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VIRTUAL REALITY IN SPEECH SOUND DISORDERS THERAPY

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Abstract

Virtual Reality is considered to be a new way in which therapists can ensure the generalization of the acquired skills. In speech and language therapy field the use of virtual reality is commonly related with communication disorders. In our research virtual reality is supposed to improve the pronunciation skills by creating a more realistic perception of the referees denoted through the words used for training articulatory skills. In order to be able to ensure this virtual reality implementation Octoplay Application was used during our training pilot program. This application is designed to train articulatory skills and it has enclosed a module to create virtual reality and to build pronunciation skills in more realistic environments. In our research we try to identify in which way the use of virtual reality improves pronunciation skills of children with speech sound disorders. Three case studies are presented in this study and the impact of using Octoplay Application in speech and language therapy is highlighted. The students participated in 30 minutes' speech and language therapy session/week for two months. Results underlined that VR helps children remained focused in the training activities, improves their motivation to be involved in training activities aiming improving their articulatory abilities, facilitates enlarging children`s vocabulary by enhancing semantic access. In conclusion, VR can be exploited in speech and language therapy field in order to help children improve their pronunciation skills. We also consider that new applications and softs in with VR models included are needed in order to help speech and language therapy process.

Keywords: *Speech sound disorders, Octoplay application, virtual reality, speech therapy, pronunciation skills.*

1. Introduction – virtual reality in speech sound disorders therapy

In recent years technological solutions have played an increasingly important role in the education field, in the health sector or in therapeutic settings. There have been significant developments both in research and practice in relation to augmented virtual reality (VR) or immersive learning as technologies have emerged as potentially beneficial intervention for learning and therapeutic outcomes (Bryant, Brunner, & Hemsley, 2020). VR technology can be separated into two different approaches: non-immersive virtual reality and immersive VR.

Non-immersive virtual reality refers to a type of VR in which a person interacts with a virtual environment, usually through a gadget. In this form of VR, the person controls some characters or activities but the virtual environment is not directly interacting. For example, all basic forms of gaming devices such as PlayStation, Xbox, Computer etc. are examples of a non-immersive virtual reality experience.

Immersive learning or immersive VR consists in the use of augmented, simulated or purely artificial environments in which their users can learn through an almost complete immersion in the context they have to study or in the current or future work environment without being *in facto* present in working conditions that may present risks or perceived treats. For example: certain workplaces need simulators or social context for autistic people or people with stuttering.

There are multiple ways in which immersive learning can be approached (Sultan, 2023):

- Virtual reality: it consists of an artificial environment, brought to reality through different vision devices, thus allowing the user to be completely immersed in the environment that he wants to experience. Because the working methods in building virtual realities have developed in recent years, the user can even interact with the objects in the virtual environment or move in it. This possibility brings huge benefits in the context of real-life threatening situation or in perceived risky situation (ex. mental health sector).

- Augmented reality: brings virtual elements to life with the help of virtual augmentation lenses. Through them, the user can see the component parts of a machine before using it or can receive written information related to objects in the environment that surrounds him by looking through pairs of special glasses or through the phone screen.
- Video learning: it is done through an immersive video capture, in which the user can only look around (this can be done with the help of specialized Oculus Rift devices) or just through the laptop or phone screen.

Concerning the potential benefits of immersive learning in clinical training and education there are few items that can be listed: (1) Students or patients could spend more time in developmental context in the or they can prepare for it through virtual reality, including real-life situation; (2) There are already several video-type programs that present a three-dimensional view of real life (eg. Eva Park, Second Life etc.) which is useful for different life context situations; (3) Programs like VR could bring many benefits in the clinical therapeutic sessions, could help patients/ students in their orientation towards their possibilities, helping them to better understand the atmosphere in every-day life situation.

Many new programs and technologies are made available to the speech therapist and to the patients or students but sometimes they do not bring enough information or are not efficient enough to bring real benefits to a patient/student. Although they could bring theoretical information, sometime the practical field is not explored enough in the therapy sessions, and this can slow down or even prevent the transfer of knowledge in real-life. In this case, to learn effectively, a patient/student must learn to: organize his time, know how to apply all the information retrieved from therapeutic session, to know how to learn logically, having the information well organized in memory, not just to be a string of ideas or numbers without meaning for the true context of the studied context. And in all this situation VR could be the solution that provides the transfer context.

Previous research indicates positive results in connection with VR and speech pathology. Mostly communicative and fluency disorders, aphasia and autism were the clinical diagnosis that were addressed by VR (Cheng & Ye 2010). Therapists used Eva Park and Second Life to provide the therapy setting for the speech language intervention sessions (Marshall et al., 2016; Stendal, Balandin, Molka-Danielsen, 2011). Gains were in the field of practicing communicative skills and improvements in communicative activities of daily living for aphasia patients and in the “theory of mind” and recognition. Also, another research (deLeyer-Tiarks et al., 2022) that used the Virtual Reality Self-Modeling (VRSM), a new self-modeling intervention that combine together video self-modeling (VSM) and virtual reality (VR confirm that “after receiving VRSM as an intervention for stuttering, participants demonstrated clinically meaningful reductions in their stuttering severity”.

VR and Immersive learning are modern and useful tools in the context of practical work, but its limitation to the visual and tactile field offer only a real and efficient alternative for the massive accumulation of information that life requires, not a substitute. Virtual reality, together with other new learning techniques, can lead to an elevation of the patient/student skills and abilities, towards the goal of forming better minds for a new knowledge and navigation through vast information on which a student/patient must know and apply. The VR and/or Immersive learning should be considered as a potential simulation tool for learning process of students, particularly in low- and middle-income countries (LMICs), where clinical training platforms or learning experience are limited and where simulation combined with teletraining or telesupervision can be used to increase access to training (Nagdee et al, 2022). Also, the user's perceived quality of experience (QoE) should be target when choosing new multimedia experiences as a key to the success intervention. Keighrey, Flynn, Murray, & Murray, (2021) proves that higher levels of QoE for users is obtained by the means of the augmented reality and tablet platforms.

2. Octoplay application

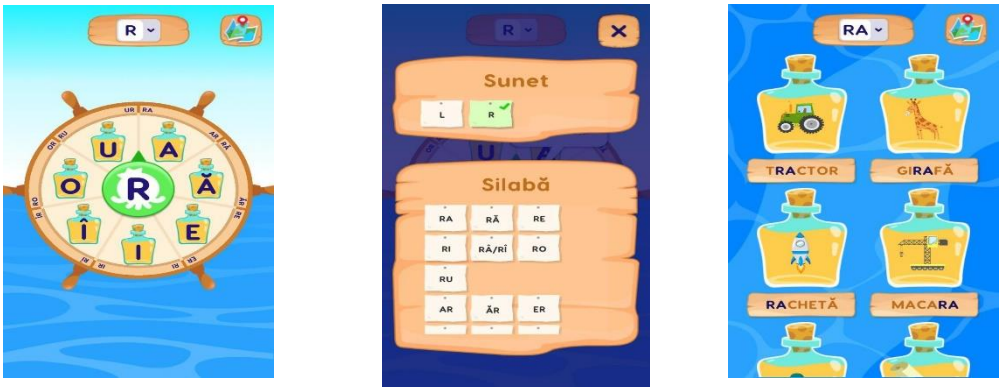
Octoplay (https://www.octoplay.io) is an interactive application through which both professionals and parents can help children train their phonetical and phonological abilities. This application has two sections, one dedicated to training Romanian phonemes (isolated phonemes from Romanian language -almost all consonants, p, b, m, n d, t, c, g, f, v, s, z, ș, ț, ț, h r. l except č and ğ, syllables – direct, CV- type and indirect, VC-type syllables), words -monosyllabic, disyllabic, three-syllabic and multi-syllabic words containing those 18 consonants trained in the first level of the application) and one dedicated to training verbal memory. These two sections are entitled Sounds Island (Insula Sunetelor) and Memorable cards (Cartonașe memorabile). The interface of the application is very friendly, the section dedicated to sounds is organized as a game, with a marine topic and the other section has very friendly and nice images based on which children can train their working and verbal memory (Vasiloiu, 2021).

The sounds training is based on demonstration and imitation techniques. This means that the selected sound/syllable/words is pronounced as example and after that the screen turns into a mirror and

the child can try his own pronunciations. For each sound/syllable and word that are three times repetitions, this offering the application the status of a therapeutic tool. The fact that the pronunciation model is given by a real person, this helps children build more accurate pronunciation abilities and, in the same time, get more involved in the task.

The original part of the application is ensured by the fact that the consolidation of the sound in syllables and words is developed starting from the idea of the speech and language therapy disk. This is an original concept put into practice in Romanian Speech and language therapy field starting with 2016, by Bodea Hațegan. In the application the speech and languge therapy disk is represented on a sailor`s wheel, having in mind the marine topic. This wheel can be rotated or a certain syllable to train can be selected by pointing on the wheel or on the list of syllables.

Figure 1. Example of speech and language therapy for R sound, the list of syllables and words available on Octoplay.



For each syllable there are six corresponding words to train, 2 words for the syllable in initial position in the word, 2 words for the syllable in middle position in the word and 2 words for the syllable in the final position in the word. This selection ensures training specific phonetic-phonological abilities in Romanian language for each consonant sound enclosed in the application.

The VR possibility to use the Sound Island from the application is a very new and interesting way that can be implemented during the therapeutic sessions. This possibility does not imply special equipment or special adjustments, with the exception of regular VR glasses.

Octoplay can be downloaded for free, it has both a variant for Android and iOS systems.

3. Design

3.1. Objectives

This study focuses on: (1) how VR can improve children`s involvement in the tasks during speech and language therapy sessions, (2) what are the benefits of using VR in speech therapy session for children with special needs.

3.2. Participants

Three primary school-aged children, all of them are enrolled in three different special schools. The participants were selected based on the following criteria: a) the diagnosis of TSA; b) age; c) the interest in using technologies in speech therapy sessions.

Case study 1 - D. N. Is a 7.3 years old boy diagnosed with TSA when he was 2.8 years old and has a comorbid diagnosis of attention deficit hyperactivity disorder (ADHD) and a profound hearing loss in his left ear. He is diagnosed with severe autism. He is non-verbal and he uses gestures to communicate and some sounds to express his needs. According to Communication Matrix profile he is at level III, Unconventional Communication, he uses unconventional gestures with the intention of change behavior of the caregiver.

Case study 2- L. I. Is a 7.10 years old boy diagnosed with TSA. He has limited communication skills; he can articulate sounds and name some objects and actions only when the adult offers a verbal model and a motivation system is used. According to Communication Matrix profile he is at level V, concrete symbols the child uses concrete symbols (gestures and images) to indicate objects and actions.

Case study 3 - S. C. Is a 8.5 years old girl diagnosed with TSA at age 3.5. She is an auditory learner, she likes singing and dancing, but her expressive language and thinking skills are limited, she used single words and rarely 2-3 words to communicate. S.C. has a comorbid diagnosis of sensory processing disorder. She reached level VI in Communication Matrix profile.

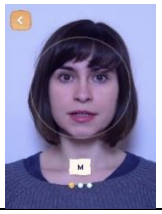
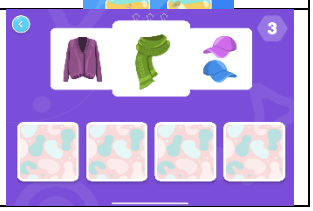
Table 1. The demographics of the participants.

Participants	Age	Gender	Area
D. N.	7.3	M	Urban
L. I.	7.10	M	Urban
S. C.	8.5	F	Urban

3.3. Procedure

The students participated in 30 minutes' speech and language therapy session/week for two months. The participants sat at the table, and they experienced VR on an iPAD 5. At the beginning of the session a visual schedule was presented to the subjects to prepare them for the session.

Table 2. Objectives and sample tasks.

Participants	Objectives set using Octoplay platform	Sample tasks using Octoplay
D. N.	To imitate single sounds; To imitate monosilabic words with sounds he can articulate (CV;VC;VV, CVC).	
L. I.	To identify objects; To imitate bisilabic and trisilabic words; To name objects.	
S. C.	To name objects; To answer questions about the objects presented in the pictures.	

3.4. Results

The results are presented in table 3.

Table 3. Objectives and sample tasks.

Participants	Objectives set using Octoplay platform	Results
D. N.	To imitate single sounds; To imitate monosilabic words with sounds he can articulate (CV;VC;VV, CVC).	Started to imitate 2 new sounds "B" and "M". Started to imitate new words (ex: "sheep", "chicken", "poppy" / "oi", "pui", "mac").
L. I.	To identify objects; To imitate bisilabic and trisilabic words; To name objects.	Can indicate and name new fruit: "gooseberries", "pomegranate", "quince" /"agrișe", "rodie", "gutuie"
S. C.	To name objects; To answer questions about the objects presented in the pictures.	Can name new objects: "hood", "cowl", "helmet", "tassel"/ „gluga", „cojoc", „opincă", „năframă" and answers correctly 4/5 questions about this objects.

The increased time the children spent on Octoplay platform is presented in table 4.

Table 4. Time used to practice articulation skills.

Initials	Time session using VR in the first session	Time session using VR in the last session
D. N.	2.5	7.3
L. I.	5.2	12.7
S. C.	6.5	13.8

The results of this study indicate that all three children demonstrate improving of their articulation skills and expressive language skills at different levels. All children demonstrate interest in the VR technology and the time they spend practicing different language skills is increasing.

4. Conclusions

The use of Octoplay platform in speech therapy demonstrates to have a great impact on children with TSA. Results underlined that VR helps children remained focused in the training activities, improves their motivation to be involved in training activities aiming improving their articulatory abilities and expressive language skills, facilitates enlarging children`s vocabulary by enhancing semantic access. In conclusion, VR can be exploited in speech and language therapy field in order to help children improve their pronunciation/articulation skills. VR has a great potential in the future speech and language therapy. New VR platforms and technologies must be created in mixt teams (speech and language therapists and specialists in IT) in order to respond to the client's needs followed by studies are recommended.

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