

Is Virtual Reality made for Men only? Exploring Gender Differences in the Sense of Presence

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Abstract

To date, merely a few studies have been conducted accounting for both emotional traits and gender differences in sense of presence. Yet, results indicate that men and women may indeed differ in the way they experience virtual environments and in the levels of presence they report. Given the scarcity of findings, the present study aimed at broadening the understanding of a possible gender gap in presence experiences. Participants (N=40) were randomly assigned to either an experimental group giving a presentation in front of a virtual audience or a control group merely imagining the audience. Significant differences between male and female participants were found on all presence subscales (Spatial Presence, Realness, Sense of Being There) except for Involvement. Men generally reported a higher sense of spatial presence, more perceived realism and higher levels of the sense of actually being in the environment than women. The inclusion of social interaction anxiety as a covariate revealed a significant influence only on the Sense of Being There. Potential contributing factors for the observed gender differences are discussed and implications for future research endeavors considering gender as a mediating factor are given.

Keywords: Presence, gender differences, virtual reality

1. Introduction

Little research has up to date considered both, the issue of gender differences in the sense of presence and emotional traits while being exposed to a stressful virtual or imaginal environment. To our knowledge, the present study is the first to tackle these questions on the background of psychological exposure methods, such as imaginal and virtual exposure. Considering the fact, that both, imaginal and virtual reality exposure are often more viable and practicable than in vivo exposure and are

mostly preferred by therapists over the rather impractical real-life exposures, we opted to include a imaginative control sample in our study to assess possible gender differences in the sense of being present either in an imagined or a virtual public speaking scenario.

Presence is usually defined as the “perceptual illusion of nonmediation” (Lombard & Ditton, 1997) and as this it refers to mediated experiences only. However, some researchers define this phenomenon more broadly, stating that the sense of being there (e.g. in a virtual environment) is not necessarily bound to a technology, but is a product of the mind encountered also in “real life” (Ijsselsteijn, 2002; Ijsselsteijn, Freeman, & De Ridder, 2001). As such, it can be seen as an attentional shift from one environment (e.g. a physical one) to another (e.g. a virtual one) based on “the (suspension of dis-)belief” (Slater & Usoh, 1994, p. 134) of being located in one (e.g. a virtual or an imaginal) environment instead of another (e.g. a physical one). Comprehensive factor analytic studies of presence have revealed a structure comprising three factors, also called *The Big Three of Presence* (Takatalo, Nyman, & Laaksonen, 2008): (1) *Spatial or Physical Presence*, i.e. the feeling of being physically located in an environment (sense of being there, Slater, 2003), (2) *Involvement or Engagement*, i.e. the focusing of attention on the (e.g. virtual) environment as opposed to physical stimuli and (3) *Realness or Perceived Realism*, i.e. the evaluation of the environment as being “real” (c.f. Lombard & Ditton, 1997). The conceptual difference between *Physical Presence* and *Involvement* has led to the perception of presence as being based upon two processes (Schubert, 2009): the construction of a coherent cognitive model of the (e.g. virtual) environment and the focusing of attention on the scenario instead of the physical surroundings. A hallmark of presence is the demonstration of behavior in an environment (e.g. virtual) that is congruent with the behavior expected in a comparable real life situation (Slater, 2003). Thus, it is not surprising, that presence has also been suspected to influence the outcome of virtual reality exposure therapy, VRET (c.f. Price & Anderson,

2007; Riva, Botella, Légeron, & Optale, 2004). It is assumed that the more presence a person experiences when exposed to a virtual stimulus, the more likely will the related emotional reactions (e.g. anxiety) be similar to those in a comparable physical environment and the more likely will the treatment prove successful.

However, studies imply that users may differ significantly in their experience of presence and thus, may also profit differently from VRET. User characteristics such as certain emotional traits and individual traits were found to exert a profound influence on the formation of presence (c.f. Gaggioli, Bassi, & Delle Fave, 2003). Anxiety for instance is considered to be one of those influencing variables, and hence, a considerable body of literature is dedicated to exploring the relationship between anxiety and presence. To date, results mostly indicate a positive correlation between anxiety and the amount of presence experienced in a fearful or stressful virtual environment (e.g. Renaud, Bouchard, & Proulx, 2002). There is evidence that individuals with high levels of trait anxiety show higher levels of presence which in turn leads them to experience more anxiety when confronted with phobic or fearful virtual cues (Alsina-Jurnet, Gutiérrez-Maldonado, & Rangel-Gómez, 2011; Price & Anderson, 2007).

In addition, another user characteristic has been repeatedly suggested to be responsible for individual differences in the experience of presence: gender (c.f. Lombard & Ditton, 1997). Despite repeated calls to investigate these issues in more depth, however, only a few studies have evaluated differences between males and females when experiencing presence.

Those studies which actually consider gender as a potential influencing variable indicate that men and women indeed tend to report different levels of presence when watching television (Botta & Bracken, 2004; Bracken, 2005; Lombard, 1995; Lombard, Reich, Grabe, Bracken, & Ditton, 2000), when being immersed in virtual environments (Slater, Steed, McCarthy, & Maringelli, 1998), when playing video games (Lachlan & Krmar, 2011) and when using simulators (Nicovich, Boller, & Cornwell, 2005). For example, two studies (Lombard, 1995; Lombard, Reich, Grabe, Bracken, & Ditton, 2000) assessing the experience of presence when watching television indicated that women tended to have stronger emotional responses and hence, higher levels of presence. Also, female participants were more inclined than male participants to respond to shifts in screen size and image size with regards to presence. Nicovich and colleagues (2005) in turn, who investigated gender differences in presence when using a flight simulator found that men

reported higher levels of presence when interacting with and controlling the simulator in an interactive condition, while women seemed to be more easily engaged in presence when merely watching the environment in a non-interactive condition. Similarly, Slater et al. (1998) assessing the influence of body movements in a virtual environment on presence found that men reported higher levels of presence than women in a complex task which required the subjects to remember and count virtual cues. In the simpler task this relationship was inverse with women showing considerably more presence. Looking more closely at specific constituting aspects of presence, such as perceived realism, spatial presence as well as involvement and control, a substantial gender gap may be found as well. Lachlan and Krmar (2011) investigated gender differences in video-game related presence and found an overall advantage of men regardless of their prior game experience: male participants expressed more sensory presence and more control over the environment than their female colleagues.

In sum, an advantage of men over women with regards to presence has been reported in earlier studies. Based on studies exploring anxiety and presence (Alsina-Jurnet, Gutiérrez-Maldonado, & Rangel-Gómez, 2011; Price & Anderson, 2007; Renaud, Bouchard, & Proulx, 2002), it is furthermore safe to consider anxiety a confounding variable for gender differences in presence in stressful virtual environments. Yet, most of these studies focus on stimuli other than virtual reality programs used for exposure such as television and simulators. Thus, it is unclear whether the reported gender differences pertain only to the above mentioned stimuli (e.g. television, video games and simulators) or whether they are also true for stressful virtual environments commonly used in VRET for patients with anxiety disorders. Furthermore, different ways of assessing presence have been used in studies investigating gender difference, not in all instances covering the above mentioned three factors of presence (*Spatial Presence*, *Involvement* and *Perceived Realness*) and thus, reducing cross-study comparability.

Consequently, the goals of the present study are to explore potential gender differences in presence when being immersed in a stressful virtual speaking task and to control for possible influences of social interaction anxiety as a trait characteristic of the participating individuals, including a control sample, which – in accordance to known imaginative techniques used in therapy (for a review see Vincelli, 1999) – was asked to imagine the audience. The present study aims at answering the following research questions:

Research question 1: Are there differences in presence between the two conditions (imaginative and virtual) when accounting for possible influences of gender?

Given the richness of the virtual environment as compared to an imagined environment and the often observed difficulty people have when merely imagining or recalling a detailed situation within the realms of imaginal exposition therapy (see Vincelli, 1999), subjects regardless of their gender are expected to report a higher sense of presence in the virtual condition. According to previous findings (e.g. Lachlan et al., 2011) men are expected to express more presence in the virtual environment than women. Additionally, possible gender differences not only in overall presence but in specific aspects of presence such as *Involvement* and *Perceived Realism* are expected to be found in favor of men.

Research question 2: Are there differences in presence between both, the two conditions (imaginative and virtual) and the gender of the participants when controlling for possible influences of social interaction anxiety?

In accordance to previous findings which indicate a mediating influence of anxiety on the perceptions of presence in a stressful environment (e.g. Alsina-Jurnet, Gutiérrez-Maldonado, & Rangel-Gómez, 2011) social interaction anxiety is expected to influence the relationship between gender and presence.

2. Methods

The present study was conducted in accordance with the current version of the Declaration of Helsinki. All participants signed an informed consent form prior to participation informing them about the goals of the study and their right to terminate participation at any time. Statistical analyses were performed using SPSS 15 (SPSS, Inc. Chicago, USA). An alpha error of 5% was chosen as a threshold for statistical significance.

2.1. Procedure

Participants were randomly assigned to either a control group or an experimental group. The experimental group was asked to hold a 5 minute presentation in front of a virtual audience (for the detailed description of the virtual scenario see below), whereas the control group was instructed to hold the same presentation in front of an imagined audience. In order to ensure the novelty of the subject across participants and hence, enable the same

condition for all participants, a fairly unfamiliar theme was chosen for presentation: the kingdom of Bhutan. Participants were told about their allocation to either the control or the experimental group upon their arrival to the lab. In a 10 minute preparation period a printed version of the 20 slide presentation was handed to the participants, allowing them to get acquainted with the subject. After preparation, a short standardized exercise based on common imaginal techniques (e.g. Wolpe, 1958) was conducted by trained test supervisors for the control group in order to facilitate the imagination of the lecture hall. In contrast to the imaginative group, the experimental group was presented with a virtual lecture hall (created with Visual Studio C++ Express and Ogre3d; see Figure 1) using a head mounted display (*eMagin Z800 3D*, Bellevue, Washington).

A standardized protocol was applied including an overall virtual audience of 20 viewers (male and female) showing both, content and discontent facial expression and evoking a constant murmur as well as loud laughing at two distinct moments during the presentation. The participants were able to manipulate the presentation slides, flipping them as they were proceeding. Movement through the virtual lecture hall however was disabled for this experimental task resulting in the participant consistently standing on a slightly heightened platform during presentation. A previously conducted study with this virtual speech task indicated its effectiveness in producing stress related psychophysiological reactions as well as insecurity and self-reported anxiety during the virtual presentation (Kothgassner, Felnhofer, Beutl, Hlavacs, Lehenbauer, & Stetina, 2012). These findings proved this particular virtual environment to be suitable for the present study.

2.2. Participants

The overall sample ($N = 40$) consisted of students who were recruited from several courses at Vienna University. The mean age was 23.65 years ($SD = 2.943$) for the virtual group ($N = 20$, 10 males and 10 females) and 24.75 ($SD = 2.712$) for the imaginative control group ($N = 20$; 10 males and 10 females). Most participants (virtual: $N = 16$; imaginative: $N = 15$) reported a lot of speech experience (>5 presentations). Only nine participants (virtual: $N = 4$ and imaginative: $N = 5$) had lesser experience (1–5 presentations). However, there were no significant differences between the control group and the experimental group in terms of presentation experience ($\chi^2(1) = 0.143$, $p = 0.500$). Similarly, there was no difference in the experience of holding presentations



Figure 1. Screenshot of the virtual lecture hall.

between men and women ($\chi^2(1) = 1.290, p = 0.225$). Also, participant's experience with computers measured via one question (*How experienced are you with computers?*) on a scale from 1 (very little) to 4 (very much) revealed no differences between neither the two groups ($\chi^2(1) = 0.465, p = 0.716$) nor between the sexes ($\chi^2(1) = 0.533, p = 0.358$).

2.3. Measures

A German version of the igroup Presence Questionnaire, IPQ (Schubert, Friedmann, & Regenbrecht, 2001; for the German version see <http://www.igroup.org/pq/ipq/download.php>) comprising 14 items on a 7-point-Likert scale (fully disagree – fully agree) was used to measure presence on three subscales: *Spatial Presence* describing the sense of being physically present in a virtual space, *Involvement* measuring the awareness devoted to a virtual scenario and *Realism* depicting the realism attributed to and experienced within the virtual scenario. Furthermore, a single overall-item assessed the *Sense of Being There*, or – in other words – the sense of being actually located within the virtual environment. Additionally, a modified German 20-item version of the Social Interaction Anxiety Scale, SIAS (see Mattick & Clarke, 1998 for the original version) measuring trait anxiety of social interaction was applied on a 4-point Likert scale (not at all – very much). The participants answered the SIAS while anticipating the

speech scenario and completed the IPQ immediately after the experimental task.

3. Results

We conducted a 2 x 2 ANOVA with gender and group as independent variables and each presence subscale as a dependent variable. In order to control for the effect of anxiety we assessed the level of anxiety prior to the presentation and included this measure as a covariate. Results indicate, that self reported social interaction anxiety does not differ between the experimental and the control group ($t(38) = 0.387; p = 0.701$), yet that there exists a marginal difference between men and women ($t(38) = -1.992; p = 0.054$) with women reporting higher levels of social anxiety. Regarding the IPQ subscale *Sense of Being There*, results reveal a statistically significant effect of gender ($F(1, 35) = 4.396, p = 0.043, \text{par. } \eta^2 = 0.112$) and group ($F(1, 35) = 4.874, p = 0.034, \text{par. } \eta^2 = 0.122$), as well as a significant interaction effect of gender by group ($F(1, 35) = 5.896, p = 0.020, \text{par. } \eta^2 = 0.144$). There is evidence that women show a significantly lower *Sense of Being There* when presenting in front of a virtual audience than men ($p = 0.004$), yet no gender differences could be found for the control group which was merely imaging the scenario ($p = 1.000$). Thus, there are differences between the experimental and the control group in women ($p = 0.016$),

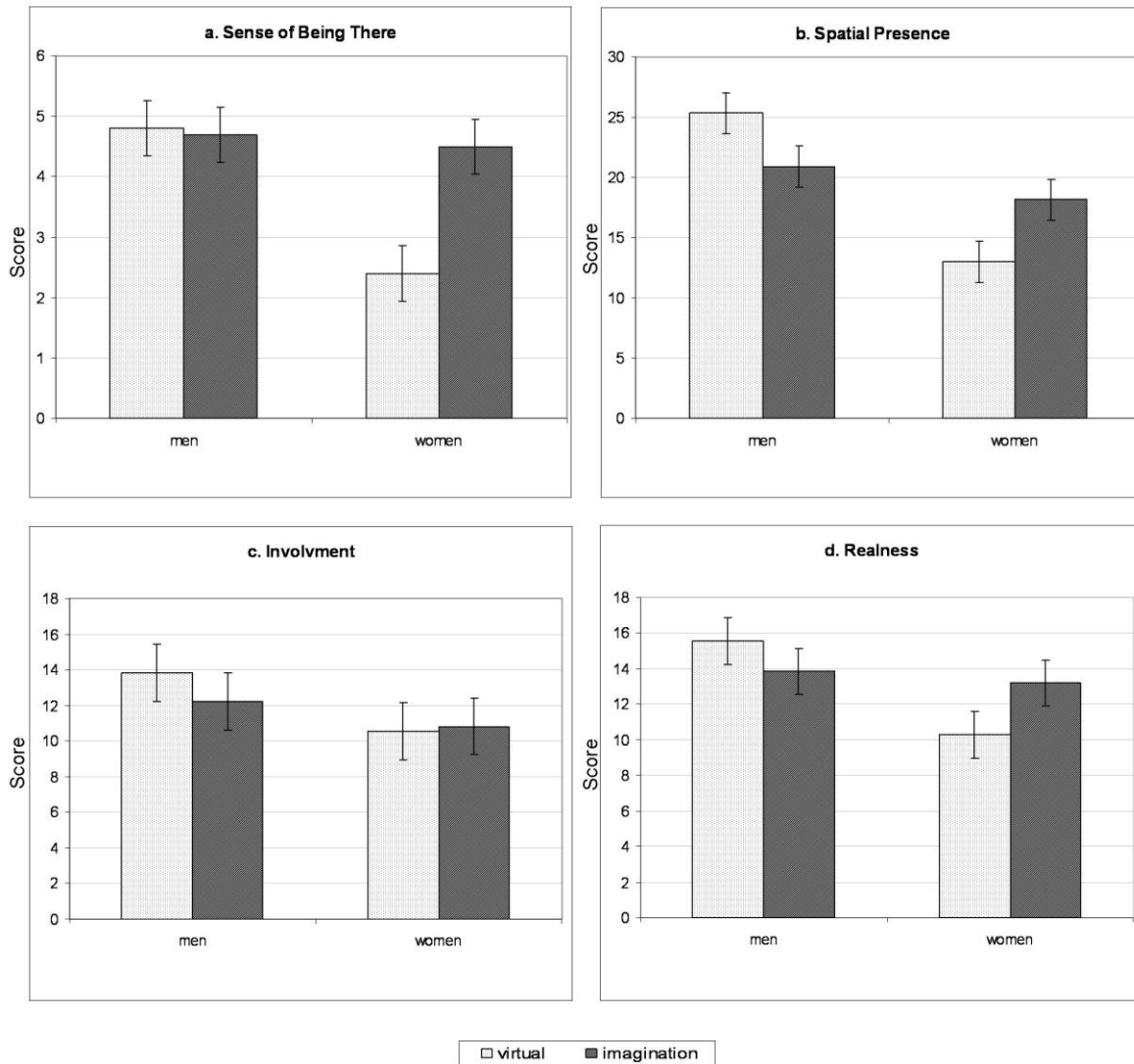


Figure 2. Means (\pm SEM) of all subscales of the iGroup Presence Questionnaire (Schubert, Friedmann, & Regenbrecht, 2001) sorted by gender and group.

but not in men ($p = 1.000$). For a graphic demonstration of the results see Figure 2.

Results regarding the IPQ subscale *Spatial Presence* show no group effect ($F(1, 35) = 0.047, p = 0.830, \text{par. } \eta^2 = 0.001$), but indicate a gender effect with men reporting significantly higher values of *Spatial Presence* than women in both groups ($F(1, 35) = 17.920, p < 0.001, \text{par. } \eta^2 = 0.339$). Another factor of presence, described as *Involvement*, shows no significant effect, neither by gender ($F(1, 35) = 1.984, p = 0.168, \text{par. } \eta^2 = 0.054$) nor by group ($F(1, 35) = 0.183, p = 0.671, \text{par. } \eta^2 = 0.005$). Moreover, the analysis of the presence factor *Realness*

indicates an effect of gender ($F(1, 35) = 4.831, p = 0.035, \text{par. } \eta^2 = 0.121$), yet no effect of group ($F(1, 35) = 0.225, p = 0.638, \text{par. } \eta^2 = 0.006$).

The inclusion of social influence of anxiety as a covariate reveals a significant influence of anxiety on the presence factor *Sense of Being There* ($F(1, 35) = 7.929, p < 0.008, \text{par. } \eta^2 = 0.185$). However, no significant influence of anxiety can be reported for neither *Spatial Presence* ($F(1, 35) = 0.079, p = 0.780, \text{par. } \eta^2 = 0.002$) nor *Involvement* ($F(1, 35) = 0.518, p = 0.476, \text{par. } \eta^2 = 0.015$) or *Realness* ($F(1, 35) = 2.881, p = 0.098, \text{par. } \eta^2 = 0.076$).

4. Discussion

Based upon repeated calls to include gender as a potential influencing variable in presence research, the current study explored differences in the feeling of presence between men and women when being immersed either in a virtual or an imaginative speech task. Our study supports previous findings that gender might be one of the contributing factors in the formation of presence (Botta & Bracken, 2004; Bracken, 2005; Lachlan & Krcmar, 2011; Lombard, 1995; Lombard et al., 2000; Nicovich et al., 2005; Slater et al., 1998). Except for *Involvement*, gender differences were found on all IPQ subscales, including the single item solution *Sense of Being There* as well as *Spatial Presence* and *Realness*. Male participants reported significantly higher levels of presence in the virtual condition than female participants. Accordingly, men did not only experience the virtual environment more like a place they had visited, they also attributed more realism to the scenario and felt more physically present when holding the speech in front of the virtual audience.

In an attempt to explain the advantage of men over women in sense of presence one encounters studies (e.g. Waller, Hunt, & Knapp, 1998) which claim that more computer experience in men may be held responsible for the observed gender differences in presence. Yet, in the current sample, men and women revealed no significant differences in their previous experience with computers. Considering this, it is appropriate to assume that this potential influencing factor does not account for the observed disparities. Furthermore, there is evidence that playing computer games may have a positive influence on presence (e.g. Lachlan & Krcmar, 2011). Since men are found to engage more frequently in playing computer games than women (Hartmann & Klimmt, 2006) and hence can be considered to be more familiar with virtual scenarios it may be easier for them to properly engage in the virtual environment and develop strong feelings of presence. Also, it is possible that men experience a greater self-efficacy in handling computer hardware and software and thus feel lesser skepticism towards virtual environments and related hardware components such as the head mounted display. As it is safe to assume, that in the light of today's ubiquity of personal computers gender differences in computer experiences may be no longer existent, subtle differences between the sexes such as diverging attitudes towards computers and related experiences of self-efficacy may be accountable for the observed gender gap in presence experiences.

Another factor possibly being responsible for the clear advantage of men over women especially in the

experience of being physically inside the virtual environment (IPQ subscale *Spatial Presence*) is spatial ability. Spatial ability has been repeatedly found to produce stable gender differences, with men showing a better performance in a number of spatial tasks than women (e.g. Kryspin-Exner & Felhofer, 2012). Hence, differences between men and women in spatial abilities may not only explain the gender differences on the factor *Spatial Presence* but may also prove to be responsible for the clear gender gap in the *Sense of Being There*. A feeling of actually being in an environment is thought to require proper spatial orientation in and navigation through the virtual environment (Nash, Edwards, Thompson, & Barfield, 2000).

Apart from gender differences, the factor *Sense of Being There* revealed another highly remarkable notion in the current study: women were found to report significantly lower levels of *Sense of Being There* in the virtual condition as compared to the imaginative task. Interestingly, no such difference was found in men. Also, both sexes seemed to engage similarly in the imaginative task. In an attempt to explain these highly interesting differences, one may hypothesize that women may have found it more difficult than men in fully suspending their disbelief of being located in a world other than the physical one (Slater & Usoh, 1994). Again, gender specific approaches and attitudes towards virtual environments may have partly been responsible for these findings.

In contrast to previous studies (Bracken, 2005; Botta & Bracken, 2004) which found women to report more perceived realism, in the current study men clearly rated the virtual scenario as being more real than women did. It must be noted that while the previously found higher ratings of women on the realness factor of presence pertained to television, we confronted the participants with a fully animated, interactive and immersive virtual environment. Thus again, men might have profited from an advantage in game experience resulting in a greater familiarity with virtual stimuli, leading them to a greater acceptance of the virtual world. An additional evaluation of technology acceptance as well as of intentions to use the technology and evaluations of its usability, usefulness (see Technology Acceptance Model, TAM, Davis, 1989) may prove insightful for the observed gender differences in the virtual task as it has previously been found that men and women may indeed differ in terms of technology acceptance and their intentions to use it (e.g. Venkatesh & Morris, 2000).

Regarding the last presence factor, *Involvement*, no gender differences were detected in the present study.

Men and women devoted approximately the same amount of attention to the environment, regardless of the experimental condition (virtual vs. imaginative). *Involvement* seems to depend on cognitive abilities, especially on the ability to draw one's attention from the surrounding physical world, to allocate it in the virtual scenario and to constantly keep up one's awareness for virtual stimuli. As our sample consisted of students of approximately the same age and advancement of studies, it may be hypothesized that they all had similar cognitive preconditions and thus, found it comparatively easy to draw their attention resources to the stimuli.

In addition to detecting a possible gender gap in presence, the current study set out to include social interaction anxiety as a covariate in order to control for possible influences of trait anxiety on presence in a stressful virtual environment. Interestingly, presence and anxiety showed no relationship on the presence factors except for the IPQ scale *Sense of Being There*. Men and women did not differ significantly regarding trait anxiety, yet there was a clear tendency for the female participants to express more social interaction anxiety. This slight difference is expected to become significant in a larger sample. Therefore, a more thorough investigation of the impact of trait anxiety on presence in a larger sample as well as the additional consideration of state anxiety promises to clarify the relationship between emotional states and traits and presence.

5. Limitations and Conclusion

To our knowledge, the present study is the first to examine gender differences with regards to presence and emotional traits in a virtual and an imaginal public speaking task. As such, the results can be considered worthwhile reporting especially when considering their robust effect sizes mostly ranging between medium to large effects (see Cohen, 1988). Yet, with regards to the sample size generalizations of the current results shall be conducted with caution. It should also be considered that the findings may be limited to the specific stimulus used in this study. Further studies including a wide variety of different participants with differing levels of trait anxiety not only in the realms of a public speaking scenario are warranted in order to verify the obtained results.

The selection of an imaginal control group for the current study was based on its frequent use for the treatment of anxieties. Nevertheless, adding another group exposed to a corresponding in vivo stimulus might prove very insightful regarding the relationships between gender, presence and anxiety in future studies. Also,

other mediating factors, such as previous computer and gaming experience, self-efficacy, spatial ability, attentional resources and technology acceptance as well as to more objective measures of presence such as heart rate or skin conductance level should be considered when examining gender differences in presence. Furthermore, the inclusion of a state anxiety measure promises to shed more light on the interaction between gender and presence especially for stressful or fearful virtual environment. In future, we hope to delineate even more the preconditions of presence in order to allow for the best possible experiences in virtual environments.

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