Original Article

Proceedings of the International Society for Presence Research 2014, pp. 173-186

ISBN: 978-3-7089-1081-9

The use of doppelgangers in virtual reality to treat public speaking anxiety: a gender comparison

Laura Aymerich-Franch[1] & Jeremy Baileson[1]

Abstract. The present study explores the potential of using doppelgangers—virtual humans that highly resemble the real self but behave independently—in conjunction with a visualization technique to reduce public speaking anxiety and compares it to the traditional form of visualization through imagination. Moreover, it explores gender differences in the efficacy of the techniques. Forty-one participants were assigned to one of two conditions (visualization with a doppelganger or visualization through imagination) in which they went through a relaxation process before giving a speech. In the condition of visualization through imagination, participants listened to a script that encouraged them to imagine themselves giving a successful speech. In the doppelganger condition, participants listened to the same script but were in virtual reality at the same time, where they watched a doppelganger, whose face was modeled from their face, performing a successful speech. There was an interaction between condition and gender for state anxiety and self-perceived communication competence, such that the doppelganger technique worked better in males than in females whereas the imagination technique worked better in females than in males.

Keywords. Doppelganger; Visualization; Public Speaking Anxiety; Social Phobia; Virtual Reality; Gender

Introduction

Doppelgangers are virtual humans that highly resemble the real self but behave independently. Human reactions to doppelgangers have been explored on the areas of health communication (Fox, & Bailenson, 2010; Fox & Bailenson, 2009; Fox, Bailenson, & Binney, 2009), financial savings (Hershfield, et al., 2011), and false memories (Segovia & Bailenson, 2009), among others. Prior research has demonstrated that doppelgangers influence behaviors and attitudes of the person they represent. Previous literature suggests that the use of doppelgangers should be explored in therapy and rehabilitation, including social anxiety (Fox & Bailenson, 2010; Fox, Bailenson, & Ricciardi, 2012). According to Fox and Bailenson (2010):

> *Bandura originally used social modeling as a method of phobia desensitization, and virtual reality exposure therapy has been successfully used for this purpose. Doppelgangers could be incorporated in VEs for […] social phobia. Participants could see their doppelgangers coping with stressful environments, thus bolstering their sense of self-efficacy. They may also observe their virtual self experiencing the rewards associated with successful phobia management, which may serve as an additional incentive to work towards managing the phobia (p.17).*

Corresponding author
Laura Aymerich-Franch
Virtual Human Interaction Lab
McClatchy Hall, Room 411
Department of Communication
Stanford University Stanford, CA, 94305-2050
laura.aymerich@gmail.com

Affiliation:
[1] Virtual Human Interaction Lab, Stanford University

Indeed, Social Cognitive Theory (Bandura, 1977) is useful to understand the efficacy of doppelgangers in the context of psychotherapy and phobia desensitization. Bandura's theory demonstrates that people do not need to experience rewards or punishments themselves in order to learn behaviors but rather, they can learn behaviors through the observation of models. Moreover, according to this theory, greater similarity and identification with a model leads to more imitation of modeled behaviors. Since digital doppelgangers possess a strong resemblance to the physical self –as they are actually a digital copy of the physical body-, they have great potential to serve as powerful models (Bailenson & Segovia, 2010; Fox & Bailenson, 2010).

The potentials of doppelgangers to treat social phobia

Virtual reality exposure therapy (VRET) has been widely implemented to treat social phobia (Anderson, Zimand, Hodges, & Rothbaum, 2005; Harris, Kemmerling, & North, 2002; Klinger et al., 2005; Roy et al., 2003). This type of therapy entails the simulation of social situations in virtual reality (VR). Variables that are likely to affect anxiety, such as the proximity, the friendliness, or the number of human agents, are typically manipulated. However, patients generally only adopt a first person perspective during these sessions and the experimental manipulations are limited to variations in the context of the scene and other social actors. We believe that exploring manipulations of the self through incorporation of doppelgangers as part of the treatment might provide unique avenues for effective VRET.

Current cognitive models of social phobia provide a relevant framework for doppelganger manipulations, as many indicate that a negatively distorted self lies at the core of social anxiety (Clark & Wells, 1995; Stopa & Jenkins, 2007). Therefore, if this distorted image can be corrected, it is possible that anxiety symptoms can be reduced. By observing their doppelgangers succeeding in social situations such as work meetings, parties or public speeches, socially anxious individuals might gain an improved self image and reduce their anxiety. A related technique that also derives from this model is Video Feedback, which has been previously used to alter negative self-evaluations of socially anxious individuals (Aderka, 2009). Although this technique seems to allow individuals with social anxiety to transform negative self-evaluations, it has not been found to be as effective in reducing social anxiety (Aderka, 2009). We believe doppelgangers can improve the effectiveness of techniques that are based on the observation of the self to reduce social anxiety as they have the advantage that they can be programmed to behave independently of the physical self, while keeping a strong resemblance to the real self. Thus, it is possible, for instance, to program them to exhibit confidence or public speaking skills.

On the other hand, visualization is a widely used intervention to treat public speaking apprehension. This intervention stresses the importance of developing positive thinking and assumes that people suffer anxiety because they cannot visualize success (Ayres & Hopf, 1993). A typical form of visualization involves listening to a script of a successful speaking experience in which the individual is invited to close his or her eyes, relax, and imagine the situation described from a first person perspective (Ayres & Hopf, 1993). However, this technique relies heavily on imaging ability and therefore it can be less effective in individuals with lower ability to create and control images (Ayres, Hopf, & Edwards, 1999). Also, Ayres and Ayres (2003) suggest that visualization may be more effectively induced using a combination of words and images. In particular, they examined whether exposing people to images, text, or a combination of images and text was the most effective way to reduce public speaking apprehension (PSA). They found that participants exposed to text accompanied by drawings reported lower PSA compared to the other conditions, and envisioned themselves as public speakers who were more in control and more positive.

VR is able to recreate highly immersive 3D environments and even recreate a digital representation of the self that can be programmed to behave in a predetermined manner. Hence,

doppelgangers might augment the efficacy of visualization techniques to treat public speaking anxiety.

Given the novelty of using doppelgangers as a visualization technique, there are no precedent studies that have examined the effectiveness of this technique to reduce public speaking anxiety. Thus, we formulated the following research question:

> ***RQ1.*** Does seeing a doppelganger perform a successful speech in front of an audience in a visualization process decrease anxiety before the speech and improve self-perceived communicative competence compared to visualization through imagination alone?

Gender differences in responses to doppelgangers and to social anxiety treatments

Our study also examines gender as a variable to determine whether males and females responded differently to the two techniques. In VR, a precedent study by Felnhofer et al. (2012) compared presence outcomes in male and female participants that had to give a presentation either in front of a virtual audience or to an imagined audience and found that men reported significantly higher levels of presence in the virtual condition than women. Another study by Fox, Bailenson, and Binney (2009) observed the effects of watching doppelgangers in eating behavior and also found a gender effect. Men displayed stereotypical gendered behavior and ate more candy, whereas women also displayed gendered behavior and suppressed the urge to eat and ate less candy.

Regarding classic visualization through imagination, Ayres and Hopf (1987) compared men and women in terms of effectiveness of visualization, systematic desensitization, and rational emotive therapy in reducing communication apprehension, and did not find significant differences between males and females before or after the treatment. Another study by Ayres and Hopf (1991) examined the effect of adding an educational component to explain the rationale behind the technique to visualization and compared that to visualization alone. Again, they did not find gender or the interaction between gender and type of treatment to have a significant effect on anxiety.

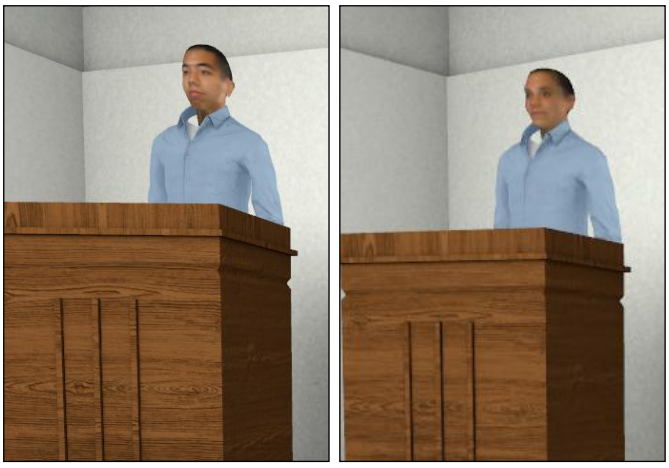

Figure 1. Male (left), and female (right) doppelgangers during the speech in the virtual classroom.

Investigating gender differences in social anxiety disorder is important because isolating aspects of the phobia that differ across genders may influence the course and outcome of therapeutic interventions (Turk et al., 1998). Furthermore, as Parsons and Rizzo point out, "a potential problem in interpreting and reconciling findings about the nature and extent of affective changes ensuing from VRET is that a number of factors other than virtual reality exposure per se may be associated with such changes including […] gender" (p.251).

Since no previous literature has examined gender differences in visualization with doppelgangers compared to visualization through imagination, we formulated the following research question:

> ***RQ2.*** Do males and females respond differently to visualization through imagination and visualization with doppelganger techniques in terms of reducing anxiety levels before a speech and improving self-perceived communication competency?

Also, we examined the differences in social and spatial presence during a visualization process in a virtual reality context compared to the same process in a context of imagination. We considered gender in the model as previous research has demonstrated gender differences (Felnhofer et al., 2012):

> ***RQ3.*** Do participants using a visualization technique in virtual reality experience more social and spatial presence compared to participants using a visualization technique through imagination? Do males and females experience different levels of social and spatial presence during a visualization technique in virtual reality compared to a visualization technique through imagination?

To test our research questions, we recreated a virtual classroom and included a doppelganger modeled after the participant's appearance that performed a speech in front of an audience. This scenario paralleled a visualization script of a successful speech. Modeling was limited to the heads, which were then affixed to a generic human body, as depicted in Figure 1. We compared this new technique with a classic visualization process through imagination. We analyzed the effectiveness of both techniques on reducing pre-speech anxiety and on improving perceived communicative competence and compared the outcomes between males and females.

Method

Participants

Forty-three participants of an American West Coast University took part in the experiment. Two participants were discarded due to technical failure or motion sickness. The final sample (N=41) included 21 males and 20 females aged 19 to 24 (M=20.6, SD=1.07).

Design

We conducted a 2 x 2 between-subjects design (Table 1 shows the number of participants per cell). The independent variables were type of visualization technique (doppelganger vs. imagination) and gender (male vs. female). The dependent variables were participants' state anxiety before the speech (State Trait Anxiety Inventory, Form Y-1; Spielberger, Gorsuch, & Lushene, 1970), physiological sensations before the speech (Body Sensations Questionnaire; Chambless, Caputo, Bright, & Gallagher, 1984) and state perceived communicative competence before the speech (State-Perceived Index of Competence; MacDonald & MacIntyre, 1998).

Table 1. Subjects per cell (condition by gender)

	Doppelganger	Imagination
Females	12	8
Males	9	12

Procedure

Participants completed the experiment individually. First, they filled out a pre-survey that contained demographic variables, variables related to previous experience with VR and in public speaking, and assessed cyber-sickness, trait communication apprehension, video game playing habits, and imagery control.

In the doppelganger condition, we built the doppelganger face from a photograph of the participant. Participants entered the experimental room after completing the survey and were seated in a chair. We equipped them with a Head Mounted Display which showed them the virtual classroom. They sat between two virtual students, among the audience, at a rectangular table and watched their doppelganger give the speech to the audience while a voice-over narrated the relaxation process. In the imagination condition, participants sat on the same physical chair but were told to close their eyes and follow the voice-over instead of going into VR.

After that, participants in all conditions completed another portion of the survey which contained questions regarding sense of presence experienced during the process. Participants in the doppelganger condition also answered questions regarding doppelganger similarity to the real self. Then, participants were instructed to give a speech on a topic of their choice in front of some researchers of the lab. They had two minutes to prepare the speech. Next, participants completed the last portion of the survey that contained anxiety measures. Finally, they gave the speech in front of a researcher and a research assistant.

Figure 2. Participant during the experiment in the physical room wearing the HMD (left) and empty spot where the participant sat in the virtual world, among the virtual audience (right).

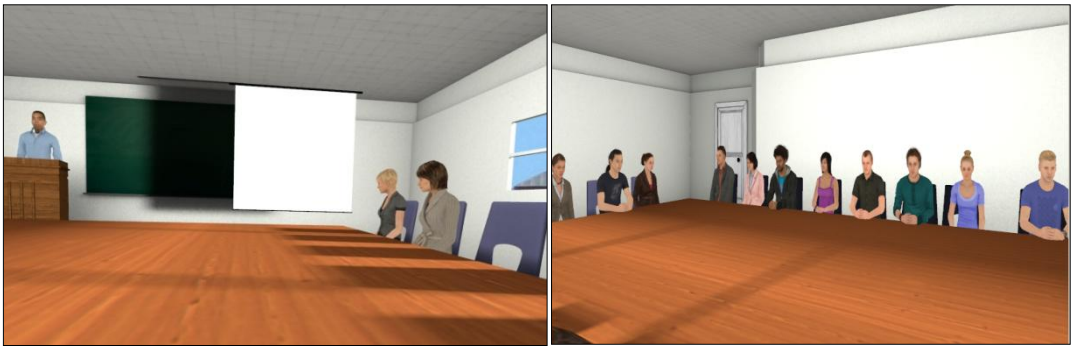

Figure 3. Doppelganger in the podium during the speech and two virtual agents (left) and the rest of the virtual audience listening to him (right).

Material

We adapted a visualization script from Ayres and Hopf (1993), listed in Appendix A, and recorded it. The script was modified so it could be used both in the doppelganger and the imagination condition. We removed the sentence "you can now open your eyes" from the recording in the imagination condition so the participant stayed with the eyes closed during the imagination process.

We created a virtual classroom using Worldviz's Vizard VR Toolkit and seated fifteen virtual agents around a rectangular table who faced a podium where we placed the doppelganger. We animated the movements of the doppelganger to correspond with the flow of the speech. Participants wore an nVisor SX111 head-mounted display (NVIS, Reston, VA) with a resolution of 2056 x 1024 and a refresh rate of 120 frames per second to visualize the virtual world. An optical tracking system (Worldviz PPTH) along with an orientation sensor (Intersense3 Cube) provided tracking on 6 degrees of freedom (x, y, z position and pitch, yaw, and roll) for the head (Figure 2 & 3).

Measures

Pretest

The Personal Report of Communication Apprehension (PRCA-24; McCroskey, 1982) was used to assess trait communication apprehension. This measure is a 24-item scale with 12 reverse items. It is a well-established measure of public speaking anxiety (Behnke & Sawyer, 1999; Bodie, 2010) and there is substantial normative data available for the instrument (Beattty & Andriate, 1985). The total score is obtained from the sum of the 24 items that compose the scale. Scores above 65 are indicative of an individual who has more general communication apprehension than the average (McCroskey, Beatty, Kearney, & Plax, 1985; Richmond & McCroskey, 1989). Cronbach's Alpha in this study was .95.

The Test of Visual Imagery Control (Gordon, 1949) was used to check for imagery control as imagination ability can determine the effectiveness of visualization (Ayres, Hopf, & Edwards, 1999). The test comprises 12 items and assesses the ability to control imagery by asking individuals if they are able to visualize various modifications on images of an automobile. Alpha reliability of the test in this study was .89.

Also, we developed a single-item scale to measure participants' video game playing habits. Participants rated how often they play video games in a five-point scale (1- daily; 2 – weekly; 3 – monthly; 4 – less than monthly; 5 - never).

Anxiety measures

We measured state anxiety, self-perceived physiological sensations before the speech, and self-perceived communication competence as dependent variables. The three measures correlated well: the more state anxiety, the more self-perceived physiological sensations, and the less self-perceived communication competence (see Table B2 in Appendix B).

The State Trait Anxiety Inventory (STAI) – Form Y-1 (Spielberger, Gorsuch, & Lushene, 1970; Spielberger, Gorssuch, Lushene, Vagg, & Jacobs, 1983) was used to measure state anxiety. The STAI self-assessment scale contains 20 items. Participants rate how they felt (e.g. calm, tense) in a particular situation (e.g. during a speech) on a four-point scale ranging from not at all (1) to very much so (4). This portion of the scale was designed to assess transitory anxiety and it is the most commonly used measure of public speaking state anxiety in empirical studies published in communication (Behnke & Sawyer, 2004). It has demonstrated reliability and validity in previous studies (Beatty & Behnke, 1991; Beatty & Friedland, 1990; Behnke & Sawyer, 2004; McCullough, Russell, Behnke, Sawyer, & Witt, 2006). The reliability of the STAI for this study was α=.96.

The Body Sensations Questionnaire (BSQ; Chambless, Caputo, Bright, & Gallagher, 1984) was used to measure self-perceived physiological sensations. This measure is a 17-item scale that comprises items concerning sensations associated with autonomic arousal. Participants rate how intensely they experienced each sensation (e.g. heart palpitations or dry throat) on a 5-point scale, ranging from not at all (1) to extremely (5). The total score is derived by averaging the individual item ratings. The BSQ has shown validity and reliability in previous studies (Aikens, Zvolensky, & Eifert, 2001; Chambless & Gracely, 1989) and it has been used in public speaking anxiety studies (McCullough, et al., 2006). In this study, the BSQ yielded a reliability of α=.92.

The State-Perceived Index of Competence (SPIC; MacDonald & MacIntyre, 1998) was used to measure the state perceived communicative competence before the speech. The scale comprises seven positive items, indicating high competence, and eight negative items, indicating low competence. The items are answered on a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7). It has shown validity and reliability in previous studies (MacIntyre & MacDonald, 1998). Reliability was = .96.

Presence and avatar similarity

Participants in both conditions evaluated spatial and social presence. We adapted the items from presence scales used in previous studies (Bailenson & Yee, 2007; Fox, Bailenson, & Binney, 2009; Nowak & Biocca, 2003).

Spatial presence was rated on a five-item scale (e.g. to what extent did you feel that you were really inside the classroom?) and each item was rated in a 5-point scale ranging from not at all (1) to very strongly (5). The data yielded an α=.84

Social presence was also rated on a five-item scale (e.g. to what extent did you feel that the audience was present?) and each item was rated in a 5-point scale ranging from not at all (1) to very strongly (5). The data yielded an α=.74.

Participants in the doppelganger condition rated how similar was their face to the doppelganger's face and their body to the doppelganger's body on a five-point scale (1- extremely; 2 – very; 3 – moderately; 4 - slightly; 5 - not at all). Most of the sample evaluated their doppelganger face as being similar to their own face (77.8% of males and 75% of females).1 There was an important divergence, however, regarding body similarity. Whereas 66.7% of males considered their doppelganger body to be similar, only 8.3% of females found it to be similar.

Results

Table B1, in Appendix B, shows estimated marginal means and standard error of anxiety measures (STAI, SPIC, BSQ), social and spatial presence, face and body similarity, video game playing habits, and imagery control, by condition and gender. In addition, Table B2, in Appendix B, shows the correlations among anxiety measures, presence, avatar similarity, video game playing habits, and imagery control.

We checked imagery control to make sure the experimental groups presented similar scores. No significant differences were found between experimental conditions (F=.66, p=.52, partial η^2=.02) or between males and females (F=2.06, p=.16, partial η^2=.04).

To test our research questions, we created a model in which we included treatment and gender as factors, the STAI, the SPIC, or the BSQ as dependent variables and cyber-sickness as a covariate and ran three univariate general linear models in SPSS, one for each dependent variable. No significant differences were found between the two experimental conditions (doppelganger vs. imagination) when STAI (F=.26, p=.61, partial η^2=.01), SPIC (F=.54, p=.46, partial η^2=.01), or BSQ (F=1.11, p=.29, partial η^2=.03) were used as dependent variables. Also, no significant differences were found between males and females for STAI (F=.56, p=.46, partial η^2=.01), SPIC (F=.02, p=.89, partial η^2=.00), or BSQ (F=.51, p=.48, partial η^2=.01).

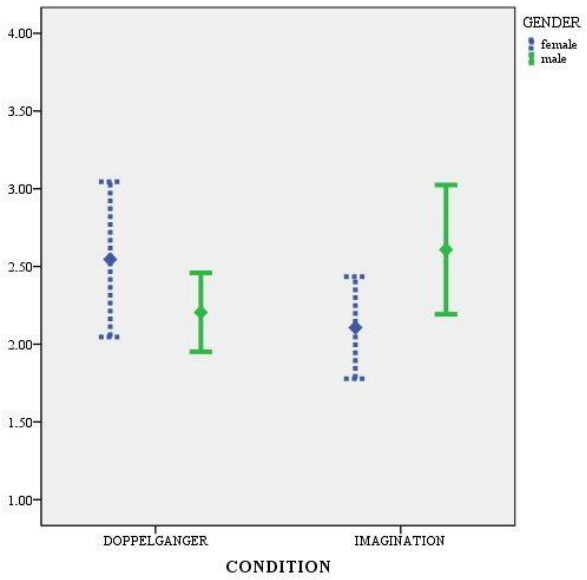

Figure 4. Gender differences in state anxiety (STAI) for the two treatments (95% CI).

[1] We considered that a participant found his or her doppelganger to be similar when answered *moderately*, *very*, or *extremely similar*.

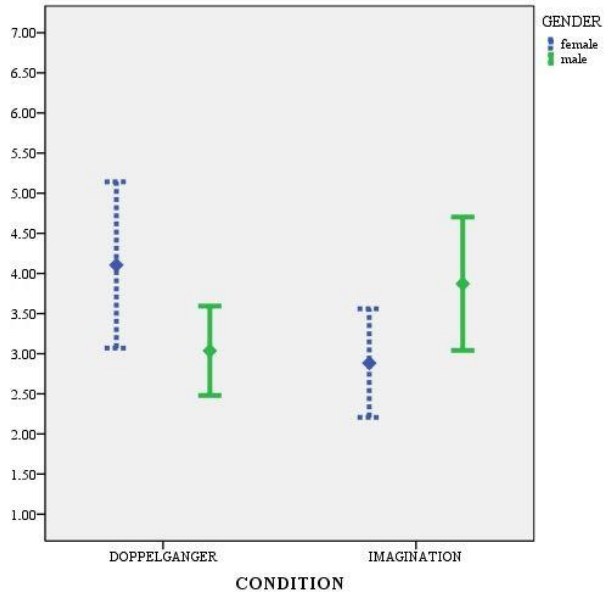

Figure 5. Gender differences in self-perceived communication competence (SPIC) for the two treatments (95% CI).

However, the interaction between gender and condition was significant for all three dependent variables: STAI (F=6.06, p=.02, partial η^2=.14), SPIC (F=7.49, p=.01, partial η^2=.17), and BSQ (F=4.69, p=.03, partial η^2=.11). Figures 4, 5 and 6 show error bars graphs for males and females for each measure. It can be observed that males scored lower than females in the doppelganger condition for all measures, indicating lower anxiety, physiological sensations, and higher self-perceived communicative competence, whereas females scored lower than males in the imagination condition for all measures, indicating lower anxiety, physiological sensations, and higher self-perceived communicative competence.

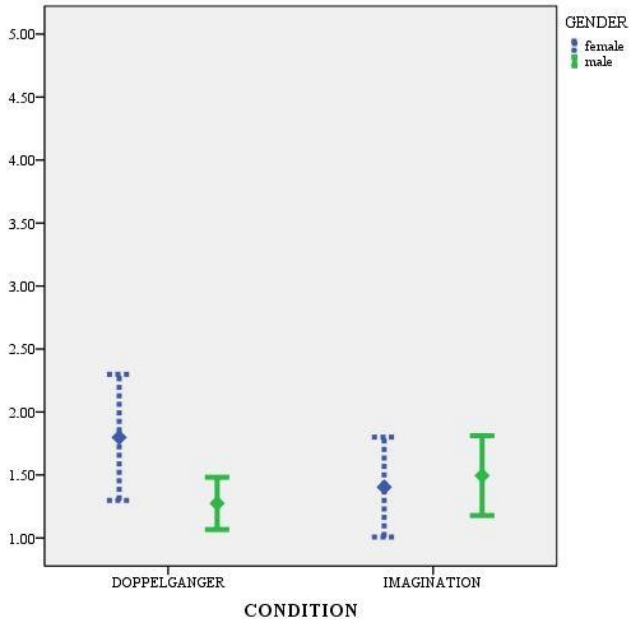

Figure 6. Gender differences in self-perceived physiological sensations (BSQ) for the two treatments (95% CI).

Finally, we compared presence and doppelganger similarity between experimental conditions and between males and females, also using the univariate general linear model. We included gender and condition as factors and ran the model four times, one for each dependent variable: social presence, spatial presence, body similarity, and face similarity. Participants in the doppelganger condition experienced more spatial presence than those in the visualization condition alone (F=9.37, p=.00, partial η^2=.19). However, there were no significant differences for social presence (F=.33, p=.57, partial η^2=.01) between conditions. Regarding gender, we did not find differences between males and females for social (F=.68, p=.41, partial η^2=.02), or spatial (F=.01, p=.93, partial η^2=.00) presence. The interaction between condition and gender was not significant either for social (F=2.31, p=.14, partial η^2=.06) or spatial presence (F=.34, p=.56, partial η^2=.01). However, in the doppelganger condition[2], whereas we did not find differences between males and females for face similarity with their doppelganger (F=.05, p=.81, partial η^2=.00), we found significant differences for body similarity (F=16.28, p=.00, partial η^2=.46). Females perceived their doppelganger's body to be more dissimilar from their own than males.

Discussion

The present study introduces the relevance and potentials of using doppelgangers in VR to treat phobias. Doppelgangers are virtual humans that highly resemble the real self but behave independently. Specifically, the study analyzes whether combining doppelgangers with a visualization script can be more effective in reducing public speaking anxiety than visualization through imagination.

Regarding RQ_1, the results did not show significant differences between the two techniques in state anxiety, self-perceived physiological sensations, or self-perceived communicative competence. However, regarding RQ_2, we found significant differences in the interaction between condition and gender for state anxiety and self-perceived communicative competence. The results suggest that the doppelganger technique worked better in males than in females whereas the imagination technique worked better in females than in males. Our results differ from those found by Ayres and Hopf (1987, 1991), who did not find significant differences in anxiety levels between males and females that experienced visualization through imagination.

Since individual's imaging ability has been described as an important factor in the effectiveness of visualization (Ayres, Hopf, & Edwards, 1999), we controlled the effect of this variable on the results in the imagination condition. We conducted a mediation analysis to examine the effect of imaging ability on the results in the imagination condition and this variable did not mediate the differences between gender in STAI, SPIC, or BSQ.

In the doppelganger condition, some females did not find their doppelganger body to be similar to their own. We considered whether identification with the body might have influenced doppelgangers to work better in males than in females. We conducted a mediation analysis to examine the effect of body similarity on the results in the doppelganger condition and this variable did not mediate the differences between gender on STAI, SPIC or BSQ.

Thus, a possible explanation for the differences in the doppelganger condition could be that men were already more familiarized to be in virtual environments and felt more comfortable during the experience. Indeed, we found a significant difference between males and females regarding video game playing habits (F=16.8, p=.00, partial η^2=.24), men in our sample dedicated more time to play these games than females (see Means and SD in Table B1, Appendix B). Another explanation would be that women in the doppelganger condition might have found the gestures of their doppelganger more artificial, as females are more sensitive to non-behavioral stimuli and

[2] Face and body similarity to the doppelganger was a measure for the doppelganger condition only.

are more skilled than men at understanding nonverbal messages (Bailenson et al., 2005; Hall, 1984).

Finally, with regards to RQ_3, although we found that participants in the doppelganger condition experienced more spatial presence than those in the visualization condition through imagination, we did not find the same differences for social presence. Also, we did not find significant differences between males and females for social or spatial presence, neither we found a significant interaction. Thus, our results did not match the findings of similar previous studies (Felnhofer et al., 2012).

One limitation of the study is that we only modeled the head and affixed it to a generic human body. Also, we were not able to keep long hair on the doppelganger for participants that had it this way, which may have affected the perceived similarity of the doppelganger to an important number of, mainly, female participants. Because of that, many female participants did not identify with the body we assigned them. Future studies should consider the possibility of modeling the body as well to increase identification.

Another limitation is that our study consisted of a single session of visualization. We encourage future research in the field of VRET to further examine the possibilities of using doppelgangers to treat social anxiety in repeated sessions. This will allow researchers to evaluate the convenience or value of adding doppelgangers to VRET.

Finally, our study has important implications for studies using VR to examine factors related to anxiety disorders and for VRET. We believe that transformations of the self (either through an avatar or a doppelganger) are a key aspect that could lead to important advancements in the treatments of social anxiety. Thus, we strongly encourage future work to continue exploring this line of research.

References

Aderka, I.M. (2009). Factors affecting treatment efficacy in social phobia: the use of video feedback and individual vs. group formats. Journal of Anxiety Disorders, 23(1), 12–17.

Aikens, J. E., Zvolensky, M. J., & Eifert, G. H. (2001). Differential fear of cardiopulmonary sensations in emergency room noncardiac chest pain patients. Journal of Behavioral Medicine, 24, 155-167.

Anderson, P. L., Zimand, E., Hodges, L. F., & Rothbaum, B. O. (2005). Cognitive behavioral therapy for publicspeaking anxiety using virtual reality for exposure. Depression and Anxiety, 22, 156–158.

Ayres, J., & Ayres, T.A. (2003). Using images to enhance the impact of visualization. Communication Reports, 16(1), 47-55.

Ayres, J., & Hopf, T. (1987). Visualization, systematic desensitization, and rational emotive therapy: A comparative evaluation. Communication Education, 36(3).

Ayres, J., & Hopf, T. (1991). Visualization: The next generation. Communication Research Reports, 8(2).

Ayres, J., & Hopf, T. (1993). Coping with speech anxiety. Norwood, N.J.: Ablex Pub. Corp.

Ayres, J., Hopf, T., & Edwards, P. (1999). Vividness and control: Factors in the effectiveness of performance visualization? Communication Education, 48(4), 287-293.

Bailenson, J.N., & Segovia, K.Y. (2010). Virtual doppelgangers: Psychological effects of avatars who ignore their owners. In W. S. Bainbridge (Ed.), Online worlds: Convergence of the real and the virtual (175-186). Springer: New York. Bandura, A. (1977). Social learning theory. Englewood Cliffs, NJ: Prentice-Hall.

Bailenson, J.N., Beall., A.C., Blascovich, J., Loomis, J., & Turk, M. (2005). Transformed social interaction, augmented gaze, and social influence in immersive virtual environments. Human Communication Research, 31, 511-537.

Beatty, M. J., & Andriate, G. S. (1985). Communication Apprehension and General Anxiety in the Prediction of Public Speaking Anxiety. Communication Quarterly, 33(3), 174-184.

Beatty, M. J., & Behnke, R. R. (1991). Effects of Public Speaking Trait Anxiety and Intensity of Speaking Task on Heart Rate During Performance. Human Communication Research, 18(2), 147-176.

Beatty, M. J., & Friedland, M. H. (1990). Public speaking state anxiety as a function of selected situational and predispositional variables. Communication Education, 38, 142–147.

Behnke, R. R., & Sawyer, C. R. (1999). Public Speaking Procrastination as a Correlate of Public Speaking Communication Apprehension and Self-Perceived Public Speaking Competence. Communication Research Reports, 16(1), 40-47.

Behnke, R. R., & Sawyer, C. R. (2004). Public speaking anxiety as a function of sensitization and habituation processes. Communication Education, 53(2), 164-173.
Bodie, G. (2010). A Racing Heart, Rattling Knees, and Ruminative Thoughts: Defining, Explaining, and Treating Public Speaking Anxiety. Communication Education, 59(1), 70-105.
Chambless, D. L., Caputo, G. C., Bright, P., & Gallagher, R. (1984). Assessment of fear of fear in agoraphobics: The body sensations questionnaire and the agoraphobic cognitions questionnaire. Journal of Consulting and Clinical Psychology, 52, 1090-1097.
Chambless, D., & Gracely, E. J. (1989). Fear of fear and the anxiety disorders. Cognitive Therapy and Research, 13(1), 9-20.
Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), Social phobia: Diagnosis, assessment, and treatment (pp. 69–93). New York: Guilford Press.
Felnhofer, A., Kothgassner, O.D., Beutl, L., Hlavacs, H., & Kryspin-Exner, I. (2012). Is Virtual Reality made for Men only? Exploring Gender Differences in the Sense of Presence. Proceedings of the International Society for Presence Research Annual Conference. October 24–26, Philadelphia, Pennsylvania, USA.
Fox, J., Bailenson, J.N., & Binney, J. (2009). Virtual experiences, physical behaviors: The effect of presence on imitation of an eating avatar. PRESENCE: Teleoperators & Virtual Environments, 18(4), 294-303.
Fox, J., & Bailenson, J.N. (2010). The use of doppelgängers to promote health behavior change. CyberTherapy & Rehabilitation, 3(2), 16-17.
Fox, J., Bailenson, J.N., & Binney, J. (2009). Virtual experiences, physical behaviors: The effect of presence on imitation of an eating avatar. PRESENCE: Teleoperators & Virtual Environments, 18(4), 294-303.
Fox, J., & Bailenson, J.N. (2009). Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. Media Psychology, 12, 1-25.
Fox, J., Bailenson J.N., & Ricciardi, T (2012). Physiological Responses to Virtual Selves and Virtual Others. Journal of CyberTherapy & Rehabilitation, 5(1), 69-72.
Gordon, R. (1949). An investigation into some of the factors that favour the formation of stereotyped images. British Journal of Psychology, 39, 156-167.
Hall. J. A. (1984). Nonverbal Sex Differences: Accuracy of Communication and Expressive Style. Baltimore, MD: John Hopkins University Press
Harris, S. R., Kemmerling, R. L., & North, M. M. (2002). Brief virtual reality therapy for public speaking anxiety. Cyberpsychology & Behavior, 5, 543–550.
Hershfield, H. E., Goldstein, D. G., Sharpe, W. F., Fox, J., Yeykelis, L., Carstensen, L. L., & Bailenson, J. N. (2011). Increasing saving behavior through age-progressed renderings of the future self. Journal of Marketing Research, 48, S23-S37.
Klinger, E., Bouchard, S., Legeron, P., Roy, S., Lauer, F., Chemin, I., & Nugues, P. (2005). Virtual reality therapy versus cognitive behavior therapy for social phobia: A preliminary controlled study. Cyberpsychology & Behavior, 8, 76–88.
MacDonald, J.R., & MacIntyre, P.D. (1998). The development of scales to measure state perceived competence and audience congeniality. Technical report. Available at: <http://faculty.cbu.ca/pmacintyre/research_pages/other_files/spacspic.pdf>
MacIntyre, P.D., & MacDonald, J.R. (1998). Public speaking anxiety: Perceived competence and audience congeniality, Communication Education, 47(4), 359-365.
McCroskey, J. C. (1982). Oral communication apprehension: A reconceptualization. In M.J. Burgoon (Ed.), Communication Yearbook 6, (pp. 136-170). Beverly Hills, CA: Sage Publications.
McCroskey, J. C., Beatty, M. J., Kearney, P., & Plax, T. G. (1985). The Content Validity of the PRCA-24 as a Measure of Communication Apprehension across Communication Contexts. Communication Quarterly, 33(3), 165-173.
McCullough, S. C., Russell, S. G., Behnke, R. R., Sawyer, C. R., & Witt, P. L (2006). Anticipatory Public Speaking State Anxiety as a Function of Body Sensations and State of Mind. Communication Quarterly, 54(1), 101-109.
Richmond, V. P., & McCroskey, J. C. (1989). Communication: Apprehension, avoidance, and effectiveness (2nd ed.). Scottsdale, AZ: Gorsuch Scarisbrick.
Roy, S., Klinger, E., Legeron, P., Lauer, F., Chemin, I., & Nugues, P. (2003). Definition of a vr-based protocol to treat social phobia. Cyberpsychology & Behavior, 6, 411–420.
Segovia, K.Y. & Bailenson, J.N. (2009). Virtually true: Children's acquisition of false memories in virtual reality. Media Psychology, 12, 371-393.
Spielberger, C. D., Gorssuch, R. L., Lushene, P. R., Vagg, P. R., & Jacobs, G. A (1983). Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press.
Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). Manual for the state-trait anxiety inventory. Palo Alto, CA: Consulting Psychologists Press.
Stopa, L., & Jenkins, A. (2007). Images of the self in social anxiety: Effects on the retrieval of autobiographical memories. Journal of Behavior Therapy and Experimental Psychiatry, 38, 459–473.
Turk, C.L., Heimberg, R.G., Orsillo, S.M., Holt, C.S., Gitow, A., Street, L.L., et al. (1998). An investigation of gender differences in social phobia. Journal of Anxiety Disorders, 12, 209–223.

Appendix A

Visualization script

"Welcome, I am the voice that will guide you through this process. Please close your eyes. Allow your body to get comfortable in the chair in which you are sitting. Move around until you feel that you are in a position that will continue to be relaxing for you for the next few minutes. Take a deep, comfortable breath and hold it...now slowly release it. That's right...now take another deep breath and make certain that you are breathing from the diaphragm, from your belly...hold it...now slowly release it and note how you feel while doing this...feel the relaxation fluidly flow throughout your body. And now, one more breath...hold it...and now release it slowly...and begin your normal breathing pattern.

(You can now open your eyes). You are in a classroom. First of all, take some time to get used to this space. Pay attention to your surroundings. The classroom is medium sized. There is a large rectangular table in the middle of the classroom. There are eight girls and eight guys about your age sitting around it. You are sitting among them at the table, close to the front part of the class, on the right corner. They are all quiet. They are probably university students. Don't be afraid of them, you can look at them if you want. They are not paying attention to you. Also, there is a large window on the wall behind you. Through it, you can see the top of a building and a blue sky outside.

Now, look at the podium at the front part of the class, on the left corner. There you are, standing at the podium, facing at your audience and ready to start your speech. You are the person that gives the speech today.

Take a breath. Make sure you are relaxed and that your muscles are not tense.

Now take a moment to look at yourself in the podium from the audience perspective. But don't move from your chair, stay within the audience, just observe yourself. You look calm, confident and ready to start. You wear just the right clothes for the task at hand. Dressing well makes you feel good about yourself, so you have on just what you want to wear, which clearly expresses your sense of inner well-being. You feel thoroughly prepared for the challenge at hand.

You look at your audience without fear and slightly smile at them. You feel connected with the audience. You seem willing to give your speech and the audience seems willing to hear what you are going to say. They appear to be quite friendly.

You have just started your speech. It is a truly fine job! And it has all the finesse of a polished, experienced speaker. Now, look again at your audience. You are aware that they are giving head nods, smiles, and other positive responses, conveying the message that you are truly "on target". They are attentive and quiet.

Excellent, now take another breath. Observe the situation on its whole for a while. Be aware of how well your speech is evolving. You give the speech and the audience listens to you. Everything is going smoothly. Everything looks natural. You feel comfortable and pleasant observing yourself giving the speech. Try to relax your muscles if you feel any tension as you observe with confidence the audience and yourself at the podium.

You are now through the body of the speech, and are heading into an absolutely brilliant summarization on your topic. Your mind is just focused on what you are going to say. You realize that you feel empathy for your audience, and your audience feels empathy for you. You don't fear them. You look at them pleased to let them know that you are all together in this room, to make them notice that they are important to you, that you are happy to have them here. And they are happy to know they are important to you. You feel present in the classroom. You look like you are enjoying giving the speech. You don't feel much pressure because you feel at ease at the podium.

The end of the speech is approaching and you feel content and satisfied. Your audience looks like it has enjoyed the speech too. You see yourself receiving the congratulations of your audience.

Now, I want you to begin to return to the time and place where we are, the physical room. Take a deep breath...hold it...and let it go. Do this several times and move slowly back into the room. Take as much time as you need to make the transition back."

Appendix B

Table B1

Means and SD of anxiety measures (STAI, SPIC, BSQ), presence, doppelganger similarity, and video game playing habits.

	Doppelganger condition (N=21) M(SD)	Imagination condition (N=20) M(SD)	Females (N=20) M(SD)	Males (N=21) M(SD)
STAI*	2.4 (.65)	2.4 (.61)	2.37 (.68)	2.44 (.56)
SPIC*	3.7 (.66)	3.5 (.48)	3.62 (1.46)	3.51 (1.15)
BSQ*	1.6 (1.4)	1.5 (1.2)	1.64 (.69)	1.4 (.42)
Social presence**	2.4 (.62)	2.52 (.72)	2.37 (.63)	2.54 (.70)
Spatial presence**	3.1 (.69)	2.48 (.60)	2.79 (.71)	2.8 (.73)
Face similarity**	2.95 (1.02)	-	3 (1.12)***	2.89 (.92)***
Body similarity**	3.76 (.99)	-	4.33 (.65)***	3 (.86)***
Video game habits**	3.81 (1.36)	3.75 (1.16)	4.25 (1.07)	3.33 (1.28)
Imagery control*	1.86 (.62)	1.94 (.56)	2.03 (.56)	1.77 (.59)

*Higher means indicate more anxiety, more physiological sensations, less confidence, and more imagery control.
**Lower means indicate playing video games more often, more presence and more doppelganger similarity.
***Measure for doppelganger condition only (males N=9, females N=12).

Table B2

Correlations between STAI, SPIC, BSQ, presence, avatar similarity, video game playing habits, and imagery control.

	STAI	SPIC	BSQ	Social Presence	Spatial Presence	Body Sim.	Face Sim.	Video Game	Imagery Control
STAI		.76**	.67**	.08	.03	.05	-.03	-.11	-.33
SPIC			.68**	-.11	.14	.19	.09	-.25	-.09
BSQ				-.18	.01	.12	.11	-.01	-.38
Social presence					.50**	-.16	-.09	-.01	-.01
Spatial presence						.34*	.46**	-.20	-.27
Body similarity							.88**	.13	.03
Face similarity								.05	.06
Video game									.36*

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).