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Ph.D. THESIS EXTENDED SUMMARY

A MULTILEVEL ANALYSIS OF COMPUTER MEDIATED INTERVENTIONS IN FLIGHT ANXIETY

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CHAPTER I. THEORETICAL BACKGROUND

1.1. Introduction and Research Problem

According to the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5; American Psychiatric Association 2013), flight phobia is classified into the specific phobias category of anxiety disorders, and it is defined as a persistent, excessive and unreasonable fear, related with the anticipation or presence of flying on an airplane. A diagnostic of flying phobia requires that symptoms must be present for at least six months for someone under age 18, and significantly impair the individual's life (DSM-5; American Psychiatric Association 2013). Some studies (McNally & Louro, 1992; Wilhelm & Roth, 1997) suggests that flight phobia is more often diagnosed as a symptom or a comorbid-factor of a primary psychological diagnosis, such as claustrophobia, height phobia, agoraphobia, generalized anxiety disorder or panic disorder. Taking these two approaches and field studies into account (see Oakes & Bor, 2010a, 2010b) we can say that the diagnosis of flight phobia is a complex clinical process, being characterized as a psychological disorder or as a symptom or co-morbid factor of another primary psychological diagnosis.

Flight phobia affects approximately 2.5% of the adult population (Fredrikson, Annas, Fischer, & Wik, 1996; Stinson et al., 2007), while flight anxiety, as a subclinical symptom, affects approximately 10%-40% of the general population (Dean & Whitaker, 1982; Van Gerwen & Diekstra, 2000). Even though flight phobia is not one of the most prevalent anxiety disorder, this mental health problem leads to major personal and financial negative consequences and often exposes the subject to severe complications (Oakes & Bor, 2010a). For example, among people who have anxiety to fly, about 20% use sedatives or alcohol to cope with anxiety (Howard, Murphy, & Clarke, 1983; Wilhelm & Roth, 1997). Flight anxiety and the fear-related avoidance draw serious personal and financial negative consequences, such as professional repercussions, stigmatization (Baños et al., 2002), and significant financial reduction in airline revenue (i.e., 9% for the US airline industry in 1982, Dean & Whitaker, 1982).

Although the field of psychology abound in research that examines the efficacy of various types of therapy for treating flight phobia symptoms, cognitive-behavioral therapies (CBTs) are the most empirically investigated, with positive long-term results (Oakes & Bor, 2010a; Van Gerwen, Spinhoven, Diekstra, & Van Dyck, 2002). One of the most effective and influential form of CBT is the Rational Emotive Behavioral Therapy (REBT; Ellis, 1995; David, 2006; David & Szentagotai, 2006). Based on the “ABCDE” model, according to the REBT (Ellis, 1995) when individuals experience negative activating events they might have rational or irrational beliefs regarding the respective events. Rational beliefs lead to functional consequences, while irrational beliefs lead to emotional, behavioral and cognitive dysfunctional consequences (David & Szentagotai, 2006). Therefore, according to REBT, to treat flight phobia symptoms, the irrational beliefs involved in this disorder need to be addressed/restructured and then the patient is exposed to threat stimuli using behavioral techniques**.** Exposure, in which a client enters and remains in a feared situation despite distress, is a key ingredient of most CBT treatments, especially in flight phobia. Exposure to feared stimuli in CBT is usually, performed *‘in vivo’* (in a natural setting) or *‘in vitro’* (in imaginary). Since the mid-eighties, the combination of exposure *in vivo* and cognitive restructuring became popular (Heimberg, Becker, Goldfinger, & Vermilyea, 1985; Mattick & Peters, 1988). Although classical exposure techniques for flight anxiety are widely used and are effective treatments (Emmelkamp, Mersch, & Vissia, 1985; Hodges & Rothbaum, 2000), they involve certain limitations: low control of the situation, confidentiality issues, financial and time costs, development of aversion or are dependent on the patient's ability to recreate the phobic stimulus (Emmelkamp, 2005; Rothbaum, Hodges, Smith, Lee, & Price, 2000). Recent studies showed that approximately 25% of patients refuse *'in vivo'* exposure when they are informed about it (Garcia-Palacios, Botella, Hoffman, & Fabregat, 2007; Olatunji, Deacon, & Abramowitz, 2009).

Efforts to develop the efficacy, benefits, and access to evidence-based psychotherapies have led to a new method of delivering exposure technique, specifically, the use of virtual reality (VR; Da Costa, Sardinha, & Nardi, 2008). VR is a new delivery tool for exposure techniques, using a computer-generated virtual environment, enabling systematic exposure to anxiogenic stimuli in a relevant context (Parsons & Rizzo, 2008). This new facility has a number of advantages compared to *'in vivo'* and '*in imago'* exposure techniques: is safer, can be repeated as often as needed, the therapist has better control over the content and exposure rhythm, exposure can be individualized, and it is cost effective for patients (Emmelkamp, 2005; Krijn et al., 2007). Results of previous systematic reviews and meta-analysis (Da Costa et al., 2008; Opriş et al., 2012; Parsons & Rizzo, 2008; Price, Anderson, & Rothbaum, 2008) gave us an overview of the efficacy of virtual-reality exposure therapy (VRET) in flight anxiety. The problem is that these reviews are not updated, complex analyses were not performed and analyses made on flight phobia are secondary objectives. Considering that research in the field of flight phobia is in development, there is a need to outline a research line based on quantitative syntheses, to estimate a population effect size on independent studies.

Even if the development of access to scientifically validated treatments for flight phobia is a pressing need for research in the field and technology based interventions represent a solution, the lack of analysis of mechanisms of change led to a number of research problems, both theoretical and practical. The number of technology based intervention that are used for mental health is constantly increasing due to their convenience and ease of use (Baumgart, 2011). Although the number of such interventions for anxiety disorders is growing exponentially, less is known about the mechanism of change proposed by theories on which interventions are based. In 2010, Oakes and Bor drew attention to the fact that many treatments for flight anxiety, including the most effective therapy –CBT, have been developed in the absence of a mainstream psychological research. Because of this, the mechanisms that maintain flight anxiety remain poorly understood.

For example, even if REBT' protocols for flight anxiety are effective (Deacon & Abramowitz, 2004; Emmelkamp et al., 1985; Hodges & Rothbaum, 2000b), their focus on changing all four types of irrational beliefs, using the same cognitive techniques, it is debatable because there are still no scientific evidence to prove that all four types of irrational beliefs are factors that maintain flight anxiety. This is a practice based on a lack of evidence data and can draw a number of negative consequences. As a result of this practice, the analysis of maintenance factors of anxiety remains as a secondary purpose. Given these points, there is a pressing need to analyze the role of irrational and rational cognitive processes in the generation and/or maintenance of flight anxiety symptomatology.

Another example of flight anxiety maintenance factors that are not studied enough are unconscious cognitive distortions. First, even if a large number of recent research on anxiety disorders (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007a), argue for the causal role of the attentional bias in developing and maintaining anxious symptoms, the impact of this distortion was not analyzed in flight anxiety. Attentional biases can be defined as a selective attention to threat that maintains the anxiety symptoms by facilitating a negative selective information process (Beard, 2011a; Hallion & Ruscio, 2011). There is no study that evaluates attentional bias as a factor in maintaining flight anxiety. Second, studies report expectancy biases in various forms of anxiety, including generalized anxiety disorder (Butler & Mathews, 1983) and social anxiety disorder (Foa, Franklin, Perry, & Herbert, 1996), as well as flight phobia (Mühlberger, Wiedemann, Herrmann, & Pauli, 2006). A higher expectation to encounter a threat is conceptualized as encountering expectancy bias (Aue & Hoeppli, 2012; de Jong & Muris, 2002), whereas consequence expectancy biases might manifest as higher expectations that such encounters will generate aversive results (Aue & Okon-Singer, 2015). In this thesis we used the term expectancy bias referring to consequence expectancy bias. However, existing studies have not investigated the influence of attentional and expectancy biases on other cognitive distortions or other possible maintaining mechanism of flight anxiety, like memory bias and irrational/rational cognitions.

Keeping in mind this puzzle of data, we can assume there is a possible relationship between cognitive distortions and flight phobia symptomatology, but we have no evidence of it. We believe that would be useful to test the additive effect of a cognitive distortion modification technique, for example one quite studied in anxiety disorders- attentional bias modification, to an evidence-based treatment for flight phobia. Moreover, the effect of this intervention on possible mechanisms of change, like irrational/rational beliefs, expectancy and memory biases should be investigated.

1.2. Relevance and Impact of the Research Topic

The general aim of the present thesis was to evaluate the efficacy of computer-based interventions in flight phobia and to analyze the maintenance factors of this disorder. Below, we briefly presented the impact of the research topic.

First, assessing the efficacy of VRET for treating flight anxiety may increase the accessibility of people to evidence-based treatments for flight phobia, taking into account the advantages that this intervention brings compared to classic approaches. VRET is a novelty element for participants, feature that leads to higher expectations. Further, using VR technology, the phobic stimulus is more environmentally friendly, does not create aversion and can predict long-term exposure in the real environment (Emmelkamp, 2005). In opposition, direct exposure to the phobic stimuli in real environment can lead to diminished confidence in treatment, changing expectations or giving up the treatment (Oakes & Bor, 2010b). In case of *'in imago'* exposure, results of therapy are dependent on the patient's ability to recreate the phobic stimulus, which may explain the low results of treatment at follow-up. Taking these arguments into account, we can say that the analysis of the VRET efficacy is a pressing need and can bring a number of major clinical implications.

Second, the analysis of the validity of the REBT's psychopathology and psychological health models for predicting flight anxiety would allow us to develop specific cognitive restructuring techniques for irrational beliefs involved in flight anxiety. An analysis of irrational and rational beliefs organization in flight anxiety can represent a shift from REBT theoretical predictions to scientific evidence, and can provide empirical support for REBT theory assumptions in flight anxiety symptomatology.

Third, the analyses of the interplay between expectancy biases and attentional biases in flight anxiety can show us whether these types of cognitive distortions are separate processes or influence each other. Also, it is important to test whether the expectancy bias is a maintenance and/or causal factor of flight anxiety. This could represent a starting point for future research in the field of unconscious cognitive processes in flight anxiety.

Finally, integrating new technology based interventions in an evidence-based treatment protocol for flight phobia might be an important direction in improving the efficacy of psychological treatments for flight phobia.

CHAPTER II. RESEARCH OBJECTIVES AND OVERALL METHODOLOGY

Through this thesis we aimed to address several methodological objectives related to the efficacy of computer-based interventions in flight anxiety. We started from the objective to upgrade flight phobia psychological treatments, more precisely, to improve existing treatments by analyzing etiopathogenetic factors of flight anxiety.

The first major goal of our research was to analyze the efficacy of VRET compared to control conditions or classical evidence based interventions in flight anxiety. Considering that the field of flight anxiety is in development, there is a need to set a research line based on a quantitative syntheses. In order to attain this objective, we conducted a quantitative meta-analysis of 11 randomized studies, we examined potential moderators of the efficacy of interventions and we investigated the degree of publication bias (Study 1).

Given that one of the biggest problems in the field is that the mechanisms that maintain flight anxiety remain poorly understood, in Study 2 we investigated the validity of REBT's psychopathology and psychological health models for predicting flight anxiety. We wanted this study to represent a shift from REBT theoretical predictions to scientific evidence regarding the organization of rational and irrational beliefs in flight anxiety. To achieve this objective REBT's psychopathology and psychological health models predicting flight anxiety were tested within a cross-sectional design, using path analysis techniques.

The third major goal of the thesis was to investigate the interplay between expectancy and attentional biases in flight anxiety, and the effects of inducing expectancy bias on flight anxiety, rational and irrational beliefs. Previous studies (Mühlberger et al., 2006; Pauli, Wiedemann, & Montoya, 1998) have demonstrated the existence of expectancy biases in flight anxiety but have not analyzed the effect of this cognitive distortion on cognitive and affective variables. To analyze this link between conscious and unconscious cognitive variables and affective consequences in flight anxiety, we designed a conditioning-like procedure to manipulate the perceived probability that certain classes of stimuli will be immediately followed by an aversive consequence. We aimed to test potential changes in the engagement and disengagement of attention toward the same stimuli categories, and to analyze the effects of inducing expectancy bias on flight anxiety levels, rational and irrational beliefs.

Analyzing together the advantages of using VRET, the possible importance of cognitive distortions in flight anxiety and the lack of related empirical research, our final objective (Study 4) was to investigate the efficacy of an attentional bias modification program into a VRCBT protocol vs. a VRCBT protocol for patients diagnosed with flight phobia, on affective, cognitive, and behavioral symptoms. To achieve this goal we implemented a randomized clinical trial, investigator-blinded, with parallel-group.

In short, to achieve assumed objective we developed four studies that use a meta-analytical approach (Study 1), a correlational design (Study 2), an experimental one (Study 3), and a clinical trial (Study 4). Being part of the PhD program, all four studies implemented within this thesis have the ethical approval from Babes-Bolyai University Ethical Review Board. The structure of the thesis, which follows the research objectives, is presented in Figure 1.

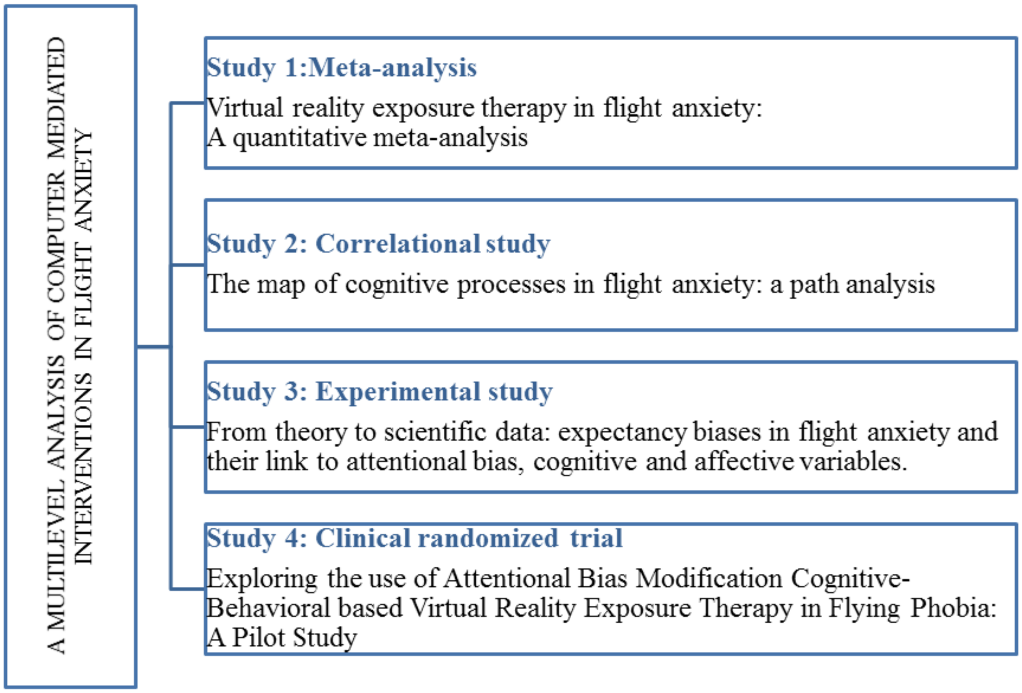

Figure 1. The schematic structure of the Ph.D. project

CHAPTER III. ORIGINAL RESEARCH

3.1. Study 1: Virtual Reality Exposure Therapy in Flight Anxiety: A Quantitative Meta-Analysis1

3.1.1. Introduction

Although classical exposure techniques for flight anxiety, *'in vivo'* and *'in imago'* exposures, are widely used and effective treatments (Deacon & Abramowitz, 2004; Emmelkamp et al., 1985; Hodges & Rothbaum, 2000a), they involve certain limitations: low control of the situation, confidentiality issues, financial and time costs, development of aversion or are dependent on the patient's ability to recreate the phobic stimulus (Emmelkamp, 2005; Rothbaum et al., 2000). Efforts to develop the effectiveness, benefits, and access to evidence-based psychotherapies have led to a new method of delivering exposure technique, specifically, the use of virtual reality (VR; Da Costa, Sardinha, & Nardi, 2008). This new facility has a number of advantages compared to *'in vivo'* and '*in imago'* exposure techniques: is safer, can be repeated as often as needed, the therapist has better control over the content and exposure rhythm, exposure can be individualized, and it is cost effective for patients (Emmelkamp, 2005; Krijn et al., 2007).

Recent qualitative systematic reviews (Da Costa et al., 2008; Price et al., 2008) and meta-analysis (Opriş et al., 2012; Parsons & Rizzo, 2008) emphasize that virtual reality exposure therapy (VRET), with or without cognitive behavior therapy (CBT), is an efficient and effective treatment for flight anxiety, being comparable or superior to in vivo exposure, progressive muscle relaxation, cognitive therapy, bibliotherapy, or supportive group therapy.

3.1.1.1. Overview of the present study

Although the results of previous systematic reviews and meta-analysis (Da Costa et al., 2008; Opriş et al., 2012; Parsons & Rizzo, 2008; Price et al., 2008) gave us an overview of the efficacy of VRET in flight anxiety, these reviews are not updated, complex analyses were not performed and analyses made on this disorder are secondary objectives. Considering that research in the field of flight anxiety is in development, there is a need to outline a research line based on quantitative syntheses, to estimate a population effect size on independent studies. Considering these needs and analyzing current methodological problems, the present meta-analysis tried to provide answers to the following questions: 1) What is the overall efficacy of VRET in flight anxiety?; 2) What is the efficacy of VRET compared to control conditions?; 3) What is the efficacy of VRET compared to classical evidence-based interventions, globally?; 4) What is the efficacy of VRET compared to exposure based interventions (i.e. classical interventions that include *'in vivo'* or *'in imago'* exposure techniques). Another objective of the present meta-analysis was to investigate potential moderators of the effectiveness of VRET.

3.1.1.2. Potential theoretical moderator variables

Moderator variables were selected on the basis of prior research. Previous studies identified these variables as potential moderators of interventions efficacy/effectiveness in anxiety disorders. We are briefly discussing these moderators below.

Continuous variables: first, we took into consideration the number of participants, participant's mean age and percentage of female participants as variables that can influence the effects of VRET. We anticipate that the effects of VRET will be larger in smaller and younger samples (Holzinger, Searle, & Wernbacher, 2011; Neguț, Matu, Sava, & David, 2016). Second, we considered that gender may influence the effect due to a greater number of women than men enrolled in studies (Krijn, Emmelkamp, Olafsson, & Biemond, 2004). Also, we considered the number of exposure sessions as a possible moderating variable due to large variations of exposure sessions number (Krijn et al., 2004) and the fact that this variable appears to influence the effect of treatments on anxiety disorders (Craske et al., 2008).

Further, the quality of randomized trials is an important variable that can impact on outcomes of interest (Kleijnen & Van Groenendaal, 2000). We assumed that low quality of randomized trials will lead to an increase in the effect size of the compared conditions.

To assess the quality of randomized trials included in the present meta-analysis we used The Cochrane Collaboration's tool for assessing risk of bias (Higgins et al., 2011).

[1]This study has been published.
Cardoș, R. A., David, O. A., & David, D. O. (2017). Virtual reality exposure therapy in flight anxiety: A quantitative meta-analysis. Computers in Human Behavior, 72, 371-380. The authors contributed to the article as follows: Cardoș R.A.: study design, conducting the study, data analysis, results interpretation and writing the manuscript. David O.A. and David. D.O.: study design, results interpretation and writing the manuscript.

Categorical variables: we analyzed the influence of outcome types on the overall effect size of VRET. Based on previous research on anxiety disorders we expected that VRET will have a higher efficacy on specific distress and behavioral level (Opriş et al., 2012). Moreover, there is a major difference between follow-up assessments in studies of flight anxiety. Therefore, we took into consideration the follow-up length variable to analyze its effects on results change. Moderation analyses with categorical variables were conducted by assuming independence of studies based on the moderators' categories.

3.1.2. Method

3.1.2.1. Literature search

The systematic literature search has been conducted on the PsychInfo, ISI Web of Science, Scopus, PubMed and ScienceDirect databases, up to 30th of September 2015, using the following terms: "virtual reality" or " VR" in combination with "fear of flying" or "flight anxiety" or "flight phobia" or "flying anxiety" or "flying phobia" or "aviophobia" or "flight phobic" or "avoidance of flying" or "fearful flyers". Also, in order to detect other studies, the references of recent studies and reviews on this topic were screened.

3.1.2.2. Selection of studies

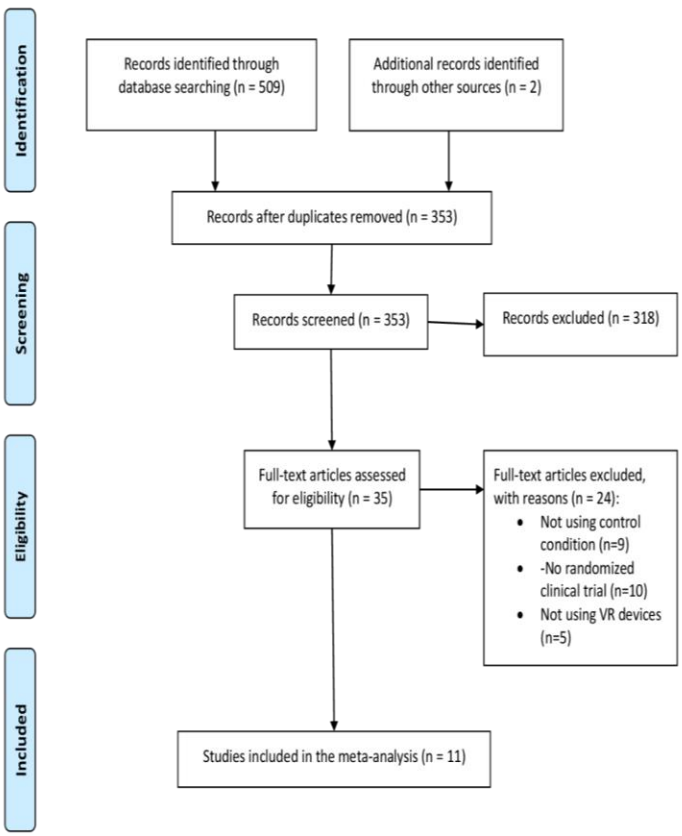

Figure 1. PRISMA flow diagram

The inclusion criteria were: a) randomized allocation of the subjects in the experimental conditions, b) studies with human subjects, c) studies investigating the efficacy of VRET in flight anxiety, d) the existence of at least one VRET condition (with/ without other intervention) and one comparison group (control conditions or classical evidence-based intervention), e) studies published in peer-review journals, f) studies written in English, and g) studies reporting original empirical findings.

The initial search procedure led to 511 potentially relevant studies, two of them being identified in additional sources. After removing 158 duplicates, 353 abstracts were scanned. A total of 35 studies were analyzed in detail for eligibility. At the end of the literature search process, eleven studies were included in the meta-analysis (see Fig. 1).

3.1.2.3. Procedure

For each included study we coded the following variables: type of comparison group (control conditions- wait list and attention control, classical evidence-based interventions), study identification data (author, year of publication), participant's mean age, percentage of female participants, number of participants per condition, number of exposure sessions, follow-up length and outcome measures. To respond at the fourth research question we extracted from the classical evidence based interventions group (CBT, bibliotherapy, cognitive therapy, relaxation, CBT plus standard exposure *(in vivo)*, relaxation techniques plus *in imago* exposure, computer aided exposure) only the studies that included an exposure based interventions ('*in vivo'* and '*in imago'* exposure). Outcome variables were categorized into the following groups (following Podină, Koster, Philippot, Dethier, & David, 2013; Powers & Emmelkamp, 2008): domain-specific subjective distress/ specific distress, general subjective distress, cognitive, behavioral and psychophysiological.

To control for the variations in sample size among studies (Hedges & Olkin, 1985), for the effect size estimates, we calculated Hedge's *g* coefficient. A value of Hedge's *g* between 0.20 and 0.50 indicates a small effect, one between 0.50 and 0.80 indicates a medium effect, while a value of 0.80 or larger show a large effect size (Cohen, 1988). To compute effect sizes the following data were used: a) means and standard deviations, when these were available, b) between-group *t* values and sample size, c) between-group *p* values and degrees of freedom, d) Chi-sqared $\chi 2$ and Cohort 2x2 (events) for behavior outcome variables. When a study reported multiple outcomes per category, we computed an average effect size of those outcomes at a given point in time (post-test or follow-up). Positive effect sizes indicated the advantage of VRET, while negative effect sizes pointed out the advantage of control conditions or classical evidence-based interventions. Effect sizes were computed using random effects model, assuming the studies included are only a sample of the entire population of studies (Borenstein, Hedges, Higgins, & Rothstein, 2009). To test the heterogeneity of effect sizes we used the Q statistic and the I^2 statistic indexes (Borenstein et al., 2009). In order to explain the observed variability in effect size, we performed meta-regression analyses with continuous variables and analog-to-ANOVA moderation analyses with categorical variables.

To address publication bias we used Duval and Tweedie's trim-and-fill procedure (Duval & Tweedie, 2000), which approximates the probable number of missing studies that would correct for publication bias, computing an effect size without publication bias. All statistical analyzes were run using Comprehensive Meta-Analysis software (version 2.2, Borenstein, Hedges, Higgins, & Rothstein, 2005).

3.1.3. Results

3.1.3.1. The overall efficacy of VRET

There were 16 effect sizes regarding the effectiveness of VRET at post-test and 15 at follow-up. The overall effect size of Hedge's g = .592 (95% CI [.327-.858], p= .00), revealed a medium and statistically significant effect size of VRET at post-test, with evidence of heterogeneity within results ($Q_{(15)}$= 32.257, p = .00, I^2= 53.49).

Results showed a medium statistically significant effect size of VRET at follow-up (g = .588, 95% CI [.216-.960], p= .00). There was evidence of heterogeneity at follow-up, with statistically significant difference between VRET effect sizes ($Q_{(14)}$= 44.51, p = .00, I^2= 68.54).

3.1.3.2. VRET vs. control conditions

First, we computed an average post-test effect size for VRET vs. control conditions. Results showed significant difference (4 studies, *g* = 1.350, 95% CI [.664-2.037], *p*= .00), indicating large effects for VRET relative to control conditions. There was evidence of heterogeneity at post-test, with statistically significant difference between VRET and control conditions average effect size ($Q_{(3)}$= 9.587 *p* = .02, I^2=68.707).

Second, we computed the mean overall effect size, demonstrating VRET superiority vs. control conditions at follow-up, by a medium statistically significant effect size of Hedge's *g* = .583 (2 studies, 95% CI [.108-1.058], *p*= .01), with no statistically significant heterogeneity ($Q_{(1)}$= .154, *p* = .69, I^2=.00).

3.1.3.3. VRET vs. classical evidence-based interventions

Results showed a small, but significant effect size in favor of VRET at post-test (12 studies, *g* = .353, 95% CI [.152-.555, *p*= .01), with no evidence of heterogeneity within results ($Q_{(11)}$= 6.880, *p* = .80, I^2= .00).

We computed an average follow-up effect size for VRET vs. classical evidence-based interventions. Results showed significant difference (13 studies, *g* = .615, 95% CI [.179-1.052], *p*= .00), indicating medium significant effect size for VRET relative to classical evidence-based interventions at follow-up. There was evidence of heterogeneity at follow-up, with statistically significant difference between VRET and classical interventions average effect size ($Q_{(12)}$= 42.84, *p* = .00, I^2=71.99).

3.1.3.4. VRET vs. exposure based interventions

There were five studies regarding the comparison at post-test between VRET and exposure based interventions. The effect size demonstrates a lack of differences between the two techniques at post-test (5 studies, *g* = .122, 95% CI [-.225-.469, *p*= .49), with no statistically significant heterogeneity ($Q_{(4)}$= 1.238, *p* = .87, I^2=.00).

We also compared VRET with exposure based interventions at follow-up and results showed medium significant effect size in favor of VRET (9 studies, *g* = .697, 95% CI [.101-1.292], *p*= .02), with statistically significant evidence of heterogeneity ($Q_{(8)}$= 31.45, *p* = .00, I^2=74.56).

3.1.3.5. Moderators of the overall efficacy of VRET at post-test and follow-up

The overall effect size of VRET pointed out statistically significant heterogeneity at post-test. There were two significant moderators of the efficacy of VRET at post-test: the quality of randomized trials and the mean age (see Table 1, Table 2). This result means that low quality of studies lead to increased differences between VRET and the other interventions included in the analysis. A second significant moderator was the mean age of participants, with greater efficacy of VRET in the case of young participants.

Table 1

Meta- regression analysis with continuous variables for the overall efficacy of VRET at post-test and follow-up

MODERATOR	TIME	*K*	B	STANDARD ERROR	95% CI	*Z*	Q MODEL	*P*
N	post	16	-0.003	0.01	[-0.02; 0.01]	-0.34	0.12	0.726
M_{age}	post	16	-0.000	0.00	[-0.00; -0.00]	-2.18	4.78*	0.028

Gender	post	16	-0.000	0.00	[-0.00; -0.00]	-0.69	0.48	0.485
Nr. exposure session	post	16	-0.081	0.11	[-0.29; 0.13]	-0.73	0.53	0.463
Quality ratings	post	16	-0.171	0.07	[-0.31; -0.03]	-2.40	5.79*	0.016
N	follow-up	15	-0.023	0.01	[-0.04; -0.00]	-2.22	4.96*	0.025
M_{age}	follow-up	15	0.000	0.00	[-0.00; 0.00]	0.66	0.43	0.508
Gender	follow-up	15	-0.000	0.00	[-0.00; 0.00]	-1.02	1.05	0.304
Nr. exposure session	follow-up	15	0.068	0.14	[-0.21; 0.35]	0.46	0.21	0.640
Quality ratings	follow-up	15	-0.022	0.10	[-0.22; 0.17]	-0.22	0.05	0.822

Note. Nr. = number; N = number/ study; M_{age} = mean age; k = number of studies included in the meta-analysis; 95% CI = 95% confidence interval around the weighted mean effect size; * = $p < .05$.

Table 2
Moderation analysis with categorical variables for the overall efficacy of VRET at post-test and follow-up

MODERATOR	TIME	CATEGORY	*K*	*G*	*P*	Q_W	*P*	95% CI	Q_B	*P*
Outcome type	post								2.682	0.612
		Behavioral	9	0.42	0.047	14.97	0.060	[0.00; 0.83]		
		Cognitive	7	0.22	0.301	7.78	0.254	[-0.20; 0.66]		
		Specific distress	16	0.59	0.000	30.28	0.011	[0.39; 0.87]		
		General distress	8	0.67	0.002	41.74	0.000	[0.24; 1.09]		
		Physiological	4	0.51	0.093	4.67	0.197	[-0.08; 1.10]		
Outcome type	follow-up								2.602	0.457
		Behavioral	13	0.41	0.002	24.02	0.020	[0.20; 0.91]		
		Cognitive	2	0.53	0.159	0.11	0.736	[-0.20; 1.26]		
		Specific distress	10	0.31	0.020	28.34	0.001	[0.06; 0.74]		
		General distress	3	0.13	0.925	0.74	0.690	[-0.52; 0.58]		
Follow-up	follow-up								21.345*	0.000

	12 months	4	0.00	0.956	0.20	0.977	[-0.34; 0.33]
	3 months	3	1.82	0.000	1.01	0.601	[1.12; 2.52]
	6 months	6	0.25	0.097	10.32	0.067	[-0.04; 0.56]

Note. k = number of studies included in the meta-analysis; *g* = Hedge's *g*; 95% CI = 95% confidence interval around the weighted mean effect size; * = $p < .05$. One study (Wiederhold & Wiederhold, 2003) that analyzes the efficacy of VRET at 36 months follow-up was excluded from the analysis presented here.

Regarding the overall efficacy of VRET at follow-up, there were two significant moderators that can explain the observed variability in effect sizes (see Table 3, Table 4). The first significant moderator was the number of participants. Thus, a small number of participants increase the opportunity to observe an overrated effect size. A second moderator was the follow-up intervals. VRET effect size is significantly higher at 3 month follow-up, while at 6 and 12 months there are not significant differences observed (see Table 4). Also, there are significant differences between 3 and 6 month follow-up (Q_b = 11.96, p = .00) and 3 and 12 month follow-up (Q_b = 23.60, p = .00), but not between 6 and 12 month follow-up (Q_b = 1.23, p = .26). This shows that the difference between VRET and other types of interventions examined is higher when the follow-up is established faster.

3.1.3.6. Moderators of the efficacy of VRET vs. control conditions at post-test

Regarding the comparison between VRET and control conditions at post-test, on account of few studies it was not possible to perform meta-regression analysis. Moderation analysis, with categorical variable-outcome types, revealed not significant moderators (see Table 3).

Table 3

Moderation analysis with categorical variables for the efficacy of VRET vs. control at post-test

MODERATOR	TIME	CATEGORY	*K*	*G*	*P*	Q_W	*P*	95% CI	Q_B	*P*
Outcome type	post								4.732	0.094
		Behavioral	3	0.95	0.034	6.78	0.034	[0.07; 1.83]		
		Specific distress	4	1.12	0.002	10.05	0.018	[0.40; 1.84]		
		General distress	2	2.48	0.000	5.22	0.022	[1.31; 3.65]		

Note. k = number of studies included in the meta-analysis; *g* = Hedge's *g*; 95% CI = 95% confidence interval around the weighted mean effect size; * = $p < .05$. Due to their small number, studies that analyzed the efficacy of VRET on cognitive and physiological outcomes were not included in the analysis presented here.

3.1.3.7. Moderators of the efficacy of VRET vs. classical evidence-based intervention at follow-up

The comparison between VRET and classical evidence-based interventions pointed out statistically significant heterogeneity at follow-up. The first significant moderator was the number of participants (see Table 4). The strength of the mean weighted effect size tends to increase in smaller samples. A second moderator was the follow-up intervals (see Table 5). There are significant differences between 3 and 6 month follow-up (Q_b = 12.43, p = .00) and 3 and 12 month follow-up (Q_b = 23.60, p = .00), but not between 6 and 12 month follow-up (Q_b = 0.12, p = .72). This shows that the difference between VRET and classical evidence-based interventions is higher at a 3 month follow-up.

Table 4

Moderation analysis with continuous variables for the efficacy of VRET vs. classical evidence-based intervention at follow-up

MODERATOR	TIME	*K*	B	STANDARD ERROR	95% CI	*Z*	Q_{MODEL}	*P*
N	follow-up	13	-0.024	0.01	[-0.04; -0.00]	-2.11	4.47*	0.003
M_{age}	follow-up	13	0.000	0.00	[-0.00; 0.00]	0.92	0.85	0.355
Gender	follow-up	13	-0.000	0.00	[-0.00; 0.00]	-1.02	1.04	0.306
Nr. exposure session	follow-up	13	0.085	0.15	[-0.22; 0.39]	0.53	0.28	0.592
Quality ratings	follow-up	13	-0.020	0.14	[-0.30; 0.26]	-0.13	0.01	0.890

Note. Nr. = number; N = number/ study; M_{age} = mean age; k = number of studies included in the meta-analysis; 95% CI = 95% confidence interval around the weighted mean effect size; * = p < .05.

Table 5

Moderation analysis with categorical variables for the efficacy of VRET vs. classical evidence-based intervention at follow-up

MODERATOR	TIME	CATEGORY	*K*	*G*	*P*	Q_W	*P*	95% CI	Q_B	*P*
Outcome type	follow-up								2.945	0.229
		Behavioral	11	0.68	0.002	23.52	0.009	[0.24; 1.11]		
		Specific distress	8	0.35	0.102	25.59	0.001	[-0.07; 0.78]		
		General distress	3	0.03	0.925	0.74	0.690	[-0.60; 0.66]		
Follow-up	follow-up								24.27*	0.000
		12 months	4	-0.01	0.938	0.20	0.977	[-0.31; 0.29]		
		3 months	3	1.81	0.000	1.01	0.601	[1.13; 2.49]		
		6 months	4	0.05	0.755	6.96	0.073	[-0.29; 0.40]		

Note. k = number of studies included in the meta-analysis; g = Hedge's g; 95% CI = 95% confidence interval around the weighted mean effect size; * = p < .05. Due to their small number, studies that analyzed the efficacy of VRET on cognitive and physiological outcomes were not included in the analysis presented here. One study (Wiederhold & Wiederhold, 2003) that analyzes the efficacy of VRET at 36 months follow-up was excluded from the analysis presented here.

3.1.3.8. Moderators of the efficacy of VRET vs. exposure based interventions at follow-up

Results revealed three significant moderators that can explain the observed variability in effect size - the number of exposure sessions, the outcome type and the follow-up intervals (see Table 6, Table 7). First, the higher number of exposures led to a larger effect size of VRET when is compared with the efficacy of exposure based interventions at follow-up. A second moderator was the outcome type (see Table 7). There are significant differences between behavioral outcome measures and specific distress measures, with significant better results on behavioral outcomes (Q_b = 5.97, p = .01). This shows that the difference between VRET and exposure based interventions is higher on behavioral outcome measures than on specific distress ones. A third moderator was the follow-up intervals (see Table 7). There are significant differences between 3 and 6 month follow-up (Q_b = 11.07, p = .00) and 3 and 12 month follow-up (Q_b = 14.53, p = .00), but not between 6 and 12 month follow-up (Q_b = 0.00, p = .97). This shows that the difference between VRET and exposure based interventions is higher at a 3 month follow-up.

Table 6

Moderation analysis with continuous variables for the efficacy of VRET vs. exposure based interventions at follow-up

MODERATOR	TIME	*K*	B	STANDARD ERROR	95% CI	*Z*	Q MODEL	*P*
N	follow-up	9	-0.024	0.01	[-0.05; 0.00]	-1.69	2.87	0.089
M_{age}	follow-up	9	0.000	0.00	[-0.00; 0.00]	1.03	9.17	0.300
Gender	follow-up	9	0.000	0.00	[-0.00; 0.00]	0.25	0.06	0.798
Nr. exposure session	follow-up	9	0.948	0.17	[0.59; 1.29]	5.29	28.02^{*}	0.000
Quality ratings	follow-up	9	-0.154	0.42	[-0.98; 0.67]	-0.36	0.13	0.714

Note. Nr. = number; N = number/ study; M_{age} = mean age; k = number of studies included in the meta-analysis; 95% CI = 95% confidence interval around the weighted mean effect size; * = p < .05.

Table 7

Moderation analysis with categorical variables for the efficacy of VRET vs. exposure based interventions at follow-up

MODERATOR	TIME	CATEGORY	*K*	*G*	*P*	Q_W	*P*	95% CI	Q_B	*P*
Outcome type	follow-up								5.792	0.016
		Behavioral	8	1.06	0.000	19.05	0.008	[0.49; 1.63]		
		Specific distress	4	0.01	0.966	3.67	0.299	[-0.62; 0.65]		
Follow-up	follow-up								14.977*	0.001

12 months	2	-0.06	0.764	0.00	0.937	[-0.49; 0.36]
3 months	2	2.15	0.000	0.38	0.537	[1.06; 3.24]
6 months	3	-0.09	0.674	3.93	0.140	[-0.51; 0.33]

Note. k = number of studies included in the meta-analysis; *g* = Hedge's *g*; 95% CI = 95% confidence interval around the weighted mean effect size; * = $p < .05$. Due to their small number, studies that analyzed the efficacy of VRET on cognitive, general distresss and physiological outcomes were not included in the analysis presented here. One study (Wiederhold & Wiederhold, 2003) that analyzes the efficacy of VRET at 36 months follow-up was excluded from the analysis presented here.

3.1.3.9. Publication bias

We computed the Duval and Tweedie's (2000) trim-and-fill procedure to investigate the presence of publication bias. Due to a small number of studies, publication bias analysis were conducted for the significant overall effect sizes of VRET at post-test and follow-up, comparing VRET vs. control conditions at post-test, VRET vs. classical evidence-based interventions at post-test and follow-up, and VRET vs. exposure based interventions at follow-up.

For the overall effect size of VRET at post-test, trim-and-fill procedure estimated 3 studies with effect sizes higher than the mean, which did not change significantly the results, *g* = .731, 95% CI [.461-1.000], Q = 47.98. At follow-up, 3 studies with effect sizes bellow the mean were estimated to significantly reduce the medium effect size of VRET to a small one, *g* = .392, 95% CI [.006-.778], Q = 59.22.

When comparing VRET with control conditions at post-test, trim-and-fill procedure estimated 2 studies with effect sizes lower than the mean, which did not change significantly the results, *g* = .865, 95% CI [.122-1.608], Q = 24.42.

For the comparative analysis at post-test between VRET and classical evidence-based interventions, trim-and-fill procedure estimated no study with effects higher or lower than the mean, which could modify the results. This indicated that our results are not affected by publication bias. At follow-up, for the same comparison, 4 studies with effect sizes bellow the mean were estimated to significantly reduce the effect size of VRET, *g* = .221, 95% CI [-.247-.689], Q = 70.07. The funnel plot showed some asymmetry, suggesting the possibility that our results are affected by publication bias, overestimating VRET efficacy compared to classical evidence-based interventions at follow-up.

When comparing VRET with exposure based interventions at follow-up, trim-and-fill procedure estimated 3 studies with and effect size lower than the mean, which change significantly the results, *g* = .201, 95% CI [-.418-.822], Q = 51.33. The funnel plot pointed out some asymmetry, suggesting the possibility of overestimating results of VRET efficacy vs. exposure based interventions at follow-up.

3.1.4. Discussion & conclusions

3.1.4.1. Main effects

Results pointed out significant efficacy of VRET in flight anxiety at post-test (*g* = .592, *p*= .00) with two significant moderators of this effect size: the quality of randomized trials and the mean age of the participants. Results are similar to previous systematic reviews that suggest that a low quality of studies leads to increased differences between the two conditions compared (Cuijpers, van Straten, Bohlmeijer, Hollon, & Andersson, 2010; Higgins et al., 2011). Although it is impossible to figure out the extent to which biases have affected the results, it is important that future studies to be conducted with higher quality. Also, present data showed that decreased age of participants is a predictor for the higher effectiveness of VRET. This result is not very surprising, considering that young people are major consumers of technology and can adapt more easily to a new type of treatment that uses the latest technological devices (Horgan & Sweeney, 2010).

Likewise, the follow-up results show significant efficacy of VRET in flight anxiety at follow-up (g = .588, p= .00). We observed two significant moderators that can explain the observed variability of this effect size: the number of participants and the follow-up intervals. Thus, a small number of participants and follow-up established earlier increase the opportunity to observe an overrated follow-up efficacy of VRET in flight anxiety.

Further, data highlighted the superiority of VRET vs. control conditions at post-test (g = 1.350, p= .00) and follow-up (g = .583, p= .01), with no significant moderators at post-test and no statistically significant heterogeneity at follow-up.

Based on present results, VRET is superior to classical evidence-based interventions at post-test (g = .353, p= .01), with no evidence of heterogeneity within results. The result remains significant at follow-up, showing VRET superiority versus the efficacy of classical evidence-based interventions (g = .615, p= .00), with two significant moderators that can explain the observed variability in effect sizes: the number of participants and the follow-up intervals. Therefore, a small number of participants and follow-up established earlier increase the opportunity to observe an overrated efficacy of VRET versus the efficacy of classical evidence-based interventions in flight anxiety, at follow-up.

Post-treatment results show similar efficacy of VRET and exposure based interventions (g = .122, p= .49), with no statistically significant difference of heterogeneity. Not least, treatment gains over time are better using VRET vs. exposure based interventions (g = .697, p= .02), with significant heterogeneity, explained by three moderators: the number of exposure sessions, the outcome type and the follow-up intervals. Given these points, higher number of exposures, the use and the analysis of behavioral measures and early set follow-up intervals led to a larger effect size of VRET compared to exposure based interventions for flight anxiety treatment.

Even if these findings are interesting and claim VRET superiority as a general effect and versus control conditions at post-test and follow-up, classical evidence based interventions at post-test and follow-up, and exposure based interventions at follow-up, these conclusions must be considered with caution given the bias of publication. The analysis conducted in this review show that the only effect that is not affected by publication bias is the efficacy of VRET compared to classical evidence-based interventions at post-test. This result certifies that VRET intervention can be successfully used in therapy, with a series of advantages over classical intervention. Otherwise, to test the stability of the conclusions outlined above, with the ultimate goal of developing efficient therapeutic protocols for this type of anxiety, it is necessary that future studies on flight anxiety to include a larger number of participants and follow the study quality guidelines.

3.1.4.2. Theoretical and clinical implications

The present meta-analysis is the first study that analyzes in detailed and comparative the effectiveness of VRET for treating flight anxiety. Research in the field of anxiety disorders needed this study because VRET represents a new area in treating flight anxiety and there is a stringent necessity to shape a line of research based on a quantitative synthesis. Furthermore, this study represents the solution for estimating the overall effect sizes of VRET in flight anxiety, by developing statistical power to detect significant effects of VRET, existing variability and clinical significance of changes after VRET.

Results of this quantitative synthesis challenge the classic CBT paradigm. One interesting result is the lack of difference observed between VRET and exposure based interventions at post-test, which shows that VRET is as effective as the classical exposure techniques in flight anxiety. This may be due to the fact that although the method of exposure delivery is different, the mechanism of change that occurs is the same- the process of habituation (David, Matu, & David, 2013). At the same time, this promising result can be explained by looking at the advantages that this new method of exposure has towards classical methods: a safe and controlled exposure environment, increase control over the phobic content, the possibility of repeated exposure sessions, particularized exposure sessions and low financial and time costs for patients (Emmelkamp, 2005).

A second unexpected result is that VRET is more efficient than exposure based interventions at follow-up. This can be explained again by analyzing the VR exposure advantages (Emmelkamp, 2005). First, this type of exposure is a novelty element for participants, feature that leads to increased expectations. In addition, using VR technology, the phobic stimulus is more environmentally friendly, does not create aversion and can predict long-term exposure in the real environment. In opposition, direct exposure to the real environment, when possible, can lead to diminished confidence in treatment, changing expectations or giving up the treatment. In case of *'in imago'* exposure, results of therapy are dependent on the patient's ability to recreate the phobic stimulus, which may explain the low results of treatment at follow-up. Patient's ability to represent phobic stimulus is not a constant variable and it is very difficult to be controlled by the therapist (Wiederhold & Wiederhold, 2003). Taking these arguments into account, we can say again that VRET owns advantages compared to exposure based interventions may explain the better results of VRET in time.

Another surprising result is that VRET is more effective for treating flight anxiety than classical evidence-based interventions. Considering that VRET is as effective as exposure based interventions, but is more effective than classical evidence-based therapies that include exposure based interventions, it is possible that classical evidence-based interventions without exposure techniques have small effects in treating flight anxiety. Unfortunately, we did not have enough data to analyze the effectiveness of these therapies versus control conditions, but we encourage future studies that will compare the effectiveness of VRET with a classical therapy without exposure techniques to include a control group in their designs and analysis. Therefore, it is essential that therapists use exposure techniques for clients with flight anxiety. Also, this result suggests that further research in the field of flight anxiety should focus their attention on developing exposure based interventions, integrating VR advantages. Keeping in mind this conclusion, we believe it is time for classical therapies to integrate this type of exposure in their protocols.

From a clinical point of view, we need to keep in mind that, based on current results, VRET may be more effective compared to exposure based interventions or classical evidence-based interventions on long-term, if the number of exposure sessions conducted with the patient is higher. In addition, moderator analyses shows that there is a pressing need for the development of therapeutic protocols for flight anxiety, so effects of VR based therapy to be observed at emotional and cognitive level, and to be maintained over time, not only at 3 months after completion of therapy. The present meta-analysis represents the first step in reducing patients' and therapist's costs and developing benefits for patients diagnosed with flight anxiety. Present results are proof of the effectiveness of VRET for flight anxiety.

Regarding future studies that will be conducted in this area, the present data show that it is necessary to include a larger number of participants, to analyze VRET effects on several levels- cognitive, emotional, behavioral and psychophysiological. In addition, results highlight the importance of developing high quality studies, with long-term follow-up intervals, multiple exposure sessions, with larger and heterogeneous samples.

3.1.4.3. Limitations and future directions

Conclusions presented in this meta-analysis have several limitations. First, there were a limited number of studies included in the analyses which could lead to a weaker statistical power, and limited the conclusions that can be draw from these comparisons. This limit can be observed also from the moderation analysis performed as there were no sufficient studies to test for all the potential moderators. Therefore, further researches should analyze the effectiveness of VRET in flight anxiety, and the stability of current findings. Second, in line with the first limit, the number of participants included in this meta-analysis was small (N = 454). As moderator analysis highlights, future studies need to include larger number of participants. Third, it is possible that percentages of heterogeneity of effect sizes could be explained by the inclusion of more potential moderators (e.g. immersion level, diagnosis length), variables that are poorly reported/detailed in randomized clinical trials on flight anxiety. Not least, we need to mention that although it was made an analysis of the clinical trials' quality, we did not exclude studies with low quality, due to the small number of eligible studies for the analysis. Therefore, there is a stringent need for future clinical trials to meet or, at least, to describe Cochrane's criteria for quality assessment.

All things considered, the present meta-analysis is a testament of the efficacy of VRET in flight anxiety and encourages the use of this type of exposure both, in clinical practice and research fields. From a clinical and theoretical point of view, present results represent a shift from the classic to the modern therapies in treating flight anxiety.

3.2. Study 2: The Map of Cognitive Processes in Flight Anxiety: a Path Analysis

3.2.1. Introduction

Even if there is a large body of empirical evidence which demonstrates that irrational beliefs are critical processes in the emergence of various anxiety disorders (Bridges, Harnish, & others, 2010; Lupu & Iftene, 2009; Montgomery, David, DiLorenzo, & Schnur, 2007; Vîslă, Flückiger, Grosse, & David, 2015), there are few studies that analyzed the organization and interrelationships among irrational belief processes on psychopathological outcomes (Hyland, Shevlin, Adamson, & Boduszek, 2014). A possible solution to this research problem is the development of empirical work that directly assesses the role of irrational beliefs in the maintenance of symptomatology. This type of research can improve the theoretical understanding of the cognitive model of flight anxiety and could help the development of more efficacious evidence-based treatments.

Starting from the fundamental theoretical assumption of REBT (Ellis, 1994), flight anxiety is not directly determined by life events (e.g., plane accidents, an unpleasant flight), but is rather the results of our evaluative beliefs about these events or about the outcome (e.g., primary anxiety) of classical conditioning relating such events. Evaluative beliefs about an event refer to the way in which a person can interpret that event. Thus, the REBT theory (David, Ellis, & Lynn, 2010) argues that there are two modalities to interpret an event: irrationally or rationally.

An irrational evaluation of an event is a rigid cognitive process, logical incoherent, not grounded in empirical, and /or pragmatically reality (see David, Ellis, & Lynn, 2010). According to contemporary REBT theory (David, Ellis, & Lynn, 2010), there are four types of irrational beliefs: 1) demandingness (DEM), 2) catastrophizing (CAT), 3) low frustration tolerance/frustration intolerance (LFT), and 4) global evaluations (GE). These irrational beliefs – be them more general (e.g., in the form of cognitive schema) or more specific (e.g., in the form of automatic thoughts) - are associated with dysfunctional cognitive (e.g., descriptive/inferential automatic thoughts), dysfunctional negative emotions, and maladaptive behavior responses (David, Ellis, & Lynn, 2010; Ellis, 1994; Vîslă et al., 2015). Various empirical research (DiLorenzo, David, & Montgomery, 2007; Hyland et al., 2014b; Oltean, Hyland, Vallières, & David, in press) argues that DEM is the core irrational cognitive process and the other three are products of it. This interaction mode between irrational beliefs and their dysfunctional consequences represent REBT's model of psychopathology (Browne, Dowd, & Freeman, 2010; Hyland & Boduszek, 2012). According to this model, DEM can predict the valence of secondary irrational beliefs, CAT, LFT, and GE, which in turn can predict increased levels of negative dysfunctional cognitive, emotional and/or behavior consequences.

On the other hand, a rational evaluation of an event is a flexible cognitive process, non-extreme, and logically coherent, with pragmatic and/or empirically supported beliefs (David & Cramer, 2010; David, Ellis, & Lynn, 2010). There are four rational alternatives to irrational beliefs: 1) preference (PRE), 2) realistic evaluation of badness (REB), 3) high frustration tolerance/frustration intolerance (HFT), and 4) unconditional acceptance (UA). As opposed to irrational beliefs, rational cognitions lead to adaptive/ functional consequences. According to REBT's model of psychological health (Browne, Dowd, & Freeman, 2010), PRE, the primary rational belief, predict the valence of secondary rational beliefs, REB, HFT, and UA, which in turn predict functional consequences. From a clinical point of view, the main objective of REBT protocols is to teach patients to dispute irrational beliefs, to change them in rational cognitive processes, which will automatically attract functional cognitive, emotional and behavior consequences (David, Ellis, & Lynn, 2010).

Even if REBT' protocols for flight anxiety are effective (Deacon & Abramowitz, 2004; Emmelkamp et al., 1985; Hodges & Rothbaum, 2000b), these focuses on modification of all four types of irrational beliefs, undifferentiated, using the same cognitive techniques, although there is still no scientific evidence to prove that all four types of irrational beliefs are factors that maintain flight anxiety. This practice, based on a lack of evidence data, can draw a number of consequences of the therapy. First, therapy takes too long, because it can become a priority the change of irrational thoughts that are not primary factors for the generation and/or maintenance of flight anxiety. As a result of this practice, the analysis of maintenance factors of anxiety remain as a secondary purpose. Second, the psychological conceptualization is poorly understood by patients. Third, if the primary irrational belief is not sufficient disputed, exists the possibility that results will not be maintained over time.

Given these points, there is a pressing need to develop future empirical research that analyzes the role of irrational cognitive processes in the generation and/or maintenance of flight anxiety symptomatology. Data from these studies may lead to the development of new cognitive techniques and therapeutic protocols, individualized for the primary and secondary cognitive mechanism involved in maintaining anxiety symptoms.

3.2.1.1. Overview of the current study

First goal of the present study was to explore if the primary irrational belief, DEM, as stated by REBT model, can predict the valence of secondary irrational beliefs, CAT, LFT, and GE, which in turn can predict increased levels of flight anxiety (see Figure 1). Secondly, we analyzed if the primary rational belief, PRE, as stated by the REBT model, can predict the valence of secondary rational beliefs, REB, HFT, and UA, LFT, and GE, which in turn can predict decreased levels of flight anxiety (see Figure 2). To our knowledge, the present study is the first to assess the organization of irrational and rational beliefs in terms of their direct and indirect effects on flight anxiety.

3.2.2. Method

3.2.2.1. Participants and procedures

Participants were recruited online by means of social networks (i.e., Facebook), and by sending invitations via e-mail. Individuals that were interested to participate in the study were given a link whereboth the informed consent and the questionnaires were completed. After singing the informed consent, participants provided demographic data (see APPENDIX 6). Participants were assured about the confidentiality of data submitted during the trial.

The convenience sample included 186 participants, 152 females (81.7%) and 34 males (18.3%), ranged in age from 18 to 59 years, with a mean age of 25.89 years (*SD* = 9.34). Regarding the previous experience with flight, 32.8% of participants have never flown, while 67.2% have flown at least once.

3.2.2.2. Measures

The *Attitudes and Belief Scale 2-Abbreviated Version* (ABS-2-AV: Hyland, Shevlin, Adamson, & Boduszek, 2014a) measures the four irrational belief processes (DEM, CAT. LFT, and GE) and the four rational belief processes (PRE, REB, HFT, and UA).

The *Flight Anxiety Modality Questionnaire* (FAM: Van Gerwen, Spinhoven, Van Dyck, & Diekstra, 1999) is a 23-item questionnaire measuring the symptoms of anxiety in flight situations.

3.2.2.3. Analysis

The following variables were included in the first proposed path analysis of REBT’s psychopathology model predicting flight anxiety: DEM, CAT, LFT, GE, and flight anxiety. For the second proposed REBT model, psychological health model predicting flight anxiety, we included the following variables: PRE, REB, HFT, UA, and flight anxiety. Both models were tested in a structural equation modelling program (Mplus, version 7.0: Muthén & Muthén, 2013), using the maximum-likelihood method of parameter estimation. We used this analysis because it allows simultaneous examination of multiple direct and indirect predicted paths and provides global indices of the fit between data and the theoretical model (Holmbeck, 1997).

3.2.3. Results

3.2.3.1. Descriptive statistics

Our sample reported moderate levels of each of the irrational and rational beliefs with the exception of global evaluation beliefs which were low. Flight anxiety level was moderate to high.

3.2.3.2. REBT's psychopathology model predicting flight anxiety

The fit of the REBT's psychopathology model for flight anxiety (see Figure 1) provided acceptable fit [χ^2 = .302, *df* = 1, *p* = .582; CFI = 1.00; TLI = 1.05; RMSEA = .00 (95% CI = .00 - .01); SRMR = 0.00]. The standardized coefficients showed that CAT (β = .32, *p* = .00) and LFT beliefs (β=.44, *p* = .00) were positively predicted by DEM, while GE beliefs (β = .08, *p* = .21) were not significantly predicted by DEM. Irrational beliefs that positively and significantly predicted levels of flight anxiety (β = .20, *p* = .00) were LFT beliefs. CAT (β = -.11, *p* = .16) and GE beliefs (β=.14, *p* = .14) have not predicted levels of flight anxiety. LFT beliefs accounted of 20% of the levels of flight anxiety variances. CAT and GE beliefs did not bring a significant contribution to the tested model (*p* > .05). A positive statistically significant indirect effect was observed between DEM beliefs and flight anxiety via LFT beliefs (β = .49, SE = .20, *p* = .01).

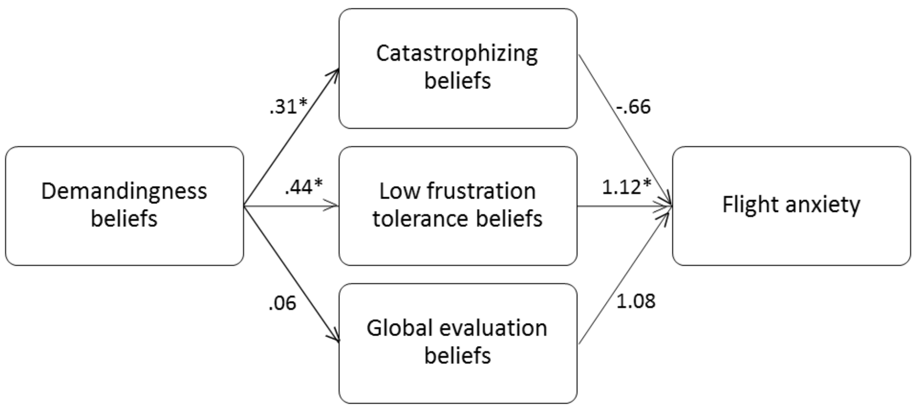

Figure 1. REBT's psychopathology model predicting flight anxiety

3.2.3.3. REBT's psychological health model predicting flight anxiety

The REBT's psychological health model for flight anxiety (see Figure 4) provided an acceptable fit of the sample data [χ^2 = .012, *df* = 1, *p* = .912; CFI = 1.00; TLI = 1.06; RMSEA = .00 (95% CI = .00 - .07); SRMR = 0.00].

Parameter estimates indicated that PRE beliefs positively predicted REB (β = .46, *p* = .00), HFT (β = .57, *p* = .00), and UA (β = .19, *p* = .00) beliefs. The only category of rational beliefs that negatively and significantly predicted levels of flight anxiety were HFT beliefs (β = -.17, *p* = .02). The other two categories, REB beliefs (β = .00, *p* = .92) and UA beliefs (β = .10, *p* = .17), have not significantly predicted levels of flight anxiety. HFT beliefs inversely accounted of 33% of the levels of flight anxiety variances. REBT and UA beliefs did not bring a significant contribution to the tested model (*p* > .05).

A negative statistically significant indirect effect was observed between PRE beliefs and levels of flight anxiety via HFT beliefs (β = -.56, SE = .25, *p* = .02).

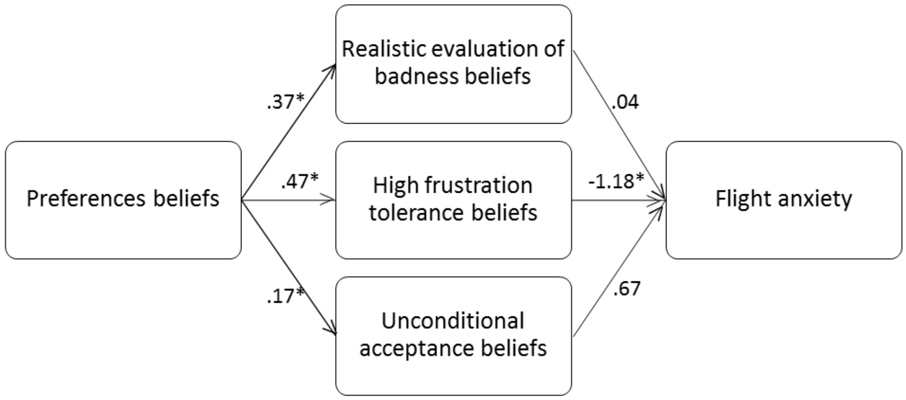

Figure 2. REBT's psychological health model predicting flight anxiety

3.2.4. Discussion

The aim of this study was to evaluate for the first time the validity of the REBT's psychopathology and psychological health models for predicting flight anxiety.

First, based on analysis of fit indicators, the path analysis results proved the validity of REBT's psychopathology model for predicting flight anxiety levels. The primary irrational cognitive processes involved in predicting flight anxiety levels were LFT beliefs. Specifically, increased levels of LFT beliefs were positively associated with flight anxiety. Secondly, DEM beliefs significantly predicted increased levels of flight anxiety via LFT beliefs.

Regarding REBT's psychological health model for predicting flight anxiety, path analysis results provided an acceptable fit of it. The critical cognitive variables which negatively predicted flight anxiety levels were HFT beliefs. More precisely, increased levels of HFT beliefs were negatively associated with flight anxiety. Further, PRE beliefs significantly contributed to decreased levels of flight anxiety via HFT beliefs.

Current results show that REBT treatment for flight anxiety symptomatology can be developed by primary relying on the modification of demandingness beliefs, along with low frustration tolerance beliefs. Moreover, given that irrational and rational beliefs are different constructs - high levels of irrational beliefs do not necessary reflect low levels of rational beliefs, and vice versa (David, 2015), based on current findings, for reducing flight anxiety, it is important to use REBT techniques for developing preference and high frustration tolerance beliefs. Therefore, decreases in symptoms of flight anxiety can be best achieved through the reduction of DEM and LFT beliefs and by increasing levels of PRE and HFT beliefs.

Although these results are promising, more research is needed to validate the possibility that DEM and PRE beliefs are the primary irrational/ rational belief processes that affect the flight anxiety symptomatology in an indirect way, via LFT/ HFT beliefs. There are a serious of limitations of the current study that must be taken into consideration, and because of which we cannot draw very firm conclusions. First, the generalization of current results to a clinical or a larger population cannot be done. A second limitation of the study is that we measured flight anxiety levels using a self-report instrument (FAM: Van Gerwen et al., 1999), which can be a source of bias for our results. Therefore, to validate the conclusions of the present study, future research should replicate the current study among diverse population groups, with larger sample sizes and different measurement tools, and by using experimental or longitudinal designs.

3.3. Study 3: From Theory to Scientific Data: Expectancy Bias in Flight Anxiety and their Link to Attentional Bias, Cognitive and Affective Variables.

3.3.1. Introduction

Even though more than ten years of research demonstrates the effectiveness of different treatments for flight anxiety (Deacon & Abramowitz, 2004; Emmelkamp et al., 1985; Hodges & Rothbaum, 2000a), some recent research (Oakes & Bor, 2010a) draws attention to the fact that many of these treatments have not been developed on the basis of scientific data. Due to this lack of scientific data regarding the development and efficacy of psychological treatment for flight anxiety, mechanisms that maintain this type of anxiety are not known.

The cognitive model explains psychopathology in terms of exaggerated responses to activating events (Beck & Haigh, 2014). Specifically, we can say that flight anxiety is caused by exaggerated responses to activating events. According to this theory (Beck & Haigh, 2014), a source of these exaggerations in reactions refers to cognitive distortions- cognitive biases in information processing. In anxious disorders a series of such cognitive distortions have been identified, such as attentional bias (Bar-Haim et al., 2007a; Pergamin-Hight, Naim, Bakermans-Kranenburg, van IJzendoorn, & Bar-Haim, 2015) or expectancy bias (Butler & Mathews, 1983; Foa et al., 1996; Mühlberger et al., 2006).

A large number of recent research (Bar-Haim, 2010a; MacLeod & Mathews, 2012a) has demonstrated a selective attention allocation process on social anxiety disorder, especially for threatening stimuli. This selective attention to threat maintains the anxiety symptoms by facilitating a negative selective information process (Beard, 2011b; Hallion & Ruscio, 2011). Even if these studies argue for the causal role of the attentional bias in developing and maintaining anxious symptoms, the impact of this distortion was not analyzed in all types of anxiety disorders. To our knowledge, there is no study that evaluates if attentional bias is a factor in maintaining flight anxiety.

As one of the most prominent characteristics of anxiety is the expectation of negative outcomes, recent studies (Butler & Mathews, 1983; Foa et al., 1996; Mühlberger et al., 2006) investigated expectancy bias in anxiety, as a source of exaggerations in response to activating events. A higher expectation to encounter a threat is conceptualized as encountering expectancy bias (Aue & Hoeppli, 2012; de Jong & Muris, 2002), whereas consequence expectancy biases might manifest as higher expectations that such encounters will generate aversive results (Aue & Okon-Singer, 2015). Studies report expectancy biases in various forms of anxiety, including generalized anxiety disorder (Butler & Mathews, 1983) and social anxiety (Foa et al., 1996), as well as specific phobias (Mühlberger et al., 2006).

Interestingly, some studies indicate that expectancy biases can be diminished in anxiety disorders by using cognitive-behavioral strategies (Foa et al., 1996; Lucock & Salkovskis, 1988). Considering that the purpose of cognitive-behavioral strategies is to restructure dysfunctional thoughts and to change them in functional thoughts, we consider it is important to analyze the effect of inducing various types of cognitive distortions on these types of thoughts. These techniques were also used to modify attentional biases in different anxiety disorders (Cristea, Kok, & Cuijpers, 2015; Mogoaşe, David, & Koster, 2014), but generated mixed results after more replications. Thus, some authors proposed that different types of cognitive biases would operate together rather than in isolation, therefore a direction of research aimed to test combined cognitive bias hypothesis emerged (Hirsch, Clark, & Mathews, 2006).

3.3.1.1. Overview of the current study

To test the effect of consequence expectancy bias in attention, in the present paper we designed a conditioning-like procedure to manipulate the perceived probability that certain classes of stimuli will be immediately followed by an aversive consequence. As we were particularly interested in flight phobia, we used similar sets of stimuli as in past work (e.g. Pauli, Wiedemann, & Montoya, 1998), consisting of pictures of flying airplane (positive stimuli) and crashed airplanes (negative stimuli), and pictures of mushrooms (neutral stimuli). By differentially administering an unpleasant sound in two groups following the presentation of the three image categories, we aimed to test potential changes in the engagement and disengagement of attention toward the same stimuli categories. In addition, we also analyzed the effects of inducing expectancy bias on flight anxiety levels, rational and irrational beliefs. We hypothesized that participants from the expectancy bias induction group would display a stronger attention bias than controls and will report significantly higher levels of flight anxiety and irrational beliefs, and significantly lower levels of rational beliefs.

3.3.2. Method

3.3.2.1. Participants

One hundred twenty-four participants were recruited online by means of social networks (i.e. Facebook) and by e-mail invitations. Persons interested in participating in the study received a direct link to the online experiment. After singing the informed consent, participants provided demographic data. Participants were assured about the confidentiality of data submitted during the trial.

Eleven participants were excluded from the study because they completed only the pre-test questionnaires and have not followed the experimental tasks. Finally, the sample, included 113 participants, randomly assigned into one of two groups: the control condition and the expectancy bias induction group. Sample consisted of 95 females (84%) and 18 males (16%), ranged in age from 18 to 55 years, with a mean age of 24.56 years (*SD* = 8.02). Regarding the previous experience with flight, 32.7% of participants have never flown, while 67.3% have flown at least once.

3.3.2.2. Measures

The *expectancy bias assessment* was conducted via PsyToolkit platform (http://www.psytoolkit.org/). The experimental paradigm was a modified version of 'threat' conditioning procedure described by Davey (1992).

The *attentional bias assessment*, before and after the expectancy bias modification procedure, was made using an exogenous-cueing approach (Posner, 1980). The original version of Posner task was modified in past studies to include categories of stimuli relevant for anxiety and phobia (N. Amir, Elias, Klumpp, & Przeworski, 2003; Koster, Crombez, Verschuere, & De Houwer, 2006) and is aimed to measure the engagement and disengagement components of attention.

The *State-Trait Anxiety Inventory- X2 Form* (STAI-X2; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to evaluate anxiety as a trait before the experimental procedure.

The *Flight Anxiety Situations Questionnaire* (FAS; Van Gerwen, Spinhoven, Van Dyck, & Diekstra, 1999) was used in the present study to evaluate flight anxiety before and after the experimental procedure.

The *Attitudes and Belief Scale 2-Abbreviated Version* (ABS-2-AV: Hyland, Shevlin, Adamson, & Boduszek, 2014a) measures the four irrational belief processes (DE,. CAT. LFT, and GE) and the four rational belief processes (PRE. REB, HFT, and UA).

3.3.2.3. Procedure:

The experiment was implemented online via PsyToolKit Platform (Stoet, 2010). An invitation to participate in the study was delivered via social platforms and e-mail invitations. Participants were told that the experiment tests cognitive mechanisms in anxiety. They were also told that their participation is voluntary, that the study procedure does not imply any risk, and they can stop the participation in any moment. After the sound-calibration phase, an expectancy bias task was completed. The first and the third sequences of the expectancy bias task were aimed at assessing the expectancy bias, while the second block was a modification procedure. Participants were randomly distributed to one of two experimental conditions by using a randomize function within PsyToolkit. Participants were distributed to either a control condition (where the unpleasant sound was equally administrated in 33% of cases for each stimulus category), or an expectancy bias induction group (where the unpleasant sound had 66% chance to occur for the crashed airplane stimulus category, while the other two stimulus categories were not followed by the unpleasant sound). At post-test, expectancy and attentional biases were measured using the same tasks as those from the pre-test assessment, followed by the self-report measures.

The *expectancy bias modification sequence* consisted of 27 trials identical to the assessment sequences, except for the fact that in this sequence the unpleasant sound was administered in the inter-trial interval (immediately after the image's offset). Participants that were randomized in the control condition received the unpleasant sound in 33% of the cases after at the onset of images from each category, whereas participants distributed in the induction group received the unpleasant sound in 66% of the cases for images with crashed airplanes.

3.2.3.3.1. Stimuli

The same sets of stimuli were used in the expectancy and the attention bias tasks. Stimuli consisted of pictures with either a flying airplane, a crashed airplane or champignon mushrooms as used in past work (see Pauli, Wiedemann, & Montoya, 1998). Three pictures of each stimuli category were collected from the Internet. To ensure different affective quality of the stimuli, we used a procedure that has been used in other studies (Bardeen & Orcutt, 2011), therefore 16 students rated each stimulus on three dimensions: positive valence, negative valence and arousal. The Analysis of Variance (ANOVA) with the within factor valence type (positive, negative and arousal) and the between factor Slide Category revealed significant difference between threat, positive and neutral stimuli regarding positive valence, negative valence and arousal.

3.3.3. Results

3.3.3.1. Pre-test outcome variables

Pre-test group differences on outcome variables were assessed by multivariate analyses of variance (MANOVA) and we found no significant pretreatment differences among conditions (all p_s >.05).

3.3.3.2. Expectancy bias outcomes

Results from ANOVA pointed out significant differences between groups for expectancy bias to threat stimuli at post-test, $F(1, 112) = 18.21$, $p = .00$, positive stimuli, $F(1, 112) = 9.32$, $p = .00$, and neutral stimuli, $F(1, 112) = 30.01$, $p = .00$, with higher expectancy bias levels to threat stimuli in the induction group and higher expectancy bias levels to positive and neutral stimuli in the control condition. Results show that the induction procedure was effective.

3.3.3.3. Cognitive and affective outcomes

In order to calculate the attentional bias levels, first we excluded the uncued (11%) and incorrect trials (1.25 %). Then, we excluded the trials with response times of 50 ms or less (0.06%), and 1200 ms or more (0.95%). In the next step, trials that were either 3 standard deviation above (1.5%) or below the median (0.01%) were excluded, and this was done separately for each group and time by calculating the median for each of the four cases.

A 2 (group) x 2 (time) repeated measures analyses was conducted to test interventions effects on cognitive and affective outcomes. Power analyses were conducted by using the multivariate partial η2 provided by SPSS for each effect (Cohen, 1988; small effect size - η2= .01; medium effect size η2=.06; large effect size= .14).

Results from the mixed MANOVA point out an overall significant main effect of time, Wilk's Λ = .646, F (5, 107) = 11.70, $p = .00$, η2 = .35. Univariate test indicated a significant time effect for the irrational beliefs levels, F (1, 111) = 14.28, $p = .00$, η2 = .11, with significant lower levels at post-test. We did not notice significant main effect of time for the rational beliefs levels, F (1, 111) = 1.35, $p = .24$, η2 = .01, engagement of attention, F (1, 111) = 2.82, $p = .09$, η2 = .02, and disengagement of attention, F (1, 111) = 0.86, $p = .35$, η2 = .00.

Pairwise comparisons on significant interaction within effect group x time revealed significant decreases from pre-test to post-test in both groups for the irrational beliefs and flight anxiety levels ($p_s < .05$).

Comparative analysis of the two groups at post-test showed that there were no significant between subjects' effects for any outcomes, Wilk's Λ = .966, F (5, 107) = .75, $p = .58$, η2 = .03.

3.3.4. Conclusions and Discussions

The aim of this study was to investigate the interplay between expectancy and attentional biases in flight anxiety, and the effects of inducing expectancy bias on flight anxiety, rational and irrational beliefs levels. Contrary to our predictions, even though the inducing procedure of expectancy bias was effective (higher expectancy bias levels to threat stimuli in the induction group and higher expectancy bias levels to positive and neutral stimuli in the control condition), we did not notice any significant differences between the two groups on flight anxiety levels, and on rational and irrational beliefs.

First, findings of this study suggest that expectancy and attentional biases are different, unrelated constructs in flight anxiety. Second, to our knowledge, this is the first study that analyzed the effects of expectancy bias on flight anxiety levels and rational and irrational beliefs. Results of the present study show that induction of expectancy bias does not increase levels of flight anxiety and irrational thoughts. Contrary to our expectations, we noticed a decrease of irrational beliefs and flight anxiety levels from pre-test to post-test in both groups. Analyzing the means we observed that the decrease of these variables from pre-test to post-test is small. Comparative analysis showed non-significant differences between groups at post-test regarding irrational beliefs and flight anxiety levels. We can assume that the effect is a secondary one of the computerized probe, or that a placebo effect has occurred.

The present study has a series of limitations which must be taken into consideration, and because of which we cannot draw very firm conclusions. First, we suggest that future studies should analyze the two types of cognitive distortion by subliminal measurements. Second, rational and irrational beliefs were measured before and after the experimental induction procedure. Future studies that will analyze the effects of expectancy bias induction on cognitive level, should measure rational and irrational beliefs after each presented stimulus. Future studies should analyze conscious expectancy of participants in the link between expectancy and attentional biases.

3.4. Study 4: Exploring the use of Attentional Bias Modification augmented Cognitive-Behavioral based Virtual Reality Exposure Therapy in Flight Phobia: A Pilot Randomized Clinical Trial

3.4.1. Introduction

Although classical exposure techniques for flight phobia are widely used and effective treatments (Oakes & Bor, 2010a; Van Gerwen et al., 2002), they involve certain limitations (Olatunji et al., 2009). For example, approximately 25% of patients refuse this type of treatment when they are informed about it (Garcia-Palacios et al., 2007; Olatunji et al., 2009). Efforts to develop the effectiveness, benefits and access to evidence-based psychotherapies have led to a new method of delivering exposure techniques, specifically, the use of virtual reality (VR; Da Costa, Sardinha, & Nardi, 2008). In recent years, VR has been utilized as the exposure component of CBT, and systematic reviews (see Cardoş, David, & David, 2017; Da Costa et al., 2008; Price, Anderson, & Rothbaum,2008) reporting controlled trials or case studies emphasize that cognitive behavior therapy based virtual reality (VRCBT), is an efficient and effective treatment for flying phobia. Even though VRCBT is effective and is based on effective CBT protocols, Oakes and Bor (2010b) highlighted the fact that many treatments for flight phobia, including CBT, have been developed in the absence of a mainstream psychological research and consequently we do not know which factors that maintain anxiety are addressed and which elements of these treatments lead to changes in the flight phobia symptoms.

For example, Clark and Rock (2016) notes that although a large number of recent researches have demonstrated a selective attention allocation process on different types of anxiety disorders (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007) no evaluation of this possible bias toward flight-related treat stimuli was identified. Since 2010, Oakes and Bor (2010a) suggested that attentional bias has a potential role in the maintenance of flight phobia, but there are still no studies to assess the link between flight phobia specific symptomatology and attentional distortions. There are a number of experimental and effective tasks (e.g. ABM- attentional bias modification training) to reduce attentional bias in some anxiety disorders (Nader Amir et al., 2009; Nader Amir, Weber, Beard, Bomyea, & Taylor, 2008; Heeren, Lievens, & Philippot, 2011; Heeren, Reese, McNally, & Philippot, 2012; MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002; Schmidt, Richey, Buckner, & Timpano, 2009).

First, keeping in mind this puzzle of data, we can assume that there is a possible relationship between attentional bias and flight phobia symptomatology, but we have no evidence of it. Second, we do not know whether alteration of the attentional bias through attentional bias modification trainings can lead to a change in the flight phobia symptomatology or can impact other maintaining mechanisms of this type of anxiety.

Some authors proposed that different types of cognitive biases would operate together rather than in isolation, therefore a new direction of research emerged with the aim to test combined cognitive bias hypothesis (Hirsch et al., 2006). Studies report expectancy biases in various forms of anxiety, including generalized anxiety disorder (Butler & Mathews, 1983) and social anxiety (Foa et al., 1996), as well as flying phobia (Mühlberger et al., 2006). To the best of our knowledge, there are still no studies to analyze the impact of therapeutic interventions on expectancy biases in flight phobia. On the same note, even if it is known that individuals with flight phobia present a memory bias toward threat words (Bogaerde, Pieters, & De Raedt, 2012) there are no studies to analyze the impact of therapeutic interventions on this type of cognitive distortion in flight phobia.

3.4.1.1. Overview of the current study

This parallel-group, superiority randomized controlled pilot study, aimed to investigate the efficacy of an attentional bias modification augmented cognitive-behavioral virtual reality exposure therapy (ABM-VRCBT) vs. VRCBT for patients diagnosed with flight phobia. Based on the results of previous studies and theoretical models discussed above, the main objective of the present study was to test the efficacy of ABM-VRCBT versus VRCBT on affective, cognitive conscious and unconscious process, and behavioral symptoms.

3.4.2. Method

3.4.2.1. Design

This superiority trial used an experimental design with two conditions: 1) ABM-VRCBT, as an experimental treatment package and 2) VRCBT, as an evidence-based intervention. Time was treated as a repeated measure. Measures were collected at pre-treatment and at post-treatment (after the final exposure session). Three clinical psychologists trained in the application of the ABM and VRCBT treatment protocols and supervised by one senior clinical psychologist provided treatment in the two conditions. Participants were randomly assigned to their experimental conditions, and they did not know to which group they belong.

3.4.2.2. Participants

The final sample used for the pilot study data analysis consists of 30 subjects: 11 in the ABM-VRCBT group and 19 in the VRCBT group. Sample consisted of 76.7% female and 23.3% male, ranged in age from 20 to 47 years, with a mean age of 30.50 years (SD = 7.53). Regarding the previous experience with flight, 30% of participants have never flown, while 70% have flown at least once. The average time that passed since the a) first flight was equal with 8.33 years (SD = 9.18), and b) last flight is equal with 12 months (SD = 20.43). The mean of the number of flights taken by participants throughout their lives is 14.66 flight (SD = 24.31).

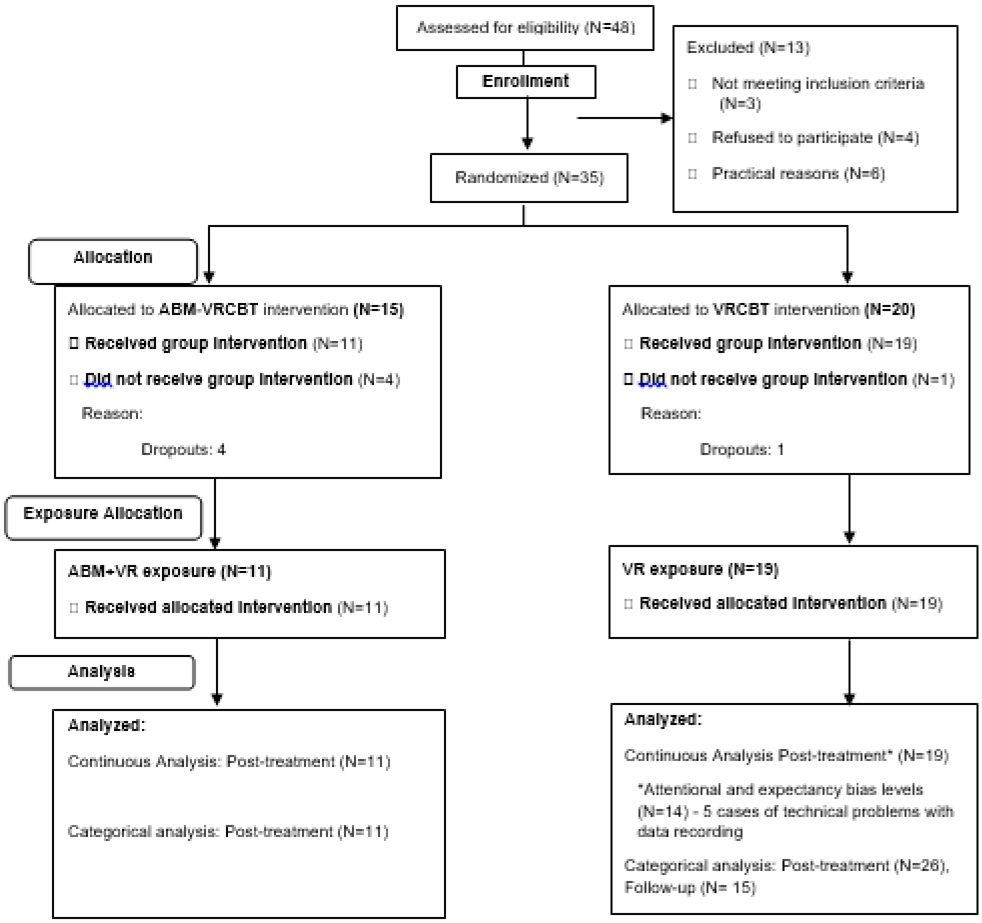

Figure 1. Flow diagram of the progress through the phases of the trial.

3.4.2.3. Measures

3.4.2.3.1. Selection of participants

The *Structured Clinical Interview for DSM-IV* (SCID; First, Spitzer, Gibbon, & Williams, 1995) was used to establish if participants fulfill the diagnostic criteria for flight phobia. Moreover, this semi-structured interview was used to test whether participants met the inclusion and exclusion criteria.

The *SCID-II Personality Questionnaire* (SCID-II/PQ; First et al., 1997) was used for the screening step, as a criterion for exclusion of participants presenting flight phobia comorbidity on Axis II. No subjects demonstrated specific symptoms of personality disorders.

The *Beck Depression Inventory II* (BDI; Beck, Steer, & Brown, 1996) measures the severity of self-reported depression in adolescents and adults. It is a self-report measure, a 21-item inventory that assesses the severity of depressive symptomatology. The BDI-II has been found to have high internal consistency (e.g., Cronbach's α = .92; Beck et al., 1996).

3.4.2.3.2. Outcome measures

Participants were evaluated before therapy and at the end of intervention.

The *Flight Anxiety Situations Questionnaire* (FAS; Van Gerwen, Spinhoven, Van Dyck & Diekstra, 1999) was used as a primary outcome, to measure flight anxiety levels.

The *Fear of Flying Inventory* (FFI; Scott, 1987) is a 33-item scale measuring intensity of fear of flying.

The *Profile of Affective Distress (*PDA; Opriș & Macavei, 2007) is a self-report questionnaire used in the present study to measure functional and dysfunctional emotions, as well as positive emotions.

The *State-Trait Anxiety Inventory- X Form* (STAI-X; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) was used to evaluate anxiety as a state and trait before and after treatments.

The *Attitudes and Belief Scale 2* (ABS-2; DiGiusepee, Leaf, Exner, & Robin, 1988) measures the four irrational belief processes (demandingness, catastrophizing, low frustration tolerance, and global evaluations) and the four rational belief processes (preferences, realistic evaluation of badness, high frustration tolerance, and unconditional acceptance).

The *Automatic Thoughts Questionnaire* (ATQ, Hollon & Kendall, $\alpha = .92$) measures the frequency of negative automatic thoughts.

The *Flight Anxiety Rational and Irrational Beliefs Scale* (FA-RIBS; David & Cardoș, in preparation) evaluate the frequency of rational and irrational beliefs in flight anxiety through 48 items (16 rational, 16 irrational and 16 neutral).

Behavioral outcome measure: participants' intention to fly was measured before and after the treatment through one ten-point Likert scale item ["On a scale from 0 (not at all) to 10 (very much) how big is your intention to fly now by airplane?"].

Measurements related to treatment: participants' satisfaction with treatment was measure after through one item on a five-point Likert scale ("How satisfied are you with the treatment you received?").

Measurements used during the VR exposure session: to measure flight anxiety levels during exposure in VR we used The Subjective Units of Discomfort (SUDs; Wolpe, 1973). SUDS, ranging from 0 (*no anxiety response*) to 100 (*overwhelming anxiety*), was used every 3 minutes for each environment in which the participant was exposed.

3.4.2.4. Apparatus

3.4.2.4.1. VR exposure technique

The VR application for flight phobia exposure intervention was created by VirtuallyBetter Inc., USA and it is designed to simulate a real flight. VR HMD system contains a computer with Intel® Core™ 2 Duo Processor T7600, 1 GB RAM, NVIDIA, GeForce 7900 eMagin Z800 HMD, with headtracking, headset. Patients were introduced through a set of HMD in a virtual 3D environment in which they saw the lobby of an airport, the boarding gates, the route followed before boarding into the plane and the plane itself.

3.4.2.4.2. Attentional bias assessment

Attentional bias level was measured before and after the attentional bias modification procedure in the ABM-VRCBT group and before and after the VR exposure in the VRCBT group, using an exogenous-cueing approach (Posner, 1980). The original version of Posner task was modified to include categories of stimuli relevant for flight phobia, following the procedure used by Amir, Weber, Beard, Bomyea, & Taylor (2008).

3.4.2.4.3. Attentional bias modification

The attentional bias modification task was a modified version of the classical dot-probe task (MacLeod, Mathews, & Tata, 1986b). In 80% the position of the threatening word predicted the position of the probe.

3.4.2.4.4. Expectancy and memory bias assessment

The expectancy bias assessment was conducted via PsyToolkit platform (http://www.psytoolkit.org/). The experimental paradigm was a modified version of 'threat' conditioning procedure described by Davey (1992). After the expectancy bias assessment task, at post-test, participants had to complete a 2 minutes Stroop Task (http://www.psytoolkit.org/experiment-library/stroop.html) used to distract participants from the initial task. After the Stroop Task, subjects were presented 20 stimulus word (10 neutral and 10 threatening) in the form of an encoding task. Following the encoding task, participants received a form to write the words they viewed on the screen.

3.4.2.5. Procedure

Participants in both treatment groups participated at three meetings. The protocol designed for this is an adaptation of the protocols used in previous studies (Muhlberg, Wiedemann, & Pauli, 2003). After the online screening, the administration of FAS, FFI, FA-RIBS, STAI, Satisfaction and Expectancies scales, participants were scheduled to an individual assessment meeting at our laboratory. At this meeting the informed consent was signed and all the questions asked by the participants were answered. At the same time, SCID interview, pre-test questionnaires and the attentional and expectancy assessment tasks were completed. After this meeting, participants were scheduled for the first stage of the treatment.

3.4.2.5.1. The VRCBT protocol

The VRCBT protocol was based on REBT theory (Ellis, 1995), and consists of four major components: (a) psychoeducation, (b) cognitive restructuring, (c) relaxation technique and (d) behavioral intervention.

3.4.2.5.2. The ABM-VRCBT protocol

The ABM-VRCBT protocol was similar to the VRCBT protocol, but besides its four components (psychoeducation, cognitive restructuring, relaxation technique, and behavioral intervention) the ABM-VRCBT protocol included an extra component, namely attentional bias modification training. Before and after the exposure in VR, participants in ABM-VRCBT group were instructed to perform the attentional bias modification task.

3.4.3. Results

3.4.3.1. Data analysis

First, a 2 (group) x 2 (time) multivariate repeated measures analyses was conducted to test interventions effects on affective, self-reported cognitive and behavioral outcomes. Second, a 2 (group) x 2 (time) multivariate repeated measures analyses was conducted to test interventions effects on attentional and expectancy bias. Power analyses were conducted by using the multivariate partial $\eta 2$ provided by SPSS for each effect (Cohen, 1988; small effect size - $\eta 2$= .01; medium effect size $\eta 2$=.06; large effect size= .14). Third, to analyze comparatively participants' memory bias and satisfaction with treatment at post-test, we used *t* tests on independent samples.

Categorical analysis was performed to assess differences between the effectiveness of the two treatments on flight phobia diagnostic criteria, based on post-treatment SCID-I interview. We calculated the Chi-Square to assess differences between the effectiveness of the two treatments taking into account the diagnostic criteria analyzed with the SCID interview after the treatment (McGough & Farone, 2009). In addition, to analyze whether individuals displayed improvement, a reliable change index was developed to measure those who improved or ($p<.05$)

over time. As the FAS was the primary outcome measure for flight phobia symptomatology, this scale was used in the determination of reliable change.

3.4.3.2. Primary outcome

Univariate test indicated a significant time effect for the FAS, F (1, 28) = 41.29, p = .00, η2 = .59. Pairwise comparisons on significant interaction within effect group x time revealed significant decreases from pre-test to post-test in both groups for flight anxiety levels (FAS), $p_s <$ .05 (ABM-VRCBT d = 3.42; VRCBT d = 0.81). Comparative analysis of the two interventions showed that there were no significant between subjects' effects for flight anxiety levels, at any assessment time ($p_s <$ .05).

3.4.3.3. Secondary outcomes

3.4.3.3.1. Affective, cognitive and behavioral outcomes

Results from multivariate repeated measures analyses pointed out an overall significant main effect of time, Wilk's Λ = .143, F (13, 16) = 7.38, p = .00, η2 = .85. Univariate test indicated a significant time effect for the FFI, F (1, 28) = 37.31, p = .00, η2 = .57, PDA negative dysfunctional emotions subscale, F (1, 28) = 4.43, p = .04, η2 = .13, PDA negative functional subscale, F (1, 28) = 13.20, p = .00, η2 = .32, STAI-X1, F (1, 28) = 14.22, p = .00, η2 = .33, STAI-X2, F (1, 28) = 5.17, p = .03, η2 = .15, ABS-2 irrational beliefs subscale, F (1, 28) = 16.40, p = .00, η2 = .36, ABS-2 rational beliefs subscale, F (1, 28) = 13.27, p = .00, η2 = .32, FA-RIBS irrational beliefs subscale, F (1, 28) = 31.15, p = .00, η2 = .52, with significant lower levels at post-test, and for the FA-RIBS rational beliefs subscale, F (1, 28) = 10.65, p = .00, η2 = .27, and intention to fly, F (1,28) = 8.75, p = .00, η2 = .23, with significantly higher levels at post-test. We did not notice significant main effect of time for the PDA positive emotions subscale, F (1, 28) = 1.59, p = .21, η2 = .05, and for the ATQ, F (1, 28) = 0.19, p = .89, η2 = .00.

Pairwise comparisons on significant interaction within effect group x time revealed significant decreases from pre-test to post-test in both groups for the FFI (ABM-VRCBT d = 2.88; VRCBT d = 0.61), ABS-2 irrational beliefs (ABM-VRCBT d = 0.37; VRCBT d = 0.31), ABS-2 rational beliefs (ABM-VRCBT d = 0.84; VRCBT d = 1.08), FA-RIBS irrational beliefs (ABM-VRCBT d = 1.66; VRCBT d = 0.43), and significant increases from pre-test to post-test in both groups for FA-RIBS rational beliefs (ABM-VRCBT d = 0.85; VRCBT d = 0.79; $p_s <$ .05). Results showed significant decreases from pre-test to post-test for PDA negative dysfunctional (d = 0.38) and functional emotions (d = 0.55), STAI-X1 (d = 1.09), STAI-X2 (d = 0.85), and significant increases from pre-test to post-test for intention to fly variable (d = 1.02), only in the ABM-VRCBT group ($p_s <$ .05).

Comparative analysis of the two interventions showed that there were no significant between subjects' effects for any outcomes at any assessment time, Wilk's Λ = .50, F (13, 16) = .35, p = .35, η2 = .49.

3.4.3.3.2. Cognitive distortions outcomes

Results from the mixed MANOVA pointed out an overall significant main effect of time, Wilk's Λ = .67, F (2, 22) = 15.02, p = .01, η2 = .32. Univariate test indicated a significant time effect for expectancy bias levels, F (1, 23) = 5.74, p = .02, η2 = .20, and no significant time effect for attentional bias levels, F (1, 23) = 2.20, p = .15, η2 = .08. Pairwise comparisons revealed significant decreases of expectancy bias levels from pre-test to post-test only in the VRCBT group (d = 0.41).

Comparative analysis of the two interventions showed that there were no significant between subjects' effects for any outcomes at any assessment time, Wilk's $\Lambda = .906$, $F(2, 22) = 1.13$, $p = .33$, $\eta2 = .32$.

The analysis between groups at post-test revealed no significant differences of memory bias levels, $t(28) = .59$, $p = .55$, $d = 0.22$, intention to book a flight ticket in the next 3 months, $t(28) = -.16$, $p = .87$, $d = 0.06$, and satisfaction with treatment $t(28) = -.41$, $p = .58$, $d = 0.15$.

3.4.3.4. Categorical analysis

At the end of the treatment phase, 81.8% of ABM-VRCBT group and 57.9% of VRCBT group have no longer met the diagnostic criteria for flight phobia (SCID-I interview), with no significant between-group differences: χ^2 (1, $N = 30$) =.246, p =.17.

In the ABM-VRCBT condition 11/11 (100%) subjects reliably improved compared to 16/19 (84.2%) in the VRCBT condition. Each participant who achieves a reliability change index of at least 1.96 ($\alpha = 0.05$) was considered to have made a clinically significant amount of improvement (Jacobson, Follette, & Revenstorf, 1984).

3.4.4. Discussion and Conclusions

Generally speaking, the outcome analysis of this pilot study shows that, ABM-VRCBT and VRCBT are both effective in reducing key flight phobia symptoms. However, the within effects demonstrates better effects for the ABM-VRCBT to decrease negative dysfunctional and functional emotions, anxiety as state and trait and to increase levels of intention to fly, and better effects for the VRCBT to decrease expectancy bias levels. First, based on previous theoretical models of anxiety disorders (Bar-Haim, 2010b; MacLeod & Mathews, 2012b) we assumed that a decrease in the attentional bias level will lead to lower flight phobia symptoms. Our data did not fit theoretical models, since in the current study ABM-VRCBT intervention seems more efficient in reducing some psychological variables than VRCBT intervention from pre-test to post-test, despite the fact that attentional biases did not change. Although this is a pilot study and we cannot draw firm conclusions, analyzing means of attentional bias levels, we can assume that better results from ABM-VRCBT group from pre-test to post-test can be seen as a result of other mechanisms of change, trained by our attentional task, such as developing attentional control (Bar-Haim, 2010b). Moreover, the attentional bias assessment was made at a 600 milliseconds presentation, procedure found in previous studies (Nader Amir et al., 2009; MacLeod et al., 1986). A time of 500 milliseconds or more is seen as a threshold where some participants' attention resources are allocated by priority to the emotional stimuli, while others avoid threatening stimuli (Cisler, Bacon, & Williams, 2009). To measure changes in attentional bias, future studies can apply an exposure time of 200 ms or shorter.

Second, based on the recent cognitive bias hypothesis (Hirsch et al., 2006) we assumed that different types of cognitive biases would operate together rather than in isolation. So we expected that modifying attentional bias to neutral stimuli will significantly reduce expectancy and memory bias levels, compared to a non-modification group. We observed in the VRCBT group a significant change from pre-test to post-test of expectancy bias levels, a change that does not take place in the ABM-VRCBT group. At the same time, we did not notice any significant difference with regard to memory bias or attentional bias levels. Based on the present pilot study, we can say that the modification of attentional bias does not increase levels of expectancy bias or memory bias. This conclusion, according to which there is no link between attentional and expectancy biases in flight anxiety, has been demonstrated in Study 3, presented in this paper. We consider that this hypothesis should be analyzed in future clinical studies. If expectancy bias levels are involved in maintaining anxiety and are not related to other cognitive distortions, independent psychological techniques should be developed to reduce expectancy distortions and to analyze their independent effect on flight phobia symptoms.

Third, outcome analysis of this pilot study showed that ABM-VRCBT and VRCBT are equally efficient for the treatment of flight phobia. Both groups have a common component: exposure in VR and CBT techniques. It is possible that the similarity of the results of the ABM-VRCBT and VRCBT in the treatment of flight phobia is related to this component. In order to further confirm the efficacy of ABM-VRCBT for the treatment of flight phobia, future research should include a third control condition, a placebo group or a waiting list.

Some of the novel features of the present pilot study were the use of cognitive restructuring and relaxation through abdominal breathing techniques in VR, the use of rational psychological pills and the assessment of the full spectrum of flight phobia. Another strength of the present study is the use for the first time of a combined VRCBT intervention with attentional bias modification for flight phobia treatment. Even if data from this pilot study does not show the superiority of ABM-VRCBT intervention compared to VRCBT for flight phobia, findings of this study are a launch pad for future studies that will analyze new computer techniques for the treatment of flight phobia and for the analysis of its maintenance factors.

It is important to mention the limitations of this study. First, the attentional bias assessment was made at a 600 milliseconds presentation, without taking into account that this interval may affect the change in attentional bias levels. To measure changes in attentional bias, future studies can apply an exposure time of 200 ms or shorter. Second, the high drop-out rate and the low number of participants could influence final results of the pilot study.

CHAPTER IV. GENERAL CONCLUSIONS AND IMPLICATIONS

4.1. General Conclusions

The general conclusions that can be drawn from the studies included in this thesis are the following:

1) VRET is an efficient intervention for flight phobia, superior to control conditions and classical evidence-based interventions.
2) VRET is similar with exposure based interventions at post-test, but with better treatment gains over time.
3) Low quality trials, with smaller samples, and higher number of exposures led to a larger effect size of VRET for flight anxiety.
4) Increased levels of frustration intolerance beliefs are positively associated with flight anxiety.
5) Demandingness beliefs predict increased levels of flight anxiety via frustration intolerance beliefs.
6) Increased levels of high frustration tolerance beliefs are negatively associated with flight anxiety.
7) Preferences beliefs significantly contribute to decreased levels of flight anxiety via high frustration tolerance beliefs.
8) Expectancy and attentional biases are different, unrelated constructs in flight anxiety.

9) Induction of expectancy bias does not increase levels of flight anxiety and irrational thoughts, which shows that expectancy bias is likely to be a maintenance factor of flight anxiety, not a causal one.
10) ABM-VRCBT and VRCBT are equally effective for patients diagnosed with flight phobia.

4.2. Theoretical Implications

At the theoretical level, we can extract four major contributions from this thesis, related with 1) the theoretical model of virtual reality exposure techniques for flight anxiety, 2) moderator variables of VRET efficacy in flight anxiety, 3) REBT's psychopathology and psychological health models in flight anxiety, and 4) the combined cognitive bias hypothesis in flight anxiety.

First of all, the present paper validates the theoretical model of VRET and the theoretical model of CBT based VR exposure techniques in flight anxiety. Results of the quantitative synthesis (Study 1) challenge the classic theoretical model of CBT in flight anxiety.

Moderator's analysis of the efficacy of VRET in flight anxiety (Study 1) has shown us that low quality trials, with smaller and younger samples led to a larger effect size of VRET for flight anxiety. Also, outcome type (affective, cognitive, behavioral or psychophysiological), the number of exposure sessions and follow-up intervals were significant moderators of the efficacy of VRET in this disorder. This means that the theoretical model of VRET in flight anxiety should take into account the importance of quality of trials, number and age of the samples. At the same time, the development of future therapeutic protocols of VR exposure for anxiety should include assessment sessions of emotional and cognitive levels, and evaluation of the maintenance of results over time, not only at 3 months after completion of therapy.

Results of Study 2 showed us that REBT treatment for flight anxiety can be developed by primary relying on the modification of demandingness beliefs, along with frustration intolerance beliefs. At the same time, it brings scientific evidences to the REBT's theoretical assumptions according to which irrational and rational beliefs are different constructs (David, 2015)**.** Study 2 state that there is much room for improvement and particularization of the REBT theoretical framework and treatment approaches for flight anxiety.

Results of Study 3 and Study 4 represents the first scientific evidence that does not confirm the combined cognitive bias hypothesis in flight anxiety (Hirsch et al., 2006). By implementing Study 3 we demonstrated that expectancy distortions are not related to attentional biases in flight anxiety. Results of the pilot clinical randomized trial showed that attentional biases are not related with flight phobia symptoms and with expectancy and memory biases. Based on our results and previous studies, we say there is a possibility that flight anxiety is maintained by exaggerated responses to activating events (e.g. attentional bias, expectancy bias), without these distorted responses being interrelated.

4.3. Practical Implications

One of the most relevant practical implications highlighted by this work is that VRET is an efficient therapy for flight anxiety symptomatology. Results of the first study represents the first step in reducing patients' and therapist's costs and developing benefits for patients diagnosed with flight phobia.

Another practical implication resulting from the implementation of the first study is that, in order to increase the effects of VRET for flight phobia, therapists should take into account the following variables: the number of exposure, the age of the client, the outcome measures, and the assessment of the results maintenance over time. Briefly, flight phobia patients will achieve effective results after using VRET, if therapists 1) use multiple VR exposure sessions, 2) assess several cognitive, emotional, behavioral and psychophysiological outcomes, both after therapy and in time, and 3) take into account the age of the client (greater efficacy of VRET in the case of young patients).

Results of Study 2 attract a number of practical implications regarding REBT's cognitive techniques for flight anxiety. We found that demandingness beliefs significantly predict increased levels of flight anxiety via frustration intolerance beliefs. On the other hand, we found that preferences beliefs significantly contribute to decreased levels of flight anxiety via high frustration tolerance beliefs. This conclusion is very important for clinical psychologists because, in order to reduce flight anxiety symptoms, they should use cognitive restructuring techniques for demandingness and frustration intolerance irrational beliefs. More, because we know that irrational and rational beliefs are different constructs (David, 2015), therapists must teach patients to develop preferences and high frustration tolerance beliefs.

The study that analyzed the effects of expectancy biases on flight anxiety levels and irrational beliefs (Study 3) showed that induction of expectancy biases does not increase levels of flight anxiety and irrational thoughts. That shows us the possibility that expectancy biases are not causative factors, but it is still possible to represent maintenance factors of flight anxiety.

Finally, the last clinical implication of this work refers to the efficacy of attentional bias modification training augmented VRCBT for flight phobia. Results of the pilot clinical randomized trial (Study 4) showed that both ABM-VRCBT and VRCBT are efficient in reducing flight phobia symptoms. However, ABM-VRBCT seems to be more efficient than VRCBT in terms of within effects. Although this result has to be confirmed by further studies, it shows that cognitive biases related to flight phobia are important factors in clinical practice and they must be taken into account.

4.4. Methodological Implications

First, approaching the meta-analytical perspective allowed us to outline a research line based on quantitative syntheses regarding the efficacy of VRET in flight anxiety. Second, path analysis results proved the validity of REBT's psychopathology and psychological health models for predicting flight anxiety levels. Third, the use of an experimental design in the analysis of cognitive variables in flight anxiety is a research development with major contributions. The development of the four assessment computerized task of cognitive distortions, the expectancy bias induction experimental task, and the attentional bias modification training represent major methodological implications of the present thesis. Computerized tasks of assessing or modifying cognitive distortions in flight anxiety are research springboards, being tasks that can be used/developed in future research.

4.5. Limits and Future Directions

The first limit of the thesis is related to the generalizability level of the findings. Two studies (Study 3 and Study 4) included mainly samples of undergraduate students. At the same time, most of the participants were woman. To overcome this general limitation, future studies should include heterogeneous samples in terms of age, profession and gender.

Second, remaining in the area of the generalizability of the results, two studies (Study 2, Study 3) were conducted on healthy participants. Even though clinical symptomatology was not a goal in these studies, results cannot be generalized in patients with clinical diagnosis. To see if there are differences in outcomes between clinical and non-clinical samples, future studies that will use the same types of design on clinical subjects can bring major contributions.

Third, we measured variables of interest using mostly self-report instruments, which can be a source of bias for our results. We believe that, in order to respond to other methodological issues in the field, further studies need to include behavioral and psychophysiological variables.

Analyzing the balance between the limits and implications of this thesis we are confident that this work brings a series of valuable information on efficacy of computer mediated intervention in flight anxiety.

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[1]Refferences marked with an * indicate studies included in the meta-analysis.

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