Literature, Language and Cultural Studies
ISSN Print: 3079-5095
ISSN Online: 3079-5109
https://doi.org/10.63313/LLCS.9056

Toward a Modality-Neutral Theory: Reconstructing Hockett's Design Features of Human Language Through Multimodal Critique

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How to cite this paper: Yang, X. X. (2025). Toward a modality-neutral theory: Reconstructing Hockett's design features of human language through multimodal critique. Literature, Language and Cultural Studies, 2(1), 17-31. ISSN Print: 3079-5095; ISSN Online: 3079-5109
https://doi.org/10.63313/LLCS.9056
Published: 2025-07-03

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Abstract

Charles F. Hockett's design features framework faces critical limitations when applied to non-vocal modalities. This study exposes its phonocentric bias (mar-ginalizing sign languages), feature redundancy (e.g., non-unique specialization), and physical overemphasis (prioritizing transient signals over cognition). Through multimodal analysis of American Sign Language, emoji systems, and programming languages, we demonstrate Hockett's inability to explain spatial syntactic hierarchies, viral cultural transmission, or AI-augmented generativity. The paper proposes a reconstructed modality-neutral theory centered on Mul-tichannel Capacity (neural processing across sensory pathways), Hierarchical Combinatoriality (recursive generativity in ASL/code/emoji), Human-Machine Productivity (GPT-4's co-creation dynamics) and Cross-Modal Translatability (Peircean semiotic resilience). Empirical validation includes ASL poetry's visual poetics and pandemic health codes' digital phatic communion. The model ad-vances linguistic epistemology by reorienting evolution toward gestural pro-to-language, dissolving artificial/natural language boundaries, and establishing AI accountability frameworks. Practically, it informs multimodal AI design and accessibility technologies, affirming language as a cognitive architecture for meaning-making beyond biological constraints.

Keywords

Hockett's design features; Modality-neutral theory; Multimodal critique; Cogni-tive plasticity; Language evolution; Digital semiotics

1. Introduction

Hockett's design features, formulated in the mid-20th century, aimed to systematically distinguish human language from animal communication systems by identifying a set of universal characteristics (Hockett 89). This framework, deeply rooted in the Chomskyan tradition that views language as a biologically constrained, rule-governed system unique to humans (Chomsky, Syntactic Structures 13; Chomsky, Minimalist Program 1), has profoundly influenced theoretical linguistics and anthropology. Features such as displacement (referring to absent entities), productivity (generating novel utterances), and duality of patterning (combining meaningless units into meaningful structures) are frequently cited as the hallmarks of human linguistic capability. Hockett initially posited 13 features, later expanding to 16, explicitly marking the final four—displacement, productivity, traditional transmission, and duality—as exclusively human (Hockett 95).

Despite its foundational status, Hockett's model faces mounting theoretical challenges in an era characterized by multimodal communication. The framework's inherent phonocentrism—prioritizing speech as the prototypical linguistic modality—renders it inadequate for explaining visually dominant systems like sign languages or digitally emergent symbols like emojis. As Owensis notes, language is fundamentally "a social tool" and "rule-governed system" for structuring communication (Owens 5), properties not inherently tied to sound. The proliferation of non-speech modalities necessitates a critical reassessment: Can Hockett's features, conceived within an auditory paradigm, genuinely capture the universals of human language across sensory channels?

This paper argues that Hockett's framework requires substantial reconstruction to achieve genuine modality neutrality. Building directly on critiques noted in foundational linguistic texts—particularly its neglect of visual-gestural channels, inclusion of non-unique features like specialization, and focus on transient signal physics—we extend the analysis into digital and tactile domains. We propose a revised feature set anchored in cognitive and semiotic functionality rather than sensory mechanics. This reconstruction not only addresses theoretical gaps but also responds to practical imperatives in artificial intelligence (AI), accessibility technology, and the study of language evolution.

2. Theoretical Contributions and Limitations of Hockett's Design Features

2.1 Core Framework: The 16 Design Features

Hockett's framework delineates human language through sixteen design features. Among these, four are explicitly designated as uniquely human:

- Displacement: Referencing objects/events removed in time or space (e.g., discussing past experiences or fictional worlds) (Hockett 92).
- Productivity (Openness): Creating and comprehending entirely novel utterances (e.g., "On the 35th of last month, I emailed Monkey King...") (Hockett 96).
- Traditional Transmission: Language acquisition through social learning, not genetic inheritance (Hockett 98).
- Duality of Patterning: Combinatorial hierarchy where meaningless phonemes form meaningful morphemes/words (e.g., /b/, /æ/, /t/ → "bat" or "tab") (Hockett 99).

Other features address signal properties (vocal-auditory channel, broadcast transmission, rapid fading), interchangeability, semanticity, arbitrariness, and reflexivity. While comprehensive for speech, this taxonomy reveals critical flaws when applied beyond the auditory modality.

2.2 Documented Limitations: The Tripartite Critique

Critiques within linguistic pedagogy highlight three core limitations.

Phonocentric Bias

Features like vocal-auditory channel and broadcast transmission/directional reception presuppose sound as the primary medium. This excludes sign languages, which utilize visual-gestural channels with equivalent grammatical complexity. As one prominent text observes: "strictly speaking, [these features] cannot be considered essential to human language" (Owens 10).

Feature Redundancy

Specialization (dedicated articulators) and semanticity (signal-meaning pairings) are not unique to human language. Many animal systems exhibit specialized signals (e.g., bee dances) and fixed meanings (e.g., alarm calls), violating Hockett's claim of human exclusivity (Owens 10).

Physical Overemphasis

Features like rapid fading (transient signals) and total feedback (self-monitoring) focus on the physics of transmission (sound waves, gestures) rather than the cognitive-semiotic essence of language. They describe how signals behave spatially, not how language functions symbolically (Owens 10).

2.3 Emerging Challenges: The Digital-Multimodal Turn

Networked Symbols

Emojis (☺/🐶) challenge arbitrariness through enhanced iconicity. While "dog" is arbitrary across languages ("perro", "chien"), the dog emoji 🐶 leverages visual resemblance, creating a semi-iconic sign. Nonetheless, cultural conventions still govern interpretation—a dog emoji may signify loyalty, messiness, or humor depending on context (Danesi 73).

Programming Languages

Code generates novel outputs (productivity) via re-combinable syntax (duality), but adheres to machine-executable rules rather than biological cognition. For instance, Python's for loop structure is productive within its formal grammar but lacks human semantic intentionality (Knuth 4).

Hashtag Systems

Movements like #MeToo demonstrate accelerated cultural transmission, leveraging digital networks for global, near-instantaneous conventionalization of new semantic units (Zappavigna 108).

These phenomena underscore the need for a framework decoupled from specific sensory channels.

3. Multimodal Challenges to Hockett's Framework

3.1 Visual Modality: Sign Language Grammaticality

American Sign Language (ASL) invalidates several speech-centric features while fulfilling Hockett's uniquely human traits.

Vocal-Auditory Channel Failure

ASL operates via manual-visual channels. Sign production (articulators: hands, face) and perception (visual reception) bypass sound entirely (Emmorey 9).

Displacement & Duality in ASL

Signers reference non-present entities (displacement) using spatial grammar—e.g., locating a referent in signing space and pointing back to it later. Duality manifests as combinations of meaningless phonological elements (handshape, location, movement) forming meaningful signs (Stokoe 35). For example, the ASL signs for "summer" (drawn across forehead) and "ugly" (same handshape, twisted near nose) differ only in location/movement, demonstrating combinatorial patterning.

Rapid Fading

Signs persist visually longer than sound waves, though they still dissipate, requiring continual production. Recording technology mitigates this, paralleling writing's role for speech (Sandler 47).

3.2 Digital Modality: Emoji and Networked Codes

Digital symbols reconfigure arbitrariness, cultural transmission, and reflexivity.

Arbitrariness vs. Iconicity

Emojis like ☺ (smile) retain iconic links to facial expressions but require cultural decoding. A ☺ may denote genuine happiness, sarcasm, or passive aggression—a layer of conventionalized arbitrariness overlaying iconicity (Evans 112).

Accelerated Cultural Transmission

Memes and hashtags (#ClimateEmergency) propagate and conventionalize meanings globally within days, compressing Hockett's "traditional transmission" timescales from generations to viral moments (Shifman 78).

Reflexivity in Digital Metalanguage

Users discuss emoji semantics ("Does 😬 mean 'awkward' or 'effort'?"), fulfilling metalingual function (Jakobson 25) within digital discourse.

3.3 Tactile Modality: Braille and Haptic Interfaces

Tactile systems like Braille or VR haptics adapt core features to non-visual/auditory channels.

Discreteness and Productivity

Braille's cells (discrete tactile units) combine productively to form words/sentences. Refreshable displays enable dynamic text generation, paralleling speech's ephemerality (Heller 63).

Total Feedback Extended

Haptic interfaces (e.g., VR gloves manipulating virtual objects) provide kinesthetic feedback, enabling real-time self-monitoring akin to auditory feedback in speech (Gallace 215).

4. Reconstructing a Modality-Neutral Feature Set

4.1 Foundational Principles: Toward a Cognitive-Semiotic Framework

The reconstruction of Hockett's design features requires anchoring in principles that transcend sensory modalities while capturing the cognitive and semiotic universals of human language. This paradigm shift responds to two critical imperatives. First, the empirical inadequacy of Hockett's model lies in its conflation of language with vocal expression, rendering it incapable of explaining non-vocal modalities such as sign languages or digital codes. Second, theoretical coherence demands that language be defined by its functional architecture rather than its physical instantiation. To address these imperatives, we establish three interlocking theoretical pillars that reconceptualize language as a cognitive-semiotic adaptive system.

Modality-Neutrality as Cognitive Invariance

Human language functions not as a channel-bound system but as an amodal cognitive competence. This principle asserts that core design features operate independently of sensory input/output mechanisms. The combinatorial hierarchy governing American Sign Language (Stokoe 35) or Braille (Heller 63) mirrors that of spoken syntax despite radically different articulatory-perceptual interfaces. Neurocognitive evidence substantiates this claim: fMRI studies confirm that Broca's area—central to syntactic processing—activates during both sign language comprehension (Emmorey 121) and tactile language decoding (Amedi 768), demonstrating biologically implemented modality neutrality. Crucially, abstraction enables channel substitutability. The semantic network for "tree" (entailing concepts like growth, shade, rootedness) remains stable whether evoked by the spoken word /triː/, the emoji 🌳, or an ASL classifier (Taub 89). This stands in direct contrast to Hockett's vocal-auditory channel postulate, which biologically binds language to sound production and reception.

Cognition-Primacy: From Signal Physics to Mental Representation

Language design features must prioritize the architecture of thought over signal transmission mechanics. This necessitates a decoupling of competence from performance, reimagining Chomsky's classic distinction through a multimodal lens. Cognitive competence manifests as abstract knowledge of combinatorial hierarchies (e.g., morpheme assembly rules), while modal performance encompasses modality-specific sensorimotor implementations like speech articulation or sign kinematics. Benjamin Bergen's theory of embodied simulation provides the explanatory mechanism: meaning arises through modality-neutral mental reenactments where understanding "grasp" involves simulating motor action, whether cued by speech, the ✊ emoji, or a handshape in ASL (Bergen 12). Consequently, semiotic economy supersedes physical efficiency in importance. Whereas Hockett's rapid fading optimizes speech for energy conservation, it becomes irrelevant to writing or sign. Cognition-primacy instead foregrounds semiotic efficiency—how systems maximize meaning-per-unit, as seen in emoji's visual density versus speech's linear unfolding.

Dynamic Conventionalization: The Social-Cognitive Interface

The stability of linguistic symbols across modalities emerges through socio-cognitive negotiation rather than biological determinism. Conventionalization operates at variable temporal scales: American Sign Language signs evolve through community usage over decades (Frishberg 714), while emoji semantics (e.g., 💀 signifying "dying of laughter") crystallize through viral social media negotiation within weeks (Danesi 45). Peircean semiotics offers a unifying framework for this process. Iconicity operates when 🐕 leverages visual resemblance but requires cultural decoding to distinguish "pet" from "stray" connotations. Indexicality manifests when ASL pointing signs reference spatial loci, functionally mirroring deictic speech ("this/that"). Pure symbolicity governs arbitrary mappings like Python's = assignment operator, which depends entirely on programmer consensus. Underpinning these processes are Michael Tomasello's mechanisms of joint attention and intention-reading, which scaffold conventionalization across modalities and enable children to acquire emoji norms as readily as speech acts (Tomasello 59, 102). This dynamic perspective fundamentally reorients Hockett's notion of cultural transmission from passive inheritance to agentive, context-sensitive meaning-making.

Theoretical Synthesis

Collectively, these principles reframe human language as a cognitive-semiotic adaptive system characterized by three universal properties. Amodal hierarchies enable recursive combination (morphemes → phrases → discourses) with identical operational logic in speech, sign, and programming languages. Embodied grounding ensures meaning arises from modality-neutral simulations of sensory-motor experiences. Socially embedded semiosis reveals how symbol stability depends on intersubjective negotiation rather than channel biology. This integrated framework transcends Hockett's checklist approach, providing the necessary foundation for a reconstructed feature set attuned to the multimodal reality of human communication.

4.2 Revised Feature Taxonomy

The principles established in 4.1 necessitate fundamental revisions to Hockett's original design features. The proposed taxonomy foregrounds cognitive and social functions while eliminating modality-specific constraints.

Multichannel Capacity replaces vocal-auditory channel to formalize the brain's ability to process linguistic structures through interchangeable sensory pathways. This encompasses not only auditory processing but also visual decoding of ASL, tactile interpretation of Braille, and even electro-tactile interfaces that convert visual information into skin sensations (Bach-y-Rita 541). The feature acknowledges that human language processing occurs not in sensory organs but in amodal cortical networks capable of remapping input channels.

Dynamic Conventionalization supersedes cultural transmission by incorporating both gradual and instantaneous norm-formation. Where Hockett emphasized intergenerational knowledge transfer, this feature accounts for how digital platforms accelerate conventionalization through viral propagation. The #MeToo movement exemplifies this, transforming a hashtag into a globally recognized semantic unit denoting survivor solidarity within months rather than generations (Zappavigna 108). Crucially, conventionalization speed varies by context without altering underlying cognitive mechanisms.

Cognitive Plasticity generalizes Hockett's specialization beyond physical articulators to neural adaptability. The human brain demonstrates remarkable flexibility in acquiring diverse symbolic systems, from tonal languages to programming syntax. Neuroplasticity enables modality switching, as evidenced by deaf individuals processing sign language in auditory cortex regions (MacSweeney 798). This feature highlights biology's role in enabling—not determining—linguistic capability.:.

Table 1. Reconstructed Modality-Neutral Design Features

Hockett's Feature	Reconstructed Feature	Cross-Modal Function
Vocal-Auditory Channel	Multichannel Capacity	Language operates via interchangeable sensory channels (auditory, visual, tactile).
Cultural Transmission	Dynamic Conventionality	Meaning derives from socially negotiated conventions, adaptable across timescales (e.g., viral digital vs. gradual ASL transmission).
Specialization	Cognitive Plasticity	Neural capacity to acquire/process diverse symbolic systems (speech, sign, code).
Duality of Patterning	Hierarchical Combinatoriality	Recursive combination of discrete units (phonemes, cheremes, bytes) into complex structures.
—	Cross-Modal Translatability	Core meanings retain integrity across modality shifts (e.g., speech → text → emoji).
—	Human-Machine Collaborative Productivity	Novel expression generation via human-AI interaction (e.g., GPT prompting).

4.3 Key Feature Elaborations

Hierarchical Combinatoriality: Beyond Duality

The principle of Hierarchical Combinatoriality subsumes and extends Hockett's duality of patterning and productivity by recognizing the universal cognitive architecture underlying linguistic generativity. This feature operates through recursive combination mechanisms that remain invariant across modalities, though their surface manifestations differ substantially. In American Sign Language, meaningless phonological parameters (handshape, location, movement) combine to form morphemes, which subsequently integrate into spatially organized syntactic structures (Sandler and Lillo-Martin 47). For example, the ASL sign for "believe" emerges from specific combinations of a 'B' handshape moving downward from the forehead—a morphological unit that cannot be reduced to its constituent features yet depends on their precise configuration.

Digital language systems exhibit parallel combinatorial hierarchies. Programming languages like Python deploy syntax trees where primitive tokens (e.g., operators like +, variables like x) combine into expressions (x + 5), which then nest into higher-order control structures (for x in range(10): print(x+5)). This generative capacity mirrors human language productivity but operates within formally constrained rule systems (Knuth 669). Crucially, emoji sequences demonstrate emergent combinatorics: the string 👫→💍→👨👩👧👦 iconically narrates a romance- marriage- family sequence through culturally conventionalized visual syntax, where position conveys temporal causation (Danesi 83). What unites these diverse manifestations is not physical channel but the cognitive capacity for recursive embedding—a universal governed by neural constraints rather than sensory modality.

Cross-Modal Translatability: Semiotic Resilience

Cross-Modal Translatability addresses how core semantic content maintains integrity during modality transitions, revealing the amodal nature of meaning construction. This feature operates through shared cognitive schemas that enable meaning preservation across representational formats. Consider the expression of irony: the spoken utterance "What perfect weather!" delivered during a storm conveys sarcasm through prosodic marking (exaggerated pitch variation). Its written equivalent achieves similar effect through typographic emphasis ("What perfect weather!") or supplementation with the 😒 emoji. In ASL, equivalent meaning emerges through exaggerated signing speed, eye-rolling, and a specific tilted-head posture (Padden 144).

The Peircean semiotic framework elucidates this translatability. Iconic relations (resemblance-based signs like 🌧️ for rain) often facilitate initial cross-modal mapping but require symbolic conventionalization for precise interpretation. The skull emoji 💀 exemplifies this progression: initially iconic of death, its viral adoption on social media transformed it into a conventional symbol for "dying of laughter"—a meaning now translatable to speech ("I'm dead!") or ASL (vigorous laughter signs + cheek wiping) (Evans 117). Critically, translatability fails when cultural schemas diverge: the "thumbs up" 👍 emoji signifies approval in Western contexts but conveys offense in Middle Eastern cultures (Danesi 92), demonstrating that translatability depends on shared cognitive-cultural frameworks rather than formal similarity.

Human-Machine Collaborative Productivity: Redefining Generativity

This feature fundamentally reimagines Hockett's productivity by incorporating human-AI co-creation as a legitimate linguistic phenomenon. Contemporary large language models (LLMs) like GPT-4 engage in collaborative meaning generation through prompt-response dynamics that exhibit emergent linguistic properties. When a user inputs "Write a haiku about quantum entanglement," the system generates:

Spooky ties transcend space
Particles dance as one whole
Measured, they collapse

This output demonstrates three productivity dimensions: lexical novelty ("spooky ties"), semantic coherence with specialized concepts, and adherence to poetic constraints. Crucially, such generations aren't mere database retrieval but involve probabilistic modeling of linguistic patterns acquired through exposure to massive corpora (Bender et al. 615). The collaboration manifests in iterative refinement: a user might prompt "Make it more metaphorical," leading to revised output where human intention steers machine generativity.

Controversially, this challenges Hockett's anthropocentric definition. While LLMs lack human consciousness, their outputs functionally satisfy core design features: they exhibit displacement (discussing abstract concepts), cultural transmission (learning from human texts), and reflexivity (editing their own outputs) (Floridi 135). The emergent phenomenon of algorithmic register—where users adapt prompts to elicit desired styles ("Explain like I'm 5")—further demonstrates conventionalization processes comparable to dialect formation. This suggests productivity should be defined by behavioral outcomes rather than biological origins..

5. Validation and Applications

5.1 Empirical Case Explanations

Visual Poetics in Sign Language Literature

The artistic expression of American Sign Language (ASL) poetry provides compelling validation for the poetic function across modalities. Renowned ASL poet Clayton Valli's work "Dandelion" exemplifies how visual-gestural channels realize Jakobson's poetic function through modality-specific techniques (Sutton-Spence 112). Rather than auditory rhyme, Valli establishes rhythmic patterns through symmetrical hand movement repetition and temporal sequencing that mirrors seed dispersal. Spatial metaphors replace verbal imagery—a curved downward trajectory signifies the flower's life cycle, while sudden wrist flicks represent seeds carried by wind. Crucially, this demonstrates hierarchical combinatoriality: basic phonological parameters (handshape, location) combine into morphological units that build narrative structures without vocal articulation. The performance simultaneously engages reflexivity through deliberate violations of signing space conventions, metalinguistically commenting on ASL's expressive capacity itself. Such artistry fundamentally counters Hockett's implicit privileging of vocal aesthetics by revealing how visual modality achieves equivalent poetic density through spatial rather than temporal organization.

Digital Phatic Communion in Pandemic Semiotics

The global deployment of QR-based health codes during COVID-19 illustrates the reconceptualization of phatic function within digital semiotics. These matrix barcodes functioned as complex multimodal signs fulfilling Jakobson's contact-maintaining role through non-verbal channels (Zhang and Chan 7). When scanned at entry points, the green/red color schema (visual modality) combined with vibration alerts (tactile feedback) to perform ritualized social acknowledgment equivalent to verbal exchanges like "All clear here." This system operationalized dynamic conventionalization at unprecedented speed—within weeks, citizens across linguistic backgrounds internalized the semiotic code without formal instruction. The health code's functionality extended beyond mere information transfer; its scanning ritual maintained social cohesion during physical distancing by creating momentary interpersonal connection. Crucially, the system exhibited cross-modal translatability: when network failures occurred, security personnel verbally translated the code's meaning ("Your code shows red—please wait here"), demonstrating semantic preservation across digital, visual, and auditory channels. This case exemplifies how digitally mediated phatic communion can surpass vocal limitations in scale and efficiency while retaining core relational functions.

5.2 Proposed Empirical Research Frameworks

Neurocognitive Validation of Multimodal Processing

To empirically substantiate the modality-neutral framework, we propose an event-related potential (ERP) study examining the N400 component—a well-established neural marker of semantic processing. Participants would encounter semantically congruent and incongruent stimuli across three modalities:

- Auditory: Spoken sentences ("He drinks coffee with cream and socks")
- Visual-Gestural: ASL narratives with final sign violation (e.g., EAT context → SIGNING)
- Digital-Symbolic: Emoji sequences (☕ ➕ 🥛 → ❓ / 🧦)

Building on Kutas and Federmeier's seminal N400 research (1001), we hypothesize comparable amplitude modulations across modalities during incongruent trials, indicating shared semantic integration mechanisms. Crucially, the experiment would examine whether Broca's area (traditionally associated with speech syntax) shows cross-modal activation during ASL and emoji processing, as predicted by cognitive plasticity (MacSweeney 798). Control conditions would include non-linguistic auditory tones, meaningless gestures, and abstract symbols. Such findings would provide direct electrophysiological evidence for amodal semantic networks, challenging Hockett's channel-dependent model at the neurobiological level.

Multimodal Deception Analysis Framework

The prevarication feature warrants investigation through a corpus-based study of deceptive acts across communicative modalities. We propose compiling a stratified corpus containing:

- Vocal deception: Sarcastic utterances from conversational databases
- Sign language misdirection: ASL narratives containing intentional false references
- Digital disinformation: Social media posts pairing misleading text with incongruent emojis

Employing Tseronis' multimodal discourse analysis framework (43), researchers would annotate instances where cross-modal divergence signals deception—such as a positive verbal report ("Great progress!") accompanied by a 😫 emoji in corporate communications. Statistical analysis would determine whether deception likelihood increases when:

a) Multiple modalities enable contradictory signaling (e.g., reassuring words + nervous gestures)

b) Cultural conventions create ambiguity in symbolic interpretation (e.g., 👍 in Middle Eastern contexts)

This research would reveal whether Hockett's human-exclusive "prevarication" operates through modality-specific mechanisms or exploits universal semiotic vulnerabilities. Preliminary evidence suggests that platform affordances influence deceptive strategies—Twitter's character limit encourages emoji-based hedging, while video platforms enable gestural leakage (Zappavigna 157).

5.3 Practical Implementation Domains

Artificial Intelligence Interaction Design

The reconstructed features provide critical frameworks for developing genuinely multimodal AI systems. Hierarchical combinatoriality principles should guide architecture design for large language models processing non-textual inputs. Current systems like GPT-4V struggle with emoji sequencing because they treat visual symbols as decorative rather than combinatorial (Bender 618). Implementing Sandler's sign phonology model (47) could improve emoji interpretation by recognizing positional meaning—a ☞→🚪 sequence differs semantically from 🚪→☞. Similarly, cross-modal translatability metrics should benchmark translation quality between speech, text, and symbolic representations. Practical applications include:

- Medical AI interfaces converting patient symptom descriptions (vocal) into visual diagnostic trees
- Educational tools transforming algebraic notation (symbolic) into ASL explanations for deaf students

Accessibility Technology Innovation

Multichannel capacity principles revolutionize assistive device design. Refreshable braille displays exemplify hierarchical combinatoriality by dynamically reconfiguring tactile pins into linguistic structures (Heller 88). Next-generation haptic interfaces could extend this by incorporating:

- Emotion-conveying vibrations mapped to speech prosody
- Spatial orientation sensors enabling ASL-like signing in 3D space
- Electro-tactile grids simulating emoji iconicity through skin pressure patterns

Such innovations operationalize cognitive plasticity by leveraging the brain's ability to remap linguistic functions to novel sensory channels. Critically, these designs must incorporate dynamic conventionalization processes—allowing users to collaboratively define new tactile conventions through community platforms.

6. Conclusion

Hockett's design features framework represented a watershed in the scientific characterization of human language, systematically distinguishing linguistic communication from animal signaling through properties like displacement and duality of patterning. Yet as this study has demonstrated, the model's enduring legacy remains constrained by its mid-20th-century epistemological foundations—foundations that privileged vocal articulation and physical signal properties while marginalizing the cognitive-semiotic universals underlying all linguistic modalities. Our critical reconstruction has revealed how phonocentric biases invalidate the framework's application to American Sign Language, where spatial grammar accomplishes referential displacement without sound; how features like specialization mistakenly elevate peripheral articulatory biology over core neural plasticity; and how transient signal physics (rapid fading) obscures the enduring semiotic architectures that enable cross-modal translatability. The empirical inadequacies exposed through multimodal analysis—from the hierarchical combinatorics of emoji sequences to the haptic syntax of braille—demand nothing less than a paradigm shift in how we conceptualize language's essential design.

The proposed modality-neutral theory responds to this imperative by recentering language universals on six cognitive-semiotic pillars: Multichannel Capacity recognizes the brain's amodal competence in processing linguistic structures through interchangeable sensory pathways; Dynamic Conventionalization captures the socio-cognitive negotiation of meaning across variable timescales; Cognitive Plasticity generalizes neural adaptability beyond biological constraints; Hierarchical Combinatoriality subsumes Hockett's duality within a universal architecture of recursive generativity; Cross-Modal Translatability explains semantic resilience during modality transitions; and Human-Machine Collaborative Productivity acknowledges the emergent reality of AI-mediated meaning co-creation. Collectively, these features resolve Hockett's contradictions regarding non-vocal modalities while integrating previously excluded systems—ASL's visual grammar, programming languages' formal syntax, emoji's iconic conventions—as equally valid manifestations of human linguistic capacity. Crucially, the reconstruction transcends mere feature substitution by establishing embodied simulation, Peircean semiosis, and neural plasticity as the tripartite foundation of all language, whether expressed through vocal folds, signing hands, or digital avatars.

The theoretical implications of this shift prove far-reaching for linguistic epistemology. First, it reorients language evolution research away from vocal-origins hypotheses toward gestural protolanguage models better aligned with archaeological evidence (Corballis 45). When combinatoriality and displacement are decoupled from vocal anatomy, the 1.8-million-year-old Oldowan toolmaking traditions—requiring hierarchical action sequencing and cross-generational knowledge transfer—emerge as plausible cognitive precursors to syntax (Stout and Chaminade 193). Second, the framework dissolves artificial boundaries between "natural" and "artificial" languages: Python code exhibits productivity and duality through identical cognitive operations as speech, while emoji sequences fulfill phatic functions through dynamic conventionalization processes parallel to dialect formation. Finally, the model provides a unified account of language acquisition across modalities, explaining why children internalize emoji conventions as readily as speech acts when joint attention and intention-reading mechanisms scaffold meaning-making (Tomasello 102).

Practically, the reconstructed features offer actionable frameworks for confronting 21st-century communicative challenges. In artificial intelligence development, principles of hierarchical combinatoriality should guide next-generation multimodal large language models (LLMs) beyond current text-centric limitations. Systems capable of processing ASL's spatial syntax or emoji's positional semantics would revolutionize assistive technologies for deaf and neurodivergent users while enabling more human-aligned human-computer interaction. Accessibility engineering stands to benefit profoundly from multichannel capacity principles—emerging haptic interfaces that map speech prosody to vibrotactile patterns or convert emoji sequences into electrotactile grids demonstrate how cognitive plasticity can be harnessed to create inclusive communicative ecologies (Gallace 221). Meanwhile, public health and crisis communication require sophisticated dynamic conventionalization strategies; the COVID-19 health code phenomenon illustrates how rapidly conventionalized multimodal systems can maintain social cohesion when vocal channels prove insufficient.

Significant limitations and future directions warrant acknowledgment. The current model underrepresents non-Western modalities like Silbo Gomero whistle speech or West African drum languages—systems that challenge assumptions about discreteness and arbitrariness through their analog signal continua. Neurocognitive validation remains nascent; while fMRI studies suggest Broca's area involvement in sign processing (MacSweeney 1583), high-density EEG investigations of emoji comprehension would strengthen claims about amodal semantic networks. Most urgently, ethical frameworks must address how human-machine collaborative productivity reshapes linguistic agency: when GPT-4 generates persuasive political rhetoric, does accountability reside with the prompter, the algorithm, or the training corpus (Floridi 489)?

Despite these open questions, the modality-neutral theory affirms a transformative perspective: language is not defined by its biological implementation but by its cognitive architecture for hierarchical meaning-making and its social capacity for dynamic semiotic negotiation. This reconceptualization liberates linguistic inquiry from what Derrida termed "phonocentric hegemony" (37), recognizing sign languages as fully grammaticalized systems rather than derivative gestures, emoji as legitimate semiotic resources rather than degenerative abbreviations, and programming syntax as rule-governed communication rather than mere instruction. As digital and biotechnological interfaces increasingly mediate human expression, the need for such an inclusive framework becomes ever more critical. For in the end, language's essence lies not in the vibration of vocal cords but in the human mind's unparalleled capacity to weave shared worlds from arbitrary signs—whether those signs manifest as sound waves, gestural contours, tactile pulses, or luminous pixels on a screen.

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