

PAULA: A Computer-Based Sign Language Tutor for Hearing Adults

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Abstract. This paper describes a new computer-based sign language tutor developed for hearing adults. The tutor, known as PAULA (Practicing ASL Using Linguistic Animation), utilizes the flexibility of 3D graphical animation to provide a better demonstration of signs than is possible with printed or current video sources. PAULA provides opportunities for sign language recognition study and practice that are not currently available to sign language students.

Keywords: ITS 2006, intelligent tutoring system, workshops, sign language

BACKGROUND

Hearing adults frequently need to learn sign language or refresh previously-acquired sign skills. For example, institutional staff members may need to learn sign language in order to communicate with clients in a therapeutic setting and support clients as they themselves learn to communicate. It is extremely important that caregivers develop communications systems with clients (Musselwhite & St. Louis, 1988). Successful establishment of a communication partner leads to much greater success in language learning for clients. In addition, use of sign language by residents and staff can help channel communication, reduce frustration, and facilitate positive social behavior (Kiernan, Reid, and Jones, 1982; Musselwhite & St. Louis, 1988; Rittenhouse & Myers, 1982).

Sign language is a visual-spatial language vs. the aural-oral language of most hearing adults. Learning sign language presents significant challenges to hearing people due, in part, to the difference in language modality, visual vs. aural (Poor & Wilkins, 1986). The hearing sign language learner must shift from "listening for language" to "looking for language".

Recognition and production of sign language take place in 4-dimensional space (i.e. width, height, depth, time) so sign language learners must enhance their ability to perceive changes in all four dimensions. Sign language learners also need to become familiar with the sub-units (handshape, location, movement, and palm orientation) of the signs (Stokoe, 1976/2001; Valli & Lucas, 2000), as well as the whole signs themselves. To further complicate sign language learning, there is no generally accepted method of writing sign language beyond the use of glosses, which are single word or phrase equivalents of the signs (Schein & Stewart, 1995; Wilcox & Wilcox, 1997).

Hearing people, when learning sign language, have much more difficulty recognizing signs than producing them (Poor, personal communication, July 17, 2003; Tennant & Brown, 1998). Opportunities to practice sign recognition are a necessity, but in most cases these opportunities are limited by the student's ability to find a skilled practice partner.

Another difficulty novice sign language learners face is the need to mentally rotate the person who is signing. Since most sign conversations take place with one signer facing another, the mental model of sign production is at a 180-degree rotation from the mental model of sign reception. Bellugi, Klima, and Siple (1975) describe the required rotation of mental models as transformation. It complicates and slows sign reception further (Schein & Stewart, 1995).

Some elements of sign language actually help the sign student. One of the most important is the use of handshapes to form signs. Most of the required handshapes are also letter signs of the American Manual Alphabet or variations on them. In most cases, the new signer learns to fingerspell before learning actual signs. This exercise helps the signer learn most of the handshapes required (Schein & Stewart, 1995). It also means that handshape is the first phoneme learned. Wilcox, Scheibman, Wood, Cokely, and Stokoe (1994) found that the handshape is the phoneme most likely to be perceived independently of other phonemes when identifying a sign.

PREVIOUS APPROACHES

One of the key components of any sign language training resource is presentation of the signs themselves. Since the hearing adult typically has difficulty recognizing signs, the quality of sign demonstrations, descriptive information, and related learning activities are a key to successful sign learning. The possible presentation styles include in-person, print-based, videotape, and computer/CD-based.

Until recently, most sign language instruction had been conducted in person. The most predominant techniques were face-to-face classroom instruction and practice with other signers and sign learners. However, instructors and other signers are not always available to demonstrate signs for students and the demonstrations may vary due to fatigue, signing idiosyncrasies, and other considerations.

Sign learners have also used textbooks and other printed references to reinforce learning in study sessions outside the classroom. Students would study static photographs or drawings of sign production, usually labeled with an English gloss. As noted above, sign language conversations occur in four dimensions, and to be most effective, demonstrations of sign language should also occur in four dimensions. This means that instructional tools that do not support depth or time such as printed material or still images will not be as effective as those that do.

There are also a wide variety of videotape- and computer/CD-based products, from narrated demonstrations of individual signs to videotaped instructional programs that are intended to take the learner through an entire introductory course in sign language. However, videotape-based products are limited in presentation quality and access, in large part because videotape is a sequential medium. While videotape-based materials can be rewound to show signs multiple times, the action of working with the videotape player to access specific video segments distracts the student from the learning process. Existing CD/computer-based sign language products are limited in their ability to present demonstrations at various angles, quiz content, and sign vocabulary. Some products use recorded videos of human signers, while others present animated signers.

A NEW APPROACH

The PAULA sign language tutor was originally developed for a specific population of sign language learners: institutional staff at the Jack Mabley Developmental Center, a state-operated residential facility located in Dixon, Illinois. Information gathering to support this project focused on the needs of Mabley Center staff as they learn the signs of a local variation used at the Mabley Center. Local variations are sign languages developed to serve a particular population within a closed community, such as a hospital or care center. They have a limited vocabulary that is based on the needs of the population. Local variation signs are usually borrowed from natural sign languages such as American Sign Language or an Educational Sign System and may be customized to provide memory cues (Musselwhite & St. Louis, 1988; Rittenhouse & Myers, 1982).

The PAULA sign language tutor presents sign demonstrations via a series of 3-D graphical animations. Animations of three presentation angles, front, side and top, are available for each of 170 signs that have been transcribed for the tutor. The sign transcription process records both geometric and linguistic information, such as handshape, for the sign. The geometric information is used to generate 3-D graphical animations of the sign, and the same information is available in a database that can provide descriptions of the associated sign characteristics for the learner. The transcription approach and the resulting database/animation synchronization eliminate the need for the tedious and error-prone post process of manual annotation of sign presentations used in many other products. Review of the resulting sign animations for visual accuracy provides a double check of the information. The database design (Furst, et al., 2000; Wolfe, et al., 1999) is based on the concept that the most important building block of a sign is the handshape, which is the most recognizable and memorable aspect of a sign (Wilcox & Scheibman, n.d.).

The author interviewed the Mabley Center staff to understand the needs that the tutor was to meet. This included observations of sign language classes conducted at the Center. Through an iterative process of user testing and feedback, the author created the sign tutor using Microsoft Visual Basic®. (See Figure 1)

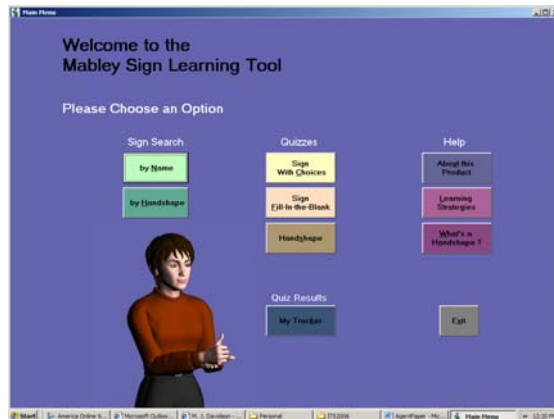


Figure 1. PAULA Main Menu

The first functions developed for the tutor were the capability for the user to look up a sign by gloss (See Figure 2) and a multiple-choice sign-quiz (See Figure 3). During a quiz session the user views PAULA demonstrating a sign and then chooses the gloss of the sign from a list of four choices.

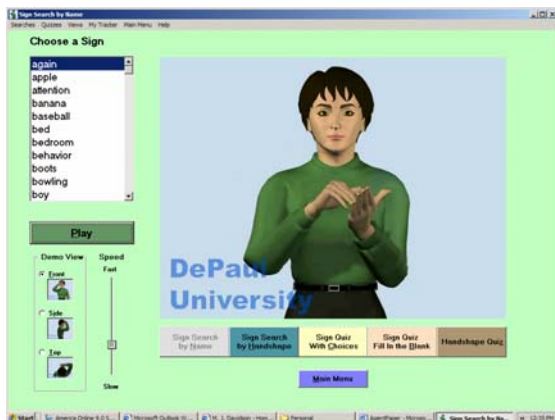


Figure 2. Sign Look-up by English Gloss



Figure 3. Multiple-Choice Sign Quiz

The user can also choose the angle of presentation --front, side, top (See Figure 4) . The side view is helpful in those cases where a sign includes location and movement that are difficult to perceive from the front. The top view is beneficial in helping users internalize the two different mental models for reception and expression.



Front

Side

Top

Figure 4. Presentation Angles

User feedback indicated that additional features would be beneficial to the sign learners. The tutor was enhanced to include an open-ended, fill-in-the-blank sign quiz and a section that documents learning strategies recommended by the sign language instructor. The second quiz format was developed for students who have progressed past the beginning stages of sign learning. When taking the fill-in-the-blank sign quiz, the user keys in a gloss that is compared with the gloss of the demonstrated sign (See Figures 5a,5b).

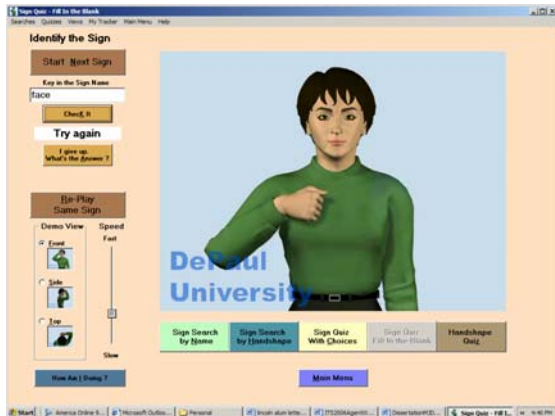


Figure 5a. Fill-in-the-Blank (TRY AGAIN)



Figure 5b. Fill-in-the-Blank (CORRECT)

Based on comments about lack of handshape knowledge, the author added a handshape quiz (See Figure 6) and handshape information reference. For all three quiz types, the user receives text feedback, either CORRECT or TRY AGAIN (See Figures 5a,5b).

The author also added a feature to allow a user to search for a sign by handshape name or handshape appearance. The user can search for signs that include basic handshapes or basic handshapes and their variants, on the right, the left or on either hand (See Figure 7).



Figure 6. Handshape Quiz



Figure 7. Sign Look-up by Handshape

In addition, the author developed a quiz results tracking function that the user can turn on if desired (See Figures 8a,8b).



Figure 8a. Quiz Result Summary

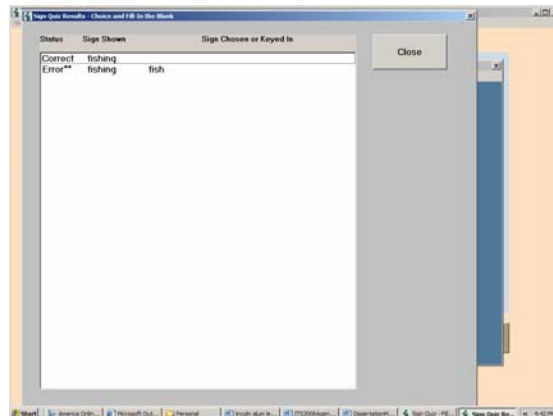


Figure 8b. Sign Quiz Report

One of the most recent enhancements to the PAULA tutor has been the addition of a speed control. This control allows the user to modify the pace of the sign demonstration and is particularly useful when a sign is complex or includes more than one handshape.

The PAULA tutor:

- Focuses on development and practice of sign language recognition skills.
- Provides consistent demonstrations of signs at three different performance angles.
- Presents and reinforces the sign vocabulary of the local variation to be used by the learner
- Allows the user to control the speed of sign presentation
- Gives text feedback on three different types of quizzes (open- and closed-end sign and handshape)
- Tracks quiz performance upon user request.
- Allows the sign language learner to control the practice and feedback process.

The PAULA tutor has been packaged and distributed to Mabley Center staff members and families of Mabley Center residents. User comments have been very favorable and a second distribution was requested. This distribution was completed earlier this year.

The Mabley Center PAULA tutor can be used by hearing adults to learn and review sign language at times compatible with their individual schedules. The design of PAULA is centered on the needs of sign language learners and the iterative nature of the development cycle has provided many opportunities for the sign learners to make their needs known. Mabley Center staff and residents will continue to derive associated benefits from improved communication based on more confidence and skill in using sign language.

The Mabley Center Sign Tutor is also being used as the framework for sign tutors for other venues, including a major Chicago hospital.

FUTURE WORK

The author would like to develop and implement enhancements to the PAULA tutor that include more precise feedback based on the user's performance history and characteristics of sign language. Other potential development avenues include modification of tutor characteristics to make them less dependent on English glosses, (e.g. presenting feedback in sign language where appropriate) and work toward a full-featured computer-based sign language dictionary.

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ACKNOWLEDGEMENTS

The author would like to thank Dr. Rosalee Wolfe, and Dr. John McDonald, continuing support. In addition, she would like to thank all of the staff of the Jack Mabley Developmental Center, Sharon DeBerry, Nick DeLeonardis, JoAnn Hiatt, Robin Roux, Steve Caudillo, and the Dixon Area Retarded Citizens group for their important contributions to this project and for their support. Thanks must also go to the transcription team; Bret Kroll, Lori Smallwood, Cynthia Dwyer, "Sunny" Srinivasan, Brent Shiver, and Roymieco Carter.