# 17. Development and evaluation of Virtual Reality environments for public speaking training

Saufnay, S.[a], Etienne E.[a] and Schyns, M.[a]

[a] QuantOM, HEC Liège, University of Liège, Liège, Belgium

**Type of manuscript: Extended abstract**

*Keywords: virtual reality; public speaking training; effectiveness*

**Extended abstract**

Oral communication is a fundamental soft skill, however critical for our personal and professional development. Good speaking skills are not innate but can be acquired through training (Morreale & Pearson, 2008), therefore justifying the implementation of dedicated solutions within institutions and companies (Robles, 2012).

An increasing body of literature explores the potential of Virtual Reality (VR) as a training tool for various skills (Jensen & Konradsen, 2018). Using this immersive and interactive technology, users can evolve in a training environment specially tailored to acquire the desired competences. As such, VR provides trainees with a customizable and safe environment suited to their needs (Kaplan *et al.*, 2021). The applicability of VR to a wide range of public speaking tasks further enhances its added value. Potential applications include training for job interviews (Stanica *et al.*, 2018), presentations (Valls-Ratés *et al.*, 2022), and for specific occupations, such as teachers (Lugrin *et al.*, 2016) or entrepreneurs (Niebuhr & Tegtmeier, 2019).

Rehearsing a speech in front of an audience appears as beneficial, reducing speakers' anxiety and improving their performance (Smith & Frymier, 2006). However, opportunities to practice in front of a real audience are limited, whereas virtual environments can be designed to contain responsive virtual avatars, powered by Artificial Intelligence (AI), in front of which users can rehearse.

To our knowledge, few articles thoroughly assess the effectiveness of public speaking training using VR, although promising results exist (Bachmann *et al.*, 2023; Takac *et al.*, 2019; Valls-Ratés *et al.*, 2023). This constitutes the overarching objective of this research. However, to develop extensive and adaptative training environments (as defined in Lugrin *et al.* (2016)), the presence of an AI-powered audience, responsive to speakers' performance, is valuable and constitutes a sub-goal of this research. Acknowledging the inherent limitation in capturing the full complexity of human behavior, AI will be employed to create interactive audiences, displaying specific behaviors according to the speaker's speech. The formulation of such virtual audience models remains scarce in the literature. To fill the identified gaps, we will rely on use cases, including VR training environments for entrepreneurs and teachers. These have not been widely investigated in the literature, further reinforcing our contribution.

Objective KPIs reflecting the quality of the speaking task, whether general or task-related, have been identified in various studies (Azaïs *et al.*, 2015; Batrinca *et al.*, 2013; Chollet *et al.*, 2016; Palmas *et al.*, 2019; Strangert & Gustafson, 2008), and include both verbal (i.e., hesitation rate, pauses, fundamental frequency) and nonverbal signals (i.e., stage usage, body language, visual connection with the audience). These indicators can be used to detect anxiety as well (Monteiro *et al.*, 2024; Wörtwein *et al.*, 2015). Multimodal cues appear as best predictors of performance but can eventually be reduced to acoustic information for the sake of simplicity (Chollet *et al.*, 2016). The considered

studies managed to approach correct evaluations, yet not reaching significant results. A deep understanding of these indicators is then primordial to develop a suited model, effectively reflecting the speakers' performance. More specifically to our use case, linguistic features reflecting persuasiveness and charisma are considered (Barkar *et al.*, 2023; Valls-Ratés *et al.*, 2023).

Once a performance assessment model has been established, it is worth considering making the audience react accordingly. The presence of an interactive virtual audience stimulates speaker's improvements in terms of stage usage, pause filters and speech intonation (Chollet *et al.*, 2016). In addition, customized audience scenarios turn out to be relevant for effective learning, keeping the audience challenging (Tudor *et al.*, 2013). Within the audience, avatars could either react through their verbal or nonverbal behavior. These signals constitute indirect feedback, subject to interpretation. This subjective aspect has given rise to an increasing number of studies investigating the perception of virtual audiences and avatars (Chollet & Scherer, 2017; Etienne *et al.*, 2023). Authors showed that specific parameters can effectively be detected by speakers, such as audience's valence and arousal (Glémarec *et al.*, 2022; Kang *et al.*, 2013), and identified specific behaviors mainly interpreted as positive, negative, or neutral (Etienne *et al.*, 2023). Behavioral styles, depending on the mood and the personality of the avatars, have also been successfully modelled (Kang *et al.*, 2016). These studies have implemented signals such as eye gaze, facial expressions, postures, body, and head movements, reflecting realistic audience behaviors (Poeschl & Doering, 2012). However, few models developing believable and challenging audiences, suited for training, have been expressively formalized. In addition, the relationship between users' perception and audience size, group dynamics, avatars gender, and realism constitutes a grey area in the literature. It is worth mentioning that the feeling of presence (as defined by Witmer & Singer (1998)), and especially co-presence, influences the intensity of perceptions (Slater *et al.*, 1999). Therefore, reaching high level of presence will be targeted as well in the development of our use cases.

When used for public speaking training, VR was positively accepted by participants (Monteiro *et al.*, 2020; Palmas *et al.*, 2019), and has shown great results regarding the improvement of communication skills and reduction of anxiety (Reeves *et al.*, 2022; Schmid Mast *et al.*, 2018). As previously mentioned, this research aims to assess the effectiveness of VR training. We will use questionnaires, related to the feeling of presence (Bouchard & Robillard, 2019; Witmer & Singer, 1998), cybersickness (Kennedy *et al.*, 1993), confidence and anxiety of the speaker (i.e., PRCS (McCroskey, 1970), SUDS (Wolpe, 1969)). They will be used to evaluate the effectiveness of VR applications, and to discuss the quantitative results that will come out from our analysis, relying on the evolution of the considered KPIs throughout the training process.

Preliminary results on the usefulness of VR environments for public speaking will be presented. This work is part of an ongoing doctoral thesis and is included in a larger project that encompasses several VR environments, dedicated to different professional applications. Extensive work has then already been done in terms of development, including the implementation of specific performance indicators. These environments, developed by a lab attached to our university, are currently being validated.

## References

Azaïs, L., Payan, A., Sun, T., Vidal, G., Zhang, T., Coutinho, E., Eyben, F., & Schuller, B. (2015). Does my Speech Rock? Automatic Assessment of Public Speaking Skills. *16th Annual Conference of the International Speech Communication Association, INTERSPEECH 2015*, 2519–2523.

Bachmann, M., Subramaniam, A., Born, J., & Weibel, D. (2023). Virtual reality public speaking training: effectiveness and user technology acceptance. *Frontiers in Virtual Reality*, *4*. https://doi.org/10.3389/frvir.2023.1242544

Barkar, A., Chollet, M., Biancardi, B., & Clavel, C. (2023). Insights Into the Importance of Lin-guistic Textual Features on the Persuasiveness of Public Speaking. *25th International Conference on Multimodal Interaction (ICMI 2023)*, 51–55. https://doi.org/10.1145/3610661.3617161

Batrinca, L., Stratou, G., Shapiro, A., Morency, L.-P., & Scherer, S. (2013). Cicero - Towards a Multimodal Virtual Audience Platform for Public Speaking Training. *13th International Conference on Intelligent Virtual Agents, IVA 2013*, 116–128. https://doi.org/10.1007/978-3-642-40415-3_10

Bouchard, S., & Robillard, G. (2019). Validation canadienne-française du Gatineau Presence Questionnaire auprès d'adultes immergés en réalité virtuelle. *87e Congrès de l'ACFAS*.

Chollet, M., & Scherer, S. (2017). Perception of Virtual Audiences. *IEEE Computer Graphics and Applications*, *37*(4), 50–59. https://doi.org/10.1109/MCG.2017.3271465

Chollet, M., Wörtwein, T., Morency, L.-P., & Scherer, S. (2016). A Multimodal Corpus for the Assessment of Public Speaking Ability and Anxiety. *10th International Conference on Language Resources and Evaluation, LREC 2016*, 488–495.

Etienne, E., Leclercq, A.-L., Remacle, A., Dessart, L., & Schyns, M. (2023). Perception of avatars nonverbal behaviors in virtual reality. *Psychology and Marketing*, *40*(11), 2464–2481. https://doi.org/10.1002/mar.21871

Glémarec, Y., Lugrin, J.-L., Bosser, A.-G., Buche, C., & Latoschik, M. E. (2022). Controlling the Stage: A High-Level Control System for Virtual Audiences in Virtual Reality. *Frontiers in Virtual Reality*, *3*. https://doi.org/10.3389/frvir.2022.876433

Jensen, L., & Konradsen, F. (2018). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies*, *23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Kang, N., Brinkman, W. P., Van Riemsdijk, M. B., & Neerincx, M. A. (2013). An expressive virtual audience with flexible behavioral styles. *IEEE Transactions on Affective Computing*, *4*(4), 326–340. https://doi.org/10.1109/TAFFC.2013.2297104

Kang, N., Brinkman, W.-P., Birna Van Riemsdijk, M., & Neerincx, M. (2016). The design of virtual audiences: Noticeable and recognizable behavioral styles. *Computers in Human Behavior*, *55*, 680–694. https://doi.org/10.1016/j.chb.2015.10.008

Kaplan, A. D., Cruit, J., Endsley, M., Beers, S. M., Sawyer, B. D., & Hancock, P. A. (2021). The Effects of Virtual Reality, Augmented Reality, and Mixed Reality as Training Enhancement Methods: A Meta-Analysis. *Human Factors*, *63*(4), 706–726. https://doi.org/10.1177/0018720820904229

Kennedy, R. S., Lane, N. E., Berbaum, K. S., & Lilienthal, M. G. (1993). Simulator Sickness Questionnaire: An Enhanced Method for Quantifying Simulator Sickness. *The*

*International Journal of Aviation Psychology*, *3*(3), 203–220. https://doi.org/10.1207/s15327108ijap0303_3

Lugrin, J.-L., Latoschik, M. E., Habel, M., Roth, D., Seufert, C., & Grafe, S. (2016). Breaking bad behaviors: A new tool for learning classroom management using

virtual reality. *Frontiers in ICT*, *3*(NOV). https://doi.org/10.3389/fict.2016.00026

McCroskey, J. C. (1970). Measures of communication-bound anxiety. *Speech Monographs*, *27*(4), 269–277.

Monteiro, D., Liang, H. N., Li, H., Fu, Y., & Wang, X. (2020). Evaluating the Need and Effect of an Audience in a Virtual Reality Presentation Training Tool. *Communications in Computer and Information Science*, *1300*, 62–70. https://doi.org/10.1007/978-3-030-63426-1_7

Monteiro, D., Wang, A., Wang, L., Li, H., Barrett, A., Pack, A., & Liang, H.-N. (2024). Effects of audience familiarity on anxiety in a virtual reality public speaking training tool. *Universal Access in the Information Society*, *23*(1), 23–34. https://doi.org/10.1007/s10209-023-00985-0

Morreale, S. P., & Pearson, J. C. (2008). Why communication education is important: The centrality of the discipline in the 21st century. *Communication Education*, *57*(2), 224–240. https://doi.org/10.1080/03634520701861713

Niebuhr, O., & Tegtmeier, S. (2019). Virtual Reality as a Digital Learning Tool in Entrepreneurship: How Virtual Environments Help Entrepreneurs Give More Charismatic Investor Pitches. In *FGF Studies in Small Business and Entrepreneurship* (pp. 123–158). https://doi.org/10.1007/978-3-030-20138-8_6

Palmas, F., Cichor, J., Plecher, D. A., & Klinker, G. (2019). Acceptance and effectiveness of a virtual reality public speaking training. *18th IEEE International Symposium on Mixed and Augmented Reality, ISMAR 2019*, 363–371. https://doi.org/10.1109/ISMAR.2019.00034

Poeschl, S., & Doering, N. (2012). Designing virtual audiences for fear of public speaking training - an observation study on realistic nonverbal behavior. *Annual Review of CyberTherapy and Telemedicine*, *10*, 218–222. https://doi.org/10.3233/978-1-61499-121-2-218

Reeves, R., Curran, D., Gleeson, A., & Hanna, D. (2022). A Meta-Analysis of the Efficacy of Virtual Reality and In Vivo Exposure Therapy as Psychological Interventions for Public Speaking Anxiety. *Behavior Modification*, *46*(4), 937–965. https://doi.org/10.1177/0145445521991102

Robles, M. M. (2012). Executive Perceptions of the Top 10 Soft Skills Needed in Today's Workplace. *Business Communication Quarterly*, *75*(4), 453–465. https://doi.org/10.1177/1080569912460400

Schmid Mast, M., Kleinlogel, E. P., Tur, B., & Bachmann, M. (2018). The future of interpersonal skills development: Immersive virtual reality training with virtual humans. *Human Resource Development Quarterly*, *29*(2), 125–141. https://doi.org/10.1002/hrdq.21307

Slater, M., Pertaub, D.-P., & Steed, A. (1999). Public Speaking in Virtual Reality: Facing an Audience of Avatars. *IEEE Computer Graphics and Applications*, *19*(2), 6–9. https://doi.org/10.1109/38.749116

Smith, T. E., & Frymier, A. B. (2006). Get 'real': Does practicing speeches before an audience improve performance? *Communication Quarterly*, *54*(1), 111–125. https://doi.org/10.1080/01463370500270538

Stanica, I., Dascalu, M.-I., Bodea, C. N., & Bogdan Moldoveanu, A. D. (2018). VR Job Interview Simulator: Where Virtual Reality Meets Artificial Intelligence for Education. *2018 Zooming Innovation in Consumer Technologies Conference, ZINC 2018*, 9–12. https://doi.org/10.1109/ZINC.2018.8448645

Strangert, E., & Gustafson, J. (2008). What makes a good speaker? Subject ratings, acoustic measurements and perceptual evaluations. *INTERSPEECH 2008 - 9th*

*Annual Conference of the International Speech Communication Association*, 1688–1691. https://doi.org/10.21437/interspeech.2008-368

Takac, M., Collett, J., Blom, K. J., Conduit, R., Rehm, I., & De Foe, A. (2019). Public speaking anxiety decreases within repeated virtual reality training sessions. *PLoS ONE*, *14*(5). https://doi.org/10.1371/journal.pone.0216288

Tudor, A.-D., Poeschl, S., & Doering, N. (2013). Virtual audience customization for public speaking training procedures. *20th IEEE Virtual Reality Conference*, 61–62. https://doi.org/10.1109/VR.2013.6549363

Valls-Ratés, Ï., Niebuhr, O., & Prieto, P. (2022). Unguided virtual-reality training can enhance the oral presentation skills of high-school students. *Frontiers In Communication*, *7*. https://doi.org/10.3389/fcomm.2022.910952

Valls-Ratés, Ï., Niebuhr, O., & Prieto, P. (2023). Encouraging participant embodiment during VR-assisted public speaking training improves persuasiveness and charisma and reduces anxiety in secondary school students. *Frontiers in Virtual Reality*, *4*. https://doi.org/10.3389/frvir.2023.1074062

Witmer, B. G., & Singer, M. J. (1998). Measuring Presence in Virtual Environments: A Presence Questionnaire. *Presence: Teleoperators and Virtual Environments*, *7*(3), 225–240. https://doi.org/10.1162/105474698565686

Wolpe, J. (1969). *The practice of behaviour therapy*. Pergamon Press.

Wörtwein, T., Morency, L.-P., & Scherer, S. (2015). Automatic Assessment and Analysis of Public Speaking Anxiety: A Virtual Audience Case Study. *2015 International Conference on Affective Computing and Intelligent Interaction, ACII 2015*, 187–193. https://doi.org/10.1109/ACII.2015.7344570