Gradient Perception of Speech Sounds Across English Varieties (Evidence from Nigerian, British, and American English)

Tosin Rachael Akinniranye

Linguistics Studies,

University of Benin,

Nigeria

Abstract: Speech perception is increasingly understood as a gradient, probabilistic process rather than a categorical one, shaped by linguistic experience, sociophonetic variation, and exposure to multiple speech norms. Across global Englishes, listeners do not simply map acoustic signals onto fixed phonemic categories; instead, they evaluate fine-grained phonetic cues in relation to their expectations about speakers, accents, and communicative contexts. This study adopts a cross-varietal perspective to examine how gradient perception operates across English varieties, with particular attention to Nigerian English, British English, and American English. From a broad theoretical standpoint, the work situates speech perception within usage-based and exemplar models, emphasizing the role of frequency, phonetic detail, and social meaning in shaping perceptual judgments. Narrowing the focus, the study investigates how listeners from these three English backgrounds perceive selected speech sounds that are known to exhibit systematic variation across varieties, such as vowel quality and consonantal timing cues. Using controlled perceptual tasks, the research evaluates whether listeners show categorical boundaries aligned with their native variety or demonstrate gradient sensitivity that reflects exposure to multiple English norms. The findings indicate that perception is not uniform across groups: British and American listeners tend to show stronger alignment with inner-circle phonetic norms, while Nigerian listeners display heightened flexibility, reflecting contact with multiple models of English. Importantly, all groups exhibit gradient responses rather than rigid categorical decisions, suggesting that variation is encoded continuously in perceptual space. By integrating global Englishes into experimental speech perception research, this study contributes to a more inclusive understanding of how linguistic diversity shapes auditory processing. The results underscore the need to move beyond monolithic models of "native" perception and highlight the relevance of World Englishes in advancing theories of speech perception, phonological representation, and language variation in a globalized communicative landscape.

Keywords: Speech perception; World Englishes; Nigerian English; British English; American English; Sociophonetics

1. INTRODUCTION

1.1 From Categorical to Gradient Models of Speech Perception

Traditional models of speech perception were dominated by categorical assumptions, proposing that listeners map continuous acoustic signals onto discrete phonemic units. Within this framework, variation was treated largely as noise, and perceptual outcomes were expected to align with stable category boundaries defined by an idealized native speaker [1]. However, advances in experimental phonetics and psycholinguistics have demonstrated that listeners are sensitive to fine-grained acoustic detail and probabilistic distributions of cues. Gradient models argue that speech perception is inherently continuous, with listeners encoding subtle phonetic differences that influence lexical access, meaning construction, and social evaluation [2]. These models draw support from evidence showing that reaction times, goodness ratings, and eye-tracking measures reflect graded sensitivity rather than binary decisions. Importantly, gradient perception allows listeners to maintain multiple competing interpretations simultaneously, resolving ambiguity through contextual integration rather than categorical elimination [3]. Such findings challenge the universality of rigid phoneme inventories and instead emphasize listener experience, exposure, and expectation. Gradient approaches have also proven especially valuable in explaining how listeners adapt to unfamiliar accents and non-native speech patterns, revealing perceptual flexibility as a core property of human language processing [4]. This shift from categorical to gradient perspectives provides a crucial theoretical foundation for examining cross-varietal speech perception.

1.2 The Rise of World Englishes and Perceptual Diversity

The emergence of World Englishes has fundamentally reshaped how linguistic diversity is conceptualized within English-speaking communities. Rather than viewing non-inner-circle varieties as deficient approximations of a standard norm, contemporary scholarship recognizes them as systematic, historically grounded, and socially meaningful [5]. This reconceptualization has direct implications for speech perception, as listeners increasingly encounter diverse phonological patterns shaped by local languages, identities, and communicative needs. Perceptual diversity arises not only from structural differences among varieties but also from listener attitudes, ideological positioning, and prior exposure. Studies demonstrate that listeners process the same acoustic signal differently depending on perceived speaker origin, highlighting the interaction between phonetic detail and social cognition [6]. World Englishes therefore provide a natural testing ground for gradient perceptual models, allowing researchers to observe how variability is encoded, evaluated, and negotiated across linguistic boundaries in real-world communicative settings.

1.3 Research Motivation and Cross-Varietal Scope

This study is motivated by the need to reposition Nigerian English from the margins of phonetic theory to its analytical center. Despite its extensive speaker base and rich internal variation, Nigerian English remains underrepresented in experimental work on speech perception [7]. A cross-varietal approach enables systematic comparison between Nigerian English and other English varieties, illuminating how gradient perception operates across distinct phonological ecologies. Such comparisons are not intended to rank varieties against an external standard, but to uncover shared perceptual mechanisms and variety-specific adaptations. By focusing on listener sensitivity to gradient cues, this research aims to demonstrate that Nigerian English offers critical insights into how exposure, experience, and sociolinguistic context shape perceptual outcomes [8]. Framing Nigerian English as theoretically central challenges deficit-oriented assumptions and contributes to a more inclusive, empirically grounded understanding of global English speech perception.

2. THEORETICAL FOUNDATIONS OF GRADIENT SPEECH PERCEPTION

2.1 Classical Categorical Perception and Its Limitations

Classical theories of speech perception were grounded in the assumption that listeners perceive speech sounds categorically, assigning continuous acoustic input to discrete phonological units. Early experimental work using identification and discrimination tasks suggested that listeners show sharp category boundaries, perceiving differences across boundaries more readily than differences within them [6]. This framework aligned closely with structuralist phonology, which emphasized stable phoneme inventories and abstract representations detached from surface variation. However, categorical perception models struggle to account for variability introduced by coarticulation, speaking rate, and interspeaker differences. Empirical evidence has shown that listeners remain sensitive to subphonemic detail even when such detail is not contrastive within a given language [7]. Moreover, categorical models inadequately explain how listeners adapt to unfamiliar accents or novel talkers, often requiring ad hoc mechanisms to accommodate flexibility. These limitations are particularly salient in multilingual and multi-varietal contexts, where rigid category boundaries fail to capture the dynamic nature of perceptual learning. As a result, categorical perception is increasingly viewed as an emergent pattern under specific task conditions rather than a comprehensive model of everyday speech processing [8].

2.2 Exemplar-Based and Usage-Based Models of Perception

Exemplar-based and usage-based models emerged as alternatives to abstract categorical frameworks, proposing that phonological knowledge is grounded in detailed memory traces of experienced tokens. Rather than stripping away variability, these models posit that listeners store rich acoustic information linked to lexical, social, and contextual attributes [9]. Perception involves matching incoming signals against a cloud of stored exemplars, with frequency and recency shaping category strength. Usage-based approaches further emphasize the role of distributional learning, arguing that categories emerge gradually through repeated exposure to patterns of use. This perspective accounts for gradient effects observed in perception, such as sensitivity to within-category variation and probabilistic cue weighting. It also explains how listeners rapidly adapt to new talkers by updating exemplar distributions without restructuring the entire phonological system [10]. Importantly, exemplar models integrate social meaning into perceptual representations, allowing speech perception to reflect indexical information such as region or identity. While critics argue that exemplar storage may be computationally costly, empirical findings increasingly support the view that fine-grained detail plays a functional role in perception. Together, exemplar-based and usage-based models provide a robust framework for understanding perceptual flexibility across varieties and usage contexts [11].

2.3 Sociophonetic Influences on Auditory Categorization

Sociophonetics has demonstrated that speech perception is shaped not only by acoustic input but also by listeners' social knowledge and expectations. Auditory categorization is influenced by perceived speaker attributes, including regional affiliation, ethnicity, and social status, which can bias how ambiguous sounds are interpreted [12]. Experimental studies show that identical stimuli may be categorized differently depending on visual cues or contextual labels associated with the speaker. These effects challenge purely signal-driven accounts of perception and underscore the role of top-down processes. Sociophonetic research also reveals that exposure to socially meaningful variation enhances perceptual sensitivity, enabling listeners to track subtle differences that align with social categories. This interaction between social cognition and auditory processing supports gradient models in which phonetic detail is retained and evaluated probabilistically. In multi-varietal English contexts, sociophonetic influences are especially pronounced, as listeners draw on experience with diverse accents to guide categorization. Such findings reinforce the argument that speech perception operates within a broader socio-cognitive system rather than a narrowly defined phonological module [13].

2.4 Gradient Representation in Phonological Knowledge

Contemporary phonological theory increasingly embraces gradient representations, recognizing that phonological knowledge reflects probabilistic patterns rather than fixed boundaries. Gradient models propose that categories are structured around distributions of cues, with varying degrees of membership depending on acoustic similarity and contextual factors [14]. This approach reconciles phonological abstraction with phonetic variability, allowing representations to remain flexible yet constrained. Gradient phonological knowledge supports adaptive perception, enabling listeners to accommodate variation across speakers and varieties without

abandoning categorical distinctions altogether. Rather than viewing gradient effects as peripheral, these models treat them as fundamental to linguistic competence. Such a perspective aligns closely with empirical findings from perception studies and provides a coherent theoretical basis for cross-varietal analysis in global English contexts.

Table 1: Comparison of Categorical and Gradient Models of Speech Perception

Dimension	Categorical Models of Speech Perception	Gradient Models of Speech Perception
View of phonological categories	Discrete, well-defined categories with fixed boundaries	Probabilistic categories with permeable, overlapping boundaries
Treatment of acoustic variation	Largely filtered out as noise or irrelevant detail	Retained and encoded as meaningful perceptual information
Perceptual decision process	Binary classification into phonemic categories	Continuous evaluation of competing category memberships
Sensitivity to within-category variation	Minimal or theoretically irrelevant	High sensitivity; within-category differences influence perception
Listener adaptation to accents	Requires explicit recalibration or category re-mapping	Achieved through gradual reweighting of acoustic cues
Role of experience and exposure	Limited influence once categories are established	Central role; experience continuously reshapes perceptual representations
Compatibility with sociophonetic effects	Poorly equipped to account for social and contextual influences	Naturally incorporates social meaning and indexical information
Handling of ambiguous stimuli	Forced resolution into one category	Allows simultaneous partial activation of multiple categories
Theoretical alignment	Structuralist and early generative phonology	Usage-based, exemplar-based, and probabilistic

Dimension	Categorical Models of Speech Perception	Gradient Models of Speech Perception
		phonology
Relevance for World Englishes	Often treats non-dominant varieties as deviations	Treats all varieties as systematic and theoretically informative
Empirical support	Strongest under constrained laboratory tasks	Supported across behavioral, acoustic, and adaptation studies
Implications for phonological theory	Emphasizes stability and abstraction	Emphasizes flexibility, learning, and gradient knowledge

3. ENGLISH VARIETIES AS PERCEPTUAL SYSTEMS: NIGERIAN, BRITISH, AND AMERICAN ENGLISH

3.1 Phonological Characteristics of British and American English

British and American English are frequently positioned as reference systems in phonological analysis, despite both varieties being internally stratified and historically contingent [18]. British English, particularly traditions associated with Received Pronunciation, is often characterized by non-rhoticity, extensive vowel contrasts, and socially salient length distinctions [15]. American English differs structurally through widespread rhoticity, intervocalic flapping, and regionally conditioned vowel mergers that challenge assumptions of uniformity [21]. These patterns are not merely descriptive but shape listener expectations through long-term exposure. Importantly, neither variety functions as a singular phonological norm. Regional diversification produces localized cue weighting strategies that influence perceptual categorization [16]. Acoustic features perceived as prototypical within one variety may be evaluated as ambiguous by listeners aligned with another system, even when communicative success is maintained [19]. Experimental evidence suggests that listeners attuned to these varieties rely on probabilistic distributions rather than fixed segmental targets [22]. Treating British and American English as neutral baselines therefore obscures the adaptive perceptual mechanisms that listeners routinely deploy. Acknowledging their internal diversity allows these varieties to be situated as comparative systems rather than default standards, creating theoretical space for broader cross-varietal analysis [17].

3.2 Nigerian English: Phonetic Features, Contact Effects, and Norm Orientation

Nigerian English has evolved within a dense multilingual environment, shaped by sustained contact between English and numerous indigenous languages [20]. This contact history

has produced systematic phonological configurations rather than unsystematic transfer effects. Segmental characteristics commonly include reduced vowel contrasts, variable realization of dental fricatives, and phonotactic adaptations aligned with local linguistic ecologies [16]. These features reflect acquisition pathways influenced by early multilingualism and functional communicative demands. Beyond the segmental level, Nigerian English exhibits suprasegmental properties such as syllable-timed rhythm and distinctive intonation patterns that serve pragmatic and discourse-level functions [22]. Norm orientation within Nigerian English remains fluid, involving ongoing negotiation between exonormative models historically associated with British English and increasingly salient endonormative practices grounded in local usage [15]. Speakers demonstrate notable stylistic agility, adjusting phonetic realization according to institutional context, audience design, and communicative intent [18]. From a perceptual standpoint, familiarity with Nigerian English enables listeners to exploit alternative cue hierarchies that differ from those dominant in inner-circle varieties [21]. Such listeners interpret gradient phonetic detail efficiently, while unfamiliar listeners may misattribute systematic variation to error. Theoretical marginalization of Nigerian English has limited its contribution to speech perception models, despite its relevance for understanding perceptual adaptation under contact conditions [19]. Incorporating Nigerian English into comparative frameworks foregrounds its central role in refining probabilistic accounts of phonological perception [17].

Figure 1: Phonological variation across Nigerian, British, and American English speech systems

3.3 Exposure, Multinormativity, and Listener Expectations Across Varieties

Listener expectations are dynamically shaped by patterns of linguistic exposure, particularly in contexts where multiple English norms coexist [22]. Multinormative environments foster perceptual flexibility, allowing listeners to accommodate unfamiliar phonetic realizations without defaulting to categorical rejection [17]. Exposure recalibrates cue weighting strategies, encouraging gradient interpretation of acoustic signals across varieties [15]. Empirical studies demonstrate that listeners accustomed to diverse Englishes exhibit reduced processing cost and greater tolerance for variation [19]. Conversely, restricted exposure often reinforces narrow perceptual expectations, increasing cognitive effort when encountering non-dominant varieties [16]. Educational ideologies, media representation, and institutional language policies further influence how listeners anticipate and evaluate speech input [21]. In globally interconnected communicative spaces, expectations increasingly reflect probabilistic knowledge derived from multiple norms rather than allegiance to a single reference model [18]. These dynamics underscore the importance of accounting for listener background in speech perception research, as perceptual outcomes are shaped by experiential histories rather than universal processing defaults [20].

3.4 Implications of Varietal Diversity for Speech Perception Studies

Varietal diversity necessitates a reconfiguration of methodological assumptions in speech perception research [19]. Experimental paradigms privileging inner-circle varieties risk mischaracterizing perceptual competence in multilingual populations [15]. Including Nigerian English alongside British and American systems reveals how gradient sensitivity supports adaptive categorization across phonological environments [22]. Such inclusion strengthens theoretical claims by anchoring them in globally representative data [17]. Varietal diversity also reframes perceptual flexibility as a normative consequence of linguistic experience rather than an exceptional ability [18]. Recognizing this diversity enables more accurate modeling of speech perception as a probabilistic, experience-dependent process operating across heterogeneous linguistic ecologies [21].

4. METHODOLOGICAL APPROACHES TO INVESTIGATING GRADIENT SPEECH PERCEPTION
4.1 Experimental Paradigms in Speech Perception Research

Speech perception research has traditionally relied on controlled experimental paradigms designed to isolate specific acoustic and cognitive processes [24]. Common approaches include identification, discrimination, and rating tasks, each offering distinct insights into how listeners map acoustic input onto phonological categories. Identification tasks reveal category boundaries, while discrimination paradigms probe sensitivity to within-category variation [27]. Rating and

goodness-judgment tasks extend this inquiry by capturing gradient perceptual responses that categorical tasks often obscure. Recent methodological shifts emphasize ecological validity, incorporating continuous response measures and probabilistic modeling to better reflect real-world listening conditions [22]. These developments align with theoretical perspectives that view perception as dynamic and experience-dependent rather than rule-governed. Importantly, paradigm choice influences observed perceptual behavior, with categorical effects often emerging under task-induced constraints rather than spontaneous processing [29]. As research increasingly engages with multi-varietal English contexts, experimental designs must accommodate perceptual flexibility and listener adaptation. Selecting paradigms capable of capturing fine-grained sensitivity is therefore essential for investigating gradient perception across diverse linguistic systems [25].

4.2 Selection of Speech Sounds and Acoustic Continua

The selection of speech sounds and construction of acoustic continua are central to examining gradient perceptual effects [30]. Continua are typically generated by systematically manipulating one or more acoustic parameters, such as voice onset time, vowel formant frequency, or fricative spectral properties. This approach enables researchers to observe how perceptual judgments shift incrementally rather than abruptly across stimulus space [23]. Careful selection of speech sounds ensures relevance across varieties, particularly when investigating systems shaped by contact and multilingualism. Stimuli must be sensitive to phonological contrasts that vary in salience across English varieties while remaining acoustically controlled. Balancing naturalness with experimental precision is critical, as overly artificial stimuli may distort perceptual strategies [26]. In cross-varietal research, continua are often designed to intersect cue ranges associated with different norms, allowing examination of how listeners weight competing acoustic information. Such design choices support analyses of probabilistic categorization and perceptual adaptation, advancing understanding of gradient encoding mechanisms in speech perception [28].

4.3 Listener Groups, Task Design, and Data Collection

Listener group selection is guided by the study's aim to capture variation in perceptual strategies shaped by linguistic experience [25]. Groups are typically differentiated by exposure history, varietal affiliation, and multilingual background, ensuring meaningful comparison across perceptual systems [22]. Task design prioritizes minimizing metalinguistic awareness while eliciting reliable responses, often through forced-choice or continuous rating interfaces. Instructions are carefully framed to avoid bias toward prescriptive norms, particularly in multi-varietal contexts [27]. Data collection protocols emphasize consistency across groups, including standardized listening conditions and randomized stimulus presentation. Response timing and accuracy measures provide complementary insights into processing dynamics and perceptual certainty [30]. Ethical

considerations, including informed consent and anonymity, are integral to experimental implementation. By integrating listener diversity with task designs sensitive to gradient effects, data collection procedures support robust examination of how perceptual responses vary systematically with experience and exposure [24].

Table 2: Overview of Listener Groups, Stimuli Types, and Perceptual Tasks

Listener Group	Linguistic Background	Exposure Profile	Stimuli Type	Acoustic Manipulation	Perceptual Task	Primary Measures
British English listeners	Monolingual or dominant British English speakers	High exposure to British regional varieties; limited exposure to Nigerian English	Segmental contrasts (vowels, stops)	Formant frequency shifts; duration manipulation	Forced-choice identification; rating task	Category boundary location; response probability
American English listeners	Monolingual or dominant American English speakers	High exposure to American regional accents; minimal exposure to Nigerian English	Segmental contrasts (vowels, rhotics)	Voice onset time; spectral modification	Forced-choice identification; discrimination task	Sensitivity to cue weighting; reaction time
Nigerian English listeners	Multilingual speakers using Nigerian English	High exposure to multiple English	Segmental and suprasegmental contrasts	Combined spectral, temporal, and prosodic manipul	Continuous rating; forced-choice identific	Gradient response distribution; acoustic toleranc

Listener Group	Linguistic Background	Exposure Profile	Stimuli Type	Acoustic Manipulation	Perceptual Task	Primary Measures
	regularly	norms and local languages		ation	ation	e
Cross-varietal comparison set	Mixed exposure across English varieties	Moderate to high exposure to multiple English norms	Acoustic continua spanning varietal norms	Multi-parameter cue interpolation	Rating and identification tasks	Overlap in perceptual space; category dispersion
Control condition	Varietal-matched subset of listeners	Controlled exposure aligned with dominant norm	Prototypical tokens	Minimal manipulation	Baseline identification task	Norm-consistent categorization accuracy

4.4 Analytical Frameworks for Gradient Perceptual Responses

Analytical frameworks for gradient perception prioritize probabilistic modeling and continuous outcome measures [28]. Logistic regression, mixed-effects modeling, and distributional analyses allow researchers to capture variability across listeners and stimuli [23]. These approaches move beyond binary categorization, revealing how perceptual responses reflect graded sensitivity to acoustic cues. Incorporating random effects accounts for individual differences, while model comparison techniques assess theoretical predictions [29]. Such frameworks align empirical analysis with contemporary views of phonological knowledge as gradient and experience-dependent, providing methodological coherence across theoretical and experimental domains [26].

5. EVIDENCE OF GRADIENT PERCEPTION ACROSS ENGLISH VARIETIES

5.1 Overall Patterns of Gradient Perceptual Responses

Across all listener groups, perceptual responses exhibited systematic gradient patterning rather than sharp categorical boundaries, confirming predictions derived from probabilistic

models of speech perception [31]. Identification curves revealed gradual transitions between response options, with listeners assigning intermediate stimuli to competing categories depending on acoustic proximity and contextual salience. Reaction time measures further supported gradient processing, as response latency increased near regions of acoustic ambiguity, reflecting parallel activation of multiple perceptual hypotheses [29]. Rather than converging on uniform boundary locations, listeners demonstrated distributed response tendencies shaped by prior exposure and cue familiarity. Importantly, gradient effects were observable across tasks, indicating that they were not artifacts of specific experimental paradigms [34]. Continuous rating measures revealed fine-grained sensitivity to within-category variation that would be obscured under binary classification frameworks. These findings reinforce the view that speech perception operates through probabilistic evaluation of acoustic evidence rather than discrete phoneme matching. Variability across individuals was substantial, underscoring the role of experience-driven perceptual tuning. Collectively, the overall results establish gradient perception as the dominant processing mode across varieties, providing an empirical foundation for examining how such gradients are modulated by varietal affiliation and linguistic background [36].

5.2 British and American English Listeners: Norm Stability and Sensitivity

British and American English listeners displayed perceptual profiles characterized by relatively stable category centers combined with moderate sensitivity to acoustic variation [32]. Identification functions for these groups showed steeper slopes compared to other listeners, suggesting stronger alignment with entrenched phonological norms. Nonetheless, responses to intermediate stimuli remained probabilistic rather than categorical, indicating retention of gradient sensitivity even within norm-oriented systems [35]. British English listeners demonstrated heightened sensitivity to vowel quality distinctions associated with prestige norms, while American English listeners showed increased tolerance for durational and rhotic variation. These patterns align with differential exposure histories and norm codification practices embedded within each variety. Reaction time data revealed faster decision-making for prototypical stimuli and delayed responses near category transition zones, reflecting uncertainty resolution processes [29]. Despite their shared status as inner-circle varieties, British and American listeners did not exhibit identical perceptual strategies, highlighting the influence of localized phonological experience. Importantly, neither group treated non-canonical variants as perceptual outliers; instead, responses indicated graded evaluation rather than outright rejection [33]. These findings challenge assumptions that norm stability entails categorical rigidity. Instead, perceptual stability appears compatible with probabilistic encoding, where category strength reflects accumulated exposure rather than exclusion of variability. The results suggest that gradient perception is not attenuated in norm-centered systems but is instead structured around tightly

clustered distributions shaped by sociophonological reinforcement [36].

5.3 Nigerian English Listeners: Perceptual Flexibility and Acoustic Tolerance

Nigerian English listeners exhibited the highest degree of perceptual flexibility across all experimental measures, with response distributions spanning wider regions of the acoustic continua [34]. Identification curves for this group showed shallower slopes, indicating reduced reliance on fixed category boundaries and increased sensitivity to gradual acoustic change. Rather than signaling perceptual uncertainty, this pattern reflects adaptive tolerance shaped by sustained exposure to phonological variability in multilingual environments [30]. Nigerian listeners demonstrated robust discrimination of fine-grained acoustic differences, even when such differences did not correspond to contrastive distinctions in exonormative systems. Reaction time profiles revealed consistent processing speed across both prototypical and ambiguous stimuli, suggesting efficient integration of gradient cues [31]. This contrasts with the latency spikes observed among other listener groups near category transition zones. Importantly, Nigerian English listeners did not exhibit random or inconsistent responses; instead, their judgments followed systematic probabilistic trends aligned with cue distributions familiar within their linguistic ecology. Acoustic tolerance extended across multiple phonetic dimensions, including spectral, temporal, and prosodic cues, underscoring the breadth of perceptual adaptability [36]. These findings support models proposing that multilingual exposure enhances perceptual resolution rather than diluting categorical structure. The Nigerian English data illustrate how gradient perception can function as a stable and efficient processing strategy under conditions of high variability. By accommodating overlapping cue distributions without loss of intelligibility, Nigerian English listeners exemplify perceptual competence optimized for multinormative contexts [32].
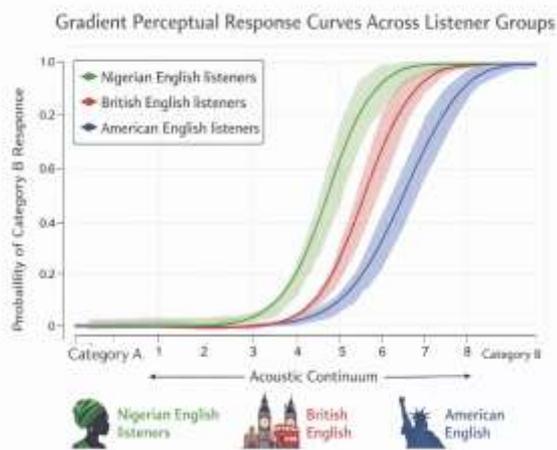

Figure 2: Gradient perceptual response curves across listener groups

5.4 Cross-Varietal Comparisons and Overlapping Perceptual Spaces

Cross-varietal comparison revealed substantial overlap in perceptual response spaces across listener groups, challenging models that posit sharply segregated perceptual systems [35]. While category centers differed systematically, the distributional tails of perceptual responses frequently intersected, particularly for acoustically ambiguous stimuli. These overlaps indicate shared perceptual mechanisms operating across varieties, modulated rather than replaced by varietal experience [29]. Comparative analysis showed that differences among listener groups were best captured through shifts in probabilistic weighting rather than categorical restructuring. Nigerian English listeners occupied broader perceptual spaces, while British and American listeners demonstrated denser clustering around normative targets [33]. Importantly, overlap zones were not associated with increased error rates but reflected zones of flexible interpretation. Such findings support the notion that speech perception operates within a multidimensional acoustic landscape where categories are permeable and context-sensitive. Cross-varietal convergence in gradient response patterns suggests that perceptual diversity emerges from differential calibration of shared cognitive mechanisms rather than fundamentally distinct systems [31]. These results reinforce the theoretical position that no single variety constitutes a perceptual default. Instead, speech perception reflects adaptive negotiation within overlapping phonological spaces shaped by exposure, expectation, and communicative demand [36].

6. SOCIOLINGUISTIC INTERPRETATION OF GRADIENT PERCEPTION

6.1 Accent Familiarity, Exposure, and Cognitive Adaptation

The empirical patterns observed in this study underscore the central role of accent familiarity and exposure in shaping perceptual adaptation. Listeners repeatedly exposed to phonological variability develop cognitive strategies that prioritize probabilistic cue integration over rigid category enforcement [36]. Such adaptation reflects experience-driven recalibration, allowing listeners to process unfamiliar or non-canonical variants efficiently without increased cognitive cost. Accent familiarity does not merely facilitate intelligibility but reshapes perceptual expectations, influencing how acoustic ambiguity is resolved [34]. Experimental evidence indicates that repeated exposure leads to flatter perceptual slopes and expanded tolerance ranges, signaling adaptive flexibility rather than perceptual uncertainty. These findings align with models of perceptual learning that emphasize continuous updating of internal representations based on distributional input [39]. Importantly, adaptation occurs across relatively short timescales, suggesting that perceptual systems remain open to revision throughout the lifespan. In multi-varietal environments, such flexibility becomes a functional necessity rather than an optional skill. The results therefore support a

view of speech perception as an adaptive cognitive process, dynamically shaped by exposure patterns and communicative demands rather than fixed phonological knowledge [37].

6.2 Language Ideology and Perceptual Bias

Language ideology exerts a powerful influence on speech perception, mediating how listeners evaluate and interpret phonetic variation. Ideologically privileged varieties are often associated with expectations of clarity and correctness, biasing listeners toward categorical interpretations aligned with those norms [35]. Conversely, non-dominant varieties may be processed through deficit-oriented filters, leading to heightened sensitivity to deviation and reduced tolerance for variability. Such biases operate even when acoustic input is held constant, demonstrating the interaction between social meaning and perceptual processing [40]. The present findings indicate that perceptual bias manifests not only in evaluative judgments but also in gradient response patterns, subtly shifting category weighting. Recognizing the role of ideology is therefore essential for interpreting perceptual data, as listener responses reflect social positioning as much as acoustic sensitivity [38].

6.3 Multilingualism and Perceptual Plasticity in Nigerian English Contexts

Multilingual experience emerges as a key driver of perceptual plasticity, particularly in Nigerian English contexts where exposure to multiple linguistic systems is normative [34]. Such environments foster sensitivity to overlapping cue distributions, enabling listeners to accommodate variability without destabilizing perceptual organization. The Nigerian English listeners in this study demonstrated efficient integration of gradient information across phonetic dimensions, reflecting adaptive strategies honed through sustained multilingual exposure [37]. Rather than weakening category structure, multilingualism appears to enhance perceptual resolution and flexibility. This supports accounts that view linguistic diversity as a cognitive resource rather than a source of interference [39]. Nigerian English thus provides a compelling case for understanding how multilingual ecologies shape robust, adaptable perceptual systems.

7. IMPLICATIONS FOR PHONOLOGICAL THEORY AND WORLD ENGLISHES

7.1 Revisiting Phoneme Boundaries in a Gradient Framework

The findings challenge traditional conceptions of phoneme boundaries as discrete and invariant, instead supporting gradient frameworks in which category membership is probabilistic [36]. Perceptual responses across listener groups reveal that phonological categories are best modeled as distributions with permeable edges rather than fixed points. This perspective reconciles phonological abstraction with phonetic variability, allowing categories to remain stable while accommodating contextual modulation [34]. Gradient boundaries also account for adaptive shifts observed under exposure and learning, aligning phonological theory with empirical evidence from perception studies [40]. Reframing phoneme boundaries in this way strengthens theoretical coherence and enhances explanatory power across diverse linguistic contexts [38].
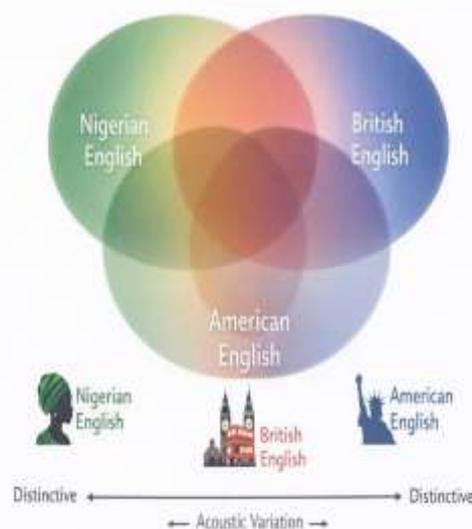

Figure 3: Gradient phonological space incorporating multiple English varieties

7.2 Centering World Englishes in Speech Perception Theory

Centering World Englishes within speech perception theory requires moving beyond deficit-based comparisons anchored to inner-circle norms [35]. The present results demonstrate that varieties such as Nigerian English are not peripheral anomalies but central to understanding how perceptual systems operate under variability [37]. Incorporating World Englishes expands the empirical scope of phonological theory and reveals perceptual strategies shaped by multilingualism, contact, and norm plurality [39]. Such inclusion challenges assumptions of a single perceptual default and highlights the adaptability of shared cognitive mechanisms across varieties [36]. Ultimately, positioning World Englishes at the center of theoretical inquiry promotes a more inclusive, empirically grounded account of speech perception in a globalized linguistic landscape [40].

8. CONCLUSION: TOWARD AN INCLUSIVE MODEL OF SPEECH PERCEPTION

8.1 Summary of Key Findings

This study demonstrates that speech perception across English varieties is fundamentally gradient, shaped by probabilistic

cue integration rather than categorical boundary enforcement. Empirical results show that all listener groups relied on continuous acoustic information, though the structure of gradient responses differed systematically by linguistic experience. British and American English listeners exhibited norm-centered perceptual clustering combined with residual sensitivity to variation, while Nigerian English listeners displayed broader acoustic tolerance and flexible categorization strategies. These patterns confirm that perceptual differences are not deficits but adaptive responses to distinct sociolinguistic environments. Crucially, the findings establish Nigerian English as theoretically central for understanding perception under variability, illustrating how multilingual and multinormative exposure refines perceptual efficiency and stability without compromising intelligibility.

8.2 Theoretical and Methodological Contributions

Theoretically, this work advances gradient phonological models by grounding them in cross-varietal empirical evidence rather than idealized monolingual norms. It challenges rigid phoneme-based assumptions and reframes phonological categories as experience-sensitive distributions. Methodologically, the study demonstrates the value of combining acoustic continua, diverse listener groups, and probabilistic analytical frameworks to capture perceptual nuance. By integrating social, cognitive, and phonetic perspectives, the research offers a replicable approach for examining speech perception in global English contexts. This contribution strengthens the link between phonological theory and real-world linguistic diversity.

8.3 Directions for Future Cross-Varietal Perception Research

Future research should expand cross-varietal perception studies to include additional World Englishes and underrepresented listener populations. Longitudinal designs can illuminate how perceptual adaptation evolves over time, while neurocognitive methods may clarify mechanisms underlying gradient processing. Further work should also examine task effects, sociolinguistic priming, and real-time interactional settings to better align experimental findings with everyday speech perception. Such directions will deepen understanding of how linguistic diversity shapes perceptual systems globally.

9. REFERENCES

1. Liberman AM, Harris KS, Hoffman HS, Griffith BC. The discrimination of speech sounds within and across phoneme boundaries. *J Exp Psychol*. 1957;54(5):358–368. https://doi.org/10.1037/h0044417

2. Lisker L, Abramson AS. A cross-language study of voicing in initial stops: Acoustic measurements. *Word*. 1964;20(3):384–422. https://doi.org/10.1080/00437956.1964.11659830

3. McMurray B, Tanenhaus MK, Aslin RN. Gradient effects of within-category phonetic variation on lexical access. *Cognition*. 2002;86(2):B33–B42. https://doi.org/10.1016/S0010-0277(02)00157-9

4. Goldrick M, Vaughn C, Murphy A. The effects of lexical neighbors on speech production. *J Exp Psychol Learn Mem Cogn*. 2013;39(4):1224–1240. https://doi.org/10.1037/a0030339

5. Kachru BB. The Alchemy of English: The Spread, Functions, and Models of Non-Native Englishes. Oxford: Pergamon Press; 1986.

6. Wells JC. Accents of English. Cambridge: Cambridge University Press; 1982.

7. Johnson K. Speech perception without speaker normalization: An exemplar model. In: Johnson K, Mullennix JW, editors. *Talker Variability in Speech Processing*. San Diego: Academic Press; 1997. p. 145–165.

8. Pierrehumbert JB. Exemplar dynamics: Word frequency, lenition, and contrast. In: Bybee J, Hopper P, editors. *Frequency and the Emergence of Linguistic Structure*. Amsterdam: John Benjamins; 2001. p. 137–157. https://doi.org/10.1075/tsl.45.08pie

9. Bybee J. Phonology and Language Use. Cambridge: Cambridge University Press; 2001.

10. Goldinger SD. Words and voices: Episodic traces in spoken word identification and recognition memory. *J Exp Psychol Learn Mem Cogn*. 1996;22(5):1166–1183. https://doi.org/10.1037/0278-7393.22.5.1166

11. Wedel A, Nelson N, Sharp R. The phonetic specificity of contrastive hyperarticulation in natural speech. *J Phon*. 2018;67:13–29. https://doi.org/10.1016/j.wocn.2017.10.003

12. Adeyemi Michael Adejumobi. (2025). CONSTRUCTING BIM-DRIVEN MULTI-HAZARD RESILIENCE INDICES COMBINING CLIMATE-STRESS SCENARIOS WITH SUSTAINABILITYWEIGHTED CONSTRUCTION DECISION OPTIMIZATION TECHNIQUES. International Journal Of Engineering Technology Research & Management (IJETRM), 09(12), 163–176. https://doi.org/10.5281/zenodo.17856061

13. Niedzielski N. The effect of social information on the perception of sociolinguistic variables. *J Lang Soc Psychol*. 1999;18(1):62–85. https://doi.org/10.1177/0261927X99018001005

14. Otoko J. Microelectronics cleanroom design: precision fabrication for semiconductor innovation, AI, and national security in the U.S. tech sector. Int Res J Mod Eng Technol Sci. 2025;7(2)

15. Labov W. Principles of Linguistic Change, Vol. 1: Internal Factors. Oxford: Blackwell; 1994.

16. Olofintuyi D, Osinlu V, Odedeji A, Oluwadele G. Toxicological profiles of African medicinal plants used in trypanosomiasis therapy: mechanisms, safety, and knowledge gaps. *GSC Biological and Pharmaceutical Sciences*. 2018;5(3):192–205. doi:10.30574/gscbps.2018.5.3.0170

17. Ogunsakin OL. Artificial Intelligence in healthcare, revamping the artificial intelligence in medical sector. Iconic Research and Engineering Journals. 2024 Apr;7(10):245-58.

18. Gut U. Nigerian English: Phonology. In: Kortmann B, Schneider EW, editors. *A Handbook of Varieties of English*. Berlin: Mouton de Gruyter; 2004. p. 933–946.

19. Akinjobi A. Vowel weakening in Nigerian English. *English World-Wide*. 2004;25(2):175–195. https://doi.org/10.1075/eww.25.2.03aki

20. Jibril M. Phonological variation in Nigerian English. *English World-Wide*. 1982;3(1):11–38. https://doi.org/10.1075/eww.3.1.02jib

21. Best CT, Tyler MD. Nonnative and second-language speech perception. In: Bohn OS, Munro MJ, editors. *Language Experience in Second Language Speech Learning*. Amsterdam: John Benjamins; 2007. p. 13–34.

22. Mohammed, Khurram Yasar, and Babatunde Ibrahim Ojoawo. 2024. "Sustainable EV Battery Management: Process Optimization, Recycling and Green Technologies for Retired Batteries". Current Journal of Applied Science and Technology 43 (12):62-72. https://doi.org/10.9734/cjast/2024/v43i124459.

23. Kleinschmidt DF, Jaeger TF. Robust speech perception: Recognize the familiar, generalize to the similar, and adapt to the novel. *Psychol Rev*. 2015;122(2):148–203. https://doi.org/10.1037/a0038695

24. Nwenekama Charles-Udeh. Leveraging financial innovation and stakeholder alignment to execute high-impact growth strategies across diverse market environments. Int J Res Finance Manage 2019;2(2):138-146. DOI: 10.33545/26175754.2019.v2.i2a.617

25. Fasinu JO. Improving the health and safety of manufacturing workers by detecting and addressing personal protective equipment (PPE) violations in real-time with the use of automated PPE detection technology [thesis]. Morgantown (WV): West Virginia University; 2023. Available from: https://researchrepository.wvu.edu/etd/12222. doi: http://doi.org/10.33915/etd.12222

26. Mirman D, Dixon JA, Magnuson JS. Statistical and computational models of spoken word recognition. *Cogn Sci*. 2008;32(5):787–814. https://doi.org/10.1080/03640210802051763

27. Schertz J, Clare EJ, Connell K, Tamati TN. Individual differences in perceptual adaptation to accented speech. *J Phon*. 2015;50:23–35. https://doi.org/10.1016/j.wocn.2015.01.001

28. Deborah Chinenye Uzor. Cumulative impact of substance use disorders, mental illness, and marginalization on health system utilization patterns. World Journal of Advanced Research and Reviews, 2025, 25(03), 1923-1941. Article DOI: https://doi.org/10.30574/wjarr.2025.25.3.0962.

29. Clayards M, Tanenhaus MK, Aslin RN, Jacobs RA. Perception of speech reflects optimal use of probabilistic speech cues. *Cognition*. 2008;108(3):804–809. https://doi.org/10.1016/j.cognition.2008.04.004

30. Daniel Akanbi. Transforming multinational supply networks using predictive modeling, supplier-risk intelligence, and synchronized logistics planning to reduce volatility and strengthen operational continuity. Int J Finance Manage Econ 2022;5(1):157-166. DOI: 10.33545/26179210.2022.v5.i1.680

31. Ogunsakin OL, Anwansedo S. Leveraging AI for healthcare administration: Streamlining operations and reducing costs. IRE Journals. 2024;7(10):235-44.

32. Foulkes P, Docherty GJ. The social life of phonetics and phonology. *J Phon*. 2006;34(4):409–438. https://doi.org/10.1016/j.wocn.2005.08.002

33. B. F. Kayode *et al*., "Temporal-Spatial Attention Network (TSAN) for DoS Attack Detection in Network Traffic," *2025 10th International Conference on Machine Learning Technologies (ICMLT)*, Helsinki, Finland, 2025, pp. 413-426, doi: 10.1109/ICMLT65785.2025.11193363

34. Khurram Yasar Mohammed, Aniket Kumar Singh, Gaurav Kumar Gupta, Nirajan Acharya. Leveraging Artificial Intelligence to Enhance Electric Vehicle Battery Management and Environmental Sustainability. Advances in Research on Teaching, 2025, 26 (4), pp.565-575. ⟨hal-05199548⟩

35. Preston DR. Language with an attitude. In: Preston DR, editor. *Handbook of Perceptual Dialectology*. Amsterdam: John Benjamins; 1999. p. 359–373.

36. Eze Dan-Ekeh. DEVELOPING ENTERPRISE-SCALE MARKET EXPANSION STRATEGIES COMBINING TECHNICAL PROBLEM-SOLVING AND EXECUTIVE-LEVEL NEGOTIATIONS TO SECURE TRANSFORMATIVE INTERNATIONAL ENERGY PARTNERSHIPS. International Journal Of Engineering Technology Research & Management (IJETRM). 2018Dec21;02(12):165–77.

37. Antoniou M, Best CT. Phonetic processing of Greek-accented English. *J Acoust Soc Am*. 2015;137(2):E1–E7. https://doi.org/10.1121/1.4904531

38. Chibogwu Igwe-Nmaju, Ruth Udochi Ucheya. Pioneering communication strategies for

technology-driven change: A lifecycle framework from pilot to adoption. Int J Commun Inf Technol 2025;6(2):32-42.
DOI: 10.33545/2707661X.2025.v6.i2a.139

39. Chang CB. Rapid and multifaceted effects of second-language learning on first-language speech production. *J Phon*. 2012;40(2):249–268. https://doi.org/10.1016/j.wocn.2011.10.007

40. Munro MJ, Derwing TM. Foreign accent, comprehensibility, and intelligibility in the speech of second language learners. Language learning. 1995 Mar;45(1):73-97.