A Virtual Reality Prototype as a Tool Against Verbal Abuse in Classrooms: A Multidisciplinary Approach

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Abstract: The exploration of affective response and its vegetative correlate to verbal abuse (VA) is a relevant research area to prevent bullying at schools. Taking advantage of the possibilities that virtual reality offers regarding to immersion in non-real environments inducing feelings in the users, this paper presents a virtual reality application focused on the study of VA in a school context. The versatility of the proposed project is directly related to its applicability. It has been designed under the premises of the psycho-neural effect of VA. The tool is intended to be used under professional and parental supervision, to perform experiments regarding bulling awareness. In this first stage, the authors propose a prototype that will be optimized and upgraded in future versions.

1 INTRODUCTION

There is no doubt that the school environment can provide favourable scenarios for the development of verbal abuse (VA) on vulnerable people. Maltreatment-related childhood adversity is the leading preventable risk factor for mental illness and substance abuse. Indeed, emerging evidence suggests that maltreatment alters trajectories of brain development to affect sensory systems, network architecture and circuits involved in threat detection, emotional regulation and reward anticipation (Teicher et al. 2010; 2016). Emotional abuse during childhood can cause significant harm to the child's development and exert a deleterious effect on adult life. Among various types of emotional abuse, VA is highly prevalent during childhood and adolescence.

Victims of VA during childhood have been associated with increased psychiatric symptoms such as depression, anxiety, or suicidal ideation. Having tools available in safe and controlled environments is crucial to explore toxic effects of early-life stress, the relationship between psychopathology and brain changes, and the distinction between resilience, susceptibility, and compensation in the behaviour of children.

1.1 Psychological and Behavioural Aspects of Verbal Abuse

It is well-known that VA is a form of psychological or emotional abuse in which an individual uses spoken or written words to harm, manipulate, or control another person. It involves the use of language to belittle, demean, intimidate, or threaten someone (https://dictionary.apa.org/verbal-abuse). For that reason, it is very important to remember that VA can take various forms, including: Name-calling (insulting, demeaning, or using derogatory names to belittle the victim); Shouting or yelling (raising one's voice aggressively to intimidate or control the other person); Blaming (holding the victim responsible for

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the abuser's actions or problems); etc. VA can have serious emotional and psychological consequences for the victim, including low self-esteem, anxiety, depression, and even post-traumatic stress disorder (Straus and Field; 2003; Vissing et al. 1991; Iram-Rizvi and Najam 2014).

VA can make individuals constantly alert for potential threats, which can lead to chronic stress and an overactive stress response. This constant state of vigilance or hypervigilance can wear down the brain and body. Finally, all these situations could have health consequences: The stress caused by VA can lead to physical problems such as, for example, cardiovascular issues or a compromised immune system (Teicher et al. 2010;2016; Jae Hyun Yoo, et al. 2023; J-W Chun et al. 2015; Choi J, et al. 2008).

1.2 Neuro-Physiological Aspects of Verbal Abuse

There is evidence of the effects on the brain of people who suffer VA. For that reason, it is important the design a multidisciplinary approach that allows evaluating in safe conditions the possible psycho-neural damages that are expected to be studied with the virtual reality tool. All the effects observed must be based on changes in neural structure, because chronic stress from VA can lead to structural changes in the brain, particularly in areas related to the emotional response. Indeed, VA can impact with diverse areas of the brain related to emotional processing, stress response, and cognitive functions. In some cases, VA can lead to changes in the reward system, potentially affecting self-esteem and the ability to experience joy. For example, an abusive relationship may lead to dependency on the abuser for emotional validation, as the brain's reward system may be activated when the abuser is temporarily kind or supportive (Teicher et al. 2010;2016; Jae Hyun Yoo, etl al. 2023; J-W Chun et al. 2015; Choi J, et al. 2008).

Regarding the present work, virtual reality previous studies have shown that exposure to peer VA is related with the incidence on anxiety, depression, anger-hostility, dissociation, "limbic irritability," and drug use. Peer and parental VA were essentially equivalent in effect and exposure to peer VA is an aversive stimulus associated with greater symptom ratings and meaningful alterations in brain structure. The evidence of the risk of suffering VA including imaging studies that have provided a remarkable view of the potential effects on brain structures previously mentioned. However, the vulnerability of brain structures to the effects of early experience may be moderated to a considerable degree by genetics. In this way, in genetically susceptible individuals, maltreatment-induced epigenetic modifications that alter trajectories of brain development may, in many cases, represent the beginning of a crucial chain of events leading to psychopathology and risk of substance abuse, for example (Yoo et al. 2023). In this way, according to a neurocircuitry model of emotion processing, recruitment of cortical regions could downregulate amygdala activity (the structure that is responsible of emotional responses, including fear or ignite behavioural responses) modulating the negative affective response. For example, a hyper-responsive amygdala and hypo-responsive ventromedial prefrontal cortex in response to traumatic scripts was associated with failures in negative emotional regulation in subjects having post-traumatic stress disorder. Interestingly, a recent functional magnetic resonance spectroscopy study with a visual perception task demonstrates a dissociation of neurovascular and neurometabolic responses (Jae Hyun Yoo, 23). These effects could be explored through stimuli induced with virtual reality tools such as those proposed in this project. In parallel with these findings, a putative mechanism for this abnormal brain development is an increased response of the hypothalamic-pituitary-adrenal axis to emotional stress (Jae Hyun Yoo, 23).

1.3 Research Hypothesis

The use of the virtual reality technology in classroom immerses students in interactive and practical learning, while enhancing their commitment and interest in the subjects. The premise is as simple as it is didactically perfect: learning in interactive environments that seem real, where mistakes can be made without suffering their consequences and that manage to enhance the effectiveness of learning (Garcia et al. 2023; Harris et al. 2020. Piccione et al. 2019).

In the context of the VA in classroom, virtual reality offers immersive experiences in three dimensional environments that allow the student to experience each situation from different points of view, analyse the consequences of their decisions and even realize the time it takes them to respond to each situation.

This technology also saves time for trainers, who are not forced to repeat the same workshop repeatedly. The content is available at any time at any place improving the user's empathy and emotional

intelligence (Garcia et al. 2023; Harris et al. 2020; Piccione et al. 2019).

The present prototype addresses the task of learning soft skills such as communication, conflict resolution or social and emotional intelligence like a response to VA. The environments provide a video game aesthetic immersing the user in a highly realistic scenario in which they are the active protagonist of a learning story (Garcia et al. 2023; Harris et al. 2020; Piccione et al. 2019).

1.4 Objective and Multidisciplinary Nature of the Virtual Reality Tool

The aim of the present work is implementing a virtual reality tool that will be used in the research of the affective and emotional response and its vegetative correlate to VA in children under professional and parental supervision. Moreover, this tool could be used for harassment prevention, concretely, in the way of VA in early educational stage.

The proposed tool constitutes the initial version developed by this multidisciplinary collaboration and highlights the need of pooling individual knowledge to achieve a useful and scientifically designed application.

The tool has been developed by a multidisciplinary group of researchers with knowledge in several fields such as Neurobiology, Psychology or Engineering.

2 MATERIALS AND METHODS

This section shows the description of the design carried out on the platform, the scenarios carried out, the parameterization possibilities, as well as the hardware and software components that allow the creation of the presented prototype.

2.1 Virtual Reality Design

The virtual reality glasses used in this prototype are the Meta quest 2 (Reality Labs, USA), which can be used in children from 10 years old, as indicated by the manufacturer's instructions, as well as Spanish legislation, always under the supervision of professionals and through parental control mechanisms.

The prototype designed used the cross-platform game engine Unity@ 2022.3.7f1 (Grant Educational License), and the most relevant packages:

- Autodesk FBX Sdk
- AiçI Navigation 1.1.5
- FBX exporter
- AR Foundation
- Google AR Core XR Plug in
- Open XR Plug in
- Shader Graph
- TextMeshPro
- Universal Render Pipeline (URP)
- Visual Studio
- XR Interaction toolkit

Additional applications used to complete the content and audio effects of the stage are: 3ds Max 2024@ (Autodesk Education Plan), Audacity and Gimp (Open Source) to create sound effects, and materials respectively.

To achieve a high level of sense of presence, each scene has been carefully designed to provide a high sensation of realism and interactivity while avoiding cyber sickness. We have added global volumes, realistic materials, personalized illumination with light and reflection probes, lighting profiles that are automatically loaded through script, etc. Hoover effects have been added as well to indicate the user whether an area or object is interactable or not. Oculus hands models have been selected to represent both controllers, improving the sense of presence when the user sees his or her own hands in the virtual reality world.

To address the cybersickness issue, we have integrated room-scale, controller-based, and teleportation-based systems. The incorporation of room-scale allows the application to capitalize on its heightened sense of presence, enabling users to navigate within the predefined guardian space established during the configuration of the Head-Mounted Display (HMD). To address the limitations associated with open-world experiences, we have introduced a teleportation system. This feature empowers users to teleport to locations beyond the guardian zone, overcoming spatial constraints and contributing to the application's resilience against cybersickness. To facilitate interaction with objects or enable slight movements, we have also implemented a controller-based system. Collectively, we have seamlessly integrated three cutting-edge locomotion methods. Each method is strategically employed to leverage its unique strengths, with the inclusion of others serving to offset individual weaknesses. Moreover, users can opt for either continuous or snap turn and activate a vignette effect, also known as a tunnel vision effect, in both turning modes. Opting for a snap turn with a vignette is widely regarded as the optimal choice to mitigate the risk of cybersickness.

2.2 Virtual Reality Scenario

Following description of the patterns shows the user experience.

2.2.1 Main Menu

The main menu includes the possibilities for the user to configure the characteristics of the experience. In it, you can adjust the volume of the music (free use), as well as the effects of the audios that are included. Turn and vignette settings can be configured in this UI menu. The values set on this first screen are maintained throughout the game, in case it is not changed, there is a default setting.

2.2.2 Training Stage

First, the user is immersed in a training scenario: a school multi-sport gym (Figure 1). There the subject can interact with different objects (such as balls rackets) or climb several wall bars.

The objective in this phase of the experience, to make the player comfortable with the virtual reality environment. The user can therefore get used to the different actions triggered by the controllers and different types of movements. Once again, in other to avoid cybersickness, we have added the option of continuous movement or teleport. The user can freely move and interact in this 3D space changing position and field of view with the subsequent feeling of immersion.

The user must remain in this scene for three minutes to ensure that the training is effective. The remaining time is showed in two UI menus.

2.2.3 Gaming Stage

After this training period (that ensures that the player does not suffer any type of discomfort related to the use of the application), the subject moves on to the second scenario that represents a classroom with individual tables for the students (Figure 2). The player enters the class and is free to move in the class interacting with different objects getting familiar with the new environment. However, after one minute, the player is "attacked" by intelligent words that approach and even chase him/her.

Several postprocessing effects, such as chromatic aberration, are launched to make the user conscious of the change of mood in the scene. These words include terms that constitute authentic VA to which, in the present prototype, the player can only be a passive spectator.

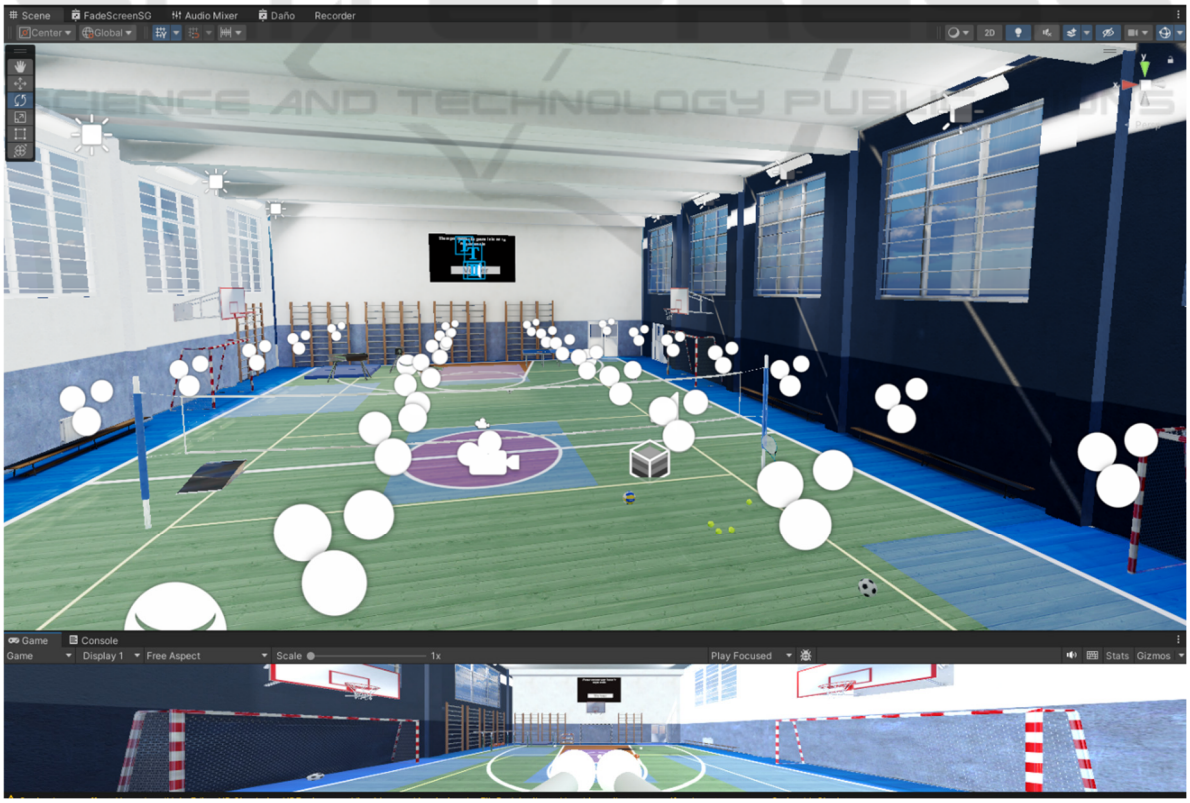

Figure 1: Training Stage a multi-sport-gym, with objects to facilitate the user immersion.

Figure 2: Gaming Stage, a classroom to interact with objects during the first minute of playing.

Words are identified as enemies and are spawned in random positions of the navmesh with a fixed delay.

These words can select the way to the player automatically avoiding the obstacles in the scene. Additionally, the words are provided with an audio source configure to work in 3D. perceives the insult coming from the place where the word is located. This allows the experience to be even more authentic.

When a word reach a location closer than a threshold of two to the player an impact occur and a epical damage effect is perceived. When the number of impacts is above a threshold, the user is supposed to lose the game and is directed to a final scene where he or she can restart the experience or quit it. Figure 3: An insult reaching the player.

Figure 3: An insult reaching the player.

2.2.4 Insults

There are multiple forms of VA, among them, insult is the most common way to belittle a classmate. In this application, words are chosen by the research team for each player, according to the personal situation. In this first technical approach, the insults have been distributed into three categories:

- General insults: Geek, weird, foolish, Imbecile, Asshole, Subnormal/delayed (incorrect, but usual).
- Specific insults (not implemented in this first prototype, to be considered in new versions): Homophobic slurs or racist/xenophobic insults.
- Expressions contempt/exclusion: It's disgusting, You smell bad, Get the out of here (these expressions used as a first-person plural are especially relevant, as they are not personal characteristic, but try to reflect that it is the entire group that is manifesting that contempt).

3 DISCUSSIONS

The evidence on the neural effects of exposure to VA comes from various scenarios (virtual environment, social networks, etc.). However, they all came together in similar results. For instance, VA is very frequently experienced via the Internet. In this way, although the Internet is an important tool in our daily life, is necessary to control its use and prevent subsequent difficult problems. There is evidence showing the cognitive control of affective events in

Internet gaming disorder (IGD) and the influence of IGD on neural activities regarding swear words (as a sign of VA) in young adolescents. Indeed, there are differences between adolescents with IGD and healthy control adolescents with respect to swear, negative and neutral word conditions. Indeed, there is neurophysiological data that shown that, swear words as a VA, induced more activation in regions related to social interaction and emotional processing such as the superior temporal sulcus, right temporoparietal junction and orbitofrontal cortex when compared with negative words. Adolescents with IGD exhibited reduced activation in the right orbitofrontal cortex, related to cognitive control and in the dorsal anterior cingulate cortex, related to social rejection during the swear word condition. In addition, adolescents with IGD were negatively correlated with activity in the right amygdala toward swear words, indicating the important role of the amygdala in the control of aggression in adolescents with IGD (J-W Chun et al 20159). All these results indicate the importance of exploring the effects on the nervous system of VA in controlled environments.

In the present study a virtual reality tool for VA awareness has been proposed. As virtual reality is an immersive technology that can create a sense of presence and realism, blurring the lines between the virtual and physical worlds, the assumption of this technique being useful in the research of VA and its phycological and neurobiological consequences is not unreasonable. Therefore, the proposed prototype could potentially simulate or even amplify the emotional impact of VA in the users.VA in virtual reality could lead to emotional distress, anxiety, and other psychological effects, just like in the physical world. Moreover, the age that the tool is intended for is a period of life when is fundamental the establishment of appropriate social interactions. In this sense, virtual reality gives the possibility of developing this kind of social interactions in game like environments. Finally, a prolonged exposure to VA in virtual reality could negatively impact mental health and well-being. It may contribute to feelings of isolation, depression, and a decline in overall mental health.

4 FUTURE CHALLENGES AND CONCLUSIONS

This article presents a new virtual reality tool to both aid in the research field of VA and prevent it in classrooms. This approach addresses the creation of virtual environments that enable analysis, prevention, and intervention in situations of verbal bullying in the school environment.

The experience consist on short scenes (2-3 minutes), designed to be used in the school with students in the last year of primary education (10–12-year-old) under professional supervision and parental control. Currently the user is able to participate in situations of verbal harassment from victim point of view. However, we are currently working in adding functionalities to the software tool. For instance, in future versions, the user will be able to adopt different roles: victim, aggressor and spectator in a multiplayer experience. This version would make possible to analyse the impact of verbal violence from the perspective of all participants, the influence of relevant contextual variables, the most common associated behaviours, the interaction between participants and the skills involved in coping. In addition to the usual psychological self-report measures, the design will allow obtaining physiological measures of response to the situations presented.

The current version of the application however is already useful in the study of VA. The level of emotion induction on virtual reality inmersion is under test while studying the victim's reactions and to exposing the victimizers to the effects of their harassment. The design principles show robustness, feasibility and in real-time intervention.

The prototype is prepared to be optimized and upgraded to future versions with impairments, and is totally customizable. For instance, the virtual reality controllers are able to be used in any type of device, scenes can be added as new modules to the experiences, etc. This prototype prioritizes the user privacy by implementing measures to protect user data and ensure a safe online environment.

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APPENDIX

Copy Rights: The list of resources used in programming the prototype is included below.

- Unity Asset Store

Standard Unity Asset Store EULA

Name	Author	Link
FREE Casual Game SFX Pack	Dustyroom	https://assetstore.unity.com/packages/audio/sound-fx/free-casual-game-sfx-pack-54116
AllSky Free - 10 Sky /Skybox Set	rpgwhitelock	https://assetstore.unity.com/publishers/3830
Free Sports Kit	Sports-Actions	https://assetstore.unity.com/packages/3d/characters/free-sports-kit-239377

- Sketchfab: Creative Commons Attribution (http://creativecommons.org/licenses/by/4.0/)

Name	Author	Link
“SELF Labs School Gym”	Mirror Image Studios is licensed under	https://skfb.ly/ozXtC
“Basic Classroom”	Kibele	https://skfb.ly/ovnsE