The Effects of Ingroup Bias on Public Speaking Anxiety in Virtual Reality

Lotte E. J. Biesmans, Pleun J. M. van Hees, Lisa E. Rombout, Maryam Alimardani and Eriko Fukuda
Department of Cognitive Science and Artificial Intelligence, Tilburg University, Warandelaan, Tilburg, The Netherlands

Keywords: Virtual Reality, Virtual Agents, Social Agents, Ingroup Bias, Emotional Intelligence, Emotional Interaction, Presence, Public Speaking Anxiety, Mental Health.

Abstract: Virtual agents can be powerful elements in virtual reality (VR) applications, as their influence on user experience is governed by complex social mechanisms. Public speaking offers a relatively high-stakes situation that involves interaction with virtual agents. We examined the effects of an ingroup versus outgroup virtual audience on public speaking anxiety (PSA). Additionally, we looked at how emotional intelligence and VR ecological validity modified these effects. Results indicated that the VR application succeeded in evoking ingroup bias, and that in the ingroup condition, self-reported PSA was related to general PSA. Emotional intelligence was also a significant moderator. Additionally, audience type influenced the level of presence experienced by the user: ingroup audiences result in a higher level of presence. This study identifies potential areas of interest for future research, approaches that could influence users in specific and measurable ways in applications involving virtual social interaction, as well as the personalization of these virtual experiences.

1 INTRODUCTION

Virtual reality (VR) applications provide a rich environment for users with many different possibilities for sensory experiences and interactive elements. The design of the virtual agents that might inhabit these spaces is one of the elements that can be used to influence the player in complex yet measurable ways. Since virtual humanoid characters are experienced by the user on a social level, their interaction is governed by higher-level social mechanisms and the personality characteristics of the user (Hamilton et al., 2016; Daher et al., 2017). There are therefore many dimensions to consider when designing virtual characters. One potentially interesting dimension is that of ingroup/outgroup distinctions.

Defining other people as ingroup or outgroup (whether they belong to the same social group as the person or not) is a common way to code and simplify social interactions. It influences how others are perceived and judged, and how they are behaved towards. This often manifests in the form of a preference for, or a more positive attitude towards, the ingroup members, which is also known as ingroup bias (Paladino and Castelli, 2008). Conversely, perception and behaviour tend to be more negative towards outgroup members.

Judging whether someone is in the in- or outgroup is an immediate and subconscious process based on automatic stereotyping (Wittenbrink et al., 1997). Grouping methods can intersect - for instance, someone can be in your ingroup with regards to race, but in your outgroup with regards to gender. An individual's strength of group identification determines how strongly they experience the effects. The way the behaviour of the other is perceived is affected by their group status. For instance, people are generally more sensitive to criticism when it is made by outgroup members as opposed to ingroup members (Elder et al., 2005). In virtual reality, the ingroup/outgroup status of a virtual crowd can influence presence (Kyriakou and Chrysanthou, 2018), and other studies also show that ingroup bias extends to virtual avatars (Guadagno et al., 2007). It should be noted that ingroup/outgroup distinctions are a common narrative device, which is also known to affect a VR experience (Troxler et al., 2018). Obviously, an individual's susceptibility to ingroup bias is dependent on their actual identification with the group, and might be affected by individual characteristics, such as their level of emotional intelligence.

Emotional intelligence (EI) is not a single trait or ability, but can be defined as the capacity to recognize the meaning of emotions, to understand their in-

Biesmans, L., van Hees, P., Rombout, L., Alimardani, M. and Fukuda, E.
The Effects of Ingroup Bias on Public Speaking Anxiety in Virtual Reality.
DOI: 10.5220/0008951600170024
In *Proceedings of the 15th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2020) - Volume 2: HUCAPP*, pages 17-24
ISBN: 978-989-758-402-2; ISSN: 2184-4321

formation, and to manage them (Salovey and Sluyter, 1997). As expected, EI highly influences social interaction. People with low levels of EI generally experience more anxiety in social situations (Summerfeldt et al., 2006; Jacobs et al., 2008) whereas high levels correspond to lower communication anxiety (Dewaele et al., 2008). However, there is a gap in knowledge on how an individual's level of EI influences their interaction with virtual agents, and whether this is comparable to their interaction with real people. We do know that people have varying reactions to virtual characters and some people are quicker to accept and trust avatars than others (Vinayagamoorthy et al., 2006), which might be partly caused by characteristics such as EI.

A quite common way of exploring the effects of virtual character design is through the use of virtual audiences in public speaking situations. This context provides an interaction with a large group of people in a relatively high-stakes situation. Virtual audiences consisting of avatars that display clear human characteristics are regarded as more realistic, competent, credible, and attractive (Nowak and Rauh, 2005), and strengthen the bond the VR user feels with the audience (Nowak et al., 2009). One study (Slater et al., 1999) focused on how an outwardly positive or negative virtual audience affected public speaking anxiety (PSA). They found that, similar to real life audiences, positive virtual audience interest reduced PSA. Additionally, they found that co-presence (the sense of being in the same space as the virtual audience) amplified this effect. A second study found that virtual audiences with an outwardly neutral or positive emotional state caused PSA to remain the same, while those with a negative emotional state increased PSA (Pertaub et al., 2002).

PSA is one of the most common social phobias, estimated to affect around 20 to 34% of people (Botella et al., 2010; Pull, 2012). People suffering from PSA experience physiological arousal such as an increased heart rate or sweating, focus negatively on how they come across, and show behavioral concomitants like shaking or speaking gibberish whenever they have to speak in front of an audience (Bodie, 2010). PSA is usually treated with cognitive behaviour therapy including exposure (Botella et al., 2010). Exposure used to be either real-life or imagined public speaking (Wallach et al., 2009), but is currently often addressed by VR mental health applications (Pull, 2012). Exposure therapy with VR can be equally effective in reducing PSA as real-life exposure (Wallach et al., 2009) and has long-term effects (Anderson et al., 2005). VR hard- and software does not need to be of the highest quality, and the exposure does not need to happen in a therapy setting for it to be effective (Lindner et al., 2019; Stupar-Rutenfrans et al., 2017). Both self-reported PSA and heart rate measurements reflect a reduction in PSA when VR is used for exposure (Harris et al., 2002).

Because the public speaking experience provides such a highly salient social interaction, with proven effects of virtual audience manipulations on the level of PSA, it seems an ideal setting to explore the influence of other social mechanisms, like ingroup bias and EI. Therefore, this study aimed to investigate whether an ingroup vs. an outgroup virtual audience can influence the amount of public speaking anxiety that users experience. Since there are indications in the literature that the behaviour of ingroup members is immediately and automatically perceived more positively than the behaviour of outgroup members (Elder et al., 2005), and more positive audiences are less anxiety inducing (Slater et al., 1999), we hypothesized that participants would experience less public speaking anxiety in front of the ingroup virtual audience compared to the outgroup audience.

Additionally, we were interested in the effects of an individual's personal traits, such as EI and general predisposition towards public speaking anxiety, on the level of specific experienced PSA in the above ingroup/outgroup scenario. Since previous research shows that low levels of EI correspond to high levels of social anxiety (Dewaele et al., 2008; Summerfeldt et al., 2006), we expected that participants with low levels of EI would generally experience more public speaking anxiety than those with high levels of EI, and that the level of EI could help explain the potential PSA difference between conditions.

Finally, as the comparison between the two conditions were done in a virtual environment, we speculated that the ecological validity of the VR simulation could influence the level of PSA that users experienced in each condition. This includes the level of presence that participants felt in the virtual room, and their actual ingroup/outgroup identification. In this context, we define ecological validity as a measure of how effective the virtual environment is in terms of making the participants feel like they are in a real space, interacting with real people.

To summarize, three research questions (*RQ*) were formulated:

RQ1: What is the effect of an ingroup vs. an outgroup virtual audience on the amount of PSA that users experience during a virtual public speaking simulation?

RQ2: How do individual traits such as emotional intelligence and general predisposition towards public speaking anxiety regulate the experienced PSA *level in each condition?*

RQ3: How does VR ecological validity, including presence and actual ingroup identification of the participants, regulate the experienced PSA level in each condition?

2 METHODS

2.1 Participants and Study Design

Forty university students (23 female) were recruited using convenience sampling. They were all native Dutch speakers and aged between 18 and 28 (M = 22.55, SD = 2.43). The participants were quite comfortable speaking English (M = 4.93, SD = 1.51 on a 7-point Likert scale). They had a medium experience with VR technologies (M = 3.75, SD = 1.81 on a 7-point Likert scale). No pre-selection was made on general PSA levels or presence of social anxiety. The study was approved by the research ethics and data management committee of Tilburg University.

We used a between-subjects design. Participants were randomly assigned to one of the two conditions: Ingroup (N = 20) or Outgroup (N = 20). In the Ingroup condition, participants were told to give a 2-minute presentation in English about their current study for a group of freshman students, who wanted to know what they could expect. In the Outgroup condition, participants were also told to give a 2-minute presentation in English about their current study, but here it would be for a group of professors.

2.2 Materials

The virtual environment was created using Unity 3D. It consisted of a simple room with a wooden floor and white walls, with one big window through which a static landscape view of a small city was visible. Nine chairs were placed in a three by three arrangement in front of the participant point of view. The virtual audience was placed on these chairs. The virtual avatars were created using the MakeHuman software, and animated with basic breathing movements from the Mixamo repository. Some general ambient sounds, such as someone shifting in their chair, were also added to the virtual environment.

The only difference between the conditions was the physical appearance of the virtual audience. In the Ingroup condition the avatars were physically smaller, and they wore bright colours and informal clothes. The avatars in the outgroup condition were bigger and wore toned down colours and formal clothes (see figure 1).

(a) The Ingroup condition

(b) The Outgroup condition

Figure 1: The virtual characters.

The environment was presented to the participants through the Oculus Rift head-mounted display (HMD), tracking only the head movements. Thus participants were able to look around the room but unable to further interact physically with objects in the environment. Furthermore, a Grove ear-clip optic pulse sensor by Seeedstudio was used to measure the heart rate of the participants.

2.3 Measurements

2.3.1 Public Speaking Anxiety Scale

To measure subjective PSA, the Public Speaking Anxiety Scale (PSAS) (Bartholomay and Houlihan, 2016) was used, consisting of 17 items on a 7 point Likert scale. Before the VR experience, the participants' general predisposition towards PSA (general PSA) was measured with the PSAS. After the presentation in VR, state PSA during the experience was measured using the altered version of the PSAS questionnaire specifically targeted towards the recent public speaking experience (state PSA) - so instead of 'I am confident when I give a speech' the statement reads 'I was confident when I gave the speech'.

2.3.2 Heart Rate

For an objective measure of PSA, mean heart rate (HR) and heart rate variability (HRV) were collected, both as a baseline and during the public speaking task. These are both indicators of stress (Kim et al., 2018) and complement each other (Kusserow et al., 2008). HR is a general measure of arousal, whereas HRV is linked to anxiety and emotional strain specifically.

Although both measures can of course respond to the general VR experience also (especially in the case of a novelty effect), we only consider the differences between conditions and not the raw values. Both HR and HRV were derived from the normal-to-normal interval of consecutive heart beats, with the variance of the inter beat intervals (functionally, the SDNN) used as the measure for HRV. To ensure that HR and HRV were obtained from a stable signal, the first and last ten heartbeats of each recording were excluded from the analysis. Skin conductance was considered as a similar measurement but proved less reliable and more restrictive in the pilots.

2.3.3 Emotional Intelligence

For this study we focused on trait EI, referring to emotion-related trait and self-perceived abilities (Petrides and Furnham, 2006). To measure trait EI, the Trait Emotional Intelligence Questionnaire - Short Form (Petrides, 2009) was used. This questionnaire consists of 30 items on a 7 point Likert scale, giving a global trait EI score.

2.3.4 Ingroup Identification and Presence

As a measure of the effectiveness of changing the VR avatars for the Ingroup/Outgroup manipulation, the actual ingroup identification was measured with the Group Identification Scale (GIS) (Sani et al., 2015), which consists of 4 items on a 7 point Likert scale. Additionally, the short version of the Presence Questionnaire by Witmer and Singer (Witmer and Singer, 1998) was used to control for the level of presence experienced in the VR environment. This version consists of 6 items on a 7 point Likert scale.

2.4 Procedure

The experiments were conducted in a neutral office room. Participants were welcomed and read the information letter. After signing the informed consent, they filled in the pretest questionnaire (demographics, English proficiency and VR experience questions, general PSA, and EI). A baseline heart rate recording was made for one minute while the participant sat still and looked at a blank wall.

Then participants put on the HMD and got accustomed to the hardware and VR by experiencing the virtual room without the audience in it for one minute. They then took off the HMD and were instructed about the task. They were told that the experimenter would leave the room and that the presentation would not be recorded. Following that, the participants put on their HMD again and the heart rate sensor started recording the speaking session.

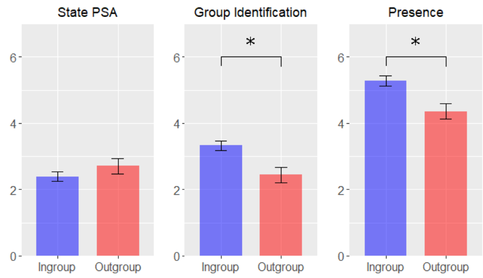

Figure 2: State PSA, GIS and Presence per condition.

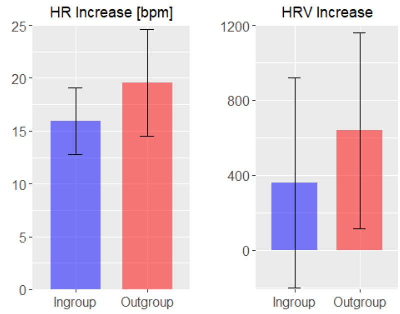

Figure 3: HR and HRV increase per condition.

After two minutes had passed, the experimenter re-entered the room and announced that the participant could stop talking and take off the HMD and heart rate sensor. The participants then filled out the post-test questionnaire (state PSA, GIS, and presence). Finally, the participants were thanked for their participation and the experiment was ended.

3 RESULTS

3.1 Public Speaking Anxiety

3.1.1 State PSA

The post-test PSAS (to measure state PSA during the VR experience) had good scale reliability (Cronbach's $\alpha = 0.88$). As shown in Figure 2, participants in the Ingroup condition (M = 2.39, SD = 0.87) reported slightly less PSA during the speech task than participants in the Outgroup condition (M = 2.72, SD = 0.74). The Levene's test showed that the variances in the two groups were homogeneous, $F(1,19) = 0.71$, $p = 0.46$. The difference between the two conditions was not significant, $Mdif$ = 0.32, $t(38)$ = 1.25, p = 0.22.

3.1.2 Heart Rate

Due to malfunctioning of the heart rate sensor (>15% of measurements compromised in either baseline or speaking measurement), eight participants (1 Ingroup, 7 Outgroup) were removed from the analysis of HR data. There was a significant general increase in mean HR from the baseline to the public speaking phase for all participants, regardless of condition (*Mdif* = -17.41, $t(31) = -6.38$, $p < 0.001$). For each participant, the difference between the baseline and the speaking HR and the difference between the baseline HRV and speaking HRV were calculated and used for further statistical testing.

Participants in the Outgroup condition ($M = 19.55$, $SD = 18.10$) had a higher mean HR increase than participants in the Ingroup condition ($M = 15.94$, $SD = 13.65$), as can be seen in Figure 3. The variances in the two groups were homogeneous, $F(1,12) = 1.76$, $p = 0.27$. The difference between the two conditions was not significant, *Mdif* = 3.61, $t(30) = 0.64$, $p = 0.52$.

Participants in the Ingroup condition ($M = 358.11$, $SD = 2445.14$) had a lower increase of HRV during the speaking task than participants in the Outgroup condition ($M = 637.71$, $SD = 1891.60$), as can be seen in Figure 3. The variances in the two groups were homogeneous, $F(1,12) = 0.60$, $p = 0.37$. The difference between the two conditions was not significant, *Mdif* = 279.60, $t(30) = 0.35$, $p = 0.73$.

3.2 Individual Traits

3.2.1 General PSA

The pre-test PSAS (to measure general PSA) had good scale reliability (Cronbach's $\alpha = 0.94$). Participants in the Ingroup condition ($M = 3.42$, $SD = 1.05$) reported slightly less general PSA than participants in the Outgroup condition ($M = 3.84$, $SD = 0.81$), but this difference was not significant. Because the level of general PSA differed greatly ($M = 3.63$, $SD = 1.33$) within all participants and cutoff scores are generally used to categorize PSA (Bartholomay and Houlihan, 2016), we first split them into two groups, one with low general PSA and one with high general PSA, with a cutoff point of 4. The low general PSA group (10 Ingroup condition, 9 Outgroup condition) had an average of 3.05 ($SD = 0.76$), and the high general PSA group had an average of 4.51 ($SD = 0.31$).

On average, participants with low general PSA also experienced less state PSA during the experiment ($M = 2.17$, $SD = 0.63$) than participants with high general PSA ($M = 3.13$, $SD = 0.72$). Levene's test showed that the variances in the two groups were homogeneous, $F(1,36) = 1.04$, $p = 0.39$. The difference in state PSA between the two groups was significant (two-way ANOVA, controlling for condition), $F(1,36) = 18.69$, $p < 0.001$, with a large-sized effect of $d = 1.4$. However, there was no significant interaction effect with the Ingroup/Outgroup conditions.

3.2.2 Regression Model - EI & General PSA

The EI demonstrated good internal consistency reliability (Cronbach's $\alpha = .88$). Participants in the Outgroup condition ($M = 5.01$, $SD = 0.58$) reported a slightly lower mean than those in the Ingroup condition ($M = 5.26$, $SD = 0.66$).

A moderated regression analysis was performed to examine further whether the effects of EI and general PSA (non-categorized values) on state PSA differed by condition. The model summary for the regression analysis was as follows: $F(5, 34) = 9.84$, $p < .001$, $R^2 = .59$. Condition significantly moderated both the effect of EI on state PSA and the effect of general PSA on state PSA (see Table 1).

A post-hoc simple slopes analysis found a significant effect of EI on state PSA, after controlling for general PSA, in the Outgroup condition ($\beta = -.90$, $SE = .30$, $t = -3.04$, $p = .005$) but not in the Ingroup condition ($\beta = .08$, $SE = .26$, $t = .30$, $p = .76$). Conversely, the simple slope of general PSA on state PSA, after controlling for EI, was significant in the Ingroup condition ($\beta = .68$, $SE = .16$, $t = 4.21$, $p < .001$) but not in the Outgroup condition ($\beta = .10$, $SE = .21$, $t = .48$, $p = .64$).

Table 1: Moderated regression model - the effect of individual traits EI and general PSA on state PSA.

	β	*SE*	*t*	*p*
gPSA	.10	.21	.48	.637
Condition	-.11	.19	-.58	.566
EI	-.90	.30	-3.04	.005
EI*Condition	.98	.40	2.47	.019
gPSA*Condition	.58	.26	2.21	.034

3.3 VR Ecological Validity

3.3.1 GIS

The GIS had good scale reliability (Cronbach's $\alpha = 0.91$). As shown in Figure 2, participants in the Ingroup condition ($M = 3.33$, $SD = 1.54$) identified more with their virtual audience than participants in the Outgroup condition ($M = 2.45$, $SD = 0.94$). Levene's test showed that the variances in the two groups were not homogeneous, $F(1,19) = 0.37$, $p = 0.04$. The difference between the two conditions was significant (independent samples t-test), *Mdif* = -0.88, $t(31.4)$ = -2.17 p = 0.04, with a moderate effect size of d = -0.67.

3.3.2 Presence

On average, the level of presence experienced by the participants was 5.2 (*SD* = 1.0). The presence questionnaire had sufficient scale reliability (Cronbach's α = 0.68). As shown in Figure 2, participants in the Ingroup condition (*M* = 5.23, *SD* = 0.68) felt more present than participants in the Outgroup condition (*M* = 4.36, *SD* = 1.04). Levene's test showed that the variances in the two groups were homogeneous, $F(1,19) = 2.36$, $p = 0.07$. The difference between the two conditions was significant (independent samples t-test), *Mdif* = -0.87, $t(38) = -3.3$, $p = 0.002$, with a large-sized effect, $d = -1.05$.

3.3.3 Regression Model - GIS & Presence

A moderated regression analysis was performed to examine whether the effect of participants' level of GIS and presence on state PSA differed by condition. The model summary for the regression analysis was as follows: $F(5, 34) = 1.22$, $p = .32$, $R^2 = .85$. Neither the GIS nor the presence effects were significantly moderated by condition (see Table 2). The model was rerun without the interaction terms to allow estimation of the partial effects of GIS and presence. Reducing the model did not significantly decrease the proportion of explained variation ($\Delta R^2 = .02$, $F(2, 36) = 4.34$, $p = .65$), but neither the partial effect of GIS nor the partial effect of presence were statistically significant (GIS: $\beta = .20$, $SE = .12$, $t = 1.75$, $p = .089$; Presence: $\beta = -.19$, $SE = .17$, $t = -1.10$, $p = .28$).

Table 2: Moderated regression model - the effect of VR ecological validity GIS and presence on state PSA.

	β	*SE*	*t*	*p*
GIS	.04	.25	.14	.888
Presence	-.05	.23	-.21	.837
Condition	-.33	.32	-1.05	.299
GIS*Condition	.22	.28	.77	.447
Presence*Condition	-.30	.38	-.80	.430

4 DISCUSSION

This study examined the effect of ingroup bias on the level of public speaking anxiety that users experienced in VR, and how their personal characteristics and the VR ecological validity regulated that experience. Our results showed that the Ingroup/Outgroup conditions did not significantly affect the level of PSA that participants experienced during the public speaking task, answering RQ1 in the negative. The ecological validity did not seem to influence PSA either (RQ3). However, there were significant effects of personal traits such as emotional intelligence and general public speaking anxiety (RQ2).

There was an interaction between EI and condition, where a higher EI predicted a lower state PSA score, specifically in the Outgroup condition. This result suggests that EI had a modulating effect on state PSA when presenting to an outgroup audience, but not when presenting to an ingroup audience. It could be interesting to explore this effect further in future research, to see whether a high emotional intelligence allows a person to be more comfortable with virtual characters that they do not necessarily identify with. If this is the case, virtual public speaking training could be improved by adding emotional intelligence training as well.

Not unexpectedly, state PSA was significantly affected by general PSA. This means that participants who experience more anxiety towards public speaking in general were also more anxious during this specific virtual public speaking experience, regardless of the condition. The regression showed that there was also an interaction effect with condition overall, meaning that general PSA predicted state PSA in the Ingroup condition. The more predisposed someone is to public speaking anxiety, the more anxious they are when they have to present in front of an audience that they consider a part of their ingroup, whereas general PSA was not significantly related to state anxiety when presenting to outgroup members.

Besides the main research questions, a few other noteworthy interactions were found. A significant increase in heart rate was observed overall. This could be caused by the novelty effect of the VR technology, as many participants did not have a lot of previous experience with VR. The 1-minute acclimatization to the VR environment might not have been enough to overcome this. If this is the case, the novelty effect might have occluded any smaller effects of the conditions, and it could be interesting to repeat the experiment with more experienced participants or over a longer period of time.

Participants in the Ingroup condition identified significantly more with the virtual audience than participants in the Outgroup condition. This is exactly as intended, and indicates that it is likely that a type of ingroup bias was triggered by the exposure to these different audiences. Unexpectedly, the audience type had a significant effect on presence, where participants in the Ingroup condition felt more present in the virtual environment than those in the Outgroup condition. This warrants further research, as it could potentially be utilized in a wide variety of virtual applications to improve the user interaction. Although it of course already makes sense from a narrative design point of view to improve user identification with the virtual characters they encounter, this result shows that it might have measurable and far-reaching effects on how the medium itself is experienced.

The ingroup audience does not seem to lead to enough of a positive association with the virtual characters to significantly affect PSA. It is however not unlikely that the increased presence and group identification have effects on other factors, which could be explored in future research. As several studies have shown, the valence of audience feedback affects the user (Slater et al., 1999; Pertaub et al., 2002). Interaction effects in this regard might be a worthwhile area of study, since positive or negative audience feedback could be perceived differently depending on whether the virtual audience is a part of the participant's ingroup or outgroup (Elder et al., 2005).

It should be noted that, as increased identification with the ingroup audience was established not only through the use of visuals, but also through means of a narrative (first-year students who want to know what to expect from their studies), it is possible that this by itself explains the increased level of presence (Troxler et al., 2018). As previous research shows that co-presence in particular can amplify positive effects of virtual audiences (Pertaub et al., 2002), it might be interesting for future research to look at co-presence specifically. Co-presence could also be induced more strongly with several techniques, such as social priming (Daher et al., 2017).

One of the limitations of this study is that we only looked at one type of in- and outgroup, namely students and professors. As is often the case, these groups hold a clear power differential in regard to how they relate to the participant. This could have influenced the results. Different types of groupings (for instance on gender, race or social class) could potentially lead to different effects. Additionally, although many VR studies currently use similar or even smaller sample sizes to the one used here, in-depth analyses of the interaction effects require a more robust sample size which could lead to deeper insights in the complex mechanisms behind social VR experiences.

As the technology and its applications advance, VR involves more of the interacting variables that are also present in real life, especially on a social level (Hamilton et al., 2016). Uncovering the social processes that govern the user interaction with the virtual world allows us to design more effective VR applications. This study has shown that while ingroup versus outgroup virtual audiences can affect group identification, which can significantly influence presence, this does not have a significant influence on the level of PSA that is experienced by users while practising public speaking in VR. It does however affect the relationship between general and state PSA. Furthermore, the effects on state PSA are moderated by the individual characteristics (EI) of the player, potentially allowing for personalization of the experience. The overall results of this study indicate that ingroup bias can be evoked in virtual environments and that it could be an interesting method of influencing the feelings and behaviour of users in specific ways. Although this study focused on PSA, the effects of ingroup bias in VR could potentially be extended towards any VR application that involves social interactions, and might prove useful in a variety of contexts.

ACKNOWLEDGEMENTS

The authors would like to thank Lisa Neve for her technical assistance with the creation of the virtual environment used in this study.

REFERENCES

Anderson, P. L., Zimand, E., Hodges, L. F., and Rothbaum, B. O. (2005). Cognitive behavioral therapy for public-speaking anxiety using virtual reality for exposure. *Depression and anxiety*, 22(3):156–158.

Bartholomay, E. M. and Houlihan, D. D. (2016). Public speaking anxiety scale: Preliminary psychometric data and scale validation. *Personality and Individual Differences*, 94:211–215.

Bodie, G. D. (2010). A racing heart, rattling knees, and ruminative thoughts: Defining, explaining, and treating public speaking anxiety. *Communication education*, 59(1):70–105.

Botella, C., Gallego, M. J., Garcia-Palacios, A., Guillen, V., Baños, R. M., Quero, S., and Alcañiz, M. (2010). An internet-based self-help treatment for fear of public speaking: a controlled trial. *Cyberpsychology, Behavior, and Social Networking*, 13(4):407–421.

Daher, S., Kim, K., Lee, M., Schubert, R., Bruder, G., Bailenson, J., and Welch, G. (2017). Effects of social priming on social presence with intelligent virtual agents. In *International Conference on Intelligent Virtual Agents*, pages 87–100. Springer.

Dewaele, J.-M., Petrides, K. V., and Furnham, A. (2008). Effects of trait emotional intelligence and sociobiographical variables on communicative anxiety and foreign language anxiety among adult multilinguals: A review and empirical investigation. *Language Learning*, 58(4):911–960.

Elder, T. J., Sutton, R. M., and Douglas, K. M. (2005). Keeping it to ourselves: Effects of audience size and composition on reactions to criticisms of the ingroup. *Group Processes & Intergroup Relations*, 8(3):231–244.

Guadagno, R. E., Blascovich, J., Bailenson, J. N., and McCall, C. (2007). Virtual humans and persuasion: The effects of agency and behavioral realism. *Media Psychology*, 10(1):1–22.

Hamilton, A., Pan, X. S., Forbes, P., and Hale, J. (2016). Using virtual characters to study human social cognition. In *International Conference on Intelligent Virtual Agents*, pages 494–499. Springer.

Harris, S. R., Kemmerling, R. L., and North, M. M. (2002). Brief virtual reality therapy for public speaking anxiety. *Cyberpsychology & behavior*, 5(6):543–550.

Jacobs, M., Snow, J., Geraci, M., Vythilingam, M., Blair, R., Charney, D. S., Pine, D. S., and Blair, K. S. (2008). Association between level of emotional intelligence and severity of anxiety in generalized social phobia. *Journal of anxiety disorders*, 22(8):1487–1495.

Kim, H.-G., Cheon, E.-J., Bai, D.-S., Lee, Y. H., and Koo, B.-H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry investigation*, 15(3):235.

Kusserow, M., Amft, O., and Tröster, G. (2008). Analysis of heart stress response for a public talk assistant system. In *European Conference on Ambient Intelligence*, pages 326–342. Springer.

Kyriakou, M. and Chrysanthou, Y. (2018). How responsiveness, group membership and gender affect the feeling of presence in immersive virtual environments populated with virtual crowds. In *Proceedings of the 11th Annual International Conference on Motion, Interaction, and Games*, page 12. ACM.

Lindner, P., Miloff, A., Fagernäs, S., Andersen, J., Sigeman, M., Andersson, G., Furmark, T., and Carlbring, P. (2019). Therapist-led and self-led one-session virtual reality exposure therapy for public speaking anxiety with consumer hardware and software: A randomized controlled trial. *Journal of anxiety disorders*, 61:45–54.

Nowak, K. L., Hamilton, M. A., and Hammond, C. C. (2009). The effect of image features on judgments of homophily, credibility, and intention to use as avatars in future interactions. *Media Psychology*, 12(1):50–76.

Nowak, K. L. and Rauh, C. (2005). The influence of the avatar on online perceptions of anthropomorphism, androgyny, credibility, homophily, and attraction. *Journal of Computer-Mediated Communication*, 11(1):153–178.

Paladino, M.-P. and Castelli, L. (2008). On the immediate consequences of intergroup categorization: Activation of approach and avoidance motor behavior toward ingroup and outgroup members. *Personality and Social Psychology Bulletin*, 34(6):755–768.

Pertaub, D.-P., Slater, M., and Barker, C. (2002). An experiment on public speaking anxiety in response to three different types of virtual audience. *Presence: Teleoperators & Virtual Environments*, 11(1):68–78.

Petrides, K. V. (2009). Psychometric properties of the trait emotional intelligence questionnaire (teique). In *Assessing emotional intelligence*, pages 85–101. Springer.

Petrides, K. V. and Furnham, A. (2006). The role of trait emotional intelligence in a gender-specific model of organizational variables 1. *Journal of Applied Social Psychology*, 36(2):552–569.

Pull, C. B. (2012). Current status of knowledge on public-speaking anxiety. *Current opinion in psychiatry*, 25(1):32–38.

Salovey, P. E. and Sluyter, D. J. (1997). *Emotional development and emotional intelligence: Educational implications.* Basic Books.

Sani, F., Madhok, V., Norbury, M., Dugard, P., and Wakefield, J. R. (2015). Greater number of group identifications is associated with healthier behaviour: Evidence from a scottish community sample. *British Journal of Health Psychology*, 20(3):466–481.

Slater, M., Pertaub, D.-P., and Steed, A. (1999). Public speaking in virtual reality: Facing an audience of avatars. *IEEE Computer Graphics and Applications*, 19(2):6–9.

Stupar-Rutenfrans, S., Ketelaars, L. E., and van Gisbergen, M. S. (2017). Beat the fear of public speaking: Mobile 360 video virtual reality exposure training in home environment reduces public speaking anxiety. *Cyberpsychology, Behavior, and Social Networking*, 20(10):624–633.

Summerfeldt, L. J., Kloosterman, P. H., Antony, M. M., and Parker, J. D. (2006). Social anxiety, emotional intelligence, and interpersonal adjustment. *Journal of Psychopathology and Behavioral Assessment*, 28(1):57–68.

Troxler, M., Qurashi, S., Tjon, D., Gao, H., Rombout, L., and Nalepa, G. (2018). The virtual hero: The influence of narrative on affect and presence in a vr game. In *CEUR Workshop Proceedings*.

Vinayagamoorthy, V., Gillies, M., Steed, A., Tanguy, E., Pan, X., Loscos, C., and Slater, M. (2006). Building expression into virtual characters building expression into virtual characters. *The Eurographics Association*, pages 1–42.

Wallach, H. S., Safir, M. P., and Bar-Zvi, M. (2009). Virtual reality cognitive behavior therapy for public speaking anxiety: a randomized clinical trial. *Behavior modification*, 33(3):314–338.

Witmer, B. G. and Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence*, 7(3):225–240.

Wittenbrink, B., Judd, C. M., and Park, B. (1997). Evidence for racial prejudice at the implicit level and its relationship with questionnaire measures. *Journal of personality and social psychology*, 72(2):262.