Perception of avatar attitudes in Virtual Reality

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Virtual Reality (VR) has considerable potential in psychology and business when human behavior is under scrutiny. It's, therefore, no wonder that marketing research is so active in VR (Loureiro et al., 2019, Boyd and Koles, 2019, Beck et al., 2019, Bonetti et al., 2018).
Our project focuses on improving a very common business activity: speaking in public. It is well known that repeated training in front of an audience can help to improve speaking performances (Wallach et al., 2009). We, therefore, want to create a realistic, challenging, and interactive (as defined in Flavián et al., 2019) audience through AI-powered avatars. In this environment, the audience must be faithfully represented and correctly perceived and the VR environment itself must be truly immersive, Chollet et al. tried to understand in their work (2017) how participants perceive virtual audiences based on the nonverbal behavior of their members, also named avatars in this digital context. They explored which non-verbal behaviors are relevant to be perceived by the speaker as expressing high or low arousal and positive or negative attitude in terms of arousal and valence. However, their experiment was conducted on a 2D flat screen through the web and not in a fully VR (3D) setting. Furthermore, some work exists on how to improve the presence and immersion (Hyun and O'Keefe, 2012, and Hudson et al., 2019) and on how to stimulate additional emotions (Flavián et al., 2021, Collange and Guegan, 2020 but also Gabory and Chollet, 2020, and Mostajeran et al., 2020 in the public speaking context). However, to the best of our knowledge, a few studies (e.g. Amin et al. 2016) have compared the immersion between high-end and low-end headsets. Moreover, the presence and the immersion are real concerns when dealing with avatars and robots (Letheren et al., 2021 and Belanche, 2021a and b). However, too little had been done considering the quality of graphism used to represent the avatars.
Our research aims to fill in the identified gaps.

Our first goal is to build a library of animated avatars representing the most common attitudes and emotions of an audience as faithfully as possible. We use Chollet and Scherer's methodology (2017) to combine different body postures, facial expressions, and head movements such as to define various sets of potentially representative attitudes. We then measure how a speaker perceives them in VR through the concepts of valence (attractiveness and averseness) and arousal (level of alertness). Finally, based on these measures, the final step is to sort the different animations into categories corresponding to typical reactions to speeches of different qualities. In practice, we surveyed 125 adults in VR. They together rated the emotional valence and arousal of 40 animated sequences. Our second related question investigates whether fully rigged 3D photo-realistic models can significantly improve participants' perception of the avatar's arousal and valence or their confidence levels

interpretation of the audience. To answer this question, four cartoon and four photo-realistic avatar models were designed in our lab. Each participant evaluated ten sequences out of the forty, featuring a cartoon model and ten sequences featuring a photo-realistic avatar. Finally, our last question investigates whether high-end or low-end headsets, like cardboards, impact the quality of immersion (four items of the Gatineau presence questionnaire) and the quality of the results. We expect better results with high-end headsets. However, if the difference in this context is limited, low-end headsets being extremely cheap, it would allow mass usage.

Regarding our first question, our study shows the associated valence and arousal for each parameter (posture and hands, facial expression, and head movements). Our results are coherent with Chollet's findings (2017), but in our case, for a 3D VR setting. Furthermore, among the combinations of behavior selected, we now have a library of avatar attitudes associated with some levels of valence and arousal. Moreover, we observe that some gestures dominate others and that links exist between valence and arousal. Thanks to these results, we know which animation to choose to represent a specific sentiment for the audience. Considering our second question, there is a positive impact of using photo-realistic avatars. While keeping the participants' judgment of valence and arousal unchanged, photo-realistic avatars improve their judgment's confidence level. Our results are coherent with Seymour et al.'s results (2021) about trustworthiness and affinity with human-realistic avatars. We expected that the assessment of the valence and the level of arousal would be changed, but this can probably be explained by a limited level of interactions in the setup. Regarding our last question, participants evaluated the level of arousal as higher when they used the high-end headset. Furthermore, the quality of immersion (the feeling of presence, the level of realism, and the spatial awareness) is improved when using a high-end headset instead of a low-end headset. Our results are coherent with Orús et al. (2021).

This research focused on investigating how people perceive a virtual audience delivered by VR technology and selecting attitudes to represent a set of audience reactions faithfully. We now have a library of avatar attitudes associated with some levels of valence and arousal.
This research is part of a three-step project to create a VR environment for public speaking training where the speaker will train himself in front of a realistic and challenging audience. We have already created different virtual rooms where participants will hold a presentation in front of a virtual audience. We have also started to work on automatic methods based on statistical, machine learning, and natural language processing methods to implement real-time biofeedback of the audience to the speaker's presentation. Even if the focus in this project is on speaking skills, the VR environment created can have many other applications to develop different business skills.
The project itself is part of a long-term project. We want to create a collaborative platform called *Eduverse* (a Metaverse for Education), where immersed users will train in totally controlled VR environments in front of two types of avatars: other participants (trainees, experts, teachers…) and Artificial Intelligence (AI) powered avatars (Butt, 2021).

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