions of Copilot's last three words: /ˈbɔɪənt/ (buoyant), /ˈbaɪə/ (buyer), and /bɪˈjɒnd/ (beyond), the /bj/ sequence does not occur in any of them. Gemini, Grok, and Perplexity each gave one incorrect example. Gemini's example, billion /ˈbɪljən/, lacks the /bj/ sequence, as do Grok's bijou /ˈbiːʒuː/ and Perplexity's bewail /bɪˈweɪl/.

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Table 3. Chatbot Responses to the Word-Medial Four-Consonant Phoneme Cluster Identification and Transcription Task

ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
extra	abstract	glimpse	abstract	abstract	extra
extreme	instruct	handstand	substrate	extra	textual ★
gangster	explore	lengths ★	exclaim	explain	handgrip
youngster	landscape	promptly	handspring	instruct	longsword ★
angstrom	angstrom	twelfths ★	windscreen	handspring	kiln-dried
textbook	hamstring	angsts ★	angstrom	temptress	sandstorm

The chatbots were requested to list six structurally varied English words, each containing a word-medial cluster of four consecutive consonant phonemes (not merely four consecutive consonant letters). They were also prompted to provide the phonemic transcription of each word to further draw their attention to their examples. This task was meant to test the chatbots' awareness of English phonotactics. All the chatbots except Copilot and Perplexity responded perfectly. According to Copilot's examples, glimpse /ɡlɪmps/ does not contain the requested word-medial consonant cluster. Both its initial and final consonant clusters also fall short of the required four-consonant cluster. Lengths /leŋkts/, twelfths /twelfθs/, and angsts /æŋsts/ contain the required four-consonant cluster, but in word-final rather than word-medial positions. Perplexity's example textual /ˈtekstʃuəl/ is incorrect. This is because the chatbot may have counted /tʃ/ as two sounds, whereas the two symbols together represent a single sound. Perplexity's longsword /lɒŋsɔːd/ contains only two consonants clustered medially, rather than the required four.

Table 4. Chatbot Responses to the Word-Final Four-Consonant Phoneme Cluster Identification and Transcription Task

ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
sixths	texts	texts	sixths	texts	twelfths
twelfths	glimpsed	sixths	glimpsed	glimpsed	sixths
texts	twelfths	twelfths	twelfths	sixths	texts
prompts	prompts	angsts	sculpts	twelfths	glimpsed
tempts	thousandths	prompts	prompts	attempts	prompts
glimpsed	sixths	lengths	angsts	prompts	thousandths

Similar to the prompt that elicited the results presented in Table 3 to test the chatbots' phonotactic competence in English, each chatbot was once again prompted to list six structurally varied English words containing a word-final cluster of four consecutive consonant phonemes (not merely four consecutive consonant letters). This time, all the chatbots responded correctly, as shown in the table above.

Table 5. Chatbots' IPA Phonemic Transcriptions and Primary Stress Assignments for Selected English Words (I)

Test Item	ChatGPT	Claude	Copilot
politician	/ˌpɒləˈtɪʃən/	/ˌpɒlɪˈtɪʃən/	/ˌpɒlɪˈtɪʃən/
economy	/ɪˈkɒnəmi/	/ɪˈkɒnəmi/	/ɪˈkɒnəmi/
university	/ˌjuːnɪˈvɜːsəti/	/ˌjuːnɪˈvɜːsəti/	/ˌjuːnɪˈvɜːsɪti/
examination	/ɪɡˌzæmɪˈneɪʃən/	/ɪɡˌzæmɪˈneɪʃən/	/ɪɡˌzæmɪˈneɪʃən/
photograph	/ˈfəʊtəɡrɑːf/	/ˈfəʊtəɡrɑːf/	/ˈfəʊtəɡrɑːf/
photographer	/fəˈtɒɡrəfə/	/fəˈtɒɡrəfə/	/fəˈtɒɡrəfə/
photographic	/ˌfəʊtəˈɡræfɪk/	/ˌfəʊtəˈɡræfɪk/	/ˌfəʊtəˈɡræfɪk/
photography	/fəˈtɒɡrəfi/	/fəˈtɒɡrəfi/	/fəˈtɒɡrəfi/
blackbird	/ˈblækbɜːd/	/ˈblækbɜːd/	/ˈblækbɜːd/
greenhouse	/ˈɡriːnhaʊs/	/ˈɡriːnhaʊs/	/ˈɡriːnhaʊs/
toothpaste	/ˈtuːθpeɪst/	/ˈtuːθpeɪst/	/ˈtuːθpeɪst/
school bus	/ˈskuːl bɔːd/	/ˈskuːl bɔːd/	/ˈskuːl bɔːd/

This table presents the results of three of the six chatbots. This is to allow wider columns for the transcriptions without unnecessary line breaks. Thus, the results of the other three chatbots are presented next.

The above table shows the chatbots' responses to a prompt requesting them to provide the phonemic transcriptions of the words listed in the 'Test Item' column. This test was meant to examine the chatbots' ability to assign stress to the correct syllables. The second group of test items (in the third/penultimate row), which are derivatives of photograph, was introduced to determine whether the chatbots could shift their stress placement accordingly, given that all four words have different stress patterns. The last set of words (in the fourth/last row) was meant to determine whether the chatbots could distinguish compounds from phrases by assigning their stress patterns accurately.

All three chatbots whose results are presented above correctly transcribed the words and assigned stress accordingly. However, there are influences of regional varieties of English in the results. For instance, ChatGPT weakens the second vowel in political by using a schwa /ə/, whereas Copilot and Claude do not. Both phonological renderings are acceptable, as the vowel lies somewhere between a schwa and the kit-vowel, but this may confuse beginning linguists. Additionally, Copilot weakens the fourth vowel in university, which the other two chatbots do not.

Table 6. Chatbots' IPA Phonemic Transcriptions and Primary Stress Assignments for Selected English Words (II)

Test Item	Gemini	Grok	Perplexity
politician	/ˌpɑlɪˈtɪʃən/	/ˌpɒl.ɪˈtɪʃ.ən/	/ˌpɑːlɪˈtɪʃən/
economy	/ɪˈkɑnəmi/	/ɪˈkɒn.ə.mi/	/ɪˈkɑːnəmi/
university	/ˌjunɪˈvɜrsəti/	/ˌjuː.nɪˈvɜː.sə.ti/	/ˌjuːnɪˈvɜːrsəti/
examination	/ɪɡˌzæmɪˈneɪʃən/	/ɪɡˌzæm.ɪˈneɪ.ʃən/	/ɪɡˌzæmɪˈneɪʃən/
photograph	/ˈfoʊtəˌɡræf/	/ˈfəʊ.tə.ɡrɑːf/	/ˈfoʊtəɡræf/
photographer	/fəˈtɑɡrəfər/	/fəˈtɒɡ.rə.fə/	/fəˈtɑːɡrəfər/
photographic	/ˌfoʊtəˈɡræfɪk/	/ˌfəʊ.tə'ɡræf.ɪk/	/ˌfoʊtəˈɡræfɪk/
photography	/fəˈtɑɡrəfi/	/fəˈtɒɡ.rə.fi/	/fəˈtɑːɡrəfi/
blackbird	/ˈblækbɜrd/	/ˈblæk.bɜːd/	/ˈblækbɜːrd/
greenhouse	/ˈɡrinˌhaʊs/	/ˈɡriː.haʊs/	/ˈɡriːnhaʊs/
toothpaste	/ˈtuθˌpeɪst/	/ˈtuːθ.peɪst/	/ˈtuːθpeɪst/
school board	/ˈskulˌbɔrd/	/ˈskuːl.bɔːd/	/ˈskuːlˌbɔːrd/

This table shows the results of the above-mentioned chatbots. The same prompt that elicited the results in Table 5 was also used. According to Table 6, all three chatbots, unlike ChatGPT in Table 5, do not weaken the second vowel in politician. The chatbots here weaken the fourth vowel in university, unlike Copilot in Table 5.

Gemini and Perplexity show a tendency to incline towards American English, just as Grok and Perplexity in Table 1. As such, Gemini and Perplexity use the American symbols for the goat-vowel in photograph and photographic. They also use American rhotic vowels in university, photographer, blackbird, and school board.

Grok breaks words into syllables using dots, which the other chatbots do not do. However, when syllable division by dots coexists with secondary stress marking, the dotting is sometimes prioritized over the stress marker, which is thus omitted. This is evident in the transcriptions of the compound words, where the first syllable of the second word should bear secondary stress.

Table 7. Chatbots' Responses to the Four-Syllable English Word Stress Placement Task

Test Item	ChatGPT	Claude	Copilot
First Syllable	category, ceremony, military, testimony	CATegory, NECessary, LITerature ★, APplicable	Beautifully, Dangerously, Wonderful ★, Excellent ★
Second Syllable	analysis, dependent ★, astonishing, accompany	parTICular, conSIDerate, enVIRonment, sigNIFicant	Computer ★, Disaster ★, Reminder ★, Delicious ★
Third Syllable	independent, entertainment, disagreeing, understandable ★	enterTAINment, popuLAtion, geneRAtion, disagreeMENT	Entertainment, Revolutionary ★, Individual, Opportunity ★

Table 7 shows the chatbots' responses to the instruction to provide twelve four-syllable words, four of which are stressed on the first syllable, another four on the second syllable, and the remaining four on the third syllable.

ChatGPT almost achieved a perfect result but gave one word with three syllables (= dependent) and another with five syllables (= understandable). However, both words have their stress placed as required by the researcher's prompt. Claude gave one incorrect example (= literature). Although the word has stress on the first syllable as requested, it has only three syllables.

Out of the twelve examples, Copilot produced only four correct ones. Although wonderful and excellent are stressed on the first syllable as requested, each has only three syllables. Also, each of computer, disaster, reminder, and delicious has three syllables, although each meets the requirement of bearing stress on the second syllable. Revolutionary has six syllables, while opportunity has five. Both words, however, bear stress on the third syllable.

Table 8. Chatbots' Responses to the Four-Syllable English Word Stress Placement Task

Test Item	Gemini	Grok	Perplexity
First Syllable	CAT-e-gor-y, MEL-an-chol-y, JAN-u-ar-y, AC-cu-ra-cy	Television, Dictionary, Elevator, Caterpillar	ap-pli-ca-ble, char-i-ta-ble, com-for-ta-ble, dic-tion-ar-y
Second Syllable	a-BIL-i-ty, phil-OS-o-phy, en-VI-ron-ment, fo-TOG-ra-phy	Photography, Information ★, Education ★, Introduction ★	ad-ver-tise-ment, par-tic-i-pate, ex-ag-ger-ate, en-deav-or-ing
Third Syllable	ed-u-CA-tion-al ★, un-der-STAND-a-ble ★, ac-a-DEM-ic, en-ter-TAIN-ing	Operation, Constitution, Appreciate ★, Generation	de-mo-crat-ic, pho-to-graph-ic, ex-hi-bi-tion, ap-pli-ca-tion

Table 8 presents the results of the remaining three chatbots on the same prompt given to the chatbots whose results are presented in Table 7. Gemini has two incorrect answers: educational and understandable, although stressed on the third syllable as requested, have five syllables each. Although Gemini neatly breaks the words into syllables, this does not help it count the syllables.

Grok has four incorrect answers. While information, education, and introduction each have four syllables, they are not stressed on the second syllable as Grok indicates but on the third syllable. Appreciate has four syllables, but its stress is on the second syllable.

Perplexity has a perfect result on this task. However, a default style to favour American English manifests again in the representation of 'en-deav-or-ing'

Table 9. Chatbots' Responses to the Silent Letter Identification Task

Test Item	Reference	ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
annihilate	h	h	h	h	h	h	first n ★
asthma	th	h ★	th	th	th	th	t ★
aplomb	b	b	b	b	b	b	b
christmas	t	t	t	t	t	t	t
chez	z	z	z	z	z	z	z
comptroller	p	p	p	mp ★	mp ★	p	p
czar	c	c	c	c	c	c	c
debris	s	s	s	s	s	s	s
drachm	ch	h ★	ch	ch	ch	ch	h ★
faux	x	x	x	x	ux ★	x	x
Greenwich	w	w	w	w	w	w	w
indebted	b	b	b	b	b	b	b
isthmus	th	t ★	th	th	th	th	t ★
muscle	c	c	c	c	c	c	c
ptolemy	p	p	p	p	p	p	p
rendezvous	z,s	zs	z,s	z,s	z,s	z,s	z,s
sandwich	d	d	d	d	d	d	d
silhouette	h	final e ★	h	h	h	h	u ★
yacht	ch	ch	ch	ch	ch	ch	ch

Table 9 shows the chatbots' results on the prompt to identify the silent letters in the words listed under the 'Test Item' column. Only Claude and Grok have flawless answers. ChatGPT gave four incorrect answers out of nineteen.

Copilot almost achieved a perfect result but gave one incorrect answer, noting that both 'm' and 'p' are silent in comptroller. This is incorrect because 'm' is not silent but represents the /n/ sound. Therefore, the assertion that 'm' is silent is misleading. Gemini shares Copilot's view on comptroller and also incorrectly notes that 'u', alongside 'x', is silent in faux, which is likewise a misleading assertion.

Perplexity has the most inaccurate answers on this test. It overlooks the silent letters in annihilate and silhouette and instead identifies the wrong ones, while identifying only one of the two silent letters in asthma, drachm, and isthmus.

Table 10. Chatbots' Responses to Emphatic Stress Interpretation Items

Reference	ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
D	D	D	C ★	D	D	C ★
E	D ★	E	B ★	E	E	C ★
C	D	C	C	C	C	A ★

To further examine the chatbots' proficiency in handling stress-related features, they were prompted to perform the following task:

"Based on emphatic stress, answer this:

1. Emeka DIED on Tuesday.

A. Did Ada die on Tuesday? B. Will Emeka cry on Tuesday? C. Did Emeka die on Wednesday? D. Did Emeka cry on Tuesday? E. Should Emeka die on Wednesday?

2. The man BROUGHT the newspaper

A. Did the woman bring the newspaper? B. Did the man bring a newspaper? C. Did the man bring the magazine? D. Does the man sell the newspaper? E. Did the man forget the newspaper?

3. All the EMPLOYEES rejected him

A. Did some of the employees welcome him? B. Does one of the employees reject him? C. Did all the employers reject him? D. Would all the employees accommodate him? E. Did some of the employers reject him?"

In order to answer the questions, the capitalized word in each statement already bears the stress; therefore, any option in which the word occupying the same position differs from the capitalized word, while the other components of the statement remain unchanged, is the correct answer. The 'Reference' column shows the correct answers. Thus, Claude, Gemini, and Grok had perfect answers. ChatGPT missed one answer, Copilot missed two, while Perplexity missed all three.

Table 11. Chatbots' Performance on English Rhyme Identification

Reference	ChatGPT	Claude	Copilot	Gemini	Grok	Perplexity
B, F	F	F	F	B	F	B

Table 11 presents the chatbots' results when they were given the following prompt:

"Choose the word that most rhymes with MAYOR

A. Mere B. Mare C. May D. Myrrh E. Favor F. Payer"

https://doi.org/10.63954/d6ypgd41
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Given the two acceptable regional pronunciations of the word mayor, in British English phonology, option B (mare) is correct, whereas in American English phonology, option F (payer) is correct. However, as they were not prompted to perform in any particular variety of English, the chatbots presumably responded according to their default language variety.

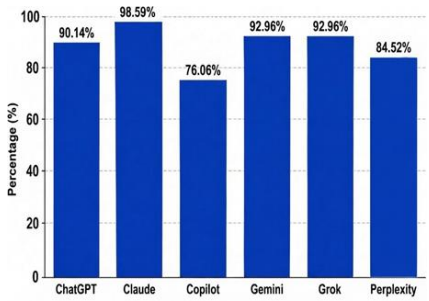

Figure 1. Overall Phonological Accuracy of the Sampled LLM-Based Chatbots

Figure 1 presents a comparative representation of the chatbots' performance on assigned tests. A total of 71 responses were obtained from each chatbot. As marked with asterisks in the tables, ChatGPT produced 7 inaccurate responses, Claude 1, Copilot 17, Gemini and Grok 5 each, and Perplexity 11. The bar chart in Figure 1 illustrates the percentage accuracy of the chatbots' responses.

Findings

The LLM-based chatbots demonstrated different levels of competence in assessed phonological features. Claude achieved the best overall performance. It failed only one phonotactic task while demonstrating advanced competence in segmental and stress-related features.

Gemini's performance declined in producing specific phonotactic patterns and identifying specific segmental features. However, it demonstrated strong competence in stress-related tasks.

Grok performed on a par with Gemini but recorded success in various areas. Its failed tasks revealed reduced accuracy in phonotactics, particularly in producing the requested sequences of sounds, while its performance on segmental and stress-related features was generally successful.

ChatGPT demonstrated a strong performance, although it showed weaknesses in correctly producing specific phonotactic patterns, and partially declined in observing segmental features. It also showed occasional variation in handling stress-related features.

Perplexity achieved an overall strong result, although it failed to produce the expected outcomes across the investigated phonological features. Its greatest inaccuracies occurred in segmental features, although it also demonstrated weaknesses in producing accurate emphatic stress interpretations.

Copilot recorded the least impressive performance, although it still demonstrated considerable accuracy overall. Its major inaccuracies occurred in phonotactic tasks, with partial weaknesses in segmental features and specific stress-related tasks.

In line with the second objective of the study, the findings reveal that the chatbots' errors are mainly systematic rather than random, as they occur in consistent patterns. The patterns of phonological errors were identified as follows. The chatbots show a preference for American English, thereby applying American phonological conventions where British English forms are required. This manifests especially in the representation of rhotacized vowels and in the failure to recognize consonants functioning as syllable nuclei (syllabic consonants).

Another error pattern identified was probabilistic associations, where chatbots' responses reflected patterns in their training data. Thus, chatbots may have encountered examples where consonants typically occur alongside vowels, American English pronunciations are predominant, and many spellings match their pronunciations. Chatbots' responses reflect these patterns.

Additionally, the chatbots show confusion between orthography and phonology. This manifests itself in the treatment of the single consonant /tʃ/ as a double consonant because it comprises two symbols. The reliance on orthographic forms is also evident in the chatbots' treatment of 'm' in comptroller as silent and the insertion of schwa /ə/ before final syllables containing syllabic consonants because the word spelling contains a vowel before the consonant.

Finally, the chatbots show considerable understanding of phonological rules but sometimes make incorrect lexical selections, inaccurate identification of phonotactic environments, inconsistent placement of stress in structurally identical words, and incorrect syllable counting despite accurate syllable division.

Conclusion

The study concludes that sampled LLM-based chatbots demonstrate high competence in English phonology but have yet to attain total phonological reliability. Their phonological competence is probabilistic rather than fully generative. From the perspective of Chomsky's Generative Phonology, the findings establish that the chatbots imitate many human rule-governed phonological processes, which allow them to generate phonological outputs according to underlying phonological rules. However, their inaccuracies imply limitations in consistently representing underlying phonological structures according to Generative Phonology.

Recommendation

This study contributes to research on LLM-based chatbots' performance in English phonology. The findings will be useful to language enthusiasts who engage sampled chatbots in phonological tasks and studies. Chatbot developers and programmers will also benefit from the findings for the necessary upgrade of chatbots' phonological competence.

Given the outcome of the study, the researcher recommends that chatbots' phonological outputs be used with caution, especially for accurate linguistic analysis and instruction. LLM-based chatbot developers should consider more balanced training data for improved phonological accuracy.

Although this study has significant findings and contributions to knowledge, it has gaps for further studies to address. Thus, future research should investigate phonological performance across other languages, language varieties, phonological features, and larger samples of chatbots for a broader understanding of the strengths and weaknesses of their phonological performance.

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Declarations:

Author's Contribution:

- Conceptualization, data collection, interpretation, drafting of the manuscript and intellectual revisions
- The author agrees to take responsibility for every facet of the work, making sure that any concerns about its integrity or veracity are thoroughly examined and addressed

Conflict of Interest: NIL

Funding Sources: NIL

https://doi.org/10.63954/d6ypgd41
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