

Comprehensive Review Of Theoretical And Linguistic Foundations Of Sign Language

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ABSTRACT

This article provides a comprehensive review of the theoretical and linguistic foundations of sign language. It explores the development of sign language studies from early descriptive research to modern linguistic and cognitive approaches. The review highlights the key theories that shaped the understanding of sign languages as fully natural and structured linguistic systems. It also examines phonological, morphological, syntactic, and semantic aspects of sign languages, emphasizing their similarities and differences with spoken languages. Furthermore, the paper discusses recent advances in sign language linguistics and their implications for language acquisition, translation, and technology-assisted communication. The study aims to summarize existing knowledge, identify research gaps, and provide a foundation for future linguistic and interdisciplinary investigations in the field of sign language research.

KEYWORDS: Sign language, linguistics, theoretical foundations, phonology, syntax, semantics, language acquisition, communication, linguistic models.

INTRODUCTION

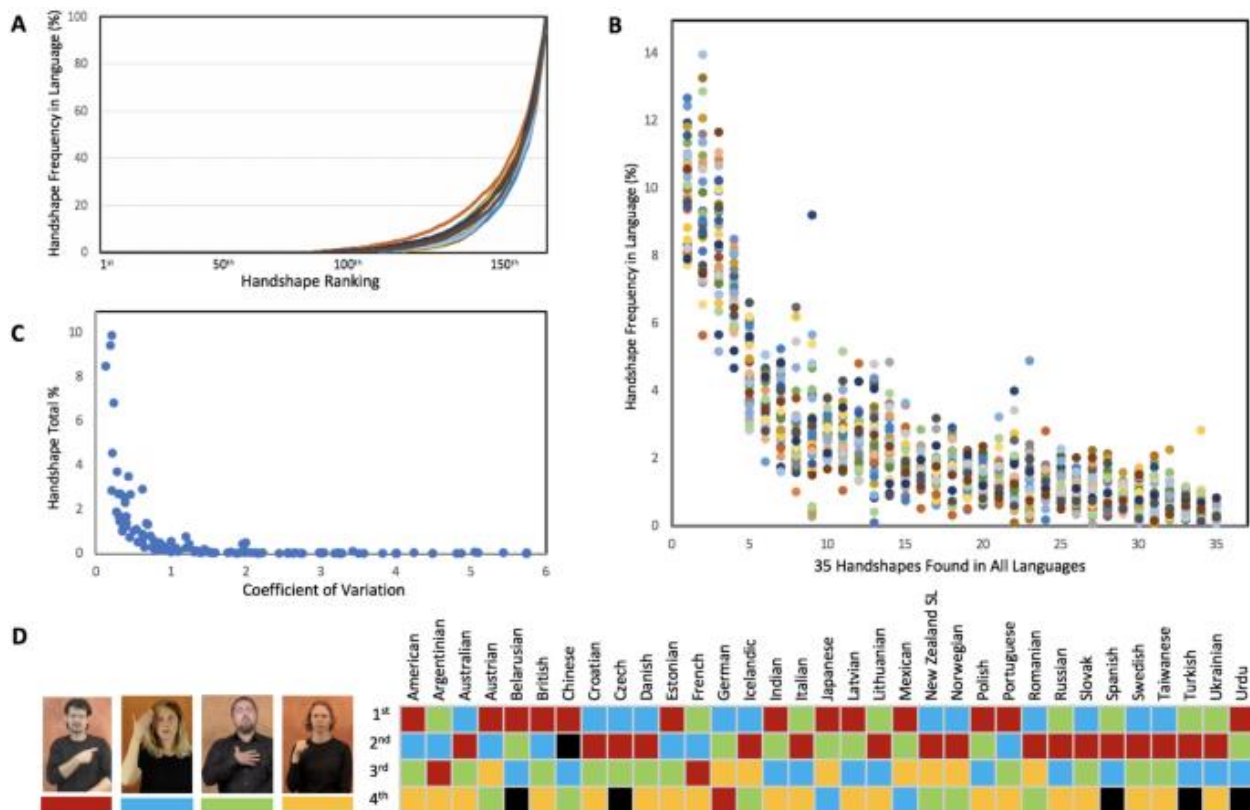
Sign languages represent complete natural languages with their own distinct rules, grammatical structures, and lexicon, serving as the primary communication mode for deaf communities globally (GEORGIEVA, 2023)(Semreen, 2023)(Moradi et al., 2023). Unlike spoken languages that rely on auditory-vocal modalities, sign languages utilize a visual-manual modality, employing hand gestures, movements, and facial expressions to convey meaning (Vite et al., 2023)(Shinde, 2023)(Gunjal, 2024)(Moradi et al., 2023). The historical development and origins of sign languages are a topic of significant research, particularly within the field of sign language historical linguistics (Power, 2022)(Galieva & Naurazbaeva, 2022)(Power et al., 2025)(Supalla et al., 2020).

Early understandings of sign languages were significantly influenced by William C. Stokoe's seminal work in the 1960s, which systematically demonstrated that American Sign Language (ASL) possessed its own distinct linguistic structure, separate from any spoken language (Bonvillian et al., 2020)(Power, 2022)(Reagan, 2022). This foundational research contradicted previous views and laid the groundwork for the scientific study of sign languages as independent linguistic systems (GEORGIEVA, 2023)(Power, 2022).

The emergence of sign languages is often spontaneous within deaf communities worldwide (GEORGIEVA, 2023). These languages are not universal; various sign languages exist globally, and they are not mutually intelligible, although they exhibit striking similarities in some aspects (Moradi et al., 2023). For instance, the Shanghai variant of Chinese Sign Language (SCSL) has significantly influenced other regional sign languages, such as Hong Kong Sign Language and

Singapore Sign Language, highlighting regional divergence and historical connections (Lin, 2021). Research into the early development of SCSL in Shanghai schools for the deaf, using archival records and interviews, provides insights into these origins (Lin, 2021).

The evolution of sign languages, much like spoken languages, is influenced by both biological constraints and linguistic, cultural, and historical processes that promote diversification (Miozzo & Peressotti, 2022). Studies analyzing over 38,000 handshapes from 33 different sign languages have shown that handshapes exhibit adaptations to biological constraints while also diversifying across languages (Miozzo & Peressotti, 2022).

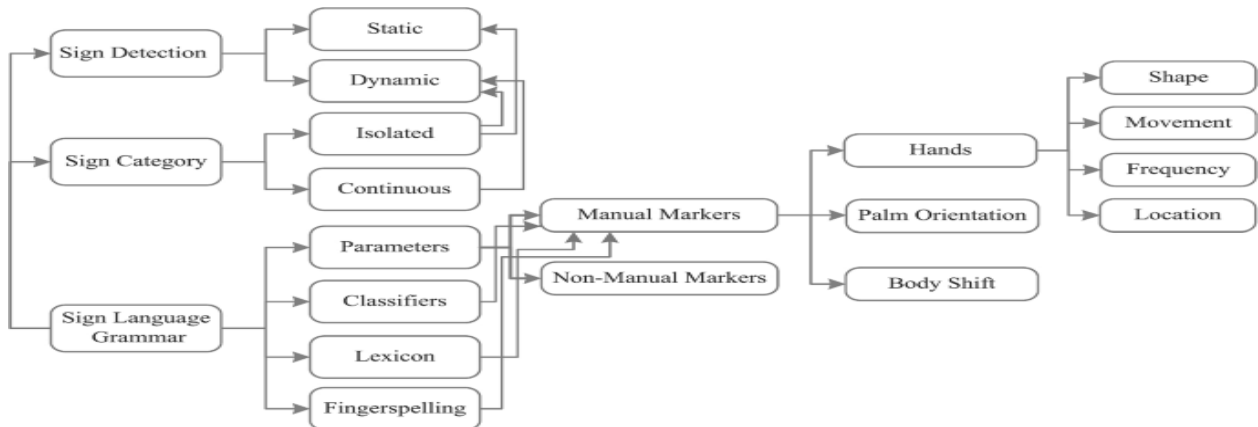


! [Handshape Frequency, Ranking, Coefficient of Variation, and Examples] (https://figure.bohrium.com/pprfig/9354/817399032648302593/817399032648302593_fig3_1.png) Source: (Miozzo & Peressotti, 2022)

The figure from Miozzo and Peressotti (2022) (Miozzo & Peressotti, 2022) illustrates these evolutionary aspects. Panel A depicts handshape frequency decreasing as ranking increases across various sign languages, indicating a core set of frequently used handshapes. Panel B shows the distribution of handshape frequencies for 35 common handshapes found in all studied languages, revealing significant variation in usage. Panel C explores the relationship between the coefficient of variation and total handshape percentage, suggesting complex interplay. Panel D provides visual examples of specific handshapes and their correspondence across different sign languages, demonstrating both commonality and diversity (Miozzo & Peressotti, 2022).

Historical linguistics of sign languages explores their diachronic change, genetic relatedness, and evolution (Power et al., 2025)(Supalla et al., 2020). This field has advanced through qualitative approaches examining typical pathways of change, quantitative methods for

classification, and archival research into signing communities (Power et al., 2025). For example, American Sign Language (ASL) has historical roots in 19th-century **langue des signes française**, indicating a process of linguistic transmission and adaptation (Power, 2022). The structure of sign languages includes phonological, morphological, syntactic, and semantic levels (Franco, 2024)(Gunjal, 2024). Key parameters of sign language grammar include handshape, movement, location, palm orientation, and non-manual markers such as facial expressions and body shifts (Moradi et al., 2023)(Shahin & Ismail, 2024). These elements combine to form isolated signs or continuous streams of communication (Shahin & Ismail, 2024).



[Sign Language Analysis Components](https://figure.bohrium.com/pprfig/2496/1037632862616027140/1037632862616027140_figure1_1.png)

Source: (Shahin & Ismail, 2024)

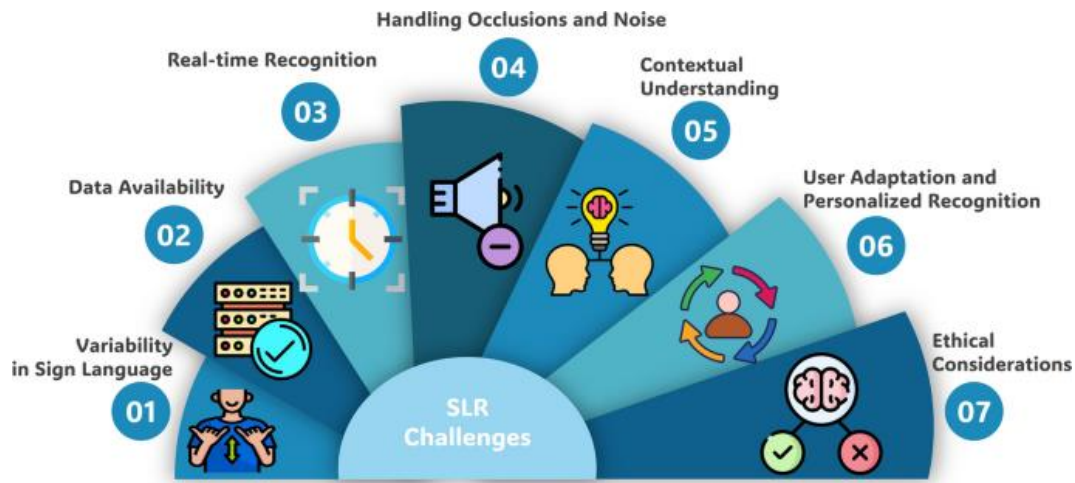
The diagram above illustrates the various components involved in sign language analysis, outlining static and dynamic sign detection, isolated and continuous sign categories, and grammatical parameters such as handshape, movement, frequency, location, and palm orientation, alongside non-manual markers like body shifts (Shahin & Ismail, 2024).

Research also highlights the critical role of the immediate linguistic context in the natural acquisition of sign language by deaf children, paralleling the development of oral language in hearing children (Vite et al., 2023). This underscores the importance of access to sign language socialization spaces for young deaf individuals (Hilde et al., 2024).

The recognition and preservation of sign languages are increasingly seen as civil rights movements, promoting democracy, freedom of expression, and inclusion for deaf communities (Reagan, 2022)(Amanda & Josiane, 2024). Despite their significance, sign languages have historically faced marginalization (GEORGIEVA, 2023)(Amanda & Josiane, 2024).

Technological advancements, particularly in artificial intelligence, deep learning, and machine learning, are contributing to bridging communication gaps between deaf and hearing communities (Shinde, 2023)(Attar et al., 2023)(Wadhawan & Kumar, 2019)(Kudrinko et al., 2021)(ZainEldin et al., 2024). These technologies facilitate sign language recognition (SLR) and production (SLP), which aim to automatically translate between spoken and sign languages (Franco, 2024)(Shinde, 2023)(Saunders et al., 2021). However, SLR research faces challenges such as variability in sign language, data availability, real-time recognition, handling occlusions

and noise, contextual understanding, user adaptation, and ethical considerations (Alyami et al., 2024)(ZainEldin et al., 2024).



[SLR Challenges](https://figure.bohrium.com/pprfig/2496/1012902232271618049/1012902232271618049_fig9_1.png)
Source: (ZainEldin et al., 2024)

This infographic visually summarizes the multifaceted challenges in Sign Language Recognition, including variability, data availability, real-time processing, occlusion and noise handling, contextual understanding, user adaptation, and ethical considerations (ZainEldin et al., 2024).

The distribution of CSLR publications by sign language shows varying levels of research activity across different regions and languages. For example, American Sign Language, Russian Sign Language, Chinese Sign Language, and Indian Sign Language show significant research, while many African regions appear to have less documented research (Alyami et al., 2024).



[Number of CSLR Publications by Sign Language](https://figure.bohrium.com/pprfig/2438/1001664459409719300/1001664459409719300_fig5_1.png)

Source: (Alyami et al., 2024)

This global map illustrates the distribution of continuous sign language recognition (CSLR) research publications, with darker shades of blue indicating a higher number of publications for specific sign languages, and lighter shades or gray areas indicating fewer or no documented publications (Alyami et al., 2024).

Further research into the origins and evolution of sign languages continues to be crucial for a comprehensive understanding of human linguistic diversity and the unique properties of visual-manual communication systems (Perrault et al., 2017)(Żywicznyński, 2019). This includes exploring the interplay between biological constraints, linguistic structure, and socio-cultural factors that shape sign language development over time (Miozzo & Peressotti, 2022)(Hodge & Goico, 2022).

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