VIRTUAL CHARACTERS VERSUS SOCIAL ROBOTS: A FUTURE COMPARATIVE STUDY OF SOCIAL AGENTS FOR ENGLISH LANGUAGE TEACHING

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ABSTRACT

This work describes the prototype of a virtual agent supporting the teaching of English as a second language with Spanish speaking children at the pre-school level. The prototype includes Object Recognition, Speech Recognition, and an Intelligent Virtual Agent (IVA). The preliminary qualitative evaluation of the last prototype suggests that a virtual agent engages with the infant users better when the activities include storytelling and gamification. We also propose to do similar implementation using a social robot prototype previously described in [11] to compare advantages and limitations in the interaction with infants learning a second language.

***K*eywords** Virtual Characters · Social Robots · English Learning

1 Introduction

The ability to learn a second language is different for each person during their lives. Native language, lexical skills, and reading ability developed during human life [1] are conditioned to particular neural connections in the brain. The cognitive process of learning a new language is still not well know. However, a significant number of methods for learning a second and a third language have been developed along with human history.

When talking about children, motivation and curiosity are critical when learning a new language. Children learn their native language in a continuous loop conditioned by the surrounding environment and stimuli. However, the stimuli required for a second language learning are not present with the same frequency compared with stimuli for native languages. Second language teachers face multiple challenges when developing skills related to the second language in children. Consequently, this critical skill that could allow better professional opportunities for kids in the future requires additional support materials and innovative methods relying on advanced interactive technologies. Interactive technologies as social agents (virtual and social robots) offer broad possibilities to improve the teaching of second languages for children compared with traditional methods if appropriately designed.

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This work describes the prototype of a virtual agent supporting the teaching of English as a second language (limited to a small vocabulary) with Spanish speaking children at the pre-school level. After three design iterations, including feedback from experts, we incorporate two fundamental Interactive Design Concepts: Gamification and Story-Telling, to increase infant users' engagement. The prototype includes Object Recognition, Speech Recognition, and an Intelligent Virtual Agent (IVA). The preliminary qualitative evaluation of the last prototype suggests that a virtual agent engages with the infant users better when the activities include a linear rational in terms of storytelling and gamification is implemented for the learning tasks.

As a second stage, we propose to do similar implementation using a social robot prototype previously described in [11] to compare advantages and limitations in the interaction with infants learning a second language.

2 Background

An initial literature review suggests that interactive technologies provide efficient support in learning languages compared with traditional methods. The social, emotional interactive learning of a language has been discussed by Hinton et al., in [2]. They conclude that emotional engagement plays a central role when learning a second language in the early stages of human development. Similarly, Mohammed and Watson suggest that educative robots would improve significantly in the next years and will be an efficient instrument supporting learning and teaching activities [3].

Like Mohammed and Watson, Pretzas forecasts that robots can provide advantages compared to computer-based learning systems due to emotional engagement triggered by the emotional display and dynamic response when interacting with children.[4]

Previous studies like the Macedonia et al. work [5] suggest that infant users still provide higher sympathy scores to human trainers; however, the overall difference between their perception of virtual and human trainers was not significant. As researchers, we find this work inspirational and triggers the exploration of better interactive scenarios that could increase engagement with the infant users and social agents' as language trainers.

Another research team lead by Macedonia [6] has tested Intelligent Virtual Agents (IVA) to teach foreign languages with adults and twelve-year-old users using an unknown artificial language. They conclude that this method's effectiveness for teaching vocabulary is high, but they did not implement or compare with other interactive technologies as social robots with a physical body.

A recent review suggests the enormous impact of social agents in roles as tutors, classmates, teachers, and learners in future education Belpame et al. [7]. The use of IVAs in language teaching and learning has shown advantages in cost, portability and individualised learning of the experience compared with human trainers. However, further explorations and comparisons among IVAs are required, including social robots. Likely, IVAs and social robots will positively impact the learning experience in cognitive and emotional ways when used as helpers for particular educative tasks.

3 Description of the Virtual Agent Prototype

At this first stage of this research, we have developed a prototype of a social agent. The goal is to support English words learning by pre-school- age users (3-5 years old). The native language of the users is Spanish. The virtual agent was implemented in Unity using a free 3D model and incorporates Object Recognition developed in Python and speech recognition using Google Speech API. The object recognition module can identify ten objects in frontal view(about 92% reliability on average) using the You Only Look Once (YOLO) method [10] and the speech recognition displays an efficiency of 90% after three attempts. The words identified by the IVA are Frisbee, banana, apple, orange, cup, book, spoon, fork, teddy bear, ball. See Figure 1.

The pronunciation of certain words in English presents significant challenges to Spanish speaker infants after the third attempt. To avoid frustration in the users, the robots' controller allows any input after the third attempt. After an initial implementation to test the modules' integration, we tested the system with one infant user and observed disengagement and frustration. Following the method proposed by Nielsen et al., [8, 9], we consulted six experts in pedagogy, and we found the main areas of improvement to engage with the user. We implement the gamification of the learning task. The infant played the game "I see I see" to identify objects in the room and name them using the proper English word. Similarly, we use storytelling to provide purpose to the learning activity. The virtual agent suggests that she requires help from the user to collect objects in her magic hat. See Figure 2a 2b.

Due to COVID restrictions, we have just one observational case study with a female user (five years old). We recorded positive results (higher engagement and accomplishment of two interactive tasks) than the initial test with the same user.

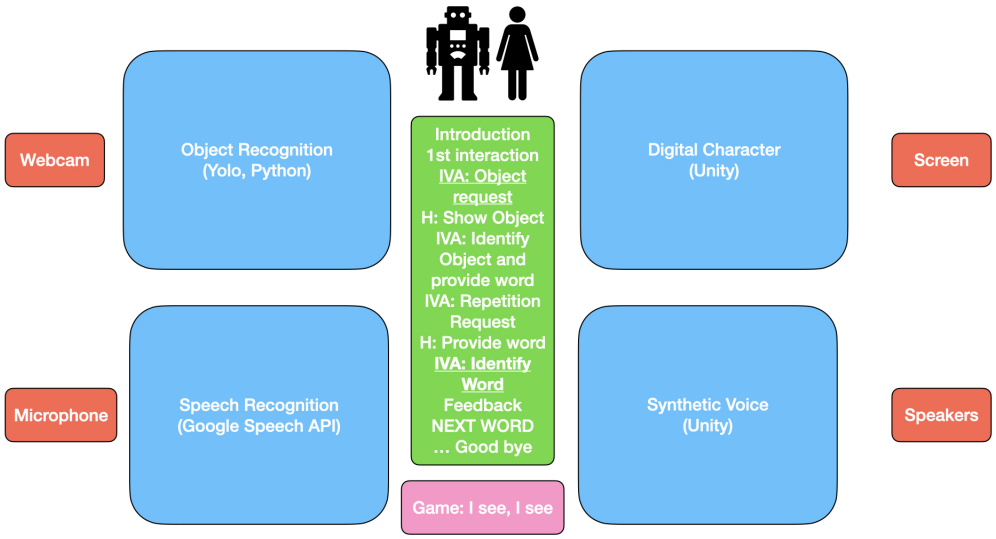

Figure 1: Architecture of the final prototype.

(a) Young adult interacting with virtual agent.

(b) Child interacting with virtual agent.

(c) Child interacting with the 2nd prototype of the virtual agent.

Figure 2: Three different stages of development of the prototype.

4 Research goals and future work

We have developed a functional prototype in three design iterations; we improved it using the feedback of six education experts and observed the interactive system's performance with one user in two test sessions. Finally, we observed positive results when pedagogic feedback was incorporated, and the same user engages significantly more with the IVA.

This project is an early-stage prototype and further tests and validations are required. In parallel, we are working on technical improvements in reliability, robustness and usability of future prototypes. We need to highlight that the design and development of this IVA is a novel area for our team. Hence, we consider that three critical areas should be further developed to understand better the gains of using interactive systems supporting the learning of a second language. These areas are Background of IVAs in language teaching, quantitative evaluation, and comparative studies with different social agents.

Firstly, we require a more comprehensive literature review to establish the underlying philosophy guiding the prototype's design. Similarly, we need to establish a robust theoretical framework explaining the gains in the use of IVAs comparing with other methods.

Secondly, we require extensive qualitative and quantitative testing and evaluation with a significant number of users. Our initial observations are promising. However, the usual metrics of usability and user's perceptions can provide valuable information for future developments.

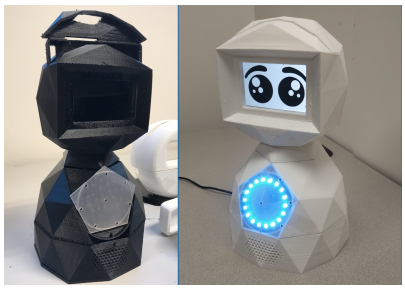

Figure 3: Social Robot to be used in future comparative experiments with the IVA

Finally, we aim to compare this IVA with a prototype of mobile social robots performing the same interactive scenarios. We will explore each of the robots' advantages and limitations when performing interactive language learning tasks with infant users. We consider that a 3D printed prototype of a Social Robot to interact with Dementia Patients could be a suitable platform for the current goal described in this paper. The robot mentioned above is described in [11]. See Figure 3.

Social robots with physical bodies could present certain advantages. For instance, they are socially situated in the same room with the infant, and the interaction provides further advantages in terms of mobility and physical interactivity. The setup used with the IVA can be adapted in the social robot, and both scenarios can be compared using usability metrics and well-know scales as Godspeed and NARS to define the user's perceptions. Our future work could be relevant to decide which Social Agents are more suitable for particular educative tasks requiring highly social interactive engagement. Future research questions are: To what extent virtual and physical agents can be compared? and What are the critical factors that make more efficient in the long-term one agent over other?

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