I-Eng: An Interactive Toy for Second Language Learning

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Figure 1: A boy interacting with I-Eng. When he present tagged objects to the talking doll and it reacts by speaking

Abstract

We present I-Eng, an interactive toy set aiming to teach new languages to young children between the ages of 3-5. The toy consists of a talking plush doll that interacts with tagged objects. The doll speaks sentences related to the objects that are nearby and, depending on the context, can ask the child for other related objects. In this way, both active and passive vocabulary are practiced. Through interaction with tangible objects, an unscripted narrative unfolds, resulting in natural exposure to the foreign language and a playful "learning by doing" experience. Using the accompanying storybook, caregivers can participate and aid in the learning process together with children.

Author Keywords

Language learning; Tangible interfaces.

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces;

Introduction

The ideal scenario in language education is children learning new words and sentence-building skills on their own. This way of learning is naturally done in native language acquisition. However, natural acquisition of a second language is difficult, as children

have less exposure to a second language compared to their native tongue. Therefore, current second language education is mainly based on external support from teachers and adults capable in the second language.

One approach to helping second language education get closer to the natural acquisition model of native language learning is to include language elements in toys, which are always around children. Play is one of the main learning activities of children. We aim to expand second language exposure to children by introducing tangible language toys to support their language learning experience. Among various types of activities, free form role play is selected. This is to provide a learning opportunity to young children, who may have difficulties in understanding organized games and rules [5].

In this paper, we propose an interactive second language learning toy named I-Eng. Diverse stories are made by role playing with the I-Eng, and the toy speaks sentences corresponding to the situation. By trying out various interactions, children "learn by doing" [1, 2] with context-related words and sentences. This differentiates I-Eng from other existing language learning toys, which are limited to providing simple words and pre-input sentences. We expect the language model to be built naturally inside children's minds by them engaging in various actions, and observing the reactions of the toy.

I-Eng targets children aged 3-5 years old, an age appropriate for starting second language learning, yet still too young for children to start learning languages through studying, or in activities with organized rules.We present the overall system and interaction details of the toy and explain how we implemented a

Figure 2: The talking doll and tangible object toys

Figure 3: Inside the storybook with formfitting recesses for objects.

working prototype. The paper concludes by explaining the potential of the design and future work to be done.

I-Eng Design

Components

I-Eng consists of three parts: a talking plush doll, a set of tangible object toys (Figure 2) and a storybook. The talking doll is the main part, giving interactive feedback to the user, and the object toys come as a group with themes such as food, transportation, plants, etc.

A themed object set provides language expressions related to the theme. In the prototype, we made a set themed "Snack Time" with 4 objects, namely a piece of bread, an apple, a teacup, and a seat cushion.

When the user puts the tangible objects in front of the doll, it detects and identifies the objects and speaks sentences corresponding to the situation.

The storybook (Figure 3) has formfitting cutouts corresponding to each object in a set, serving as storage for the toy pack. The book contains essential expressions related to the theme pack. As the user flips the book's pages, the objects are revealed one by one. This prompts the user to give the objects to the doll in sequence, and introduces important expressions that might be missed in free play.

Interaction Design

The interaction can detect multiple objects at once and give different responses reflecting the object combinations, e.g. "A piece of bread! What a perfect match with my warm tea," when the cup and bread toys are placed in front of the doll, and "Let's make apple juice," when a cup and an apple are placed together. Due to technical limitations, only up to two objects can be detected by the talking doll prototype. The interaction state machine was designed to
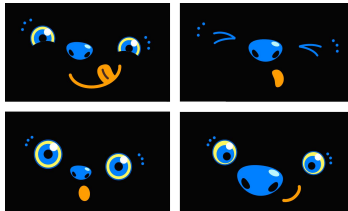
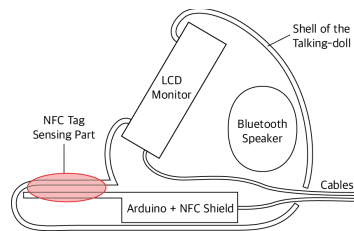Figure 4: Different facial expressions in the interaction.

Figure 5: The hardware design (side section view of the doll)

incorporate states, in which the talking doll detects zero, one or two objects.

The system keeps track of the tagged objects placed near to the doll and models responses based on three states. An *approach state*, where a tag that has not been previously detected is newly detected, an *idle state*, where a tag is continuously detected for more than 5 seconds, and a *loss state*, where a tag that has been detected is lost. When the bread is newly detected (*approach state*), the doll says "Umm, the bread smells so nice." When the bread doesn't move for more than 5 seconds (*idle state*), "Would you pass me some water, please?", and when the bread is put away (*loss state*), it says "I want to eat something else, too." The system remembers information from the tags in the previous step to determine which tag has newly arrived or been removed.

Facial expressions (Figure 4) have been added to help children recognize the doll's social character and support understanding of the language [6]. Different looks are assigned depending on the mood of the response sentence. For example, when the doll says, "Thank you," it smiles, and when it says "Ouch, my behind hurts," it frowns. The facial expressions use stop-motion animation, moving as the doll speaks. In the prototype, the audio was manually voice-recorded, so we limited the options to only one response per discrete situation. The prototype has 4 tag objects, 66 response sentences, and 7 different facial expression animations.

User Scenario
I-Eng is designed for both children learning a second language and their caregivers. The interaction design supports two scenarios.

In the free play interaction scenario, a caregiver provides I-Eng to a child, and the child plays freely and independently with I-Eng, introducing various object toys to the talking doll. The child learns second language words and sentences. As it is important for the caregiver to be able to monitor the progress of the child, the doll collects usage data, and in the future might set difficulty levels as well.

In the guided interaction scenario, a caregiver reads the storybook that comes in the object pack, and role-plays synchronously with the guided sequence of object toys and the talking doll. This guided interaction following the storyline emphasizes important expressions.

Prototype Implementation
The talking doll prototype was built using Arduino and Processing. An Arduino board with an NFC-shield has been embedded inside the doll (Figure 5). The board is connected to a laptop with the Processing code. An LCD monitor and a Bluetooth speaker are also embedded inside the doll, and these two devices receive signals from the laptop through Processing. The monitor shows the facial expression of the doll using stop-motion animation.

The NFC-shield used in the prototype has a tag detection distance limit of approximately 5cm. To decrease detection misses and make the act of positioning the object toys stable, we placed the NFC shield on the lower front part of the prototype, the lap, as shown in Figure 6. The part is covered by the doll's tail, and the detection plate is a bright orange color to help users easily learn where to place objects.

The object toys have been 3D-printed in shapes familiar and interesting to children, such as an apple, a

teacup and a slice of bread. NFC tags are embedded inside each object, enabling the system to identify them.

Conclusion and Future Works

We have introduced an interactive doll and toy set which applies "learning by doing" in second-language learning for young children. The design provides tangible objects children can easily play with to produce immediate responses. Children engage in dynamic storytelling throughout play, learning new words and sentences within the context of the story.

The current prototype has a simple interaction system with only 4 object toys. As we plan longitudinal studies and are expecting children to use I-Eng frequently, the learning materials need to be engaging and rich in their contents. We hope to increase the number of tags and provide varied object toys for children to play with. In addition, enabling the system to tag existing objects could be a way to embed the learning experience into the children's environment [3, 4]. If more than two objects are detected at the same time in the prototype, we will be able to design a more accurate algorithm for guessing user actions and providing better matching responses. We are investigating the use of an AI system with a voice synthesizer.

The storybook that comes with the toy is to guide children in learning the most essential lessons. Studies on how to make the book interactive, and how interaction between the book and the child can better encourage children to perform the expected actions, would make the learning process even more effective. Improved versions of the prototype might use an embedded smart phone instead of a dedicated display. Other types of tags to identify objects could be considered to overcome the limitations of the current prototype.

References

1. Seymour Papert. 1980. *Mindstorms, Children, Computers and Powerful Ideas*. Basic Books, Inc.

2. Seymour Papert and Idit Harel. 1991. Situating Constructionism. In *Constructionism*. 1–11.

3. Suhwa Lee and Young Yim Doh. 2013. iSpy : RFID-Driven Language Learning Toy Integrating Living Environment. CHI '13 *Extended Abstracts on Human Factors in Computing Systems*, 697–702. http://doi.org/10.1145/2468356.2468479

4. Helma Van Rijn and Pieter Jan Stappers. 2008. The Puzzling Life of Autistic Toddlers : Design Guidelines from the LINKX Project. *Advances in Human-Computer Interaction* 2008, 1–8. http://doi.org/10.1155/2008/639435

5. Peter K. Smith and Anthony Pellegrini. 2008. Learning through play. *Encyclopedia on early childhood development*, 1–6. Retrieved from http://www.child-encyclopedia.com/pages/PDF/Smith-PellegriniANGxp2.pdf

6. Jacqueline M. Kory, Sooyeon Jeong, and Cynthia L. Breazeal. 2013. Robotic Learning Companions for Early Language Development. *Proceedings of the 15th ACM on International conference on multimodal interaction*, 71–72.