Owl Pellets and Head-mounted Displays: A Demonstration of Visual Interaction for Children who Communicate in a Sign Language

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ABSTRACT

This demonstration will provoke discussion of the role of head mounted displays (HMD) in Deaf science education for children. The demonstration mimics the classroom laboratory experience of children who are Deaf or hard-of-hearing. When these children dissect an owl pellet, their teachers can not stand behind them and offer instruction over their shoulder while the students looks at the specimen. A teacher can sign for the student but this requires the student to switch visual attention back and forth between the specimen and the signing teacher. This can be difficult if the specimen is on a table and the teacher is standing nearby. HMDs allow students to put the signing teacher and the laboratory specimen in close visual proximity. Participants in our demonstration will be given an owl pellet study kit and no verbal instruction. Participants will be asked to use visual aids to identify bones in the pellet. Some participants will view the visual aids on a poster placed behind them. Others will view visual aids in an HMD.

Categories and Subject Descriptors

H.1.2. [**Information Systems**]: User/Machine Systems—*human factors, human information processing*;
H.5.2. [**Information Interfaces and Presentation**]: User Interfaces—*evaluation/methodology, prototyping*

Keywords

American Sign Language, STEM Education, Head-mounted display

1. INTRODUCTION

Our aim is to facilitate interaction between children and teachers communicating in sign language in logistically challenging learning environments. We define "logistically challenging environments" as environments in which visual learning materials are distributed over a large fraction of the students' field of view. These environments are particularly difficult for students that communicate in sign language because the student must see the speaker in order to interact with the speaker. If visual aids are spread over a large area, then the student must split their visual attention between the signer and visual aids. For example, an environment containing a single speaker with no visual aids is not logistically challenging because visual attention is focused only on the speaker. A planetarium dome or a museum field trip can present a logistically challenging environment because visuals can be spread over a large visual area.

We focus on educational settings because they are among the most logistically challenging. In museums, field trips and other settings in which visual aids can be spread over a wide area. Even in the classroom visual aids and visual instruction in sign language can be distributed over a wide area. Our target population is deaf or hard-of-hearing (DHH) children from age 8 to 18. Sign language is important for these children in an educational setting because DHH children often acquire the ability to read English at a slower rate than their hearing peers. This makes captions and other techniques based on written languages, particularly ineffective for acquiring new vocabulary or learning new concepts.

Teachers of DHH students successfully teach children in sign language. These teachers manage the students' visual attention and pause at appropriate times. Careful eye contact allows both students and teachers to pay attention and to sign at the right times. However, head-mounted displays (HMDs) may create new possibilities for teachers of DHH students.

HMDs have been in development for over fifty years and have been available for consumer use for many years. HMDs are often used in augmented reality (AR) applications that overlay virtual information onto the physical world. Presenting sign language to children in an HMD is a new application which is different than prior work involving HMDs. However, it is not clear how to present sign language to children

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Figure 2: Two owl pellets and contents. Participants will be asked to discover and identify the contents of an owl pellet. Objectives and information will be given only using visual resources.

in a HMD and it is not clear if viewing sign language in a HMD will be useful or comfortable to DHH children.
This demonstration provides a very small insight in the difficulty that DHH students experience in a lab setting at school. The demonstration is summarized in Figure 1. Some participants, like the student on the left, will dissect an owl pellet while splitting attention between the specimen and the instructions. The instructions are intentionally placed outside the participant's field of view when the participant is looking at the specimen. Other participants, like the student shown on the right, will view instructions in an HMD. We hope that our continued research with deaf/hoh children and the use of HMDs will provide a means to reduce the increased cognitive costs that split-attention causes.

2. THE DEMONSTRATION

2.1 The Experience

Participants will be invited to dissect an owl pellet while receiving visual instruction in an HMD. The owl pellet will be wrapped in a protective layer of paper. An owl pellet is a mixture of undigested food regurgitated by an owl. Figure 2 shows two owl pellets on the left with contents on the right. These pellets contains hair and bones. A pellet might contain hair, teeth, seeds, bones and other matter. Scientists examine pellet contents to learn about owl diets. Students examine owl pellets in order to learn about the food chain and to identify bones in the skeletal system. The wooden probes are used to pry apart the pellet in order to examine the contents.

Participants will be asked to locate, classify and count bones found in the pellet. The objective is to add to a shared chart which tracks how many of each kind of bones have been found by all participants. Only visual instruction will be given regarding the objective of the task and the kinds of bones in the pellets.

Visual instruction will be given either using a poster located behind the participant or in the HMD. The visual instruction consists of a description of the purpose and goals and a bone identification chart. Instruction given on the poster behind the participant simulates the challenge of performing a visual task while attending to instructions located outside the field of view.

There will be four HMDs to choose from: a Vusix Tac-eye, Laster PMDG-1 displays for either the left or right eyes and an Epson Moverio BT-100. All three models are shown in Figure 3. The Vuzix Tac-eye LT, which weighs 51 grams, uses a 800x600 pixel display which partially blocks the eye. This display offers a 30 degree horizontal field of view. The display was attached to Oakley SI Ballistic M-frames with a clear lens. The display can be attached to either the left or the right side of the glasses.

The Laster displays are see-through with a 40 degree horizontal field of view and offers a resolution of 800x600. These displays project the image onto a curved mirror placed in front of the eye. Displays for either the left or right eye will be available at the demonstration. The eye box, which is the volume of space in which the display is visible, is quite small and requires careful adjustment and handling to ensure that the display does not move during use.

The Epson display is a consumer-grade binocular see-through display at a resolution of 960x540 . The field of view is 23 degrees. This display weighs 220 grams and is the largest of the three.

2.2 The Discussion

The demonstration invites participants to consider a child's experience using HMDs in visual-only instruction while performing visual tasks. Participants will evaluate how seeing visual instruction in an HMD creates a different experience than seeing visual instruction on a piece of paper placed in an awkward position. We invite participants to consider how this experience might reshape a child's classroom experience and to consider how this might reshape education for children who communicate in sign language.

3. POPULATION

The target population for our work is children age 8 to 15 who communicate primarily in sign language. We include children in both hearing classrooms who use an interpreter and children in sign-only classrooms in which instruction is given directly in sign language.

Sign language is important for these children in an educational setting because DHH children often acquire the ability to read English at a slower rate than their hearing peers [3]. This makes captions and other techniques based on written languages, particularly ineffective for acquiring new vocabulary or learning new concepts.

4. RELEVANCE TO INTERACTION DESIGN FOR CHILDREN

4.1 Relevance to Others' work

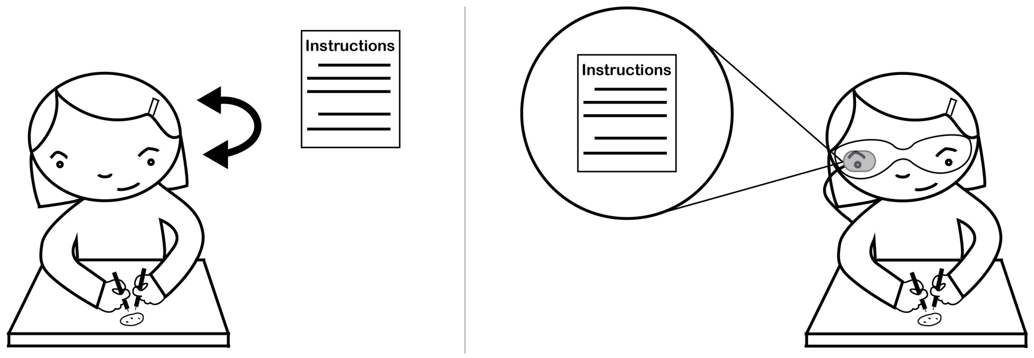

Figure 1: The purpose of the demonstration is to illustrate that the placement of visual instructions is significant. This will lead to a discussion of how HMDs might change the education experience of children who are deaf or hard-of-hearing and who communicate only visually.

Figure 3: Examples of HMDs, made by Vuzix, Laster and Epson. Each display offers a different viewing experience for participants dissecting owl pellets.

In this demonstration we consider presenting sign language on an 800 by 600 pixel display. Weaver et al.'s evaluation of sign language viewed on small mobile displays at varying video qualities suggests novice viewers could understand and repeat displayed signs equally well regardless of video quality [4]. In the study, video was viewed at a size of 60 mm wide and 45 mm high at resolutions of 640x480, 320x240 and 160x120 pixels on a hand-held portable phone. While viewing sign in an HMD involves a different viewing sizes and distances, Weaver et al.'s results indicate that the 800x600 resolution of an HMD is likely to be good enough for viewing sign.

Translation is a common theme in work involving sign language and technology. Translation is an interesting problem because it also involves video rather than audio processing. [5] classify signs to verify the correctness of a child's response to a sign language tutoring program. Signs are classified using a forward and backward pass model, essentially considering possible phrases both forward and backward, using a confidence model and accelerometer data from gloves worn on the signers' hands. This work is particularly relevant since it also involves children but the intent in [5] is to teach sign language while our demonstration fosters discussion about technology to teach *in* sign language.

Adamo-Villani et al. pursue technology for teaching in sign language as well, but they explore sign shown using 3D computer animated avatars [2] [1]. In this demonstration we will present no sign language in order to make the demonstration accessible to persons who do not know sign language. But the demonstration is intended to raise questions about viewing sign language in an HMD. Adamo-Villani's work provides another source, beyond filming people signing, of sign language instruction and might be part of a different experience.

4.2 Relevance to Our Own Work

This demonstration is relevant to our investigation of sign language viewed in HMDs. Our work investigates how to configure HMDs for use by children viewing sign language in an educational setting. In our work, we invited 9 children ages 5 to 18 who sign to use the partially opaque Vuzix HMD to view sign language while viewing video on a large screen.

Open coding of English transcripts of American Sign Language interviews with these individuals suggests that they were excited about being about to move their heads and still see a signer while viewing sign in an HMD. However, three themes emerged from the interviews: discomfort, split focus and signer position. Children found the partially occlusive Vuzix display distracting and uncomfortable. The display is heavy and had not been balanced. Adding weight to balance the display may have resulted in a more comfortable experience. Some children found it difficult to split their visual attention between the signer and the video while others did not. Finally, children expressed preferences about the position of the signer in their field of view with a slight preference for the signer placed in the center of the field of view.

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