Ogma – A Virtual Reality Language Acquisition System

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ABSTRACT
One of the traditional methods of learning a new language, or Second-Language Acquisition (SLA), is immersion, seen today as one of the most effective learning methods. Using this method, the learner relocates to a new place where the target language is the dominant language, and tries to learn the language my immersing themselves in the local environment. One of the disadvantages of this method is that relocating to a new place is not always a viable option. That's where Virtual Reality (VR) can come to our rescue. VR is an immersive technology that allows the user to wear a head-mounted display to be immersed in a life-like virtual environment. In our research, we explore the possibility of utilizing the power of VR for SLA by building a system called Ogma, which helps users immerse themselves in an environment representing a foreign place. In our pilot study, we built a VR system and performed user studies by comparing learning performance using VR against the traditional method. In both cases, users were given a set of ten Swedish words to learn. Results indicated that percentage retention using our VR method was significantly higher than that of the traditional method. In addition, the effectiveness and enjoyability ratings given by users were significantly higher for the VR method. This proves that our system has potential impact on SLA by using VR technology, without suffering the disadvantages of the traditional method.

Categories and Subject Descriptors
H.5.1 [**Information Interfaces and Presentation**]: Multimedia Information Systems – *Artificial, augmented, and virtual realities*.

General Terms
Design, Experimentation, Human Factors.

Keywords
Virtual Reality, Language Acquisition, Learning

1. INTRODUCTION
Immersion is often believed to be the most effective method of language learning. Being placed in a setting in which the target language must be used provides immense learning motivation and exposes the learner to a vast amount of content. However, it isn't always reasonable for a learner to immerse themselves by, for example, living in another country. There is high economic and social incentive to develop better foreign language learning methods.

Virtual reality is an emerging technology that shows a high degree of potential in a wide array of fields, including entertainment, healthcare, and education [7]. Language learning is a realm in which virtual reality has had very little application, with very little research found.

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Applying virtual reality to language learning would allow learners to experience virtual immersion, with the convenience of home. The resources required to develop a fully immersive virtual language learning environment would be immense, but reasonable for a large company to develop. Due to these limitations, we focus only on vocabulary in this study, corresponding to tangible objects.

In order to assess the effectiveness of this virtual reality method, we use a control group of participants that use a traditional method of language learning on the same list of vocabulary. This traditional method consists of a list memorization session and a flashcard study session.

In this paper, Section 2 describes the related work done in this area. Section 3 describes the implementation of our proposed virtual reality language learning system. Section 4 and 5 describe the experiment carried out on nineteen subjects and the results of these experiments.

2. RELATED WORK
Research on using technology to assist with language learning has been ongoing for many years, but technology remains a small part of language learning in the classroom [2].

Research on virtual reality in other areas of learning finds that virtual reality can be successfully be applied in a learning environment where there is a significant lack of knowledge regarding the technology [4].

One of the benefits of learning in virtual worlds is that users don't face the same risks and consequences associated with making mistakes in the real world. Just as interaction is found to be beneficial to learning, interaction can be simulated in virtual reality for the same benefit [3]. Emotion detection can be used together with virtual reality to tailor the learning to the student's needs.

In a study assessing the benefits of telepresence in a foreign-language virtual world, higher levels of interaction and investment were found to create increased feeling of immersion, depending on a variety of factors depending on the video game, video, etc. [1].

In an experimental study on display fidelity and interaction methods, it was found that higher fidelity interaction methods, such as Kinect, paired better with high fidelity displays, such as Oculus Rift, where low fidelity interaction methods, such as keyboard and mouse, went better with low fidelity displays, such as a computer monitor [5].

The only similar content found on language learning in virtual reality was that of a startup company called Learn Immersive with a similar concept, focused on school children, for students to take a "virtual field trip" to real world locations to in virtual reality to simulate being immersed in the country of the target language [6].

Doing tasks in virtual environments can be so immersive that a person can forget they are not in a fake world. Presence is often described as the "sense of being there" [8]. In more detail, it refers to the degree to which a person feels rather in the virtual

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environment than in the laboratory used for creating the presented stimuli [9, 10]. A person's memory is impacted by audio and visual cues they get from the environment. Text remains in short term memory if it is not revised till a certain amount of time. [9] describes vividness of visual imagery and source memory for audio and text. [8] describes audio-video correspondence and its role in attention and memory.

Despite significant research and development in the 1990s, the immersive VR experiences did not reach consumers. [11] posited a number of reasons for this, such as that the technical quality of HMDs was considered poor (in terms of resolution, Field of View (FOV), comfort, motion sickness, etc.), socialization was not facilitated (with users unable to interact with others), the graphical quality of the rendered scenes was poor, and the cost was prohibitive. However, many of these issues are on the verge of being addressed, e.g. the Oculus Rift's DK2 features a 1920x1080 low latency OLED display. As such, high quality HMD with accurate head tracking are on the verge of being widely available. However, interacting with reality remains a challenge: existing consumer HMD such as the Oculus Rift or Gear VR1 do not yet incorporate the sensors needed to adequately track hands, identify objects, or provide a wide-angle FOV of reality.

3. IMPLEMENTATION

The traditional method was implemented by printing a list of English terms beside their corresponding Swedish terms. The flash cards were hand-made, with English written on one side and Swedish on the other.

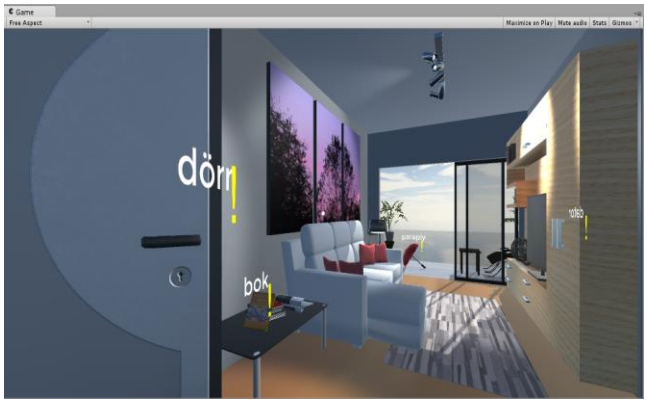

Figure 1 – Virtual Learning Environment

The virtual reality environment, shown in Figure 1, was created in the Unity game engine, using a combination of custom-made and downloaded assets. Choosing the best input method was initially an obstacle, and many possibilities were explored for locomotion in the virtual environment. We decided upon using a Myo armband for locomotion, with the user pointing their arm forward to move as shown in Figure 2. In pilot studies, users found this to be the easiest method of locomotion. In addition, classical music was set to play in the background during learning, as users found this to add to the immersiveness of the environment and improve their focus.

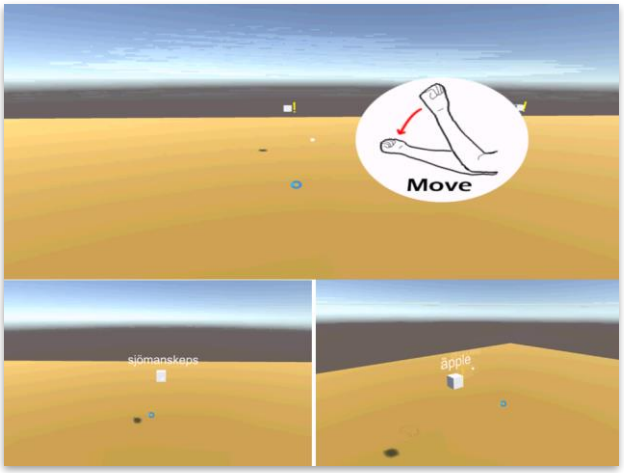

Figure 2 – High Fidelity Prototype

Figure 3 – Virtual Practice Environment

Because of the learning curve associated with navigation, a practice environment, shown in Figure 2, was developed so participants could practice moving around using the Myo armband before entering the learning environment. They were given ample time to become familiar and comfortable in virtual environment and navigate it with ease. Participants were given a pair of headphones, as well.

Objects relevant to learning in the virtual environment were marked with exclamation points, as shown in Figure 1. When users approach and look at the object, the Swedish text is displayed above the object and pronounced. Meanwhile, a five-minute timer runs down.

Once the timer runs out or the user chooses to skip forward, a second phase is entered, in which the explanation points are removed and objects no longer display text. Instead, the Swedish words is shown and pronounced directly in the user's view, and they must point to the corresponding object by going near the object in the virtual environment. Once each object has been completed, a message is displayed that they may remove the headset.

4. EXPERIMENT

Twenty student volunteers were chosen as participants out of which nineteen participants successfully completed the user study. They were randomly placed in either the traditional or virtual reality group.

Traditional group participants were first given a list of ten Swedish words and their English equivalents and told to study them for up to five minutes. The words were read out loud to them, repeated upon request. Then, they were given flash cards corresponding to the words, and told to study them until they felt they were ready for the test.

Figure 4 – Virtual Reality Experiment

Virtual reality group participants entered a virtual practice environment where they could become accustomed to navigating virtual reality. Then, they entered the virtual apartment and were allowed to explore freely for up to five minutes, looking at objects to see and hear the corresponding Swedish words, as shown in Figure 4. Afterward, they entered the second phase, in which the Swedish words were displayed and pronounced and participants had to point to the corresponding object, until each was complete.

After training, both groups took a test in which they were given the list of English words and told to write and pronounce the corresponding Swedish words. For each word, participants were graded on both spelling and pronunciation with correct, almost correct, and incorrect, with correct being completely accurate, almost correct being fully comprehensible but not completely accurate, and incorrect being incomprehensible or missing. 5 points were given for correct, 2.5 points for almost correct, and 0 points for incorrect, for a maximum total 100 points.

Participants then made an appointment to return one week later for a follow-up, and were told not to review the terms. Upon return a week later, they took a post test that was exactly the same as the first. Finally, participants filled out a survey to provide feedback on their experience.

5. RESULTS

5.1 Objective Metrics

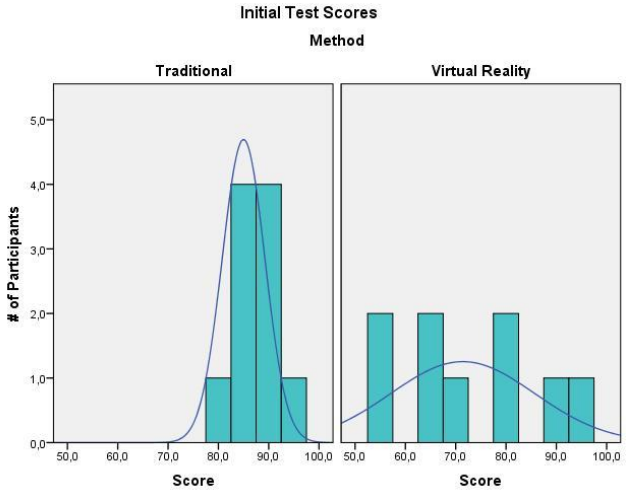

Figure 5 – Initial Test Scores

Initial test scores, taken immediately after training, can be seen in Figure 5. There was a significant difference in these initial test scores, with traditional scores (M=85.0, SD=4.25) being higher than virtual reality scores (M=71.39, SD=14.31); $t(9.268)=2.746$, $p=.022<.05$.

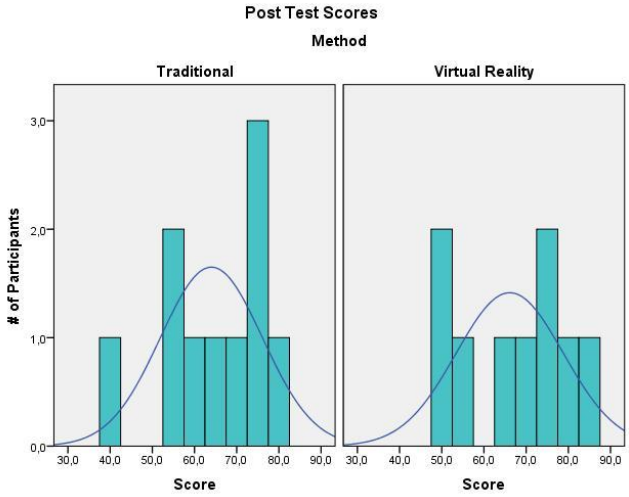

Figure 6 – Post Test Scores

Post test scores taken a week later, however, as seen in Figure 6, were not significantly different, with traditional scores (M=64.0, SD=12.09) being similar to virtual reality scores (M=66.1, SD=12.69); $t(16.574)=-.370$, $p = .716 > .05$.

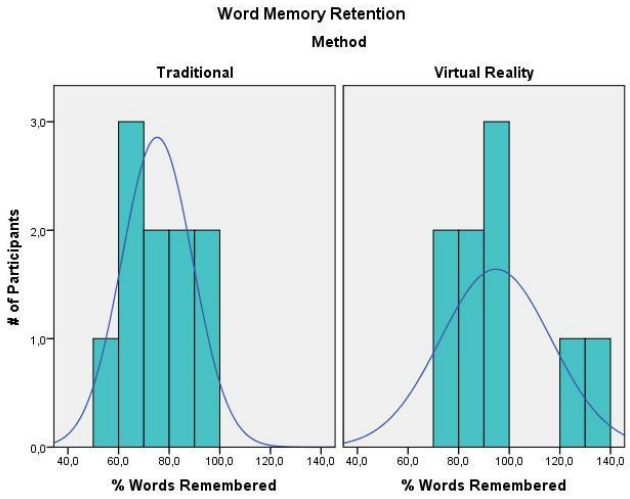

Figure 7 – Word Retention

In Figure 7, memory retention is shown. Retention is calculated as (post test score / initial test score) * 100, or as the percentage of the initially correct words the participant "retained" a week later. There was a significant difference in memory retention, with virtual reality retention (M=94.7, SD=21.88) being higher than traditional retention (M=75.2, SD=13.96); $t(13.346)=-2.282$, $p = .040 < .05$.

Abnormalities in the data include two participants who scored better on the post test than the initial test. Participants waiting to take their test may have reviewed with each other, or studied without out knowledge. Or, they may have simply had better recall a week later.

5.2 Subjective Metrics

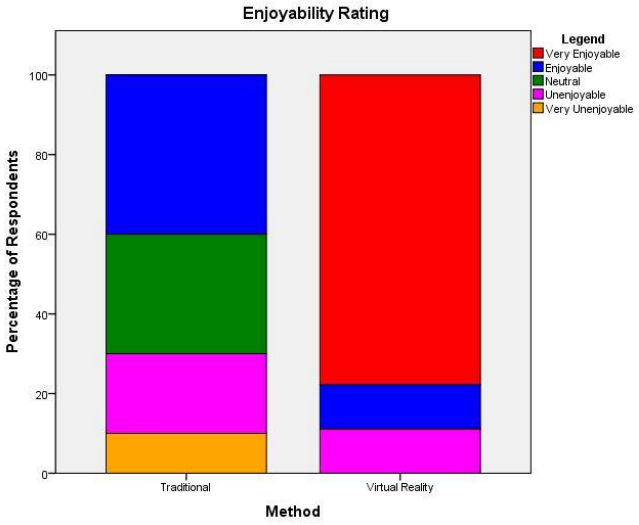

Figure 8 – Enjoyability Rating

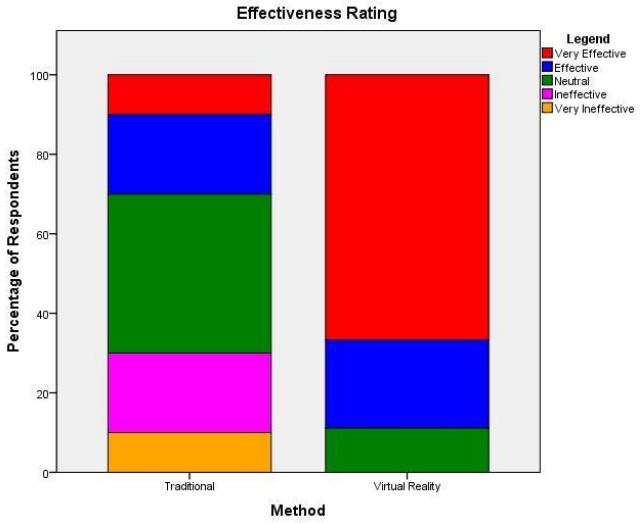

Figure 9 – Effectiveness Rating

Figure 8 represents the enjoyability ratings for each method given by participants. Ratings were much higher for virtual reality than for the traditional method, with the majority of participants rating virtual reality as "Very Enjoyable". The same trend can be seen in Figure 9 for effectiveness, in which the majority of virtual reality participants rated the system as "Very Effective".

Open-ended feedback given in the "Other feedback" section of the questionnaire included a variety of notable comments. Participants who used the traditional method suggested that it was easy to remember ten words, but that it required much focus and attention, and would be difficult to apply to a larger list of words. Many traditional group participants suggested that it was a familiar, effective method, but not very interesting. Participants who used the virtual reality method almost unanimously that they found it very enjoyable. Many reported dizziness from using the Oculus Rift, and some discomfort with the wires and weight of the Rift. Several virtual reality group participants stated that it felt easy and natural to navigate the virtual environment. Finally, some virtual reality participants commented that they were able to mentally explore the apartment and visualize the objects when taking the test.

6. DISCUSSION

Table 1 – Method Comparison: Findings

Traditional	Virtual Reality
+Higher initial test scores	+Higher memory retention +Higher perceived enjoyability +Higher perceived effectiveness

Table 1 shows a comparison of the benefits of the traditional and VR methods. The traditional method causes better memory immediately after training, where virtual reality causes better retention of the words, being able to remember them almost equally as well a week later. The virtual reality method also has higher perceived enjoyability and effectiveness.

Given that the goal of language learning and vocabulary training is to remember words long-term, we can assume that this virtual reality method is a better method of vocabulary training. The reason why the VR method causes better retention may be because, as participants stated - it allows them to visualize objects.

In addition, the virtual reality method is first-language free, meaning that no other language is used to teach the target language. This is advantageous is that one can use the system regardless of their first language. The disadvantage as that there is more limitation in explaining grammatical rules and more complex features of language that may arise later in learning.

Furthermore, some other factors may have influenced test scores. First is the familiarity of the learning method. Traditional method users commented that the method was familiar. They may have used this method in school - especially to pass a test. They are accustomed to quickly memorizing and forgetting information in this way before a test, whereas virtual reality users have never used this method to study for a test. This may have caused higher initial test scores for traditional users. Also, virtual reality test scores may in fact have been negatively affected by users being distracted by the new experience, thus less focused on actual learning.

7. FUTURE WORK

This project has shown promising results and has given leads and insights for further research and investigation. Some potential directions for future work are

-Include numbers, simple expressions and other common words/phrases in the VR environment.

-Design avatar co-learners or coaches with whom users can interact and speak the foreign language words they learned in a particular context.

-Include voice recognition so that the user can see, listen and speak the foreign language and also practice it efficiently.

8. CONCLUSION

Our findings show excellent potential for virtual reality in immersive language acquisition. Participants had higher initial test scores using the traditional method, but were significantly more capable of recalling the words a week later using the virtual reality method. Participants using the virtual reality method reported significantly higher perceived enjoyability and effectiveness.

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