RhymASL: An Interactive Rhyming ASL Story Generator

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Figure 1: Overview of the prototype interface supporting rhyming ASL story generation. (1): The user begins by selecting or inputting a story prompt; here, "Red worm, orange bison, yellow whale" is selected. (2): The system displays the story with an autogenerated image and gloss words ("worm red bison orange whale yellow") as clickable buttons. The sign video for "red" is currently playing. (3): After selecting the gloss word "yellow," the user enters phonological exploration, chooses "handshape" as the feature, chooses three related signs to recommend, and views related signs. A new story sentence, "They call a yellow silly dog to play", is automatically generated using the recommended signs. The user can choose to continue this new story sentence or return to the previous one.

Abstract

Early acquisition of American Sign Language (ASL) is critical for deaf and hard-of-hearing (DHH) children's language, literacy, and social development. ASL rhymes, characterized by shared phonological features such as handshape, location, and movement, play a valuable role in promoting phonological awareness and early language acquisition. Incorporating these patterns within narrative contexts further supports communication skill development in an engaging and contextualized manner. In this work, we present a prototype that leverages phonological features and large language models (LLMs) to support interactive rhyming ASL storytelling. The prototype enables users to explore phonologically related signs, generate new story content grounded in those features, and visualize stories through ASL sign videos and illustrations.

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CCS Concepts

• **Human-centered computing** → **Accessibility systems and tools**.

Keywords

ASL Rhymes, ASL Phonological Features, Interactive Storytelling, Large Language Models

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1 Introduction

Early acquisition of American Sign Language (ASL) is crucial for the language, literacy, and social development of deaf and hard-of-hearing (DHH) children [2, 3, 6, 45, 58]. While English rhymes involve the repetition of sound units or phonemes, ASL rhymes are characterized by shared handshapes, locations, or movements, demonstrating phonological patterns across words or phrases [5,

24]. For instance, Hands Land[1] demonstrates a shared Y-shape in the phrase "yellow whale" [24]. By leveraging the phonological structure of signs, these ASL rhymes enhance children's awareness of phonological units (e.g., handshape, location, and movement) that support communication [25], early English and ASL literacy [5, 17, 24, 25], promote vocabulary acquisition [5, 8], and offer playful language experience [5, 23].

Many ASL language acquisition tools have explored the use of interactive games and context-aware features to support vocabulary development [7, 9, 28]. Prior work also highlights the value of ASL rhymes for phonological awareness and language development, motivating us to explore their integration into interactive sign language learning. While some systems incorporate sign language phonological concepts, such as demonstrating signs with similar handshape [41, 42], they rarely present similar signs in a narrative context that encourages building communication skills [19], and language development in a fun, engaging, and contextualized manner [35]. This motivates our prototype to integrate phonological similarity into interactive storytelling to encourage communication, ASL usage, and literacy.

Building on recent advances in AI-human co-creative storytelling [32, 44, 53], we also leverage large language models (LLMs) to generate story text and images automatically. To encourage user agency and engagement in interactive storytelling [30, 59], our prototype supports user participation by enabling the selection of phonological features, exploring ASL signs, and collaboratively constructing ASL stories with rhymes.

This work aims to demonstrate leveraging phonological features to support interactive ASL rhyming storytelling. The prototype allows users to (1) explore signs with shared phonological features, (2) generate new story sentences based on those related signs, and (3) visualize ASL sign videos and images for stories. We present the prototype's design and interface, outline current limitations, and propose future work to gather feedback from experts with ASL rhyming knowledge in early education through a technology probe and a usability study [26, 27].

2 Related Work

2.1 ASL Rhymes in Language Acquisition

Existing work and activities have demonstrated the value of ASL rhymes in language acquisition. Teachers used ASL handshape rhymes to increase DHH students' ASL vocabulary and understanding of signs that shared the same handshapes [8, 17]. For example, some preschool teachers use "ASL handshape of the week" activity, which asks students to bring objects or pictures that incorporate the use of a handshape to emphasize different signs with the same handshape structure [17]. Studies also show that lexical access in sign language is facilitated by the phonological similarity of the lexical representations in memory [57]. Gietz et al. [21] found that deaf children demonstrated higher English vocabulary scores after viewing ASL stories with handshape rhymes, compared to stories without rhyme. In the ASL Mother Goose program, caregivers produce ASL signs in rhythmic and repetitive patterns on the DHH children's bodies, and deaf toddlers demonstrate positive responses while viewing ASL rhyme [5, 25].

[1]https://handsland.podia.com

2.2 ASL Language Acquisition Tools

Prior ASL learning tools employ context-aware and interactive games to facilitate vocabulary acquisition. CopyCat engages children to practice vocabulary and instructs the main character in the game via sign language [9, 11, 22]. Sign my world and MemoSign focus on interactive object-based learning and memory games to reinforce vocabulary [28, 29, 46, 47]. SmartSignPlay provides a context-aware and interactive learning environment for hearing parents and DHH children to practice ASL vocabulary by selecting handshape, hand movement, and facial expression [16]. Despite the diversity of these tools, the demonstrated benefits of ASL rhymes in promoting phonological awareness and language development motivate us to explore their integration into interactive sign language learning systems.

Some systems embed sign language phonological concepts to support language learning. Naranjo-Zeledón et al. [41, 42] implemented a system that provides signs with similar handshapes in response to letter selections. McQuarrie et al. [37] co-designed ASL handshape apps with deaf children to encourage handshape recognition and vocabulary learning. Although these tools incorporate handshape proximity, similar signs are typically presented in isolation, disconnected from narrative contexts. This limits opportunities for users to engage with ASL rhymes that support meaningful language use. Storytelling has been shown to support deaf children's language, literacy, and narrative development [19]. Building on this, we propose an interactive system that leverages shared phonological features to support user-guided sign exploration and construction of ASL stories with rhymes.

2.3 Interactive Storytelling Tools

Interactive storybook reading stimulates children's vocabulary, language development, literacy, and imagination by providing meaningful contexts for language use and interaction opportunities [38, 48, 51, 56]. For DHH children, storytelling similarly fosters communication skills, literacy, and the use of sign languages [4, 19, 20].

Recent advances in AI have enabled semi-automated and human-AI co-creative storytelling systems, where users co-construct narratives with the support of digital tools [32, 44, 53, 59]. LLMs now allow on-the-fly story generation with practical quality and scalability [32]. Building on these capabilities, our prototype integrates LLM-based methods for generating story text and images. While automation provides fluency, user participation could support user agency and engagement [30, 59]. Inspired by the benefit of human-in-the-loop, our prototype encourages active user involvement by allowing users to select phonological features and explore or edit rhyming ASL story generation.

3 System Design

The prototype enables interactive ASL rhyming story generation in three steps: (1) ASL and image generation based on English story input, (2) phonologically related signs recommendation, and (3) new story sentence generation using related signs. The prototype is implemented as a web-based application using Python and Streamlit, with modules for LLM-based language and image generation, ASL gloss translation, sign video lookup, and phonological matching.

3.1 ASL Generation from English Input

The prototype translates English sentences to ASL through a text-to-gloss and gloss-to-video pipeline, a widely used approach in sign language generation systems [18, 39, 40]. This approach involves converting text into sign gloss, a structured, text-based representation of signs, and then generating ASL videos through motion synthesis models [49] or dictionary-based video lookup methods based on the gloss sequence [50, 54]. Given the current challenges of ASL generation systems in producing accurate and grammatically complete ASL output, the current RhymASL prototype is designed to provide ASL vocabulary supporting rhyming ASL storytelling.

Text-to-gloss translation employs neural models such as RNNs and Transformers [49, 54], and a recent approach using GPT-4o [60]. Our prototype translates text into ASL gloss using GPT-4o [1] prompts guided by handcrafted linguistic rules. These rules, developed in collaboration with two native signers with professional ASL translation expertise, include the removal of articles and be-verbs, WH-word reordering, topicalization, and other syntactic adjustments.

Each gloss token is matched to a sign video from a library of signs pre-recorded by human signers, primarily sourced from the ASL-LEX dataset (`https://asl-lex.org/`) [15, 52]. If no direct match is available, the system searches based on gloss definitions. For glosses with variants (e.g., multiple signs for the same gloss word "can"), GPT-4o selects the contextually appropriate variant. For unmatched glosses, GPT-4o pre-generates English sentences containing each gloss, and RoBERTa model [34] extracts gloss embeddings. At runtime, the embedding of the target gloss is computed and compared via cosine similarity to the precomputed list to find the sign with the most similar meaning.

3.2 Phonologically Related Signs Recommendation

The prototype supports phonology-driven sign exploration by recommending signs that share specific phonological features with a selected word. Sign feature data is extracted from the ASL-LEX database [15, 52], which includes frequency rating, iconicity ratings, and phonological description, such as handshape, movement, and location. When a user taps a word in the interface, the prototype retrieves its phonological features and identifies signs with matching features. The feature defaults to handshape initially, and users can also select location, movement, or combined mode.

For handshape, we use ASL-LEX's composite encoding of selected fingers, flexion, spread, thumb position, and thumb contact. While one single handshape may not fully represent the dynamic nature of signs, this parameter remains familiar and accessible for novice signers. For movement, we consider path movement (e.g., straight, curved, Z-shaped trajectories through three-dimensional space), internal movement, including finger changes in flexion or spread, or wrist twisting, and whether the movement is repeated. For location, we include both major location, the general area of the dominant hand at sign onset (e.g., head, arm), and minor location, which captures a more specific location of the dominant hand at sign onset (e.g., forehead). In combined mode, the system recommends signs that share the largest number of overlapping phonological features across properties, including hand configurations, movement, and location.

After retrieving signs with similar features, the prototype ranks the related signs in descending order of iconicity. Iconicity refers to a resemblance between a linguistic form and its meaning [55] (e.g., the ASL sign for "house" visually outlines the 3D shape of a house), and has been shown to support sign language acquisition [10, 36, 43]. To encourage diversity of sign recommendations [33], signs ranked by iconicity are grouped into high, medium, and low tiers. The prototype randomly selects within each tier, favoring the high tier, to balance the interpretability of signs with variability. The prototype also prioritizes unseen, phonologically related signs to broaden ASL vocabulary exposure.

3.3 New Story Generation Using Related Signs

Inspired by ASL rhymes that promote early language acquisition and a playful language experience, the prototype enables story generation using signs that share phonological features such as handshape, movement, or location. After the user explores related signs with shared features, GPT-4o is prompted to construct a new follow-up story sentence that incorporates the related signs. Users can then edit the story sentence, follow this newly generated story sentence, or return to the original story. If they choose the new story path, the system runs the text-to-gloss and gloss-to-video pipeline again. To support children's comprehension of stories by providing visual cues that complement and reinforce textual content [12, 13], the prototype also generates an illustration image based on the newly generated story sentence. The cartoon-style image is generated by prompting the FLUX-Schnell text-to-image generation model [31] with the new story sentence and returns around one second. All story sentences are stored for later revisiting.

4 User Interface

As shown in Fig. 1, the prototype features a web-based interface designed to support interactive rhyming ASL storytelling through phonological features exploration and story generation. It guides users through three main interaction stages: Story Selection, Story Playback, and Phonological Feature Exploration and Story Generation.

Story Selection View **1**: Users begin by either creating their own story in the text input box or selecting from a set of prewritten stories. Upon selection, the system translates the text input into ASL gloss and retrieves the corresponding sign videos using the method described earlier.

Story Playback View **2**: The story text and a generated cartoon-style image are shown at the top of the interface. Below, each ASL gloss word is rendered as a blue button. By default, the prototype autoplays the sign videos in gloss order. Users can also replay the full story sequence by tapping the "Story Playback" button. Clicking on any individual word brings the user into the Phonological Feature Exploration view.

Phonological Feature Exploration and Story Generation View **3**: Upon selecting a gloss word, users can choose one phonological exploration mode (e.g., handshape, movement, location, or combined) from the dropdown menu and use a slider to control how many related signs are recommended and shown. Based on

the recommended signs, the prototype automatically generates a new story sentence that continues the current sentence. Users can edit the story sentence by pressing "Edit", choose to follow this new story sentence by selecting "Explore New Story", or return to the previous one by selecting "Return to Story". If the user chooses to replace the current story sentence with a newly generated story, the Story Playback View updates accordingly, completing a loop of story construction.

5 Limitations and Future Work

While the prototype demonstrates an approach to interactive rhyming ASL story exploration, several limitations remain. First, the current text-to-gloss translation cannot fully capture ASL features. For instance, non-manual signals are not represented, and the gloss output may be inaccurate in complex contexts. The gloss-to-video step is constrained by the limited video dataset and the lack of natural signing due to individual video lookup. Our future work may explore avatar-based generation for continuous and fluent ASL signing. At this stage, the prototype focuses on introducing ASL vocabularies supporting rhyming ASL storytelling, paving the way for future integration of more natural ASL narrative generation. Second, the prototype recommends signs based on shared phonological features, which are restricted by the coverage and granularity of the ASL-LEX database. Moreover, although iconicity is used to order sign recommendations, there is still ongoing debate about the impact of iconicity on language acquisition [14, 43]. Other factors, such as sign frequency, may also be considered in future strategies for related sign recommendations. As a next step, we plan to gather feedback from experts with ASL rhyming knowledge in early education through a technology probe and a usability study [26, 27]. Future work includes gesture-based sign input, adaptive story generation based on user behavior, and family-centered collaborative rhyming ASL storytelling to support ASL interaction.

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