



# Virtual reality with distractors to overcome public speaking anxiety in university students

Realidad virtual con distractores para superar el miedo a hablar en público en universitarios

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## ABSTRACT

The ability to communicate effectively is a crucial aspect of education. For college students, learning how to speak in public is essential for their academic and professional future. However, many students report fear of speaking in public, the so-called Public Speaking Anxiety (PSA). This study aims to implement a training program using Virtual Reality (VR) with distractors to reduce the college students' anxiety. Anxiety was measured with two methods: electrodermal activity and self-report. We also analyze gender differences. There were an experimental and a control group. Both groups had to deliver the same speech twice: pre-test (before training); and post-test (after the training program) while participants' electrodermal activity was measured. Only the experimental group was trained with VR. Students also completed the Public Speaking Anxiety Scale and a survey to examine their experience. The results showed that the VR training reduced the anxiety levels significantly in the experimental group, but there were no significant differences in the control group. The data also revealed a higher level of anxiety in male than in female students. Finally, participants reported a positive impression of the VR training. These results showed the effectiveness of Virtual Reality software with distractors to reduce public speaking anxiety.

## RESUMEN

La capacidad de comunicarse de manera eficaz es un aspecto fundamental en la educación. Para los estudiantes universitarios, aprender a hablar en público es esencial para su futuro académico y profesional. Sin embargo, muchos estudiantes manifiestan tener miedo a hablar en público, lo que se conoce como ansiedad a hablar en público (PSA en inglés). Este estudio tiene como objetivo implementar un programa de capacitación utilizando Realidad Virtual (RV) con distractores para reducir la ansiedad de los estudiantes universitarios medida con actividad electrodérmica y métodos autoinformados. Para ello se utilizó un grupo experimental y otro de control. Ambos grupos tuvieron que pronunciar el mismo discurso dos veces: prueba pretest (antes del entrenamiento) y postest (después del entrenamiento) mientras se midió la actividad electrodérmica. Solo el grupo experimental fue entrenado con RV. Los estudiantes también completaron una escala de ansiedad al hablar en público y una encuesta para examinar su experiencia. Los resultados mostraron que el entrenamiento con RV redujo significativamente los niveles de ansiedad en el grupo experimental y no hubo diferencias significativas en el grupo de control. Los datos también revelaron un mayor nivel de ansiedad en los estudiantes varones que en las mujeres. Finalmente, los participantes reportaron una impresión positiva del entrenamiento con RV. Estos resultados muestran la efectividad del entrenamiento de RV con distractores para reducir la ansiedad al hablar en público.

## KEYWORDS | PALABRAS CLAVE

Virtual reality, public speaking, anxiety, education, communication, university students.  
Realidad virtual, hablar en público, ansiedad, educación, comunicación, estudiantes universitarios.



## 1. Introduction

Public communication is critical for career success. College graduates acknowledge the importance of acquiring skills in oral communication and public speaking. The ability to effectively deliver a speech is frequently perceived as crucial for graduates' adequate performance in the working environment (Smith & Sodano, 2011; van-Ginkel et al., 2019), for career success, and effective participation in the democratic society (Chan, 2011). However, today's college students might not be getting adequate oral communication education. In an analysis of oral communication education in Alabama (USA), Emanuel (2011) identified four critical concerns that could indicate similar issues affecting the field throughout the United States and beyond. Firstly, education on public speaking is insufficient. Secondly, oral communication education is relegated to a module rather than a core course in the curriculum. Thirdly, college faculties are unprepared on the topic. Fourthly, courses tend to be narrower than broader in scope within the education curriculum. Moreover, as the majority of people experience at least some kind of anxiety when facing the public, college students rarely will be willing to voluntarily choose a public speaking course if they can avoid it (Docan-Morgan & Nelson, 2015).

As a result, graduates often lack the competence required to speak in public. Chan (2011) has identified insufficient communication skills and related oral abilities, especially in science graduates. Therefore, addressing this issue is fundamental for education institutions. To answer this uncertainty, the present study applies a Virtual Reality (VR) training with distractors to teach public speaking in college classes to reduce anxiety levels and, consequently, improve oral communication skills. An experimental methodology was designed to test the effectiveness of a VR program with distractors to reduce students' anxiety, measured using electrodermal activity and self-reported methods before and after training.

The main contributions of this study will be threefold: a) to show the usefulness of a VR program as similar as possible to a real situation that generates distractors and asks questions to lower anxiety; b) to use a combination of methods to measure the level of anxiety: electrodermal activity (physiological response) and self-report (perception); c) to examine gender differences in anxiety.

### 1.1. Public speaking anxiety

In front of the public, one of the main problems faced by any communicator is stage fright. A full 85% of the general population suffers some fear when speaking in public (Burnley et al., 1993). The context in which undergraduates cope with this fear throughout their college years is challenging. A study conducted by Ferreira et al. (2017) measured the prevalence of fear of public speaking among 1,135 college students. Their work found that 63.9% reported suffering this fear. In a close look at these data by gender and voice quality, the results proved that female students had low participation as speakers in groups and perceived their voices as high-pitched, increasing the probability of exhibiting fear of public speaking. The results also showed that up to 89.3% of the students would like their undergraduate program to include public speaking courses. Also defined as Public Speaking Anxiety (PSA), this social phobia has been characterized as a distinct subtype of social anxiety disorder with a 12-month prevalence rate. According to Pertaub et al. (2002), people with social phobia usually suffer from an intense fear of social performance. This fear makes them act in a humiliating or embarrassing way because they think others will judge them negatively. At a physiological level, the body reacts preparing itself for either a battle or for running, which has been known as the flight-fight response. In this situation, during a public performance, the fear of embarrassment in front of the audience can be intensified by the audience's verbal or nonverbal response.

The Beatty and Behnke's (1991) adaptation of Schacter and Singer's model of emotional response (1962) is one of the most extended models of PSA. This model includes two arousal dimensions: cognitive and physiological. In this study, we analyze these two dimensions: the cognitive dimension by using a Public Speaking Anxiety Scale and the electrodermal activity (EDA) to measure the physiological levels of PSA. EDA has been widely used as a clinical sign of stress-related psychophysiological disorders (Hugdahl, 1995). Some studies have explored electrodermal responses to laboratory stressors (Carrillo et al., 2001), for instance, stressful films (Kohler et al., 1995). However, there is still a scarcity of studies that include this measure to test PSA in response to a public speaking task (Carrillo et al., 2001; Yadav et al., 2019). In general, oral communication skills have received little research attention (De-Grez et al., 2009).

### 1.2. VR to reduce public speaking anxiety

To solve PSA's problem, VR seems to be a promising sphere. In recent years, literature has accumulated some practical classroom experiences to teach oral presentation skills (OPS) (González-Zamar & Abad-Segura, 2020). The research by Boetje and van-Ginkel (2020) focused on the importance of practice to develop oral skills. The results showed that participants benefited from practicing a third time on VR. This kind of experience proved that facilitating practices in a controlled virtual environment should be part of educational institutions' curricula. In the study by van-Ginkel and colleagues (2019), the students practiced their presentation in a virtual environment and received feedback in competencies such as cognition, behavior, and attitudes towards presenting. The effects were compared with a control condition, which was a face-to-face presentation task with expert feedback. Results revealed significant improvements from pre- to post-test in all the competencies. These studies support the benefits of using VR and, more specifically, its application as a feedback tool, proven to be a useful process highly welcomed by participants (De-Bofarull, 2003; De-Grez et al., 2009).

Recent empirical studies have explored simulation with VR as a tool to treat and quantify PSA (LeFebvre et al., 2020; Yadav et al., 2019). The study by Yadav et al. (2019) analyzed whether systematic exposure to public speaking tasks in the VR environment could help alleviate PSA. The results indicated significant improvements in terms of both self-reported and physiological indices. Reeves et al. (2021) examined 360° video VR exposure therapy as an effective intervention for treating PSA.

Other studies have focused on the role of the audience and its implications on public speaking success. Söyler et al. (2016) designed a virtual auditorium that included major physical and vocal cues experienced by a speaker addressing a crowd in an auditorium. The resulting simulator helped subjects overcome PSA. Additionally, results proved that VR could be used to identify cues to which speakers are more sensitive, helping identify the root causes of the participant's PSA disorder. Other studies by Pertaub et al. (2001) examined the audience's reaction, assessing whether a speaker's anxiety response depends on the type of feedback received from a virtual audience (positive, negative, static). In general, these results showed that the patients experienced an attenuation of their anxiety due to prolonged exposure to the stimulus, a process known as habituation. A recent study by Radianti et al. (2020) provided a systematic mapping to identify design elements of existing research dedicated to applying VR in higher education. Their results highlighted that the focus has been put primarily on the usability of the VR application rather than being applied regularly in actual teaching. However, the actual body of research on virtual reality programs to train oral skills is either based on non-empirical evidence, examines a low number of subjects, or does not contemplate distractors as part of the training program. Based on previous studies, we can formulate our first hypothesis: (H1) The level of students' anxiety will be significantly higher in the pre-test than in the post-test in the experimental group after the VR training program with distractors.

### 1.3. Gender differences in public speaking

Gender differences in social anxiety disorder (SAD) have not received much empirical attention despite the large body of research on other disorders. Little is known about how to adjust feedback strategies for differences in the users' socio-cultural parameters, such as gender or age (Strand, 1999).

The role of gender in the control of speaking anxiety has remained a topic of controversy. Gaibani and Elmenfi (2014) proposed a guide to identify the effects of gender differences on public speaking anxiety. These authors found opposite positions. Some authors documented a linear relationship between gender and speaking anxiety (Intaraprasert, 2000). In these studies, women displayed higher anxiety than men (Behnke & Sawyer, 2001) and were more prone to speaking about anxiety (Mejias et al., 1991). In the same line, Mohamad & Ab-Wahid (2008), among English as a second language college students, concluded that female students experienced more anxiety than male students while speaking in class. According to these authors, this happened because girls experienced lower self-confidence influenced by their interest in friends who could be judging them (Gaibani & Elmenfi, 2014). By contrast, Levitt (1980) showed that male students felt a higher anxiety level when conscious of their anxiety. This relationship was not observed among females. The study by Mills (2006) on gender and performance anxiety at academic conferences explored the role of power and gender moderating performance anxiety and concluded that

this anxiety was influenced by the speaker's level of internalization (or rejection) to the gender stereotypical views acting in the public sphere. On the other hand, recent studies do not show gender as having a significant effect on overall anxiety (Matsuda & Gobel, 2004; Wang, 2010).

In the specific field of psychophysiological there has been an increasing interest in studying gender stress reactivity (Carrillo et al., 2001; Davis & Matthews, 1996; Girdler et al., 1997; Lash et al., 1995; Matthews et al., 1991; Steptoe et al., 1996). Carrillo et al. (2001) concluded that gender could act as a moderator but not as a cause for different performances. Mood, anxiety, and hormonal background could affect the response. Results showed that men and women did not differ in anxiety, hostility/aggressiveness, or the task's appraisal. There were no gender differences in Heart Rate (HR) and the frequency of the skin conductance responses (NSRs), but women had higher finger pulse volume (FPV) in all periods, except during the task. However, at this moment, no studies have compared the EDA responses to public speaking in men and women. As most of the studies conclude that women report more anxiety than men, we formulate the following hypothesis: (H2) The level of anxiety will be higher in female students than in male ones.

## 2. Materials and methods

### 2.1. Design

The experiment to measure anxiety level consisted of two tests (pre-test and post-test VR training) by two genders (male and female) mixed factorial design.

### 2.2. Participants

We chose students from two major European universities. The participants were selected from those who enrolled in public speaking courses and voluntarily wanted to participate in the study. There were 100 students, fifty-eight were female, and 42 were male (19-21 years old). This group was divided into two groups of 50: an experimental group (30 females and 20 males) and a control group (28 females and 22 males). The sample size was formed according to the psychophysiological studies in communication (Potter & Bolls, 2012). The university approved the study protocols and all the participants signed the informed consent.

### 2.3. Stimuli

For the experiment, students wrote their scripts as part of the training. These scripts had the same length in all the cases: three minutes. Duration was measured using a chronometer to avoid differences among students. Students in the control group received the usual training in the public speaking course which consisted of two main parts: the first part was devoted to writing the script of the speech. They learned how to select, structure, and write the information. Once they had the final script, the training was focused on the performance (voice and gesture). Those in the experimental group were also trained with virtual reality. The VR platform used for this experiment was Psious. Psious is a virtual reality platform for psychology and mental health, designed especially for the treatment of phobias. This platform includes hardware, VR glasses, and biofeedback sensors. For this experiment, we used the therapeutic environment devoted to fear of public speaking. In this environment, participants are immersed in an auditorium with a lot of people in the audience.

The use of this platform has two main advantages. The first one is that researchers can control in their own computer what is happening in the virtual environment and change the conditions, for example, the loudness of people talking, being in silence, or the number and attitude of the attendees. The second, and most important advantage, is the possibility to add distractors throughout the presentation. The subject is placed on the stage on a podium with lights and television cameras. The researcher can then add, at any moment of the presentation, people murmuring, laughing or coughing, or objects sounding (i.e., a phone). Also, at the end of the speech, some avatars can stand-up and ask questions to the speaker in different levels of complexity that the researcher can choose, from easy (What is the main application of your project?) to difficult questions (I disagree with your main statement; could you prove that it is true?). In this study, we used three different distractors: an attendee coughed, an attendee left the auditorium, and an attendee

asked a challenging question at the end of the speech. We measured the skin conductance level at these specific moments. We think that these characteristics are essential to differentiate this research from other studies with passive VR platforms.

## 2.4. Dependent variables

### 2.4.1. Physiological level of anxiety

We conceived the anxiety level as the sympathetic nervous system's response to a novel situation such as a public presentation. This measure is an indicator of emotional, cognitive changes and the sympathetic nervous system's response to a novel situation such as a public presentation. Anxiety was measured as skin conductance, called electrodermal activity (EDA) (Dawson et al., 2016). To do so, two 8mm AG/AGCL electrodes, connected to a GSR+ sensor (Shimmer technology) were placed on the palmar surface of the subject's non-dominant hand. The GSR+ unit is suitable for measuring the electrical characteristics or conductance of the skin. After the experiment, the data were processed by taking the 180 seconds of the speeches (3 minutes).

### 2.4.2. Anxiety scale

We used Bartholomay and Houlihan's Public Speaking Anxiety Scale (2016). This scale comprises 17 items related to cognitions, behaviors, and physiological manifestations of speech anxiety. The scale is formed by three subscales that measure cognitive, behavioural and physiological aspects. Students rated these items on a 5-point scale, where the lowest value was a little, and 5 was a lot. The scale has five reversed code items. The three subscales showed a very high internal consistency according to the Cronbach's Alpha coefficient (cognitive,  $\alpha = .738$ , behavioural,  $\alpha = .900$ , physiological,  $\alpha = .801$ ).

### 2.4.3. Survey

We completed the Public Speaking Anxiety Scale with a survey formed by some questions related to the VR experience. The first ones were two questions in which students had to assess in 7-point scales to what extent the VR had helped to deliver a better presentation and if this training had reduced their anxiety level. The second group was formed by two open questions in which the students listed the main advantages and disadvantages of using VR to reduce PSA. The third group had two questions in which students had to rate if they would use VR again to prepare their public presentations and recommend VR to other colleagues.

### 2.4.4. Procedure

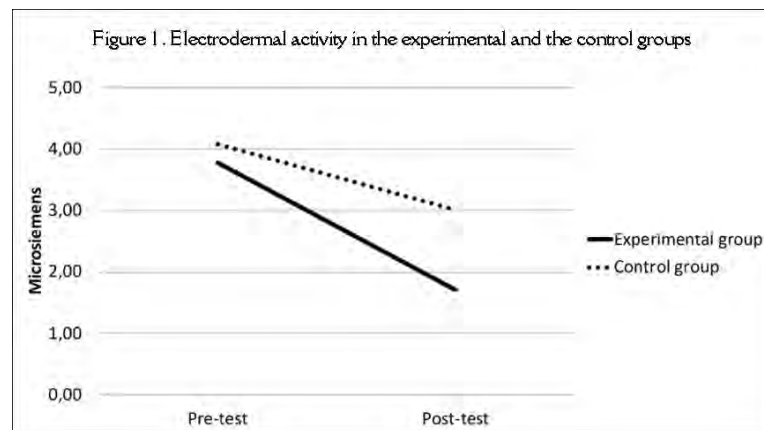
The process for conducting the study was as follows. The experiment was performed in the Public Speaking course at two major European universities as part of the training. The students of both universities started the course with the training in oral communication skills. The first part was devoted to writing the script of the speech. They learned how to select, structure, and write the information. Once they had the final script, the training was focused on their performance. The first time that they delivered the speech in front of the rest of the students, we attached the electrodes to measure the electrodermal activity while they gave the discourse. Before the delivery, we took the baseline by registering the electrodermal activity in relaxation, and the students completed the Public Speaking Anxiety Scale (pre-test). Then the students gave the speech. They were standing up in an auditorium with the public, with a chronometer in front of them, lights, and a lavalier microphone.

The session was video-recorded. After this experience, students were divided into two groups: control and experimental. The control group had five sessions of intensive public speaking training with an instructor. The training sessions included distractors (e.g., a person coughing, an attendee's question) during the speech rehearsal. The VR training was started for the experimental group. A total of five trial sessions were conducted. All the students practiced with the same platform and environment. Also, the distractor was the same. In the last part, the final public presentations were delivered again by participants on both groups, and the skin conductance was retaken. Here the students had to perform the final presentation that they had previously prepared and rehearsed. This final measurement of the electrodermal activity was used to analyze whether the VR training had reduced anxiety. These measurements were

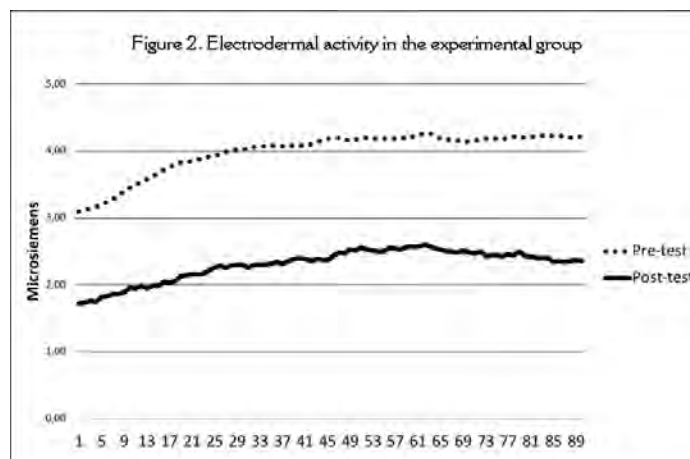
completed with the Public Speaking Anxiety Scale (post-test) and a survey to determine the students' perception of this experience and how much they felt VR helped them. Therefore, both self-report and physiological measures were applied to this project.

### 3. Analysis and findings

All the statistical analysis has been performed with SPSS. The results were analyzed by applying an analysis of variance in a 2 (measures) X 180 seconds (time) repeated-measures ANOVA for the dependent variable level of anxiety. First, data on the measurement of anxiety level through skin conductance were taken by subtracting each subject's baseline. The results of the last measurement (post-test) were lower than in the first (pre-test) in both groups, experimental and control. The electrodermal activity decreased in the experimental group from ( $M=3.57$ ;  $SD=.39$ ), in the pre-test to ( $M=1.71$ ;  $SD=.32$ ) in the post-test while, in the control group, EDA diminished from ( $M=4.07$ ;  $SD=.49$ ) to ( $M=3.01$ ;  $SD=.41$ ), as Figure 1 shows.



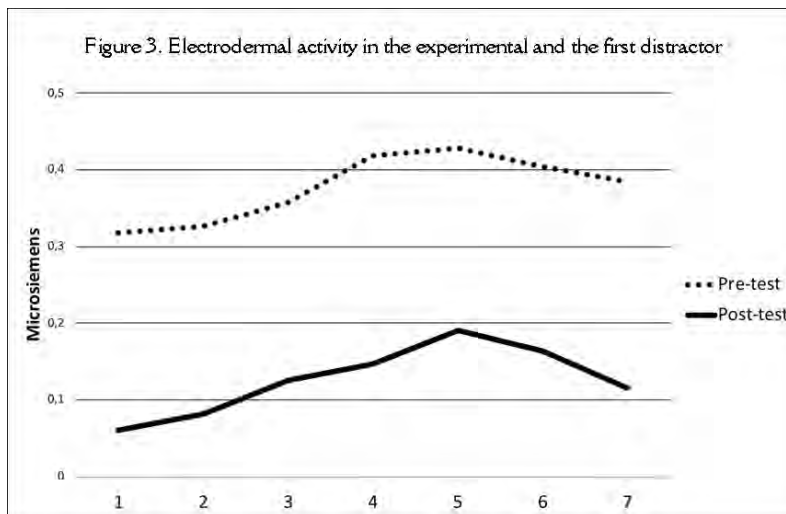
However, there were only significant differences in the experimental group in the measurement,  $F(1.49)=14.57$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.229$ , and in the interaction between the measurement and time,  $F(1.49)=1.98$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.039$ , but not in the control group,  $F(1.49)=2.85$ ,  $=.098$   $v^2_{\text{partial}} h^2=.055$ . Figure 2 shows the differences between the first measurement before VR (pre-test) and the second measurement (post-test), throughout the speech in the experimental group.



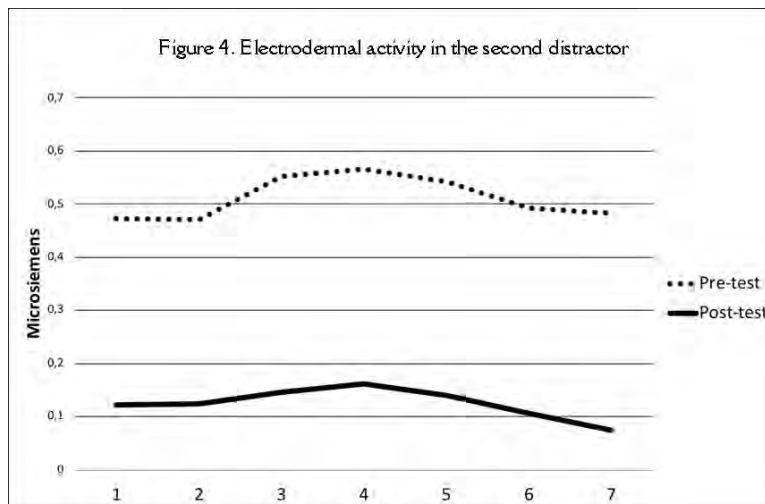
As shown in Figure 2, the first measurement is continuously rising with a maximum of 4.23 and a minimum of 3.09; therefore, a difference of 1.14. On the other hand, the second measurement does not have a full upward progression. It shows a minimum of 1.72 and a maximum at the second minute of

2.57. The difference is 0.85, considerably less than in the first measurement. From the second minute onwards, a descent begins, which brings the anxiety level back to the first minute's values.

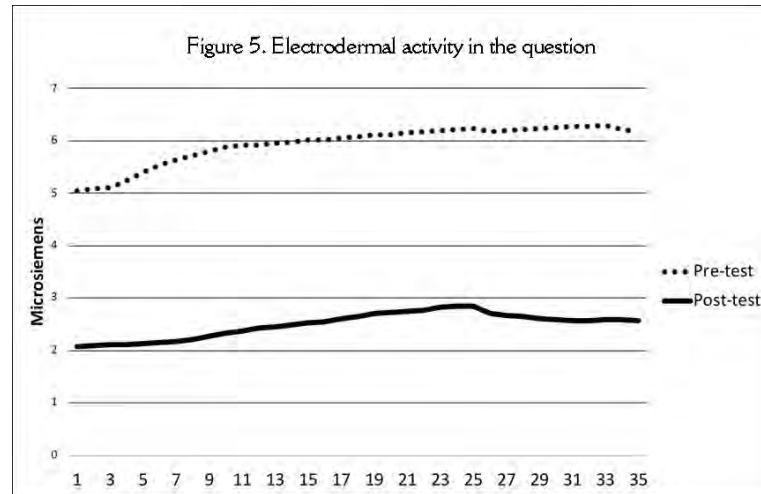
The distractors were placed at seconds 40 (the attendee coughed) and 60 (one of the attendees left the auditorium). We measured the skin conductance level at these specific moments. The first distractor was a person coughing in the second 40. We calculated the baseline from the five seconds previous to the onset and then compared both pre-and post-VR. The results were significant for measure,  $F(1.49)=7.93$ ,  $=.007$ ,  $v^2$ partial  $h^2=.139$ , and for time,  $F(1.49)=7.46$ ,  $<.001$ ,  $v^2$ partial  $h^2=.132$ . Throughout time, the changes can be observed in Figure 3.



The second distractor was an attendee that left the auditorium at second 60. We followed the same procedure as that in distractor 1. The results were significant for time,  $F(1.49)=5.16$ ,  $<.001$ ,  $v^2$ partial  $h^2=.058$ . The differences can be observed in Figure 4.



At the end of the speech, all the students had to answer a complicated question. One person in the audience (an avatar in the VR scenario) stood up and asked the question. We measured the reaction from the question to the answer, a total time of 35 seconds. The results were significant in the measurements  $F(1.49)=26.51$ ,  $<.001$ ,  $v^2$ partial  $h^2=.438$ , and time,  $F(1.49)=17.61$ ,  $<.001$ ,  $v^2$ partial  $h^2=.341$ . The measurement post-test was lower ( $M=2.57$ ;  $SD=.46$ ) than the pre-test ( $M=5.93$ ;  $SD=.43$ ). Figure 5 shows the differences.



In relation to gender, there was a significant difference between men and women,  $F(1.49)=192.14$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.015$ , and a significant interaction between gender and measurement,  $F(1.49)=10.99$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.001$  in the experimental group. Overall, men ( $M=3$ ;  $SD=.75$ ) recorded a higher level of anxiety than women ( $M=2.37$ ;  $SD=.89$ ). Regarding the interaction between measurement and gender, men recorded a difference between the first and second measurements of 1.66, while in women, it was 1.96. Therefore, even starting from a lower anxiety level, women managed to reduce it, with a significant difference, to a greater extent than male students.

Secondly, the Public Speaking Anxiety Scale results showed significant results in the three scales between the pre and the post-test in both groups, control and experimental. The results were significant for the cognitive scale,  $F(1.49)=260.17$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.570$ , the behavioural scale,  $F(1.49)=65.74$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.251$ , and the physiological scale,  $F(1.49)=237.14$ ,  $<.001$ ,  $v^2_{\text{partial}} h^2=.547$ . In the cognitive scale, the values in the post-test ( $M=1.87$ ;  $SD=.39$ ) were lower than in the pre-test ( $M=2.71$ ;  $SD=.32$ ). In the behavioural scale, the results were also lower in the post-test ( $M=2.30$ ;  $SD=.51$ ) than in the pre-test ( $M=2.93$ ;  $SD=.57$ ). Finally, in the physiological scale, the values in the post-test ( $M=2.42$ ;  $SD=.48$ ) were also lower than in the pre-test ( $M=3.43$ ;  $SD=.45$ ). Table 2 shows the values.

Table 1. descriptive statistics of the public speaking anxiety scale					
Scale	Group	Measurement	Mean	SD	Effect size
Cognitive	Control	Pre-test	2.74	.32	.570
		Post-test	1.90	.38	
	Experimental	Pre-test	2.68	.32	
		Post-test	1.85	.41	
	Total	Pre-test	2.71	.32	
		Post-test	1.87	.39	
Behavioural	Control	Pre-test	2.90	.53	.251
		Post-test	2.29	.51	
	Experimental	Pre-test	2.96	.61	
		Post-test	2.31	.51	
	Total	Pre-test	2.93	.57	
		Post-test	2.30	.51	
Physiological	Control	Pre-test	3.34	.46	.547
		Post-test	2.52	.51	
	Experimental	Pre-test	3.52	.42	
		Post-test	2.32	.44	
	Total	Pre-test	3.43	.45	
		Post-test	2.42	.48	

There were significant differences between the control and the experimental group, but there was a significant difference in the interaction group by measurement in the physiological scale,  $F(1.49)=8.21$ ,  $=.005$ ,  $v^2_{\text{partial}} h^2=.040$ , but not in the cognitive and behavioural. Students in the experimental group felt that the physiological manifestations had decreased to a larger extent than the control group. Therefore, the public speaking training helped these students in the three levels: cognitive, behavioural, and physiological,



but the VR training contributed specially to reduce the perception of the physiological symptoms. The survey was only completed by the experimental group as it was about their VR experience. The answers were analyzed with the software Nvivo. In the two first questions, on a 7-point scale, the students considered that VR helped them deliver a better presentation ( $M=5.14$ ;  $SD=1.03$ ). However, the training did not reduce their anxiety level ( $M=3.83$ ;  $SD=1.4$ ).

In the second group of questions, on the one hand, the advantages that the students mainly highlighted were focused on the fact that the training increased their level of confidence and helped them reduce nervousness. Most of them mentioned that the VR distractions significantly helped them concentrate and avoid getting distracted in presentations. On the other hand, the students mentioned fewer disadvantages than advantages. Most focused on the fact that it was not a very real experience, that they were not real people, the image's quality was not optimal, and the dizziness that sometimes occurred when they wore the glasses. Finally, students said they would use VR again to prepare for their public presentations (73%). Only 27% said they would not. When asked if they would recommend VR to other colleagues, the answer was also mostly affirmative. 82% said yes, and 18% said no.

#### 4. Discussion and conclusions

The goal of this study was to determine whether a virtual reality (VR) program with distractors, added to the usual training applied to college students delivering a public speech, could reduce their levels of anxiety measured using self-reported methods and electrodermal activity (EDA). We also analyzed gender differences. No previous studies had examined the effectiveness in reducing anxiety by combining EDA and self-report and using a VR training with distractors. Also, few studies had studied gender differences.

This study's first hypothesis postulated that the anxiety level would be higher in the pre-test than in the post-test after the VR training program with distractors. The results supported this first hypothesis in both groups, control and experimental. However, these results were only significant in the experimental group. The level of activation and anxiety, measured with electrodermal activity (EDA), was significantly lower in the post-test after the VR program than in the pre-test before the training. In the post-test, the EDA levels were lower, but the second measurement did not have a full upward progression, as in the pre-test. Also, there was a decrease in the post-test, which brought the anxiety level back to the first minute's values. These results reinforced other studies that have shown VR to be a useful tool for reducing anxiety and stage fright (van-Ginkel et al., 2019; Howard & Gutworth, 2020). Although VR's effectiveness as a training tool has shown different levels of success, most studies, such as this research, have proven their benefits for social skills like public speaking.

However, one of the most pivotal parts of this study was introducing distractors to reduce the students' anxiety and exercise public speaking skills. We placed distractors (an attendee coughing and an attendee leaving the auditorium) at two different moments of the discourses (seconds 40 and 60 respectively). In both cases, the EDA levels were significantly lower in the post-test compared to the pre-test. Moreover, at the end of the speech, all the students answered a complicated question. Once again, the EDA levels decreased in the post-test compared to the pre-test with significant differences. Therefore, this study shows that training with distractors is essential. Firstly, as it reproduces a more real situation and secondly, since some studies have shown that the audience's physical and vocal cues are crucial contributors to PSA. These distractors can increase PSA and make public speaking a traumatic experience (North & Rives, 2001; Pertaub et al., 2001; Söyler et al., 2016). The use of systematic exposure to feared situations ("exposure therapy"), such as the VR program in this study, has effectively overcome anxiety.

The self-report results also reinforced the effectiveness of the VR training to reduce stage fright. The Public Speaking Anxiety Scale showed that there were significant differences in the three subscales: cognitive, behavioural and physiological in both groups. Therefore, the usual public speaking training was effective in the self-perception level, but additionally, the VR application was more effective in the experimental group to reduce the physiological symptoms with significant differences with the control group.

Regarding the survey, the students reported that the VR training helped them concentrate on what they were saying, make fewer mistakes, feel more relaxed and confident, and have less tension. The main

advantages for these students were that VR increased confidence, helped them become less nervous, and allowed them to interact in front of a large audience when rehearsing the speech. The students rated the experience as positive globally and considered that VR helped them deliver a better presentation. The main disadvantages were the software's quality, which was a bit blurred, the fact that the characters did not seem very real, and the dizziness that some people felt when wearing the glasses for a long time.

The second hypothesis of this study stated that the level of anxiety would be higher in female students than in the male ones. Contrary to previous studies (Behnke & Sawyer, 2001; Mejias et al., 1991; Mohamad & Ab-Wahid, 2008), male students registered a higher level of anxiety than female students, as in the study by Levitt (1980). Therefore, these results did not support our second hypothesis. In addition, male students reduced the anxiety level in less quantity in the post-test. These data mean that VR training was more effective for females than for male students. These results break the stereotype that shows that men suffer less anxiety than women. One possible explanation is that one thing is what people expressed explicitly in self-reported scales and questionnaires and other what the physiological levels show, as, in fact, our results also indicate. According to different studies (Behnke & Sawyer, 2000; Mejias et al., 1991; Mohamad & Ab-Wahid, 2008), women systematically report higher anxiety patterns than men. Therefore, the self-perception of anxiety could not coincide with the real physiological response. Either way, due to the different results, more studies are needed to study this subject.

In conclusion, the main contributions of this study were threefold: a) we demonstrated the effectiveness of a VR program with distractors and questions to lower students' anxiety; b) we combined different methods, electrodermal activity (physiological response) and self-report (perception) to measure anxiety and achieved more reliable results; and c) we showed gender differences in anxiety with male students showing higher levels and less reduction in the post-test. This study's findings have implications for how VR technology can be embedded in higher education communication courses. This research suggests a practical activity that can be implemented in university classes with positive learning results. The results also support the "at-home practice" using smartphones, VR glasses, and free body movement.

The results of this study should be interpreted within the context of this research. First, we used a VR software which, as all those available in the market now, has some limitations, especially regarding the design. Therefore, further research could extend these results with different technology, especially looking for more realistic scenes and characters. The possibility to use Extended Reality instead of Virtual Reality could solve this problem. Another area that needs further study is the gender differences found in this study. Contrary to previous studies, in this case, male students' physiological anxiety level was higher than female participants'. These gender differences may be produced due to many factors. Therefore, this is an area that requires further research. Finally, the field of applications for educational purposes is still unexplored. In this regard, future research could suggest different training models and elaborate new applications.

### Authors' Contribution

Idea, E.R.; Literature review (state of the art), O.L.; Methodology, O.L., E.R.; Data analysis, E.R.; Results, O.L., E.R.; Discussion and conclusions, O.L., E.R.; Writing (original draft), O.L., E.R.; Final revisions, O.L., E.R.; Project design and sponsorship, E.R.

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