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An exploration of virtual reality exposure therapy for social anxiety

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An exploration of virtual reality exposure therapy for social anxiety

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Thesis submitted in partial fulfilment of the requirements for the degree of Doctorate in Clinical Psychology

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Chapter 1

Thesis Abstract

An exploration of virtual reality exposure therapy for social anxiety

The first part of this thesis was a meta-analysis examining the efficacy of virtual reality exposure therapy (VRET) for social anxiety. Effect sizes suggested that VRET was more effective than waiting list controls, and at least as effective as traditional therapeutic interventions. Some concerns were identified with regards to potential for bias. It was also noted that VRET involved the individual viewing a virtual reality (VR) scenario from a first-person perspective. As a recent study has investigated the use of third-person VR doppelgängers for public-speaking anxiety (PSA), this was identified as a key area of further research for the thesis to address.

Some research has suggested that individuals who struggle to form vivid mental imagery (MI) are more likely to experience high levels of social anxiety, and may not benefit from visualisation techniques used in therapy. The next part of the thesis found that MI ability was a significant predictor of PSA. Five students with high PSA and low MI were then invited to engage in an enhanced version of the VR doppelgänger intervention, in order to examine the feasibility of incorporating this into the undergraduate psychology programme. The study suggested that the intervention could feasibly be rolled out as part of the course. Participants reported that they struggled with a standard visualisation script due to difficulties associated with MI, but the VR intervention compensated for this. They also discussed noticing significant improvements outside of the VR sessions, and that they felt safe and present in the simulation. A decline in PSA was recorded over time for all participants.

The thesis concludes with a review of the theoretical implications of these findings and provides some suggestions for future research, before outlining the implications for clinical practice.

Chapter 2

Virtual reality exposure therapy for social anxiety: A meta-analysis and risk of bias evaluation

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Submission to the British Journal of Psychology

Virtual reality exposure therapy for social anxiety: A meta-analysis and risk of bias evaluation

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Abstract

Although some reviews have examined the effectiveness of Virtual Reality Exposure Therapy (VRET) across anxiety disorders, these have included small numbers of social anxiety studies and have not reviewed their quality. The purpose of this meta-analysis was to synthesise outcome data from clinical trials of VRET for social anxiety, whilst examining each study for potential risks of bias. Searches of online databases identified eight suitable studies (n=389). Meta-analysis suggested that VRET is much more effective than waiting list controls, and that it is at least as effective as traditional therapeutic approaches. Heterogeneity was attributed to inconsistencies between the type of VRET and traditional interventions used. Potential for bias was identified in three studies due to insufficient randomisation and allocation concealment procedures. Difficulties with blinding participants to treatment conditions meant that a possible placebo effect could not be ruled out for all studies. A low risk of bias was found in many key areas, although a lack of reported information meant that some aspects could not be properly assessed. The current findings relating to VRET efficacy mirror those found in previous reviews. However, more high quality studies are required in order to determine its effectiveness relative to traditional exposure techniques.

Introduction

According to a review of forty-three epidemiological studies from a variety of Western countries, approximately 7-13% of people will experience social anxiety at some point in their lifetime (Furmark, 2002). Meta-analyses have suggested that persistent social anxiety can have a devastating impact on an individual's life, and can severely reduce their level of psychosocial functioning (Olatunji, Cisler & Tonin, 2007). As approximately two thirds of socially anxious individuals will not attain remission if left untreated (Keller, 2006), there is a strong case for high quality psychological research in this area.

Social anxiety refers to a heightened fear of evaluation from other people in social situations, which results in an increased focus on internal cues relating to threat (Morrison & Heimberg, 2013). Although this can be a global fear that applies to all social interactions, in recent years researchers have recognised specific forms social anxiety. For example, cognitions associated with public speaking anxiety relate to the same core concerns as those found in individuals diagnosed with Social Anxiety Disorder (SAD; Hales, Yudofsky & Roberts, 2014). As a result, the DSM-V now recognises performance anxiety as a variety of SAD (Bögels *et al.*, 2010). A large body of research suggests that cognitive behavioural therapy (CBT) is the most effective approach for treating social anxiety (Mayo-Wilson *et al.*, 2014). This involves identifying and modifying cognitions and behaviours that are maintaining the fear response (Otte, 2011). There is also evidence to suggest that cognitive therapy can be effective without the behavioural component (Clark *et al.*, 2006). Exposure is often used in conjunction with CBT, in which the individual is systematically confronted with the feared stimulus either in person or through imagery (Abramowitz, Deacon & Whiteside, 2012). For the purpose of the current review, the term "traditional approaches" (TA) will be used when referring to these models and their associated techniques.

Over the last ten years, VRET has emerged as an innovative and cost-effective alternative to traditional exposure therapy. After donning a headset or being placed in front of a large screen, the individual enters an immersive computer-generated environment that recreates the feared situation (Parsons & Rizzo, 2008). The therapist views the client's interactions with the virtual environment on a computer monitor, and is able to manipulate aspects of the simulation as required. VRET has been used for a variety of phobias including fear of flying, spiders, heights and driving (Wiederhold & Bouchard, 2015). The majority of research into VRET for social anxiety has focused on public speaking, in which the individual is required to give a speech in front of a virtual audience (Vannii *et al.*, 2013). Whilst this approach focuses on performance anxiety, other VRET interventions have recreated environments relating to assertiveness, intimacy and scrutiny (Klinger *et al.*, 2004). This type of intervention has several advantages over TAs including compensating for difficulties in forming vivid mental images, assisting those who struggle to avoid remaining in a feared situation, protecting the individual's anonymity and allowing the therapist to adapt the environment according to the client's needs (Wallach, Safir & Bar-Zvi, 2009).

To date, three meta-analyses have examined the effectiveness of VRET across a variety of different anxiety presentations (Parsons & Rizzo, 2008; Powers & Emmelkamp, 2008; Opriş *et al.*, 2011). Each included a small number of studies focusing on social anxiety, alongside several studies on other anxiety disorders. As part of their meta-analysis, Parsons and Rizzo (2008) combined the effect sizes of four studies looking at the impact of VRET on social anxiety (n=40). They found a large significant summary effect size with Cohen's *d*=0.96, 95% CI: 0.34 to 1.59. However, their analysis only looked at pre-post differences for the VRET group and did not compare this to any controls. This limits the conclusions that can be drawn, as there is no way to determine whether this effect size was due to the VRET intervention. Powers and Emmelkamp (2008) did incorporate control group data in their meta-analysis, which included two studies of VRET for social anxiety (n=50). Combining the effect sizes of these two studies resulted in a moderate to large summary effect size that favoured VRET, with

Hedge's *g*=0.73 (95% CI not provided). Unfortunately, one of the social anxiety studies used a waiting list (WL) control whereas the other consisted of individuals who had completed CBT plus exposure. On the basis of this analysis, it is therefore not possible to ascertain the relative benefits of "VRET vs WL" and "VRET vs TA". A further limitation of both meta-analyses was that neither included studies with a VRET+CBT intervention. In order to address these shortcoming, Opriş *et al.* (2011) analysed clinical trial data that related to VRET+CBT interventions and completed subgroup analyses for WL and TA controls. They included two studies of social anxiety in their VRET vs WL comparison (n=87), and found a large significant effect size that favoured VRET (*d*=1.01, 95% CI: 0.69 to 1.33). Their VRET vs TA analysis included three social anxiety studies (n=124) with a non-significant effect size (*d*=0.13, 95% CI: -0.11 to 0.38), which suggested that VRET was equally as effective as TAs.

Whilst these meta-analyses appear to suggest that VRET is an effective intervention for social anxiety, such findings should be interpreted with caution due to the small number of studies and lack of follow-up data. In their systematic review, Meyerbröker and Emmelkamp (2010) included two studies relating to social anxiety. Similar to Opriş *et al.* (2011), they noted that these studies found VRET was more effective than no treatment and equally as effective as traditional CBT. The authors concluded that although these results were promising, more controlled studies were required before any definitive conclusions could be drawn. However, as this study was a systematic review it did not yield any effect size data. As with the meta-analyses, this review did not assess the quality of the included studies. A recent evaluation focused solely on the quality of VRET studies for anxiety disorders, and found that they only met an average of 2.85 (sd = 1.56) out of 8 quality indicators (McCann *et al.*, 2014). Although the review only included three studies of social anxiety, it does highlight the limitations of the meta-analyses and systematic reviews carried out to date. McCann *et al.* (2014) stress that findings in the field should therefore be interpreted with caution, which suggests that future meta-analyses must assess for possible bias resulting from methodological limitations.

Since the most recent meta-analysis by Opriş *et al.* (2011), several new studies have been published. The purpose of the current study is to therefore carry out an up to date review of the literature, in order to examine the effectiveness of VRET for social anxiety. This meta-analysis will then focus on comparing VRET outcomes to WL and TA conditions. Follow-up data will also be analysed when available, in order to determine whether any measured effects are maintained. Previous reviews have only included a small number of social anxiety studies alongside other anxiety disorders. The current review will be the first meta-analysis to focus solely on a larger number of VRET for social anxiety clinical trials. Unlike previous efficacy reviews, close attention will be paid to study quality and potential for bias using the latest Cochrane assessment tools.

Method

Eligibility criteria

Studies needed to meet the following criteria to be included in the analysis:

- Studies had to use random or matched assignment approaches when allocating participants to conditions
- Studies needed to be written in English and in a peer-reviewed journal
- Studies had to have at least one VRET condition and one control condition, consisting of either a WL group and/or a traditional evidence-based intervention
- Studies had to present anxiety data for before and after VRET
- All follow-up data was considered
- Sufficient reporting of means and standard deviations was required, for at least one primary outcome measure of social/performance anxiety per study

- Studies that used fewer than ten participants in the VRET group were excluded, in line with recommendations made in previous meta-analyses looking at a broad range of anxiety disorders (Opris *et al.*, 2011; Powers & Emmelkamp, 2008).

Information sources

Studies were identified by searching electronic databases and looking through reference lists of previous reviews. This search was applied to Pubmed (1966-Present), Web of Science (1970-Present), Psycinfo (no date restrictions) and the Cochrane Central Register of Controlled Trials (CENTRAL; no date restrictions). These searches were performed in November 2015.

Search strategy

The following search terms were used to search all databases and the CENTRAL register: *("virtual reality" AND/OR "VRET") AND ("social anxiety" AND/OR "social phobia" AND/OR "public speaking" AND/OR "performance anxiety").* Additional studies were identified by carrying out ancestral searches on existing meta-analyses and reviews.

Study selection

All abstracts and titles were screened and those that did not meet the eligibility criteria were excluded. The remaining articles were read in full, in order to fully assess their eligibility for inclusion in the analysis. It was unclear how one study had allocated participants to treatment groups, so further clarification was obtained from the authors.

Data collection process

A data extraction spreadsheet was developed to capture data from the included studies. Data that was not a primary outcome measure of anxiety, such as heart rate or clinical judgement, was not extracted from the studies. As some of the studies were by the same authors, contact was made with the researchers in order to establish whether any of the data related to the same trials. Where this was the case, it was only extracted from one of the relevant studies in order to avoid duplication. Further details on which studies related to the same trials are provided in the Results section.

Data items

The following data was extracted from the included studies: author names, study design (randomised or matched clinical trial), participant numbers for each group (pre, post and follow-up), age, gender, type of primary outcome measure of social anxiety, VRET means and SD (pre, post and follow-up), comparison means and SD (pre, post and follow-up), number of sessions, type of sample (clinical or analogue), social situations targeted in treatment, equipment, type of VRET, type of control groups and follow-up periods (none, 3 months or 12 months).

Risk of bias in individual studies

The latest PRISMA statement suggests that authors should focus on the potential risk of bias within studies, as opposed to the previous approach of assessing the quality of studies (Liberati *et al.*, 2009). Whereas "quality" refers to the best that the researchers' could do, "risk of bias" takes into account the fact that studies can still be biased despite the authors' best efforts. The PRISMA guidelines recommend approaches that focus on individual components, such as the Cochrane risk of bias assessment tool for RCTs (Higgins, Altman & Sterne, 2008). This tool was therefore used to assess bias

in the following areas for each of the RCTs: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data and selective reporting. The potential for bias in these areas was assessed as being either low, high or unclear due to insufficient information in the study.

As non-RCTs consist of different components to an RCT, an alternative approach was required for any matched-group trials. "A Cochrane Risk Of Bias Assessment Tool for Non-Randomized Studies" (ACROBAT-NRSI; Sterne, Higgins & Reeves, 2014) was therefore selected, which focuses on potential bias arising from: confounding, selection of participants, measurement of interventions, departures from intended interventions, missing data, measurement of outcomes and selection of the reported result. Risk of bias in these domains was rated as being low, moderate, serious, critical, or lacking information on which to base a judgement.

In order to account for the varying degrees of reliability of the included outcome measures, correlation coefficient scores (Pearson's *r*) were obtained for each measure from published studies. The *r* scores were entered into the data extraction spreadsheet, so that they could then be incorporated into the effect size calculations (see "synthesis of results").

Summary measures

The primary measure of treatment effect was the mean difference between pre-intervention and post-intervention social/performance anxiety scores. As different outcome measures were used across studies, the decision was made to calculate standardised mean difference (SMD) scores. This allowed the results to be transformed to a common scale, which assisted with pooling (Hedges, 1984; Hedges & Olkin, 1985). Effect sizes (Cohen's *d*) and 95% confidence intervals were calculated for each

study and were then combined to produce summary effect sizes, using the following synthesis procedure.

Synthesis of results

Cohen's *d* effect sizes and 95% confidence intervals were calculated for each outcome measure per study for the following comparisons: VRET vs WL, VRET vs TA, VRET vs TA at three month follow-up and VRET vs TA at twelve month follow-up. The correlation coefficient scores for each outcome were included in the effect size calculations, in order to reduce the bias associated with the scales' reliability. Outcome measure effect sizes were then averaged within each study, to provide single effect size scores and corresponding confidence intervals. Details of these calculations can be found in Appendix A.

The effect size data was then entered into the Comprehensive Meta-Analysis Version 2.2.064 (2011) software package, in order to combine studies in each of the comparison groups. A random effects meta-analytic model was used, to account for the observed heterogeneity between studies. In order to reduce risk of bias associated with study size, the outputted summary effect sizes were weighted by the inverse of variance. Effect sizes were interpreted in accordance with Cohen's (1988) conventions in which *d*=0.2 is small, *d*=0.5 is moderate and *d*=0.8 is large.

Tests for heterogeneity were carried out using the chi-squared statistic, and the percentage of variation due to heterogeneity was assessed using the I^2 (Higgins, Thompson, Deeks & Altman, 2003). A key benefit of the I^2 is that its accuracy does not depend on the number of studies and it includes an uncertainty interval (Higgins et al., 2003). Sensitivity analysis was carried out by systematically removing studies from the analysis and assessing the impact that this had on the heterogeneity statistics and summary effect sizes.

Risk of bias across studies

The PRISMA statement suggests states that risk of bias assessments should be carried out in relation to factors that could affect the cumulative evidence (Liberati *et al.*, 2009). Specifically, it identifies the following two areas: bias due to missing studies (i.e. those that have not been published due to statistically non-significant results) and missing outcomes (i.e. selective reporting bias). In order to identify unpublished studies, searches were carried out on the World Health Organisation's International Clinical Trials Registry Platform Search Portal at http://apps.who.int/trialsearch/. This search engine covers sixteen of the key clinical trial registry databases from around the world. The possibility of absent outcome data was reviewed as part of the Cochrane risk of bias assessments discussed earlier. Finally, the individual study effect sizes were examined in order to determine whether smaller studies were yielding larger estimates, as this is a common indicator of publication bias (Liberati *et al.*, 2009).

Results

Study selection

This search resulted in 363 publications. An additional 69 potentially suitable studies were located by ancestral searches on some of these papers. All 432 titles and abstracts were then examined, in order to determine which articles to include on the basis of the eligibility criteria listed above. After screening titles and abstracts, 210 studies were excluded for not meeting the eligibility criteria. The remaining 85 articles were then read in full, which resulted in 76 ineligible articles being removed. This process is summarised in the PRISMA flowchart in Figure 1.

----------INSERT FIGURE 1 HERE----------

Study characteristics

A total of seven RCTs (Anderson *et al.*, 2013; Price & Anderson, 2012; Heuett & Heuett, 2011; Robillard, Bouchard, Dumoulin, Guitard & Klinger, 2010; Safir, Wallach & Bar-Zvi, 2012; Wallach, Safir & Bar-Zvi, 2009; Wallach, Safir & Bar-Zvi, 2011) and one matched-group trial (Klinger *et al.*, 2005) were identified as suitable. In all of the trials, participants were allocated to either a VRET, TA or WL group. Those in VRET and TA groups then engaged in a number of weekly sessions. The number of sessions ranged between 1 and 16 (mean=10). Those in the WL condition did not engage in an intervention. Measures of social anxiety or communication apprehension were taken prior to starting the intervention and again at the end. A variety of different primary outcome measures were used, all of which measured social anxiety (e.g. Liebowitz Social Anxiety Scale; Liebowitz, 198) or performance anxiety (e.g. Personal Report of Communication Apprehension; McCroskey, 1978). Research suggests that these concepts are closely related, as performance anxiety is often conceptualised as a part of social anxiety (Bögels et al., 2010).

All VRET interventions used headsets with the exception of Klinger *et al.* (2005), who opted for large computer monitors. VRET was either administered by itself or with CBT components. TAs in the control conditions included group CBT with exposure, individual CBT with exposure, cognitive therapy and a CBT visualisation technique written by Ayres and Hopf (1993). The TA exposure sessions involved being systematically exposed to the feared situation, either in person or through imagination. In contrast, the VRET component involved the participant being exposed to various social situation through VR. In studies that included CBT, these sessions were run alongside the TA exposure and VRET. CBT sessions involved discussing the links between thoughts, feelings and behaviours in social anxiety, whilst introducing new ways of challenging these thoughts.

Overall, the meta-analysis included n=142 VRET recipients, plus n=137 in the TA control and n=110 in the WL control groups. Four studies were in the VRET vs WL comparison, six were in the VRET vs TA comparison (which represented five clinical trials, as two of the studies were from the same sample), one study was in the three month VRET vs TA follow-up and two were in the twelve month follow-up. Ages ranged from 18 to 40 years. Female to male ratio varied across studies, although all samples included more female than male participants. Four studies used analogue samples and five used clinical samples. Participants in the analogue samples were university students without a formal diagnosis of social anxiety, who were recruited through lectures and advertisements on campus. The clinical samples consisted of members of the public who met the DSM-IV criteria for social anxiety. These participants were recruited through newspaper advertisements, clinical referrals and recommendations from other professionals and participants.

See Table 1 for an overview of the study characteristics and outcome measures.

----------INSERT TABLE 1 HERE----------

When Anderson *et al.*, (2013) was cross-referenced with Price and Anderson (2012), it appeared that the data related to the same samples of participants. Contact was made with the studies' authors, who confirmed that this was the case. However, different outcome measures had been used in each study, so both were included and treated as one study by calculating the average effect size. The following studies were then cross-referenced: Wallach *et al.*, (2009), Wallach *et al.*, (2011) and Safir *et al.*, (2012). It transpired that Wallach *et al.* (2011) reported the same CBT and WL control data as Wallach *et al.* (2009). However, it also included a new VRET group and a new cognitive therapy control,

so this data was included in the meta-analysis. Safir *et al.* (2012) contained follow-up data for Wallach *et al.*'s (2009) study, so this was also included.

Risk of bias within studies

As Klinger *et al.*'s (2005) study used matched groups rather than random allocation, this was the only study to be quality assessed using the ACROBAT-NRSI tool. This assessment suggested a moderate risk of bias in relation to participant selection, as the matched-group approach meant that condition allocation could be influenced by the researchers. Bias relating to selective reporting of results is best assessed by reviewing the study protocol or similar, in order to check if the reported results correspond to the intended outcome measures (Sterne *et al.*, 2014). As these documents were not available, there was insufficient information on which to assess risk in this area. All other areas in the ACROBAT-NRSI were assessed as representing a low risk of bias.

The quality of the other studies was assessed using the Cochrane risk of bias tool for RCTs, as summarised in Table 2. It was noted that three of these studies allocated participants by order of arrival (see Safir *et al.*, 2012; Wallach *et al.*, 2009; Wallach *et al.*, 2011). As alternation can be influenced by the actions of the researchers, it is not regarded as a true randomisation method under the Cochrane tool. Alternation also means that researchers may be able to foresee allocation. These studies were therefore assessed as having a high risk of bias with regards to random sequence generation and allocation concealment. In terms of incomplete outcome data, the RCT completed by Anderson *et al.* (2013) and Price and Anderson (2012) reported a 35.9% drop out rate for CBT compared to just 16.7% for VRET. If this dropout was due to high levels of social anxiety about engaging in group CBT, then this could potentially bias the outcome. As the researchers explain that they were unable to obtain reasons for the majority of the dropouts, the risk of bias in this area remains unclear. Wallach *et al.* (2009) reported similar dropout rates of 33% for CBT compared to 18%

for VRET. However, they carried out further analysis by comparing completers and non-completers on six different pre-therapy measures of social anxiety. There was a significant difference on only one measure (the FNE), which suggests that the drop outs were unlikely to influence outcome.

The authors of the Cochrane tool state that most RCTs will be assessed as "unclear" with regards to selective reporting bias, due to a general lack of study protocols that can be used to determine which planned outcomes have been reported (Higgins *et al.*, 2008). This was the case with the studies included in the meta-analysis, with the exception of Anderson *et al.* (2013) and Price and Anderson (2012) who had published their protocol online. Although blinding of outcome assessment was not possible due to the nature of the interventions, this would not have impacted on the outcome and was therefore assessed as presenting a low risk for all studies. Blinding of participants and personnel would also not be possible, as people would be aware of the nature of the intervention they are engaging in. Whilst this is unavoidable, engaging in a novel intervention which cutting edge technology would present a high risk of leading to a placebo effect. For this reason, this was assessed as representing a high risk across all studies.

----------INSERT TABLE 2 HERE----------

Results of individual studies

Individual pre-post effect sizes, standard error, variance and 95% confidence intervals can be found in Figures 2 and 3. Since Anderson *et al.* (2013) and Price and Anderson (2012) used the same sample, their study effect sizes were averaged and were treated as one study in the analysis. Anderson *et al* (2013) reported data relating to those who had completed the intervention and on an intention to treat basis. As Price and Anderson did not report any such data, in order for the average effect size to be meaningful only data for those who completed the intervention was used.

In the VRET vs WL comparison, effect sizes varied in size from moderate to large and favoured VRET. Confidence intervals indicated that all individual effect sizes for this comparison were significant. Individual effect sizes for VRET vs TA were a lot more variable. Wallach et al.'s (2009, 2011) studies suggested an absence of any difference between VRET and TA, as reflected in effect sizes that were approaching zero. The remaining studies yielded non-significant effect sizes that trended towards favouring VRET. The only significant effect size in this comparison related to the combined outcomes for Anderson *et al.* (2013) and Price and Anderson (2012), which produced a large *d* that favoured TA over VRET (*d*=0.905, 95% CI: 0.509 to 1.300).

Only Anderson *et al.* (2013) examined the impact of VRET at three month follow-up. A large significant mean effect size was found (*d*=0.858, 95% CI: 0.414 to 1.302), which favoured traditional CBT. This effect size was still significant at twelve month follow-up (*d*=0.477, 95% CI: 0.056 to 0.898). Although Safir *et al.*'s (2012) twelve month follow-up also favoured traditional CBT, this was not found to be significant (*d*=0.317, 95% CI: -0.160 to 0.793).

----------INSERT FIGURES 2 & 3 HERE----------

Synthesis of results

Meta-analysis of the VRET vs WL control studies showed a large and significant overall effect size that favoured VRET (*d*=-0.956, 95% CI: -1.302 to -0.610). Evidence of moderate heterogeneity was also found within this comparison (I^2=52.86%; Q=6.364, df=3; P=0.095). Exploration of this heterogeneity revealed that Robillard *et al.*'s (2010) VRET intervention was a lot more intensive than the others in this comparison. It consisted of sixteen weekly exposure sessions that covered a variety of different social situations, whereas the other studies included between one and seven exposure trials for public

speaking only. Excluding this study from the analysis removed the heterogeneity (I^2=0%; Q=1.926, df=2; P=0.382) whilst the effect size remained significant (*d*=-0.837, 95% CI: -1.073 to -0.600).

With regards to the VRET vs TA comparison, the meta-analysis initially suggested that there was no significant difference between the two groups (*d*=-0.017, 95% CI: -0.467 to 0.433). However, very high levels of statistical heterogeneity were identified (I^2=82.38%; Q=28.383, df=5; P<0.001). This appeared to be attributable to the large combined effect size found for Anderson *et al.*'s (2013) and Price and Anderson's (2012) studies, as heterogeneity was removed when they were excluded (I^2=0%; Q=3.922, df=4; P=0.417 . As discussed earlier, it was possible that this outcome was biased due to the high rate of unexplained dropouts from the CBT group. However, further exploration of this heterogeneity revealed that Anderson *et al.*'s (2013) group CBT contained several additional components that were missing from the VRET intervention and from other studies. Firstly, their group CBT included six trials of exposure compared to four trials of VRET. All other studies had an equal number of sessions in both conditions, with the exception of Wallach *et al.* (2009) in which the number of exposure trials in the CBT group was unspecified. Secondly, Anderson *et al.* (2013) videotaped participants' speeches and played these back to the whole group. Thirdly, group members were encouraged to give each-other feedback on their performance. These forms of video and peer feedback were absent from Anderson *et al*'s (2012) VRET intervention and from all other studies in the analysis. On this basis, it was hypothesised that these elements were reinforcing the benefits of the CBT group intervention. When this trial was excluded from the analysis, a small significant summary effect size was found in favour of VRET (*d*=-0.214, 95% CI: -0.421 to -0.014).

Only Anderson *et al.* (2013) looked at the maintenance of effects at three month follow-up, and found improvements that favoured TA over VRET (*d*=0.858, 95% CI: 0.414 to 1.302). In the absence of other relevant studies, no further analysis was carried out for this time point comparison. With regards to improvements at twelve month follow-up, a small but significant summary effect size favoured TA

over VRET (*d*=0.407, 95% CI: 0.091 to 9.723). However, sensitivity analysis revealed that this was reduced to non-significance when Anderson *et al.*'s (2013) study was removed (*d*=0.317, 95% CI: -0.160 to 0.793). No heterogeneity was found for this comparison (I^2=0%; Q=0.245, df=1; P=0.620).

Risk of bias across studies

Searches on the International Clinical Trials Registry Platform did not reveal any unpublished study that would match the eligibility criteria. As previously discussed, with the exception of Anderson *et al.* (2013) and Price and Anderson (2012), there was insufficient information available to ascertain whether outcomes were being selectively reported. A review of estimates across the included studies did not identify a pattern of smaller studies with larger effect sizes being published (Figures 4 and 5). However, this observation should be interpreted with caution given the relatively low number of included studies.

----------INSERT FIGURES 4 & 5 HERE----------

Discussion

Summary of evidence

The present review aimed to synthesise evidence on the efficacy of VRET for social anxiety. All individual study effect sizes found VRET to be much more effective than WL controls, which was reflected in a large summary effect size. Moderate heterogeneity was attributed to Robillard *et al.*'s large effect size, which appeared to be the result of a more intensive VRET intervention. When this study was removed from the analysis, a large summary effect size was still apparent which suggests that this is a robust finding. The outcome of the VRET vs TA comparison was less clear. Although the summary effect size initially appeared to suggest that there was no difference between VRET and TAs,

the very high level of heterogeneity suggested that there was a lot of variation between studies. This appeared to be due to a highly intensive group CBT intervention that was used in one clinical trial, which may also have accounted for the dropouts reported within this condition (see Anderson *et al.*, 2013; Price & Anderson, 2012). The large effect size reported in this study may suggest that a thorough group CBT approach can be more effective than a standard VRET intervention, although this conclusion is clouded by the unexplained dropout rate. Although removal of this study resulted in a small summary effect size that favoured VRET, this should also be interpreted with caution given that it was only marginally significant. Indeed, none of the other studies that contributed towards this summary effect size were significant. Whilst it can therefore be concluded with some certainty that VRET was at least equally as effective as TA, it remains unclear whether VRET actually yields better results.

Similarly, the follow-up results should also be interpreted with caution. A large effect size suggested that TA significantly outperformed VRET at three months. However, this comparison only contained data relating to the clinical trial with an exceptionally thorough TA intervention (i.e. Anderson *et al.*, 2013; Price & Anderson, 2012). This effect size can only be interpreted as evidence of a strong TA control group for this study alone, as opposed to a global estimate of efficacy. The smaller effect size at twelve months initially suggested that TA was still outperforming VRET, although further investigation revealed that this was due to the aforementioned study and that the effect size was reduced to non-significance when it was removed. Interpretation of this finding is further complicated by the fact that there were only two studies in the twelve month comparison condition. In light of these limitations, no definitive conclusions should be made on the basis of the follow-up data.

Limitations

This review combined data across studies in order to provide a cumulative estimate of treatment effect. One limitation is that different outcome measures were used across studies, some of which might be measuring slightly different constructs with varying degrees of accuracy. Although attempts were made to account for this by incorporating correlation coefficient scores for each measure into the effect size calculations, these scores vary across studies and so a certain degree of bias in inevitable. As with most meta-analyses, different participant ages and gender ratios were also apparent across studies.

Several limitations were also identified at a study and review level, with the key issue being a variation in potential bias. As previously discussed, only two studies were assessed as representing a low risk with regards to selection bias. The remaining studies either used allocation techniques in which the outcome could be influenced by the researchers, or did not report enough information for this to be assessed. The high TA dropout rate for one RCT was largely unexplained (see Anderson *et al.*, 2003), so it was not possible to ascertain whether this was related to reasons that could impact the overall effect size. However, it is possible that some socially anxious participants may have dropped out because they found this high intensity group setting to be too stressful. Due to a lack of study protocols, only one of the clinical trials could be assessed as presenting a low level of reporting bias (Anderson *et al.*, 2003; Price & Anderson, 2012). As such, the possibility of selective reporting within studies cannot be ruled out. Finally, although blinding of participants would not be possible due to the explicit nature of the intervention, it does raise concerns regarding the possibility of a placebo effect. Unfortunately, it is unlikely that this could be controlled for in future research.

A further limitation with the review is the variation between the types of VRET interventions employed across studies, which caused heterogeneity in the VRET vs WL comparison. Typical VRET interventions

consist of several sessions of exposure to a public speaking scenario. This means that studies with more exposure to a wider variety of situations may yield larger effect sizes, as was the case with Robillard *et al.*'s (2010) study. In order to ensure that an individual study effect size can be attributed to the type of intervention, the only difference between the approaches should be the method of exposure. In other words, VRET and TA groups should be equally matched within studies in terms of therapeutic process. Heterogeneity in the VRET vs TA comparison appeared to be attributable to a more intensive TA approach for one of the clinical trials (Anderson *et al.* 2013; Price & Anderson, 2012). Although this was accounted for when the study was removed from the analysis, it meant that the follow-up effects could not be properly interpreted. This highlights the importance of carefully examining the structure of each VRET and TA intervention prior to analysis. Although the current review has included the largest quantity of clinical trials examining VRET for social anxiety to date, it is also important to note that only a small number of high quality studies have been published. As a result, study numbers in each of the comparison conditions were limited (see Figures 2 and 3) which may have had an impact on the summary effect sizes.

Conclusions

In conclusion, this meta-analysis found that VRET was more effective than WL controls. With the exception of Anderson *et al.* (2013) and Price and Anderson's (2012) RCT, there was also sufficient evidence to suggest that VRET was at least equally as effective as TA interventions. This reflects the findings in the most recent efficacy reviews (Opriş *et al.* 2011; Meyerbröker & Emmelkamp, 2010). In less complex cases where only basic exposure is required, these findings suggest that VRET could represent a promising alternative to traditional exposure. This could result in significant changes to the way that therapy for social anxiety is conducted, as practitioners would have access to a versatile tool that allows them to customise their clients' exposure sessions in a manner that has not been previously possible. More complex cases of social anxiety tend to involve a combination of talking

therapy (e.g. CBT) and exposure. At present, artificially intelligent technology has not advanced to the point that it can mimic the complexities of talking therapy. Despite a number of promising technological advances in VR technology, it is still a long way from reaching this stage. As VRET is purely an exposure tool, at this time it would therefore be inappropriate to consider it to be a replacement for talking therapy. A more reasoned approach would be to regard it as a replacement for traditional exposure in less complex cases, and a therapeutic tool to be used alongside talking therapy for more complex presentations.

Despite these promising findings, it is apparent that this field of research is still in its infancy. As such, there is a clear demand for more controlled studies with greater numbers of participants. The current review identified a distinct lack of sufficient follow-up data, which meant that no definitive conclusions could be made about the lasting effects of VRET. Further follow-up studies are therefore required. Future clinical trials would also benefit from ensuring that their VRET and TA conditions are matched on everything except for the method of exposure. As this is the first review to carry out a thorough risk of bias assessment using the latest Cochrane tools, several recommendations have been identified in this regard. Firstly, future clinical trials would benefit from giving careful consideration to their methods of randomisation and allocation concealment, whilst ensuring that details of this process are provided. Secondly, reasons for dropouts should be fully explored and further analyses carried out where possible, in order to establish whether this could have impacted the measured outcomes. Thirdly, it is highly recommended that researchers publish a copy of their research protocol online.

To date, VRET interventions have focused on first-person viewing perspectives. However, one study has introduced the notion of virtual reality doppelgängers for social anxiety, in which the individual views themselves from a third-person perspective interacting with others in a socially-confident manner (Aymerich-Franch and Bailenson, 2014). Further research is therefore required into the efficacy of this type of intervention, as discussed in the following empirical paper. It is hoped that as

more high quality studies are published and virtual reality technology continues to develop, researchers can start to turn their attention towards the possibilities of incorporating VRET into daily therapeutic practice.

References

Abramowitz, J. S., Deacon, B. J., & Whiteside, S. P. (2012). *Exposure therapy for anxiety: Principles and practice*. Guilford Press.

Anderson, P. L., Price, M., Edwards, S. M., Obasaju, M. A., Schmertz, S. K., Zimand, E., & Calamaras, M. R. (2013). Virtual reality exposure therapy for social anxiety disorder: A randomized controlled trial. *Journal of consulting and clinical psychology*, *81*(5), 751.

Aymerich-Franch, L. & Bailenson, J.N. (2014). The use of doppelgangers in virtual reality to treat public speaking anxiety: a gender comparison. *Proceedings of the International Society for Presence Research Annual Conference.* March, 17-19, Vienna, Austria.

Ayres, J., & Hopf, T. (1993). *Coping with speech anxiety*. Greenwood Publishing Group.

Bögels, S. M., Alden, L., Beidel, D. C., Clark, L. A., Pine, D. S., Stein, M. B., & Voncken, M. (2010). Social anxiety disorder: questions and answers for the DSM-V. *Depression and anxiety*, *27*(2), 168-189.

Clark, D. M., Ehlers, A., Hackmann, A., McManus, F., Fennell, M., Grey, N., Waddington, L. & Wild, J. (2006). Cognitive therapy versus exposure and applied relaxation in social phobia: A randomized controlled trial. *Journal of consulting and clinical psychology*, *74*(3), 568.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Vol. 2. *Lawrence Earlbaum Associates, Hillsdale, NJ*.

Comprehensive Meta-Analysis Version 2.2.064 [Computer software] (2011). Englewood, NJ: Biostat. Available from http://www.meta-analysis.com.

Furmark, T. (2002). Social phobia: overview of community surveys. *Acta Psychiatrica Scandinavica*, *105*(2), 84-93.

Hales, R. E., Yudofsky, S. C. & Roberts, L. W. (2014). *The American Psychiatric Publishing Textbook of Psychiatry*. American Psychiatric Publishing: Washington DC & London.

Hedges, L. V. (1984). Advances in statistical methods for meta-analysis. *New directions for program evaluation*, *1984*(24), 25-42.

Hedges, L., & Olkin, I. (1985). Statistical models for meta-analysis. *New York: Academic Press. Hedges, LV, & Pigott, TD (2001). The power of statistical tests in meta-analysis. Psychological Methods*, *6*, 203-217.

Heuett, B. L., & Heuett, K. B. (2011). Virtual reality therapy: A means of reducing public speaking anxiety. *International Journal of Humanities and Social Science*, *1*(16), 1-6.

Higgins, J. P., Altman, D. G., & Sterne, J. A. C. (2008). Assessing risk of bias in included studies. *Cochrane handbook for systematic reviews of interventions version 5*. Available from http://handbook.cochrane.org/chapter_8/8_assessing_risk_of_bias_in_included_studies.htm [accessed on 13/02/16].

Higgins, J. P., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *Bmj*, *327*(7414), 557-560.

Keller, M. B. (2006). Social anxiety disorder clinical course and outcome: review of Harvard/Brown Anxiety Research Project (HARP) findings. *The Journal of clinical psychiatry*, *67*(12), 1-478.

Klinger, E., Bouchard, S., Légeron, 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*(1), 76-88.

Klinger, E., Légeron, P., Roy, S., Chemin, I., Lauer, F., & Nugues, P. (2004). Virtual reality exposure in the treatment of social phobia. *Studies in health technology and informatics*, *99*, 91-119.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., Clarke, M., Devereaux, P. J., Kleijnen, J. & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Annals of internal medicine*, *151*(4), W-65.

Mayo-Wilson, E., Dias, S., Mavranezouli, I., Kew, K., Clark, D. M., Ades, A. E., & Pilling, S. (2014). Psychological and pharmacological interventions for social anxiety disorder in adults: a systematic review and network meta-analysis. *The Lancet Psychiatry*, *1*(5), 368-376.

McCann, R. A., Armstrong, C. M., Skopp, N. A., Edwards-Stewart, A., Smolenski, D. J., June, J. D., Metzger-Abamukong & Reger, G. M. (2014). Virtual reality exposure therapy for the treatment of anxiety disorders: An evaluation of research quality. *Journal of anxiety disorders*, *28*(6), 625-631.

Meyerbröker, K., & Emmelkamp, P. M. (2010). Virtual reality exposure therapy in anxiety disorders: a systematic review of process-and-outcome studies. *Depression and anxiety*, *27*(10), 933-944.

Morrison, A. S., & Heimberg, R. G. (2013). Social anxiety and social anxiety disorder. *Annual review of clinical psychology*, *9*, 249-274.

Olatunji, B. O., Cisler, J. M., & Tolin, D. F. (2007). Quality of life in the anxiety disorders: a meta-analytic review. *Clinical psychology review*, *27*(5), 572-581.

Opriş, D., Pintea, S., García-Palacios, A., Botella, C., Szamosközi, Ş., & David, D. (2012). Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis. *Depression and anxiety*, *29*(2), 85-93.

Otte, C. (2011). Cognitive behavioral therapy in anxiety disorders: current state of the evidence. *Dialogues in Clinical Neuroscience*, *13*(4), 413-421.

Parsons, T. D., & Rizzo, A. A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of behavior therapy and experimental psychiatry*, *39*(3), 250-261.

Powers, M. B., & Emmelkamp, P. M. (2008). Virtual reality exposure therapy for anxiety disorders: A meta-analysis. *Journal of anxiety disorders*, *22*(3), 561-569.

Price, M., & Anderson, P. L. (2012). Outcome expectancy as a predictor of treatment response in cognitive behavioral therapy for public speaking fears within social anxiety disorder. *Psychotherapy*, *49*(2), 173.

Robillard, G., Bouchard, S., Dumoulin, S., Guitard, T., & Klinger, E. (2010). Using virtual humans to alleviate social anxiety: preliminary report from a comparative outcome study. *Stud Health Technol Inform*, *154*, 57-60.

Safir, M. P., Wallach, H. S., & Bar-Zvi, M. (2011). Virtual reality cognitive-behavior therapy for public speaking anxiety: one-year follow-up. *Behavior Modification*, *36*(2) 235–246.

Sterne, J., Higgins, P. T., & Reeves, B. C. (2014). *A Cochrane risk of bias assessment tool: For non-randomized studies of interventions (ACROBAT-NRSI), version 1.0.0.* Available from http://www.riskofbias.info [accessed on 13/02/16].

Vanni, F., Conversano, C., Del Debbio, A., Landi, P., Carlini, M., Fanciullacci, C., & Dell'Osso, L. (2013). A survey on virtual environment applications to fear of public speaking. *European review for medical and pharmacological sciences*, *17*(12), 1561-1568.

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

Wiederhold, B. K., & Wiederhold, M. D. (2005). *Virtual reality therapy for anxiety disorders: Advances in evaluation and treatment*. American Psychological Association.

Table 1: Study characteristics and outcome measures

Study	Design	Sample type	Sessions	Mean age (years)	Gender % f:m	Treatment group	Control group	N (treatment, control)	Time point comparison	Outcome measures
Anderson *et al*. (2013); Price & Anderson (2012)	RCT	Clinical	8	39	62:38	VRET+CBT	Group CBT+Exp	32, 33	Pre & post	PRCS, FNE-B, PRCA-SF, SSPS (pos), SSPS (neg)
Anderson *et al*. (2013)	RCT	Clinical	8	39	62:38	VRET+CBT	WL	32, 25	Pre & post	PRCS, FNE-B
						VRET+CBT	Group CBT+Exp	27, 29	Pre & 3 months	
						VRET+CBT	Group CBT+Exp	27, 29	Pre & 12 months	

Heuett & Heuett (2011)	RCT	Analogue	1	20	59:41	VRET	WL	40, 40	Pre & post	PRCA-24, STAI (state)
						VRET	CBT-VIS	40, 40	Pre & post	
Klinger *et al*. (2005)	Matched groups	Clinical	12	31	53:47	VRET	Group CBT+Exp	18, 18	Pre & post	LSAS (total)
Robillard *et al*. (2010)	RCT	Clinical	16	35	71:29	VRET+CBT	WL	14, 15	Pre & post	LSAS (total), SPS, ASC (prob), ASC (cons), FNE
						VRET+CBT	Individual CBT+Exp	14, 16	Pre & post	
Safir *et al*. (2012)	RCT	Analogue	12	27	Unknown	VRET+CBT	Individual CBT+Exp	25, 24	Pre & 12 months	FNE, LSAS (fear), LSAS (avoid), SSPS (pos), SSPS (neg)

Wallach *et al.* (2009)	RCT	Analogue	12	27	77:29	VRET+CBT	WL	28, 30	Pre & post	FNE, LSAS (fear), LSAS (avoid), SSPS (pos), SSPS (neg)
						VRET+CBT	Individual CBT+Exp	28, 30	Pre & post	
Wallach *et al.* (2011)	RCT	Analogue	12	27	55:45	VRET	Individual Cognitive Therapy	10, 10	Pre & post	FNE, LSAS (fear), LSAS (avoid), SSPS (pos), SSPS (neg)

CBT+EXP: Cognitive Behavioural Therapy with standard exposure
CBT-VIS: Cognitive Behavioural Therapy Visualisation script (Ayres and Hopf, 1993)

ASC (cons): Appraisal of Social Concerns – Consequences Subscale (Telch *et al.*, 2004), correlation coefficient r=0.58 (Telch *et al.*, 2004)
ASC (prob): Appraisal of Social Concerns – Probability Subscale (Telch *et al*, 2004), correlation coefficient r=0.58 (Telch *et al.*, 2004)
FNE: Fear of Negative Evaluation (Watson & Friend, 1969), correlation coefficient r=0.71 (Arkowitz, Lichtenstein, McGovern & Hines, 1975)
FNE-B: Fear of Negative Evaluation – Brief Form (Leary, 2983), correlation coefficient r=0.56 (Weeks *et al.*, 2005)
LSAS (avoid): Liebowitz Social Anxiety Scale – Avoidance Subscale (Liebowitz, 1987), correlation coefficient r=0.45 (Heimberg *et al.*, 1999)
LSAS (fear): Liebowitz Social Anxiety Scale – Fear Subscale (Liebowitz, 1987), correlation coefficient r=0.51 (Heimberg *et al.*, 1999)
LSAS (total): Liebowitz Social Anxiety Scale (Liebowitz, 1987), correlation coefficient r=0.49 (Heimberg *et al.*, 1999)
PRCA-24: Personal Report of Communication Apprehension – 24 (Levine & McCroskey, 1990), correlation coefficient r=0.76 (Kelly & Keaton, 1992)
PRCA-SF: Personal Report of Communication Apprehension – Short Form (McCroskey, 1978), correlation coefficient r=0.88 (McCroskey, 1978)
PRCS: Personal Report of Confidence as a Speaker (Paul, 1966), correlation coefficient r=0.67 (Hofman & DiBartolo, 2000)
SPS: Social Phobia Scale (Mattick & Clarke, 1998), correlation coefficient r=0.52 (Osman *et al.*, 1998).
SSPS (neg): Self Statements during Public Speaking – Negative Statements (Hofman & DiBartolo, 2000), correlation coefficient r=0.67 (Hofman & DiBartolo, 2000)
SSPS (pos): Self Statements during Public Speaking – Positive Statements (Hofman & DiBartolo, 2000), correlation coefficient r=-0.58 (Hofman & DiBartolo, 2000)
STAI (state): State-Trait Anxiety Inventory – State Index (Speilberger, Gorsuch & Lushenes, 1970), correlation coefficient r=0.59 (Bertolotti *et al.*, 2015)

Table 2: Risk of bias for all included RCTs

Table Key

+ = Present (low risk of bias)

− = Absent (high risk of bias)

? = Unclear (insufficient information)

Figure 1: PRISMA flowchart detailing literature search and identification of suitable studies

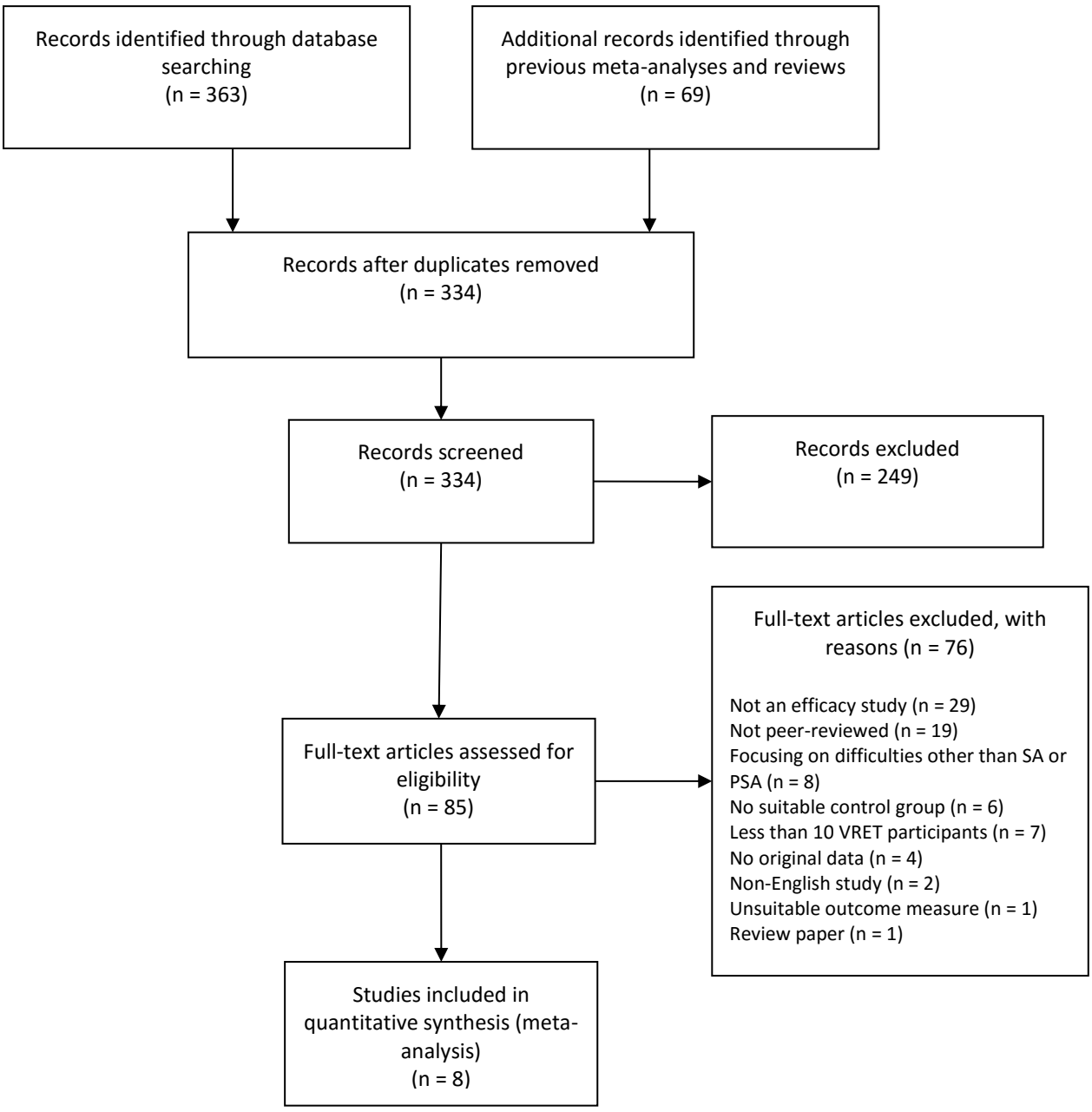
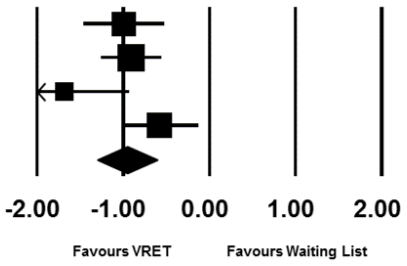


Figure 2: Forest plot of effect sizes (Cohen's d) and 95% CIs for VRET vs WL comparisons

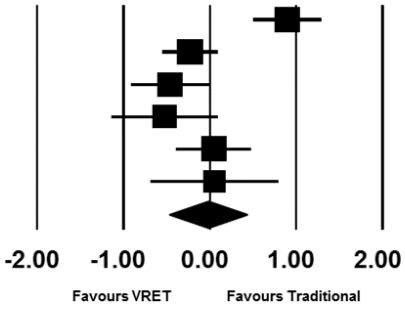
Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit
Anderson et al. (2013)*	-0.996	0.237	0.056	-1.461	-0.531
Heuett & Heuett (2011)	-0.909	0.179	0.032	-1.260	-0.558
Robillard et al. (2010)	-1.689	0.386	0.149	-2.446	-0.932
Wallach et al. (2009)	-0.578	0.226	0.051	-1.021	-0.135
Summary	-0.956	0.177	0.031	-1.302	-0.610



* Includes effect size from Price & Anderson (2012)

Figure 3: Forest plot of effect sizes (Cohen's d) and 95% CIs for VRET vs TA comparisons

Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit
Anderson et al. (2013)*	0.905	0.202	0.041	0.509	1.300
Heuett & Heuett (2011)	-0.220	0.164	0.027	-0.542	0.102
Klinger et al. (2005)	-0.453	0.234	0.055	-0.912	0.006
Robillard et al. (2010)	-0.518	0.316	0.100	-1.138	0.102
Wallach et al. (2009)	0.050	0.220	0.049	-0.382	0.482
Wallach et al. (2011)	0.059	0.380	0.144	-0.686	0.804
Summary	-0.017	0.230	0.053	-0.467	0.433



* Includes effect size from Price & Anderson (2012)

Figure 4: Funnel plot for VRET vs WL comparisons

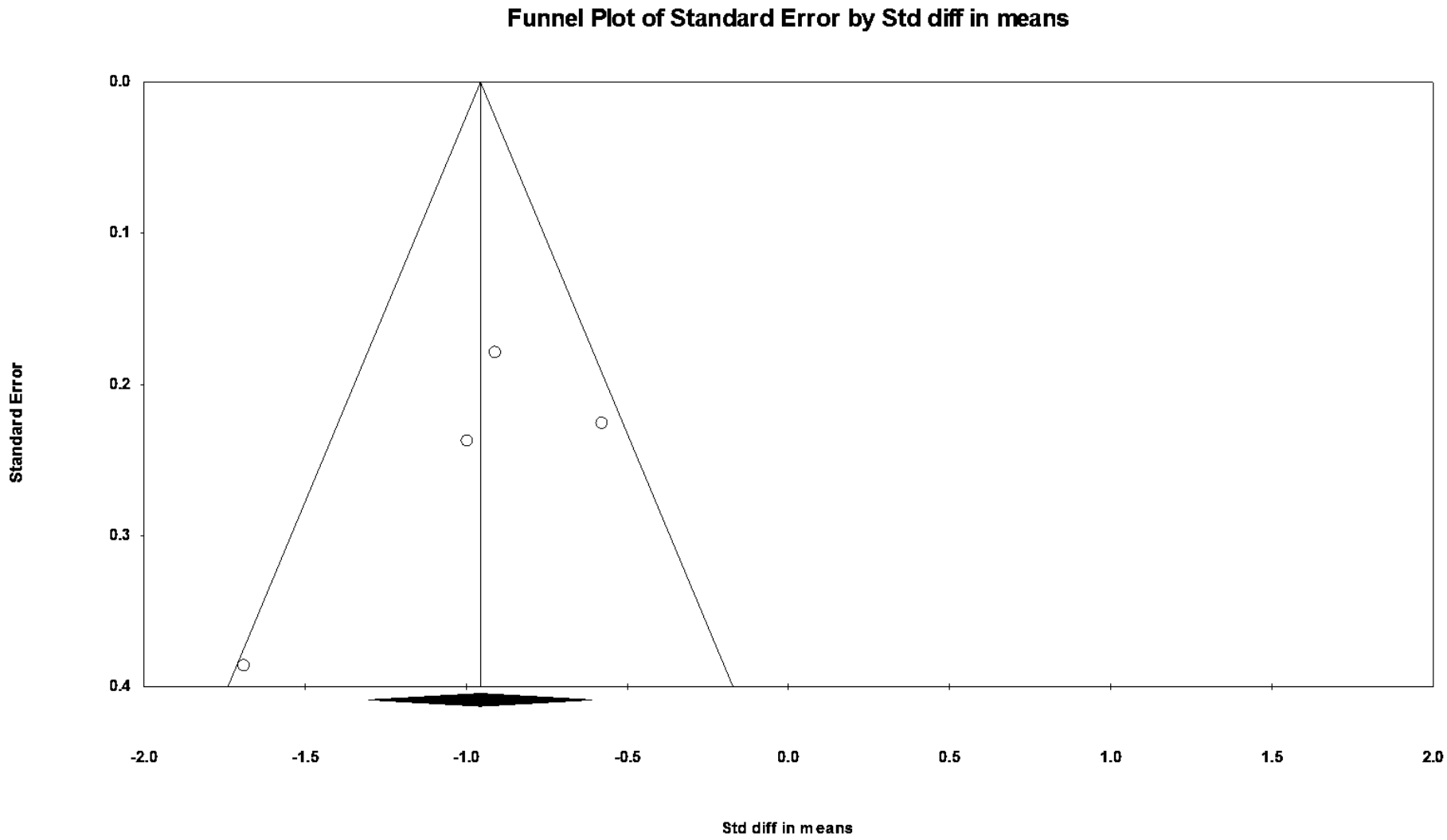
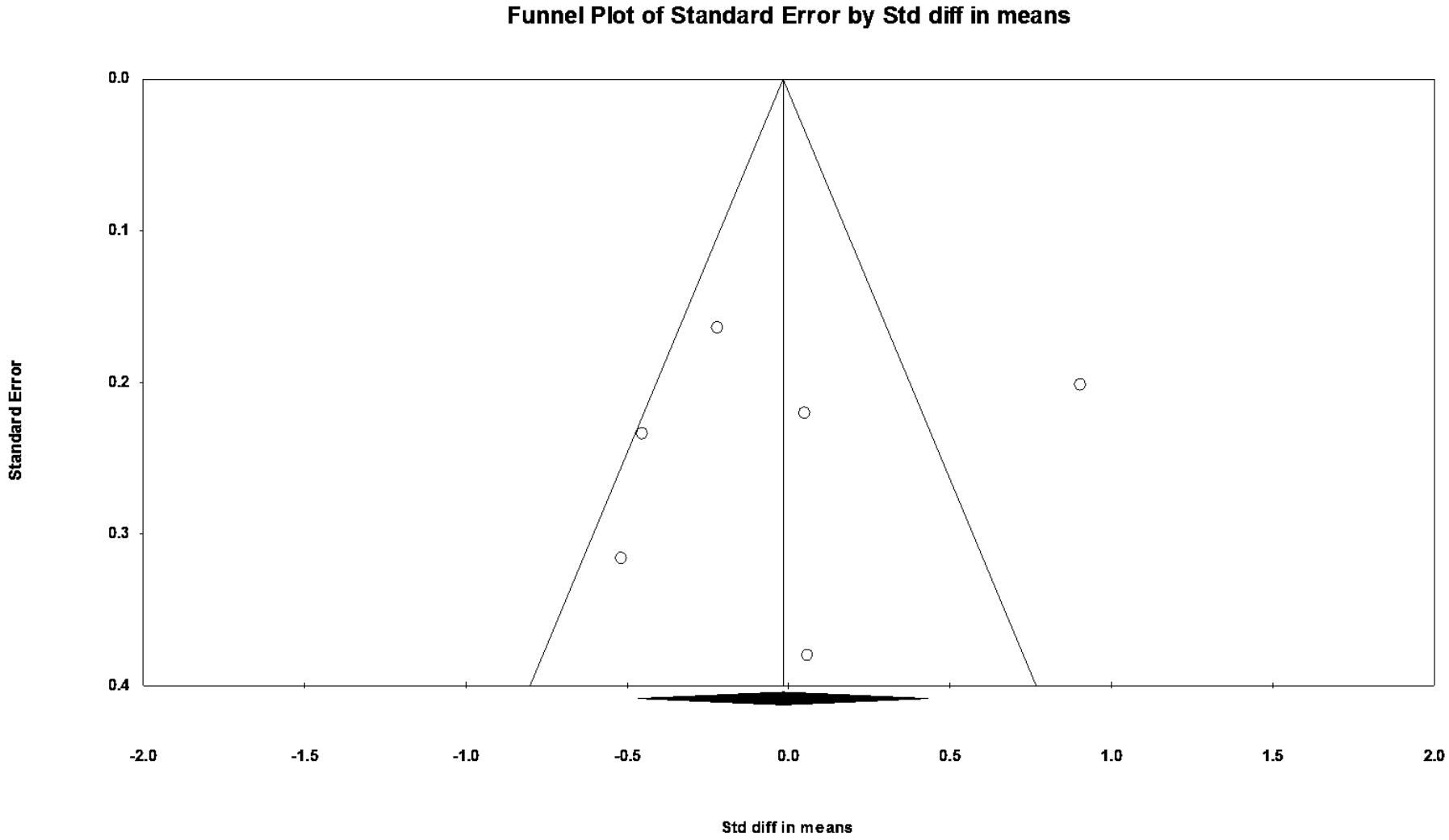


Figure 5: Funnel plot for VRET vs TA comparisons



Chapter 3

Public speaking anxiety, mental imagery and virtual reality: A feasibility study into the therapeutic use of computer-generated doppelgängers

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Submission to the British Journal of Psychology

Public speaking anxiety, mental imagery and virtual reality: A feasibility study into the therapeutic use of computer-generated doppelgängers

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Abstract

Research suggests that individuals who struggle to form vivid mental imagery (MI) are less likely to benefit from visualisation techniques, and may experience higher levels of public speaking anxiety (PSA; Ayres, Hopf & Edwards, 1999). The purpose of this study was to explore this link amongst undergraduate psychology students, and to investigate the feasibility of incorporating a virtual reality doppelgänger intervention into the course to help this group. A survey suggested that MI ability was a significant predictor of PSA, when differences relating to gender and year group are controlled for. Five participants with high PSA and low MI ability from the survey then engaged in a standard PSA visualisation exercise, before attending six weekly virtual reality sessions. The intervention proved easy to implement, was regularly attended and relatively inexpensive. Time series data identified an incremental decline in self-reported PSA. Thematic analysis of interview data suggested that participants struggled with the visualisation session and that VR compensated for this, that socially-confident modelling and self-imagery modification had taken place, and that they felt present and safe in the simulation. The implications of these findings are discussed and avenues for further research are identified.

Introduction

Public speaking anxiety (PSA) is a specific subtype of social anxiety (Cox, Clara, Sareen & Stein, 2008). Individuals with PSA experience physiological arousal, negative self-appraisals and behavioural responses to anticipated or actual public speaking (Bodie, 2010). Common examples include sweating, thoughts relating to poor performance and avoidant coping strategies. Responses such as these can lead to a lack of preparation for the speech, impaired decision-making and underperformance (Daly, Vangelisti & Weber, 1995; Beatty & Clair, 1990; Mentzel & Carrell, 1994). Repeated experience of PSA can lead to long-term performance-related anxiety and a reliance on avoidance, which can have a serious impact on an individual's level of functioning (Behnke & Sawyer; 1998).

Numerous studies have found that cognitive behavioural therapy (CBT) is an effective approach to reducing social anxiety (Mayo-Wilson *et al*., 2014). This involves identifying and modifying anxiety-maintaining cognitions, whilst engaging in activities that change the behavioural response (Hofmann & Otto, 2008). The behavioural component often involves systematic exposure to the feared social stimulus, thereby allowing the individual to become habituated to the situation (Rodebaugh, Holaway & Heimberg, 2004). Research suggests that exposure is an efficacious technique for reducing social anxiety (Ponniah & Hollon, 2008). As PSA is a subtype of social anxiety, it is not surprising that many of the formalised PSA interventions overlap with CBT and exposure. For example, the most widely-used PSA techniques include systematic desensitisation, cognitive modification and skills training (Duff, Levine, Beatty, Woolbright & Park, 2007).

A number of studies have investigated the use of virtual reality exposure therapy (VRET) for social anxiety, most of which have focused on public speaking situations (Vanni *et al*., 2013). The purpose of VRET is to immerse the client in a computer generated environment, in which they are exposed to situations that elicit the same responses as would be experienced in a real-life scenario (Wiederhold

& Bouchard, 2014). This is usually achieved through the use of a head-mounted display unit, motion-tracker and therapist-operated software. When applied to PSA, the individual typically has a first-person perspective of being in front of a virtual audience to whom they must address (Vanni *et al*., 2013). Meta-analyses and systematic reviews of VRET for the anxiety disorders suggests that it is effective in reducing anxiety and is equally as effective as traditional exposure (Meyerbröker and Emmelkamp, 2010; Parsons & Rizzo, 2008; Powers & Emmelkamp, 2008; Opriş *et al*., 2011).

Whilst this research suggests that VRET may be a viable alternative to traditional exposure, it is arguable that further improvements could be made to the intervention to better reflect our understanding of social anxiety. According to the most widely cited models of social anxiety, a negative self-image is a key maintaining factor (Clark & Wells, 1995; Hofmann, 2007; Rapee & Heimberg, 1997). This image reflects how the individual believes they appear to others, and increases the likelihood that they will selectively attend to this information in social situations. Although previous VRET interventions have focused on manipulating aspects of the environment and the audience, until recently they have not attempted to directly modify the individual's distorted self-image. As research suggests that socially-anxious individuals tend to view their self-image from an outsider perspective (Ng & Abbott, 2014), it is arguable that the first-person VRET perspective might not be the most effective approach.

Doppelgängers are characters that are designed to resemble the user but behave independently (Fox & Bailenson, 2010). Aymerich-Franch and Bailenson (2014) hypothesised that as people imitate the behaviours of models that they personally identify with (Bandura, 1977), socially confident doppelgängers could be used to help people with PSA. Although they found no significant differences in PSA between this intervention and a standard visualisation technique, this may be due to the fact that their participants were only given the opportunity to engage in one session. They also note that many female participants did not identify with the generic body that was used for all of the

doppelgängers. Furthermore, participants had no control over the design of their own doppelgängers. Although the authors controlled for differences in mental imagery (MI) ability between groups, the possible impact of this variable on an individual's ability to engage with each intervention was also not explored.

The term "mental imagery" refers to a state of consciousness in which the mind recreates a sensory experience (Holmes & Mathews, 2010). The vast majority of studies examining the role of MI in social anxiety have focused on the *content* of negative self-images (Morrison, Amir & Taylor, 2011), with studies consistently finding that such images have an adverse effect on anxiety and associated cognitions (Ng, Abbott & Hunt, 2014). However, individuals differ in their *ability* to generate and control vivid MI (Lequerica, Rapport, Axelrod, Telmet & Whitman, 2002). There is evidence to suggest that individuals with low MI ability do not benefit from PSA visualisation to the same extent as those with higher MI ability (Ayres *et al*., 1999). It follows that this group may benefit more from the compensatory immersive visual stimulus provided in a VR environment. There is also a largely unstudied question regarding the possible link between low MI ability and social anxiety, as preliminary research suggests that socially anxious participants struggle to generate neutral MI when compared to non-anxious controls (Morrison *et al*., 2011). It is therefore plausible that global MI difficulties inhibit the ability to generate positive images to compete with a negative self-representation (Ayres *et al*., 1999; Morrison *et al*., 2011).

The purpose of the current study was to answer the following questions:

1) Is there a link between MI ability and PSA?
2) Do participants with low MI ability have difficulty utilising standard visualisation techniques often used in therapy?

3) Could an updated version of Aymerich-Franch and Bailenson's (2014) doppelgänger intervention feasibly help students with high PSA and low MI ability?

In order to answer these questions, the study comprised of two phases. Phase 1 was an online survey that aimed to measure participants on MI ability and PSA amongst undergraduate psychology students. The purpose of the survey was twofold. Firstly, the possible link between these two variables could be examined, with further analysis focusing on differences across gender and academic year groups. Secondly, the survey would provide a dataset from which a small group of participants with high PSA and low MI ability could be identified for the VR intervention.

The purpose of Phase 2 was to assess the feasibility of the Psychology Department using this intervention to assist students with high PSA and low MI ability. In order to take into account the limitations of Aymerich-Franch and Bailenson's (2014) original study, the updated intervention consisted of six weekly sessions and a three month follow-up assessment. The doppelgängers' bodies were designed to match the participants, and individuals had input into the design of their avatar. All psychology undergraduates are enrolled in a public speaking module, which is a peer-led learning environment where presentation skills are learnt and developed through practice and feedback. Phase 2 therefore aimed to assess whether the VR intervention could be successfully timetabled around these sessions, and if it would fit in with the limited timeframe of the academic programme. An additional aim was to examine whether the simulation could be produced relatively easily and on a limited budget, and if students would be willing to engage in a six week intervention. All individuals were to participate in an initial standard visualisation session, in order to investigate whether they encountered any difficulties relating to MI ability. Changes to PSA were to be monitored over the course of the VR intervention, and participants' experiences (e.g. how they felt in the simulation, adverse effects and perceived benefits) were to be explored in depth through post-intervention interviews.

Phase 1 Method

Participants

First and second year undergraduate psychology students at Bangor University were invited to take part in the online survey. In total, 162 participants completed the survey. Participant ages ranged from 18 to 34, with an average age of 19.7 (*sd*=1.88). 109 of the respondents identified as female and 53 identified as male. 87 students were in their first year of study, whereas the remaining 75 were in the second year.

Measures

The State Trait Anxiety Inventory (STAI) – Form Y1 (Spielberger, Gorssuch, Lushene, Vagg, & Jacobs, 1983). The STAI-Y1 consists of 20 items in which participants rate how they feel about certain situations, in this case related to public speaking. Each item is on a 4 point scale from 1 (not at all) to 4 (very much so).

The Vividness of Visual Imagery Questionnaire 2 (VVIQ2; Marks, 1995) was used to assess MI vividness. The VVIQ2 consists of 32 statements that ask the participant to imagine different images and to rate how vivid the mental image is, from "no image at all" (score = 0) to "perfectly clear and vivid as if I was actually seeing it" (score = 5).

Procedure

As this was an analogue sample from a student population, ethical approval was sought and granted from the university (Appendix B). Some amendments to the study design were subsequently

requested and granted, details of which can be found in Appendix C. The survey was designed and published through Bristol Online Surveys (https://www.onlinesurveys.ac.uk/; Appendix D). It was made accessible via the university's Student Participant Panel (SONA), in which course credits are awarded for study participation. Data was collected over a three week period and analysed using SPSS, in order to obtain descriptive statistics and to examine the extent to which the two measures were correlated.

Phase 1 Results

Table 1 shows the means and standard deviations for public speaking anxiety (STAI-Y1) and vividness of MI (VVIQ2). The mean total STAI-Y1 score of 50.74 would fall comfortably within the "moderate" range, in accordance with guidelines provided by the scale's authors (Lam, Michalaak, & Swanson, 2004). Female students reported higher levels of PSA than males across both year groups, whereas first year students' PSA scores were higher than those reported by participants in the second year. VVIQ2 mean scores were largely static across gender and year groups.

----------INSERT TABLE 1 HERE----------

A multiple linear regression was used to predict PSA scores based on MI ability scores, with gender and year group included to control for the observed differences mentioned above. MI ability was a significant predictor of PSA (β=-0.103, SE=0.031, z=-3.323, $p < 0.05$), by which low MI was associated with higher levels of PSA. Gender was a highly significant predictor, in which female students were more likely to experience higher levels of PSA than males (β=13.394, SE=2.272, z=5.895, $p < 0.001$). Year 2 students reported lower levels of PSA than year 1; however this difference was not statistically significant (β=-3.891, SE=2.136, z=-1.822). An additional multiple linear regression was used to test for possible interactions between the variables. No significant interaction effect was found between MI

ability and gender (β=-0.204, SE=0.111, z=-1.840) or between MI ability and academic year (β=0.161, SE=0.100, z=1.610).

Phase 2 Method

Participants

The intention was to send out invites to ten participants who had both the highest PSA and lowest MI scores. SPSS was therefore used to identify participants with scores of at least 1*sd* above the mean on the STAI-Y1, and at least 1*sd* below the mean for the VVIQ2. As this did not result in a large enough group, the *sd* parameters were incrementally reduced by 0.1*sd* until ten potential participants were identified. Each of the selected individuals scored at least 0.7*sd* above the mean on the STAI-Y1 and 0.7*sd* below the mean for the VVIQ2. Five participants expressed an interest in proceeding with the intervention. All were second year female second year students aged 19-24 (mean=20.2), although at the time of the online survey they had been in their first year.

Measures

In addition to completing the STAI-Y1 form at the start of Phase 2 and after each session, the following post-intervention measures were administered:

Self-presence, social presence & spatial presence: Self presence is the extent to which the individual believes the doppelgänger's body is their own body, social presence relates to the feeling that the audience is present and spatial presence is how much the environment feels like the real world. These were assessed using a 15 item scale produced by Aymerich-Franch, Kizilcec and Bailenson (2014).

Participants rated the extent to which each item seemed present on a 5 point Likert scale from 1 (very highly) to 5 (not at all).

Doppelgänger similarity: Participants rated how similar they perceived their doppelgänger to be to themselves on a 5 point Likert scale (1- extremely; 2 – very; 3 – moderately; 4 - slightly; 5 - not at all)

Procedure

All participants had their photograph taken and were asked to write down what clothes they would wear in a formal public-speaking setting. Over the course of the next five months, a member of the Computer Sciences Department designed the doppelgängers and VR simulation. This involved approximately fifty hours of work and was done as a favour, as the designer was a friend of the researcher. Software for designing the doppelgangers cost £30 and the designer was given an additional £100 as a goodwill gesture. Participants were invited to provide feedback on their doppelgängers during the design process; however all comments were positive and no changes were requested. At the start of the intervention, all five students attended an initial session in which consent forms were signed (Appendix E), session timetables were provided (Appendix F) and baseline STAI-Y1 forms were completed (Appendix G). The group was then asked to close their eyes whilst they listened to an amended version of Ayres and Hopf's (1993) visualisation script, based on the one used by Aymerich-Franch and Bailenson's (2014) in their study (Appendix H). A post-session questionnaire was then completed, which consisted of another STAI-Y1 form and presence measures (Appendix I).

Two weeks' later, participants began the weekly VRET intervention. In each session, participants wore an Oculus Rift headset and a pair of headphones (Figure 1), both of which were connected to a laptop running the relevant software. The amended version of Ayres and Hopf's (1993) pre-recorded visualisation script was played through the headphones, whilst the events in the VR scenario (Figures

2 to 5) were controlled by the researcher via the keyboard. At their third VRET session, participants signed consent forms to confirm that they wanted to proceed with three more (Appendix J). STAI-Y1 forms were completed after each session, in order to monitor changes in PSA over time. A "presence and likeness" questionnaire was filled in after the final session (Appendix K), and post-intervention interviews were carried out in accordance with a semi-structured schedule (Appendix L). All interviews were recorded and transcribed. Three months after the final session, all participants completed an online follow-up survey (Appendix M).

----------INSERT FIGURES 1 TO 5 HERE----------

Quantitative data from Phase 2 was analysed in Microsoft Excel in order to produce PSA time series plots, and to calculate mean scores for "presence and likeness" across participants. The interview transcripts were entered into the ATLAS.ti Version 7.5.4 (2016) software package, which offers a variety of tools to assist with qualitative analysis. A thematic analysis was then carried out, in which discursive patterns were identified across participants. The analysis consisted of the following six phases, as recommended by Braun and Clarke (2006): familiarisation with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report. An output summary of the coded data can be found in Appendix N and an example coded transcript is in Appendix O.

Phase 2 Results

Practical issues relating to feasibility

In order for this intervention to be incorporated into the undergraduate psychology programme, it would need to fit around their public speaking module and take place within term time. It transpired

that students did not usually have lectures on Wednesdays, so the intervention took place on this day each week. Similar arrangements could be made if the intervention was to be rolled out across the department, although appropriate timetabling would be essential in order to ensure that there are at least six weeks of term time left. No issues were identified with regards to engagement. In fact, after the first VR session all participants were keen to proceed with more. In terms of pricing, the simulation cost £130 and took approximately 50 hours to develop by the university. However, if this were to be developed by a freelance programmer then prices would start from around £10 per hour. All equipment was supplied by the Computer Sciences Department, although the following costs would be incurred if it was newly-purchased: Oculus Rift headset at £400, powerful laptop at £1,000 and headphones at £15. This was sufficient for the small sample used in this study, although more would be needed if the intervention was integrated into the psychology programme. These costs were considered to be a reasonable investment, should the intervention prove to be effective.

Measures of PSA, doppelgänger similarity and presence

Figure 6 shows self-reported levels of PSA across the duration of the study. In all cases, anxiety levels appeared to plateau after the third VR session in week 63. Effects were largely maintained at three month follow-up. When asked to rate the similarity of their doppelgängers' face and body to their own after their final session, the mean scores were 3 and 3.8 out of 5 respectively. Presence ratings for the visualisation session and the VR sessions are shown in Table 2.

----------INSERT FIGURE 6 HERE----------

----------INSERT TABLE 2 HERE----------

Thematic analysis of interview data

Analysis of participant interview data suggested three key themes were present: (a) MI difficulties and the compensatory power of VR, (b) imagery modification made possible through VR, (c) a sense of presence and safety. Participants also responded to questions on the study's limitations and gave their views on incorporating the intervention into their public speaking module. This was not included in the current analysis due to space limitations, although a summary of this data can be found in Appendix P.

All participant names have been changed.

a) MI difficulties and the compensatory power of VR

This theme focused on the different types of problems relating to MI and how VR helped to compensate for this. As predicted on the basis of their low VVIQ2 scores, participants reported considerable difficulties in forming vivid MI during the initial non-VR visualisation session. The clarity of the images varied considerably across participants, although all participants reported low levels:

> Kelly: [It was] not as clear as with the headset, but it was pretty… I could make out what everything is. I can imagine basic things, I've just not got the best… imagination in the world [laughs]

> Liz: It's kind of… you can kind of *imagine* it… but it's not like really solid. So it's kind of… harder. I don't know how to explain it! [laughs] But it's kind of really *vague*.

In these examples, there appears to be a gap between the participants' subjective experience of MI and an actual perceptual experience. For Kelly and Liz, the key distinguishing factors were a lack of clarity, solidness and vagueness. Research suggests that these difficulties are often associated with

low levels of vividness (D'Anguilli *et al*., 2013). It is interesting to note that despite their difficulties, participants reported that they were able to form clearer MI of past experiences:

> **Interviewer:** Is that something you notice in other… when you sort of imagine other things? They don't always come to mind?
>
> **Rachael:** Yeah… yeah… not always. Obviously, if it's happened then yeah. But if it hasn't, then… no. [laughs]
>
> **Interviewer:** Okay, that's interesting. So kind of thinking back to stuff that actually has gone on, then…
>
> **Rachael:** I can see them, but if it hasn't happened… my imagination just isn't there! [laughs]

Participants also discussed significant difficulties in forming *complete* MI, and often reported than many important details in the image were missing:

> **Claire:** I like find it hard to bring about the whole picture and I sort of lose the picture or like I lose the sense of other people being there or… it… the picture changes so it seems less real. So like… I have the image of a classroom but then there's a window so I have to add that in.

Key aspects relating to the self, others and the environment were therefore appeared to be missing from the overall picture. This may relate to a process known as imagery control, which involves manipulating an image in different ways (Lequerica *et al*., 2002). As the story in the visualisation script unfolds, the listener is required to constantly add to and change the details in the image (for example, to include windows in the room and a responsive audience). Participants reported that they found this to be particularly challenging, which may have impacted on how believable their experience was. There was a consensus of opinion that the VR intervention compensated for these difficulties by providing a complete image, thereby making the experience feel more realistic. For example, Liz reflected on how "you kind of place yourself more in it with the VR because you can actually… *see* it". Participants also reported on how the VR compensated for the lack of vividness in the imagery:

Rachael: [The VR] put me there. It… what I should have been imagining, it was there in front of me so I could see it for myself. So it did help a lot, for me to understand what you were saying and… like when you say "look out the window and you can see the outline of buildings", I could see it. Whereas when I was just sat there listening to it, like I couldn't see it and that was it.

It is therefore possible that a lack of MI vividness impacted Rachel's understanding of the task. Creating a clear virtual world may have compensated for this challenging aspect of the task, thereby allowing the participants to engage in a more meaningful experience. Given how cognitively demanding the participants reported finding the visualisation task, it is perhaps unsurprising that there was a lot of discussion around how this impacted their level of engagement:

Liz: It is one less thing [with the VR headset]. When you've got it in front of you, it's easier to actually listen to everything else and have your other senses rather than purely focus on trying to imagine it, because my other senses kind of shut down when I'm trying to really focus on something! [laughs]

This difficulty with focusing on the visualisation task whilst trying to create MI was reported by all participants, each of whom gave a similar account of the process. It appears from Liz's account that trying to maintain a MI was cognitively demanding, and that this may have resulted in her other senses "shutting down" which in turn impacted on her concentration. This is also implied in her assertion that the VR meant that she had her "other senses", and that she could "focus on what you're hearing and what you're seeing". This suggests that not only did the VR help to compensate for low levels of vividness and image control, but it may have freed up attentional resources which could then be used to improve focus and engagement with the intervention.

b) Imagery modification made possible through VR

Participants stated that they had noticed significant reductions in their public speaking anxiety and improvements in their performance, which they attributed to modelling their behaviour on an internalised representation of their virtual doppelgänger:

> Rachael: I was watching the avatar, the stance and the way they use their hands and things. When I was *doing* my speech, I was sort of *imitating* the avatar by using my hands and things like that. Like… I was wasn't thinking about doing it like that, but… I *noticed* that I *was* doing it when I was speaking. So I was sort of like *copying*, if you like.

This suggested that participants had learnt a range of confident behaviours and mannerisms from their doppelgängers, which they were now utilising during their public speaking module. This appears to have happened at a subconscious level, as Rachael states that she was not thinking about speaking in this manner but rather "noticed" that she was. Subsequent analysis of the transcripts suggested that this social modelling had facilitated a modification of the participant's negative self-image:

> Kelly: I just think "there's nothing to worry about". Like when I used to think "oh, this could go wrong and this could go wrong and this could go wrong", I just think if you *planned* it to a certain extent not over-planned it like I used… usually do and you're just calm, relaxed and *confident* then… like now when I do my speech I always have to do my hair and makeup, because I'll just end up like this [points to hair and laughs] and wouldn't feel *as* confident. Yeah, I definitely feel *more* confident *now* than I did before.

Kelly reflects on how her previous self-image was that of nervous speaker who would worry about what could go wrong. This is a sharp contrast to her current self-image of a relaxed, confident speaker with a positive attitude towards public speaking. It would appear that this modified self-image appears to have had a positive impact on participants' behaviour, as they reported acting in accordance to

their new self-image. For Kelly, this includes adopting a calmer and more confident approach during speeches, whilst dressing in a manner that reflects this newly found belief in her own ability. Participants also reflected on how their personal expectations for social performance had changed:

> **Sarah:** I always thought public speaking was very important because my dad does it in his job and he's always said how, like, important it is. So that probably boosted a lot more pressure than there should have been. And my mum's a teacher so there's obviously going to be *constant* public speaking with her.
>
> **Interviewer:** Right, so some expectations there perhaps?
>
> **Sarah:** Yeah, expectations.
>
> **Interviewer:** Right. And it sounds as though that recently then, you said that you've…
>
> **Sarah:** Kind of *lowered* them to a more, like, realistic… yeah.

According to Clark & Wells' (1995) model, socially anxious individuals are likely to have high expectations with regards to social performance. For Sarah, these appear to have been related to the high standards and importance placed on public speaking by her parents. By engaging in an intervention that models a more realistic approach to public speaking, it appears that she was therefore able to lower her own expectations in this regard. Participants reported significant consequences arising from these changes, including a reduced focus on physiological symptoms of anxiety and safety behaviours. In the following example, Liz is reflecting on a recent speech she gave and how different she felt after engaging in the VR intervention:

> **Liz:** Normally I really, really panic. *Horribly*. And then during it I just try and speed through it to get everything out! [laughs] And end up falling over my words, which just makes me *more* nervous because then you make a mistake and then… but I get, like, really bad shaky legs and like sort of feel I'm going to pass out. It's *awful*. But, like… it wasn't… as bad as it used to be. I could feel it, like every time I gave a speech I was getting more and more… confident.

Socially anxious people tend to focus on internal cues that confirm their negative self-image, whilst engaging in safety behaviours that inadvertently reinforce their anxiety (Clark & Wells, 1995). For Liz, this involved focusing on how much her body was shaking. Although rushing through a speech is a common safety behaviour, for Liz it resulted in her falling over her words which triggered further anxiety whilst reinforcing her self-image as a nervous speaker. However, a more positive self-image appears to have resulted in a reduced focus and awareness of internal cues, as Liz reports that her physiological response is no longer "as bad as it used to be". It would appear that this allowed for a more confident self-image to be reinforced with each subsequent speech. Clark and Wells also suggest that a focus on internal cues and associated safety behaviours reduces the individual's receptiveness to information that could disconfirm their negative self-image, due to high levels of distress and avoidance. It was therefore interesting to note that reports of these changes were accompanied by an apparent willingness to accept feedback in relation to their speeches:

> Kelly: My one last week, [my public speaking mentor] said "I can't say anything bad about you." The only thing she said is… I took my notes up and she said "you took your notes up and you didn't even look at them" so she said "next time, don't take your notes up – you don't need them." And they just said I was clear and confident, I had a clear voice, everything was explained really well. They just said that I engaged really well with everybody in the room. Didn't say anything negative!

For someone with public speaking anxiety, being told that "you took your notes up but didn't even look at them" could be construed as negative feedback. However, Kelly does not appear to have interpreted it in this manner and instead seems to have focused on the positive aspects of the message. Participants' comments suggested that these changes had resulted a significant shift in their thoughts, feelings and behaviours in the days leading up to a public speaking session task:

> Claire: For me, like, obviously the night before… the morning before… the morning *of*… the thing, you get very… I would just be very nervous. Like thinking about it constantly, it would be running through my

head, like, what was going to happen. Sort of thinking of possible things that could go wrong… And then when I'm sat down waiting to go up or, like, I'm getting stuff ready on the computer like the Powerpoint up. I get very clammy and, like… nerv... jittery… and I can feel the shortness of breath and everything.

Claire *[later in the interview]*: Whilst *now* it would not bother me on the day at all.

Interviewer: And the night before?

Claire: No, not at all. Like, I'd obviously maybe rehearse it and practice it but I wouldn't be, like, stressing about it…

Clark and Wells suggest that socially anxious individuals engage in anticipatory rumination, in which they reflect on potential negative outcomes thereby increasing their anxiety. This seems to be reflected in Claire's comments about panicking at the thought of the speech, to the point that she would enter the scenario in a distressed state. However, Claire and the other participants reported an absence of pre-event stress since engaging with the intervention. They discussed feeling a lot calmer when starting the speech as a result, thereby decreasing the likelihood of responding in an anxious manner.

The final stage in Clark and Wells' model relates to post-event rumination, in which socially anxious individuals mentally replay and review their perceived failures. However, no evidence of this form of rumination was found in the interview data. In fact, participants provided an abundance of information relating to their success and newly-found confidence when public speaking. This suggests that a tendency to ruminate had been replaced with a form of positive reflection, which in theory should further reinforce their positive self-image. Evidence of this change was found throughout the interview transcripts:

Sarah: It's kind of like… you know if you, like, progress through a grade or something you know that you're getting better at it, you are kind of more self-confident. You know like "ah yeah, next time I know that I'm still

going to be, like… *good*". It's kind of similar to that. Like you know that you're going to keep getting calmer, and the calmer you are the better you'll get at public speaking.

This suggested that a modified self-image was having a positive impact on participants' public speaking behaviour. Their awareness of this change appears to have altered the content of their post-event reflections, and participants were now stating that they felt more confident and were anticipating future success. This appears to have resulted in lower levels of anxiety when entering a public speaking situation. As reflected in Sarah's comments, repeated exposure to performing in a calmer and more confident manner may have resulted in a further reduction in anxiety. Ultimately, the self-perpetuating nature of these changes was seemingly associated with significant improvements in performance.

c) A sense of presence and safety

In order for a VR intervention to be effective, individuals need to experience virtual objects in the same way as real-life objects (Aymerich-Franch *et al*., 2014). As previously discussed, participants reported higher levels of spatial, social and self-presence in VR compared to the non-VR condition. In their interviews, they discussed their subjective experiences of presence in each of these areas:

Sarah: It was a good classroom. *Good* classroom! Nice classroom [laughs]. No, I liked it. I think it was the little [university] logo on the podium because it made it specific. And it was sort of similar to a lot of the other rooms I've been in so that helped as well.

Kelly: I think [the audience] looked really realistic. It was just like being in a classroom with the normal people there. I could *put* them to people on our course, if you know what I mean! [laughs]

Liz: I think I did… see the similarities, like with the hair and the glasses and everything. I could picture… it wasn't really, really clear but I could actually picture it as me. So it was easier to put yourself in the position and feel that it was you.

In terms of spatial presence, participants reported that the abundance of real-life detail in the virtual environments was the key contributing factor. Sarah mentions the university logo on the podium, whereas other participants reflected on the moving clock hands and the realistic view through the window. With regards to social presence, it was interesting to note that participants spoke about the virtual audience as if they were real people. Terms such as "friendly" were used and attributions were made with regards to their beliefs and intentions (e.g. "they liked the speech… I could tell.") As reflected in Kelly's comments above, this sense of realism appears to be related to the use of audience members that seemed familiar to the participants. Whilst this abundance of detail may have accounted for the high levels of spatial and social presence, it was interesting to note that participants reported high levels of self-presence in the *absence* of such detail. This was mainly in relation to the software resolution, which resulted in a blurring of the doppelgangers' facial features. Liz reflects on how she was able to focus on the similarities and "picture" the doppelgänger as her, even though it "wasn't really, really clear". Other participants reported doing the same, which suggests that highly detailed doppelgängers are not essential for self-identification. Interestingly, all participants reported a gradual increase in presence over the six weeks that they were engaging in the intervention:

Interviewer: So I would just be interested to find out – did it feel as though you were sat in the room with actual people?

Sarah: Yeah, yeah. Maybe not in the first week, but it definitely got more realistic as it went on because you start to, like, notice all the little touches. So it's definitely… no, it was *good*. It was good.

This suggests that as the sessions progressed, participants became more aware of the "little touches" which in turn resulted in a more realistic experience.

Previous research has suggested that high levels of presence are associated with increased levels of anxiety in virtual environments, so this is often found in studies investigating the use of VR in exposure work (Price & Anderson, 2007). However, participants in the current study reported feeling calm throughout the intervention:

> Claire: I think because there is no stress when you're *watching* your avatar speaking, obviously that is not a stressful situation, for me anyway. So I am calm during the VR task.

It is therefore possible that viewing themselves in third person resulted in a feeling of detached safety, which may not have been apparent in a more traditional first-person VRET. Interestingly, all participants expressed their disapproval regarding the notion of a first-person intervention during informal discussions with the researcher, stating that they would feel unsafe and that it would be too anxiety-provoking. Although two participants reported that being in a VR public speaking situation triggered minor levels of anxiety, they reflected on how this was short-lived as they became familiar with the environment and their self-image began to change.

Discussion

Phase 1 of this study found a significant negative correlation between PSA and MI ability. This is consistent with previous studies, which have found individuals with MI difficulties are more likely to have high levels of social anxiety or PSA (Ayres et al., 1999; Morrison et al., 2011). It is therefore possible that participants' PSA was partially related to their ability to form clear MI to counter negative self-imagery. Gender was also a significant predictor of PSA, whereby female students reported higher levels of PSA than males. This gender difference in anxiety is commonly found in the research literature, and may be linked to differences in biological or psychosocial factors (McLean, Asnaani, Litz

& Hofmann, 2011; Leach, Christensen, Mackinnon, Windsor & Butterworth, 2008). It is also possible that under-reporting of anxiety was more prevalent amongst men, as research suggests that male students are more likely to hold negative stereotyped views about mental health (Chandra & Minkovitz, 2006).

On the basis of the survey data, five participants were recruited for the VR intervention. It was encouraging to note that no concerns were identified with regards to practical feasibility issues. Time series data suggested that PSA was reduced over the course of the intervention and that effects were maintained at follow-up. In all cases except one, there was an initial drop in self-reported PSA after the visualisation session followed by a larger decline after the first VR session. Kelly reported a much larger drop in PSA following the visualisation session. In her post-intervention interview, Kelly was the only participant to say that she could "could make out what everything is" when imagining herself give the speech. It is therefore possible that her MI ability was higher than suggested by the VVIQ2.

In the first interview theme, "MI difficulties and the compensatory power of VR", participants discussed how they struggled to form vivid and complete MI. According to participants' comments during the interviews, the VR intervention compensated for these related difficulties which suggests it may be particularly suited for individuals with low MI ability. The second interview theme was "imagery modification made possible through VR", in which participants discussed how they modelled their public speaking behaviour on their doppelgänger. This appeared to result in a modified image of the self as a confident speaker, which was associated with a variety of improvements in other areas. The third theme focused on "a sense of presence and safety". Participants reported feeling present and connected with their doppelgänger, despite being unable to see many facial details. This suggests that the intervention may allow for high levels of presence to be felt in an environment that feels safe, without the anxiety that has been reported in other VRET studies.

Limitations

Whilst these preliminary findings are promising, it is important to acknowledge several limitations. With regards to the Phase 1 survey, it is important to note that the relationship between PSA and MI ability was only marginally significant. As this is one of only three known studies to examine this relationship, these findings should therefore be interpreted with caution. Furthermore, MI ability was only a significant predictor when the model controlled for gender and year group. This suggests that further research is required into the relationship between PSA and MI, whilst examining the potential role of other variables. In addition to this, only one measure of PSA and MI ability were included. In order to further investigate the link between these variables, future studies should include multiple measures whilst also assessing for MI control. Due to time constraints, Phase 2 focused solely on a small group of participants with low MI ability. As it is unclear whether the reported themes and changes in PSA would also be found amongst individuals with higher MI ability, this study should therefore be repeated with students scoring highly on the VVIQ2. It is also important to note that participants were enrolled in the public speaking module whilst engaging in the intervention. As a result, there were several possible influences on participants' PSA over the course of the study. These include being enrolled in the module, engaging in the VRET sessions and a possible interaction between these two interventions. Indeed, a recent audit carried out by the department found that students enrolled in the module experienced a significant reduction in PSA over a 12 week period. Whilst the potential impact of the module should therefore not be underestimated, the substantial drop in PSA after the first VR session would be consistent with the intervention eliciting the change. Although participants reported that they felt present and connected in the simulation, future VRET could aim to increase this even further with more highly-rendered doppelgängers and realistic environments.

Conclusion

This study has found some evidence of a link between MI ability and PSA, and has outlined the experiences of five students who felt they had benefited from a VR doppelgänger intervention. Self-reported PSA declined with repeated exposure, which might account for the lack of a significant difference in the original study. As this was only a feasibility study, further research is now warranted in the form of randomised controlled trials. Control groups should ideally include traditional evidence-based approaches for social anxiety such as CBT, or one of the commonly used first-person VRET interventions. With further research, VR doppelgängers could emerge as a cost-effective alternative to anxiety-provoking exposure therapy and first-person VRET.

References

ATLAS.ti Version 7.5.4 [Computer software] (2016). Berlin: Scientific Software Development GmbH. Available from http://www.atlasti.com.

Aymerich-Franch, L., & Bailenson, J. (2014). The use of doppelgangers in virtual reality to treat public speaking anxiety: a gender comparison. In *Proceedings of the International Society for Presence Research Annual Conference* (pp. 17-19).

Aymerich-Franch, L., Kizilcec, R. F., & Bailenson, J. N. (2014). The relationship between virtual self similarity and social anxiety. *Frontiers in human neuroscience*, *8*.

Ayres, J., & Hopf, T. (1993). *Coping with speech anxiety*. Greenwood Publishing Group.

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

Bandura, A. (1977). *Social learning theory.* Englewood Cliffs, NJ: Prentice-Hall.

Beatty, M. J., & Clair, R. P. (1990). Decision rule orientation and public speaking apprehension. *Journal of Social Behavior and Personality*, *5*(2), 105.

Behnke, R. R., & Sawyer, C. R. (1998). Conceptualizing speech anxiety as a dynamic trait. *Southern Journal of Communication*, *63*(2), 160-168.

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.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Chandra, A., & Minkovitz, C. S. (2006). Stigma starts early: Gender differences in teen willingness to use mental health services. *Journal of Adolescent Health*, *38*(6), 754-e1.

Clark, D., & Wells, A. (1995). A cognitive model of social phobia. In R. Heimberg, M. Liebowitz, D. Hope, & R. Schneier, (Eds.) *Social phobia: Diagnosis, assessment and treatment* (pp. 69–93). New York: Guilford Press.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. Vol. 2. *Lawrence Earlbaum Associates, Hillsdale, NJ*.

Cox, B. J., Clara, I. P., Sareen, J., & Stein, M. B. (2008). The structure of feared social situations among individuals with a lifetime diagnosis of social anxiety disorder in two independent nationally representative mental health surveys. *Behaviour research and therapy*, *46*(4), 477-486.

Daly, J. A., Vangelisti, A. L., & Weber, D. J. (1995). Speech anxiety affects how people prepare speeches: A protocol analysis of the preparation processes of speakers. *Communications Monographs*, *62*(4), 383-397.

D'Angiulli, A., Runge, M., Faulkner, A., Zakizadeh, J., Chan, A., & Morcos, S. (2013). Vividness of visual imagery and incidental recall of verbal cues, when phenomenological availability reflects long-term memory accessibility. *Frontiers in psychology*, *4*.

Duff, D. C., Levine, T. R., Beatty, M. J., Woolbright, J., & Sun Park, H. (2007). Testing public anxiety treatments against a credible placebo control. *Communication Education*, *56*(1), 72-88.

Fox, J., & Bailenson, J.N. (2010). The use of doppelgängers to promote health behavior change. *CyberTherapy & Rehabilitation*, *3 (2)*, 16-17.

Hofmann, S. G. (2007). Cognitive factors that maintain social anxiety disorder: A comprehensive model and its treatment implications. *Cognitive behaviour therapy*, *36*(4), 193-209.

Hofmann, S. G., & Otto, M. W. (2008). *Cognitive behavioral therapy for social anxiety disorder: evidence-based and disorder-specific treatment techniques*. Routledge.

Holmes, E. A., & Mathews, A. (2010). Mental imagery in emotion and emotional disorders. *Clinical psychology review*, *30*(3), 349-362.

Lam, R. W., Michalaak, E. E., & Swinson, R. P. (2004). *Assessment scales in depression, mania and anxiety*. CRC Press.

Leach, L. S., Christensen, H., Mackinnon, A. J., Windsor, T. D., & Butterworth, P. (2008). Gender differences in depression and anxiety across the adult lifespan: the role of psychosocial mediators. *Social psychiatry and psychiatric epidemiology*, *43*(12), 983-998.

Lequerica, A., Rapport, L., Axelrod, B. N., Telmet, K., & Whitman, R. D. (2002). Subjective and objective assessment methods of mental imagery control: Construct validations of self-report measures. *Journal of Clinical and Experimental Neuropsychology*, *24*(8), 1103-1116.

Marks, D.F. (1995). New Directions for Imagery Research. *Journal of Mental Imagery, 19*, 153-167.

Mayo-Wilson, E., Dias, S., Mavranezouli, I., Kew, K., Clark, D. M., Ades, A. E., & Pilling, S. (2014). Psychological and pharmacological interventions for social anxiety disorder in adults: a systematic review and network meta-analysis. *The Lancet Psychiatry*, *1*(5), 368-376.

McLean, C. P., Asnaani, A., Litz, B. T., & Hofmann, S. G. (2011). Gender differences in anxiety disorders: prevalence, course of illness, comorbidity and burden of illness. *Journal of psychiatric research*, *45*(8), 1027-1035.

Menzel, K. E., & Carrell, L. J. (1994). The relationship between preparation and performance in public speaking. *Communication Education*, *43*(1), 17-26.

Meyerbröker, K., & Emmelkamp, P. M. (2010). Virtual reality exposure therapy in anxiety disorders: a systematic review of process-and-outcome studies. *Depression and anxiety*, *27*(10), 933-944.

Morrison, A. S., Amir, N., & Taylor, C. T. (2011). A behavioral index of imagery ability in social anxiety. *Cognitive therapy and research*, *35*(4), 326-332.

Ng, A. S., & Abbott, M. J. (2014). The impact of self-imagery on affective, cognitive, and attentional processes in social phobia: A comprehensive literature review of the theoretical and empirical literature. *Behaviour Change*, *31*(03), 159-174.

Ng, A. S., Abbott, M. J., & Hunt, C. (2014). The effect of self-imagery on symptoms and processes in social anxiety: a systematic review. *Clinical psychology review*, *34*(8), 620-633.

Opriş, D., Pintea, S., García-Palacios, A., Botella, C., Szamosközi, Ş., & David, D. (2012). Virtual reality exposure therapy in anxiety disorders: a quantitative meta-analysis. *Depression and anxiety*, *29*(2), 85-93.

Parsons, T. D., & Rizzo, A. A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of behavior therapy and experimental psychiatry*, *39*(3), 250-261.

Ponniah, K., & Hollon, S. D. (2008). Empirically supported psychological interventions for social phobia in adults: a qualitative review of randomized controlled trials. *Psychological medicine*, *38*(01), 3-14.

Powers, M. B., & Emmelkamp, P. M. (2008). Virtual reality exposure therapy for anxiety disorders: A meta-analysis. *Journal of anxiety disorders*, *22*(3), 561-569.

Rapee, R. M., & Heimberg, R. G. (1997). A cognitive-behavioral model of anxiety in social phobia. *Behaviour research and therapy*, *35*(8), 741-756.

Rodebaugh, T. L., Holaway, R. M., & Heimberg, R. G. (2004). The treatment of social anxiety disorder. *Clinical Psychology Review*, *24*(7), 883-908.

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.

Vanni, F., Conversano, C., Del Debbio, A., Landi, P., Carlini, M., Fanciullacci, C., & Dell'Osso, L. (2013). A survey on virtual environment applications to fear of public speaking. *European review for medical and pharmacological sciences*, *17*(12), 1561-1568.

Wiederhold, B. K., & Bouchard, S. (2014). *Virtual reality for posttraumatic stress disorder*. Springer US.

Table 1: Descriptive results

	n	STAI-Y1 mean & SD	VVIQ2 mean & SD
1st year students	**87**	**52.81 *(15.43)***	**116.77 *(20.98)***
- male	26	43.29 *(13.86)*	112.58 *(20.34)*
- female	61	56.86 *(14.33)*	118.56 *(21.16)*
2nd year students	**75**	**48.33 *(14.66)***	**114.45 *(21.16)***
- male	27	40.27 *(10.90)*	114.64 *(19.36)*
- female	48	52.86 *(14.65)*	114.34 *(22.31)*
Total sample	**162**	**50.74 *(15.20)***	**115.69 *(21.03)***
- male	53	41.75 *(12.41)*	113.63 *(19.68)*
- female	109	55.10 *(14.54)*	116.70 *(21.68)*

Table 2. Mean scores out of five for self, social and spatial presence (N=5)

	Self-presence	Social Presence	Spatial Presence
Visualisation	3.1	3.8	3.2
VR	3.2	4.0	3.8

Figure 1: VR equipment – Oculus Rift headset and headphones*

* Image is not of a participant and is used with the indiviudal's consent.

Figure 2: Participants' view of their doppelgänger*

* Example doppelgänger used for illustrative purposes only. Not modelled on anyone involved with the study.

Figure 3: The virtual environment

Figure 4: Audience applauding

Figure 5: A doppelgänger modelling socially-confident behaviour

Figure 6: Self-reported public speaking anxiety (cont. overleaf)

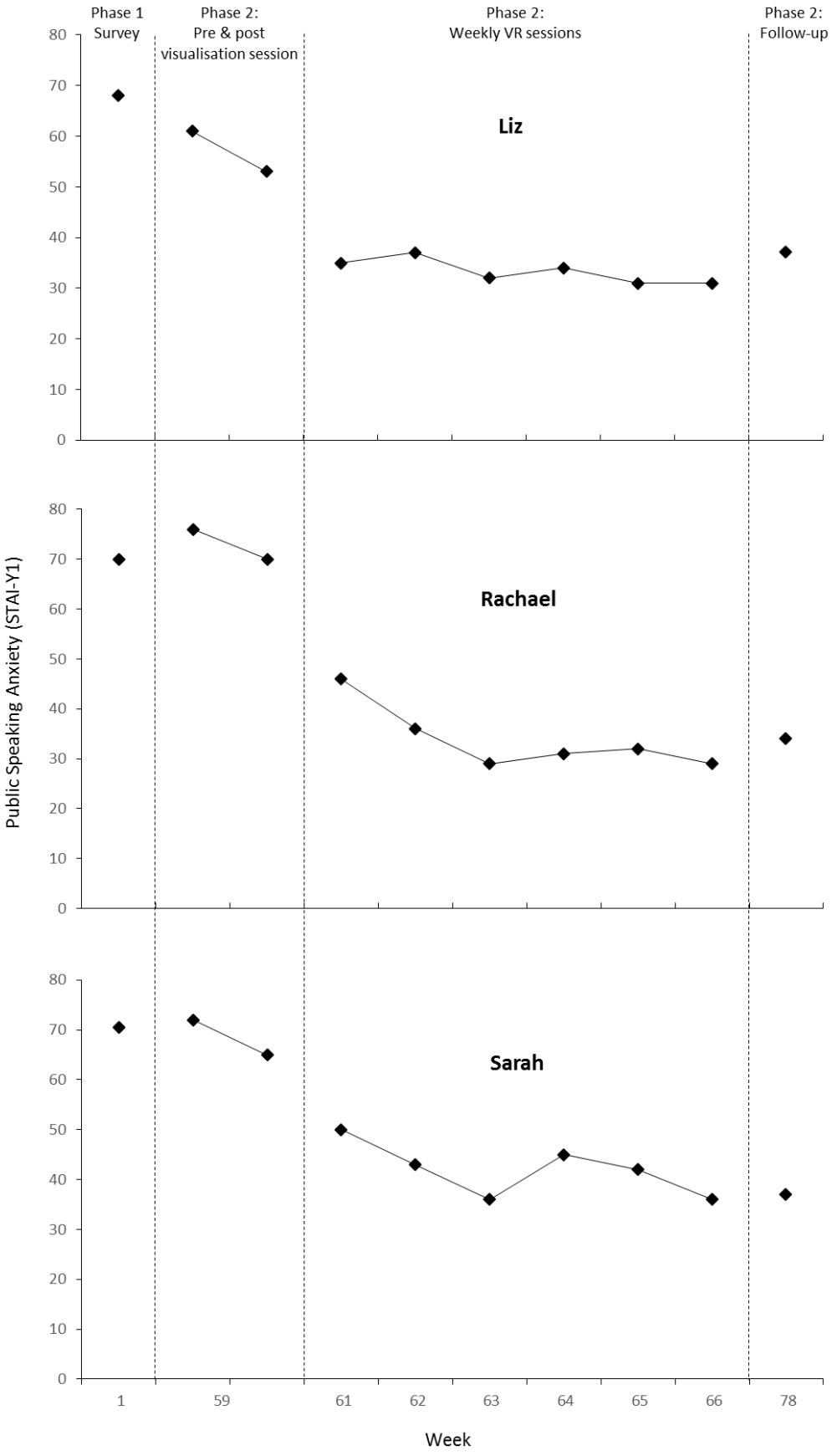
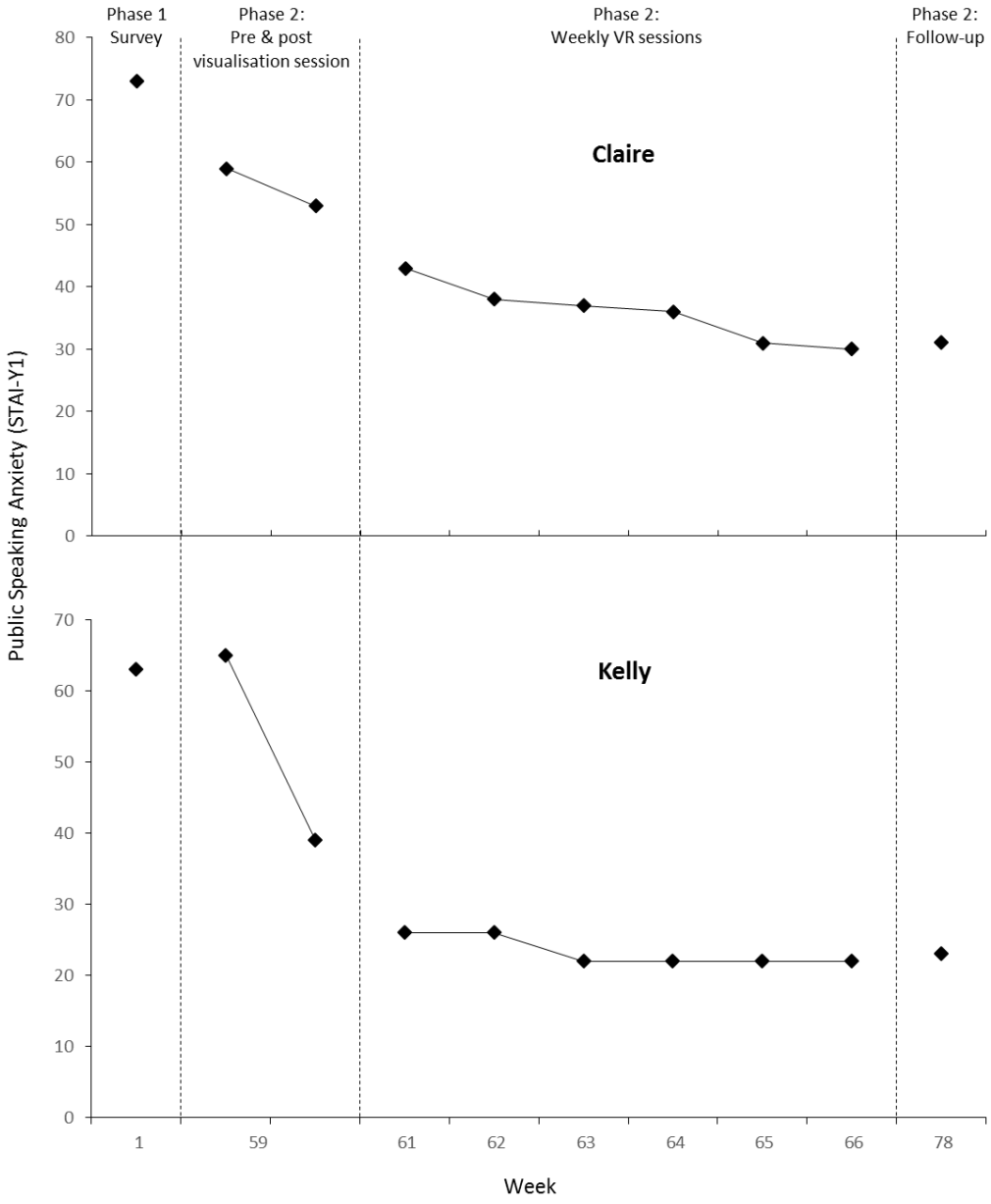


Figure 6 (cont.) Self-reported public speaking anxiety



Chapter 4

Contributions to theory and clinical practice

Overview

The first part of this paper will focus on the implications that this study has for theory development, and how this could help to guide future research. Following this, some issues relating to clinical practice will be discussed before conclusions are drawn in relation to the study as a whole.

Implications for theory development and future research

This study began with a meta-analysis of research examining the efficacy of virtual reality exposure therapy (VRET) for the social anxiety. Effect sizes suggested that VRET is more effective than no treatment and at least equally as effective as traditional therapeutic approaches. This suggests that VRET is able to address the same psychological mechanisms as those targeted in CBT and standard exposure therapy. In order to test this theory, future research should focus on the exact nature of the changes across conditions. For example, although participants in the VRET conditions reported a reduction in anticipatory anxiety, it is unclear whether this change was reflected in their patterns of social behaviour. Whilst it is apparent that individuals who had been exposed to the VR stimulus had habituated to the *idea* of interacting in that particular situation, it is possible that those who had been exposed to real-life scenarios would be better prepared and equipped for the situation when it occurs. Further research is also recommended in order to examine the factors that account for the reductions in PSA. As reflected in the empirical study that followed the meta-analysis, participant interviews are an effective method of identifying the nature of these changes and how they have impacted that person's life. One possible avenue of research would therefore be to interview participants who have completed traditional therapy and first-person VRET. Subsequent analysis could then focus on the differences and similarities between their reported experiences. Such research should be supplemented with randomised controlled trials (RCTs) that investigate these changes, by examining a variety of different social anxiety and behavioural outcomes.

To date, very little research has been carried out on the possible relationship between mental imagery (MI) ability and social anxiety. Previous research has suggested that individuals with low MI ability are more likely to experience higher levels of social anxiety or public speaking anxiety (PSA), due to difficulties with producing MI that might assist with self-imagery modification (Ayres, Hopf & Edwards, 1999; Morrison, Amir & Taylor, 2011). Such a link was found in Phase 1 of this study, which also suggested that female participants were more likely to experience higher levels of PSA. As gender differences in relation to this link have not been previously examined, this merits further consideration here.

One potential explanation is that the levels of PSA experienced by male participants were too low for the link to be detected, or that men were more likely to underreport their anxiety. Alternatively, it is possible that negative self-representations play a greater role in maintaining social anxiety for women when compared to men. Cross and Madson (1997) suggest that American women are socialised to construct *interdependent* self-construals, in which they view themselves as being interconnected with others and see themselves as an extension of their social group. In contrast, American men learn to develop *independent* self-construals, whereby the self is constructed as autonomous and distinct from the group. It is arguable that these construals are apparent across Western culture, including the United Kingdom. Research has suggested that interdependence is associated with a heightened awareness of social cues and of being evaluated by others, which in turn results in higher levels of social anxiety (Singelis & Sharkey, 1995; Okazaki, 1997; Dinnel, Kleinknecht & Tanaka-Matsumi, 2002). It is therefore plausible that self-imagery involving anticipated interpersonal failure is more likely to be a key maintaining factor for women, whereas men are more likely to have an independent self-construal that could potentially mitigate against this. On this basis, being able to form vivid MI to counter negative self-representations could be more beneficial for women than men.

Several avenues for future research have been identified on the basis of these findings. Firstly, this study focused on an analogue sample of undergraduate students with varying degrees of PSA. Future studies should therefore aim to explore this relationship in a sample from the general population, in order to examine whether the gender-specific findings are replicated. This link should also be investigated amongst individuals who have been diagnosed with social anxiety disorder, as it is possible that symptoms such as negative self-imagery will be more prominent within this group. As previously discussed, the role of self-construals in accounting for gender differences needs to be considered in the context of MI ability and PSA. However, various other mediators might also account for these findings (e.g. variations in depressive symptomology), which suggests that there is a need for a well-controlled study that carefully examines a range of different variables. As men are more likely to hold stereotyped views of mental health difficulties (Chandra & Minkovitz, 2006), examining the relationship between these beliefs and self-reported PSA may also help determine whether underreporting could be having a negative impact on the outcomes. As the present study relied on self-reported MI ability, future studies should also consider using objective behavioural measures such as the mental rotation or mental paper folding tasks (Shepard & Metzler, 1971; Shepard & Feng, 1972).

In Phase 2 of the study, participants reported an incremental decline in their PSA over the course of the intervention. These changes were explored in greater depth through a thematic analysis of interview transcripts. The first theme related to “MI difficulties and the compensatory power of VR”. All participants reported low levels of MI vividness, which suggests that their VVIQ scores were accurate in this regard. It was interesting to note that when discussing this theme, participants reflected on how MI relating to past experiences was a lot clearer than anticipatory MI. This may be due to the likelihood that retrieval of visual information from long-term memory is a separate process to “mental synthesis”, which involves combining ideas into new constructs (Pearson, 2007). The latter process involves a greater reliance on working memory in order to construct visual information, so it is possible that variations in this ability may account for the participants’ difficulties in creating new

vivid MI. This might account for the reported difficulties in imagery control, as this is a key component of mental synthesis. Participants also reported that they struggled to concentrate on the visualisation task, due to the effort involved in trying to form vivid MI. This may be understood with reference to Kahneman's (1973) influential model of attention, which proposes that our attention is constantly being adjusted in accordance with the demands of a task or tasks. Attempting to form vivid MI would have required a large amount of processing capacity, which not only impacted task performance but also limited their attentional resources in other areas. Participants' comments suggested that the VR compensated for these difficulties by immersing them in the imagery that they had difficulty in creating themselves, thereby reducing the demands that the task was placing on them. In doing so, it would appear that participants' were able to allocate greater attentional resources to other aspects of the task, which resulted in increased levels of engagement.

Whilst these findings initially appear to suggest that the VR intervention was particularly suited to individuals with low MI ability, similar interviews have not been carried out on individuals with varying levels of MI ability due to time constraints. It is therefore unclear whether people with high MI ability would report similar issues in relation to retrieval of past imagery, mental synthesis and attentional resources. In order to establish whether this intervention is particularly suited for people who struggle to form vivid MI, this study should be repeated on a sample of high MI students. Cross study comparisons can then be made with regards to MI difficulties and the compensatory power of the intervention. A subsequent RCT would be required with a 2x2x2 design, in order to properly examine the roles of high and low MI ability, gender and type of intervention (VR or visualisation) on PSA. In addition, the theoretical concepts identified in relation to this theme have not been previously examined in the context of MI ability and social anxiety. Future RCTs should therefore focus on the potential roles that imagery retrieval, mental synthesis and attention may play in this process for individuals with varying levels of MI ability. Furthermore, as this study focused on MI vividness, further research is recommended with regards to imagery control and generation.

The second theme focused on "imagery modification made possible through VR", in which participants discussed how they had modelled their public speaking behaviour on their doppelgängers. Bandura (1977) suggested that people learn social behaviours by imitating others, and identified various factors that determine whether this form of social learning occurs. These included the similarity of the learner to the model, and the perceived rewards and punishments associated with the observed behaviour. Participants in the current study reflected on how they often thought about their own doppelgänger when performing a speech, particularly with regards to how confident they appeared and the praise they received from the virtual audience. In the absence of any punishment in the simulation, it would therefore appear that participants were responding to the perceived reward. This theme is supported by previous research, which has found positive modelling effects from doppelgängers in relation to healthy eating and exercise (Fox & Bailenson, 2009; Fox, Bailenson & Binney, 2009). When Bandura first began theorising on the nature of social learning, it was under the assumption that people can only model their behaviour on other people. However, this theme suggests that modelling can effectively occur in a virtual world in response to a computer-generated character, without the need for other "real life" people to be present. There was also evidence to suggest that this modelling resulted in self-imagery modification, which brought about a number of associated changes that could be understood in relation to Clark and Wells' (1995) model of social anxiety. These included a more realistic expectation for social performance, reduced focus on physiological symptoms, less of a reliance on safety behaviours, a receptiveness to positive social cues, less anticipatory and less post-event rumination. This suggests that self-imagery modification resulting from modelling behaviour can trigger a "ripple effect", leading to changes that are often associated with traditional CBT and exposure.

In order to properly examine the role of social modelling, future RCTs should assess the extent to which individuals think about their doppelgängers when performing a speech and whether this

corresponds to changes in PSA. As the current study focused on social learning through perceived rewards, the impact of perceived punishment in a VR environment should also be investigated. Careful consideration would have to be given to the design of such a study, in order to avoid any adverse effects or distress. As this theme suggested that modelling can occur in a virtual environment, future studies could make changes to the simulation in order to examine this further. For example, doppelgängers could be observed dealing with different situations in an assertive and proactive manner. Alternatively, the power of modelling in VR should also be investigated in relation to other psychological difficulties such as low mood or psychosis. With regards to the self-imagery modification and the associated benefits reported in this theme, there is a strong argument for an RCT that compares these changes to those observed in a traditional intervention and/or first-person VRET group. In doing so, we can start to consider whether this type of VRET is a viable alternative to other empirically-supported interventions.

The third theme related to "a sense of presence and safety" that participants experienced whilst in the simulation. Participants reflected on how the abundance of details helped to contribute to a sense of spatial, social and self-presence. However, they also reported difficulties in seeing the facial details of their avatars. Although it would be reasonable to assume that this could be a barrier to developing self-presence, participants reported that they were able to relate to their doppelgängers due to personally identifiable features such as glasses and hairstyle. This may be related to a form of "extended self-presence", in which certain aspects of a self-representation are significant enough to the individual's personal identity to allow self-identification to occur (Ratan & Hasler, 2010). Participants also reported that their awareness of details in the simulation increased over time, thereby contributing to the perceived realism. The unified theory of spatial presence (Wirth, Hartmann, Bocking, Vorderer et al., 2007) proposes that individuals start forming mental models of a virtual world, based on the various cues available and their own previous assumptions. Once their mental model is complete, they then decide (consciously or unconsciously) whether they feel present

in that world. This is a dynamic process that is susceptible to change over time. In light of participants' comments, it is therefore possible that their mental models were constantly being developed as new cues were detected. In the original study upon which the current empirical paper built upon, Aymerich-Franch & Bailenson (2014) suggested that VR doppelgängers for PSA are a form of VRET. In order for exposure to take place, the individual must first experience heightened anxiety when exposed to the stimulus in order to allow for habituation to occur (Abramowitz, Deacon & Whiteside, 2013). However, participants reported that they felt safe when viewing their doppelgängers due to the third person perspective. This, coupled with the modelling and imagery rescripting processes outlined earlier, suggests that different mechanisms were underlying these changes and that an alternative name for this type of intervention is therefore required.

This theme highlights several possible avenues for future research. Firstly, the possible link between presence and efficacy needs to be examined, and the factors that allow for extended self-presence to develop should also be identified. This will help to determine whether greater resources need to be invested in order to produce a more realistic experience. If it transpires that clients can relate to objects in a cost-effective basic simulation, then this research will also help to determine what the essential components are. For example, participants in the current study reflected on how the clothes, glasses and hairstyle were important. Additional research should aim to investigate whether the theory of unified spatial presence is able to account for an increase in realism over time, and what factors might assist in speeding up or streamlining this process. It would also be useful to determine what factors account for the feelings of safety experienced in this intervention, relative to what would be expected from a first-person VRET session. Finally, further research is required into the differences between this approach and traditional VRET, in order to establish whether social modelling through VR doppelgängers can be conceptualised as a form of exposure.

Implications for clinical practice

Visualisation techniques are commonly employed in therapy, and play a key role in many third-wave approaches such as Acceptance and Commitment Therapy. This study suggested that many individuals struggle to form vivid MI, low MI ability may be associated with higher levels of PSA and that asking such clients to engage in a visualization exercise could have a negative impact on their attention. It is therefore advisable that clinicians screen clients for MI ability using a validated tool such as the VVIQ2, before including such exercises in their treatment plan. This might also help to guide clinicians when asking clients to imagine different scenarios in therapy, as people who struggled to form vivid MI may benefit from the use of additional visual material or support. If the visualisation exercise requires the client to be immersed in the image, then the current findings suggests that VR could be a viable alternative. However, it is important to recognise that VR technology would not be restricted solely to those with low MI ability. As reflected in the meta-analysis, individuals of varying MI ability have benefited from the use of VRET across studies. The current feasibility study suggests that such an intervention could be effective, affordable, easy to implement and that individuals are likely to engage in the sessions. As such, there is a case for this technology to be incorporated into university programmes and daily clinical practice within the NHS.

In recent years, the price of VR technology has declined rapidly as companies have been competing for the home market. For example, in March 2016 the Occulus Rift headset used in the current study was released as a low-cost consumer product (Dixon, 2016). Add-on equipment has also been released for mobile phones, which converts them into a set of VR "goggles" (Hoberman, Krum, Suma & Bolas, 2012). Previously, this technology had only been available to developers at a cost of several thousands (Bohil, Alicea & Biocca, 2011). Given the amount of time and resources involved in systematically exposing clients to real-life social situations, VR could therefore represent a pragmatic and cost-effective alternative.

These findings have several implications with regards to the future of clinical practice. For the first time, therapists could have access to a tool that allows them to completely customise an exposure session to a client's needs. VR technology is continuously advancing, so it is highly likely that simulations will be developed that could assist with other aspects of therapy. This could lead to substantial changes in the nature and quality of therapy that clinicians are able to offer. As VR technology becomes more readily available in the home market, members of the public could download empirically-supported interventions to run on their own headsets. This could potentially ensure that individuals have immediate access to an appropriate intervention, whilst reducing NHS waiting lists and the associated pressure on staff. At present, we are a long way from having to consider whether VR could replace clinicians. However, in light of the present study and previous research, it is important to consider whether any undesirable consequences could arise from replacing aspects of therapeutic human interaction with VR. As research consistently suggests that the therapeutic relationship is a key predictor of treatment outcome (Lambert & Barley, 2001), it is essential that VR is viewed as a clinical tool and to be used in conjunction with traditional therapy when assisting clients with more complex presentations.

Conclusions

Through synthesising and reviewing previous findings across a range of outcome measures, the meta-analysis found effect sizes that suggested VRET was an effective method of reducing social anxiety. Building upon this body of research, the empirical paper then considered the possible role of MI ability in PSA and examined the feasibility of a new type of VR intervention. This preliminary study highlighted several theoretical implications that require further study, most of which have not been previously explored in the literature. In addition to this, a number of clinical implications have also been identified which to date have also received little consideration. As VR continues to advance whilst becoming

more affordable, the questions posed in this paper should be addressed and the exciting prospect of utilising this cutting edge technology can be explored.

References

Abramowitz, J. S., Deacon, B. J., & Whiteside, S. P. (2012). *Exposure therapy for anxiety: Principles and practice*. Guilford Press.

Aymerich-Franch, L., & Bailenson, J. (2014). The use of doppelgangers in virtual reality to treat public speaking anxiety: a gender comparison. In *Proceedings of the International Society for Presence Research Annual Conference* (pp. 17-19).

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

Bandura, A. (1977). *Social learning theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bohil, C. J., Alicea, B., & Biocca, F. A. (2011). Virtual reality in neuroscience research and therapy. *Nature reviews neuroscience*, *12*(12), 752-762.

Chandra, A., & Minkovitz, C. S. (2006). Stigma starts early: Gender differences in teen willingness to use mental health services. *Journal of Adolescent Health*, *38*(6), 754-e1.

Clark, D., & Wells, A. (1995). A cognitive model of social phobia. In R. Heimberg, M. Liebowitz, D. Hope, & R. Schneier, (Eds.) *Social phobia: Diagnosis, assessment and treatment* (pp. 69–93). New York: Guilford Press.

Cross, S. E., & Madson, L. (1997). Models of the self: self-construals and gender. *Psychological bulletin*, *122*(1), 5.

Dinnel, D. L., Kleinknecht, R. A., & Tanaka-Matsumi, J. (2002). A cross-cultural comparison of social phobia symptoms. *Journal of Psychopathology and Behavioral Assessment*, *24*(2), 75-84.

Dixon, W. W. (2016). Slaves of Vision: The Virtual Reality World of Oculus Rift. *Quarterly Review of Film and Video*, 1-10.

Fox, J., & Bailenson, J. N. (2009). Virtual self-modeling: The effects of vicarious reinforcement and identification on exercise behaviors. Media Psychology, 12(1), 1-25.

Fox, J., Bailenson, J., & Binney, J. (2009). Virtual experiences, physical behaviors: The effect of presence on imitation of an eating avatar. *Presence: Teleoperators and Virtual Environments*, *18*(4), 294-303.

Hoberman, P., Krum, D. M., Suma, E. A., & Bolas, M. (2012, March). Immersive training games for smartphone-based head mounted displays. In *Virtual Reality Short Papers and Posters (VRW), 2012 IEEE* (pp. 151-152). IEEE.

Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hall.

Lambert, M. J., & Barley, D. E. (2001). Research summary on the therapeutic relationship and psychotherapy outcome. *Psychotherapy: Theory, research, practice, training*, *38*(4), 357.

Morrison, A. S., Amir, N., & Taylor, C. T. (2011). A behavioral index of imagery ability in social anxiety. *Cognitive therapy and research*, *35*(4), 326-332.

Okazaki, S. (1997). Sources of ethnic differences between Asian American and white American college students on measures of depression and social anxiety. *Journal of abnormal psychology*, *106*(1), 52.

Pearson, David G. (2007). Mental imagery and creative thought. *Proceedings of the British Academy*, 147, 187-212.

Ratan, R., & Hasler, B. S. (2010). Exploring Self-Presence in Collaborative Virtual Teams. *PsychNology Journal*, *8*(1), 11-31.

Shepard, R. N., & Feng, C. (1972). A chronometric study of mental paper folding. *Cognitive Psychology*, *3*(2), 228-243.

Shepard, R. N., & Metzler, J. (1971). Mental rotation of three-dimensional objects. *Science, 171*, 701-703.

Singelis, T. M., & Sharkey, W. F. (1995). Culture, self-construal, and embarrassability. *Journal of Cross-Cultural Psychology*, *26*(6), 622-644.

Wirth, W., Hartmann, T., Böcking, S., Vorderer, P., Klimmt, C., Schramm, H., Saari, T., Laarni, J., Ravaja, N., Gouveia, F. R., Biocca, F., Sacau, A., Jänckea, L., Baumgartnera, T. & Jänckea, P. (2007). A process model of the formation of spatial presence experiences. *Media psychology*, *9*(3), 493-525.