

VIRTUAL REALITY EXPOSURE THERAPY IN ANXIETY DISORDERS: A QUANTITATIVE META-ANALYSIS

(David Opris, Sebastian Pintea, Azucena García-Palacios, Cristina Botella,
Stefan Szamosközi, and Daniel David)

Wiley Periodicals, Inc, 2011

Anton Görgl Bsc
0826681

Introduction

- Est. 13,6% of EU population has anxiety disorders (18,1% US)
- Exposure based treatments
 - Form of cognitive behavior therapy (CBT)
 - Among most effective evidence based treatments

Virtual reality exposure therapy (VRET)

- Systematic exposure to feared stimuli within a relevant context and setting
- Standalone or combined with classic therapy
 - Cognitive-behavioral therapy (CBT)
 - Change thoughts, beliefs, attitudes
 - Behavioral therapy (BT)
 - Exposure therapy
 - VRET

Previous meta-analysis

- VRET as standalone
 - Esp. not combined with evidence based interventions
- Often no control group
- Often no randomized clinical trial
- Small number of studies
- Sometimes not state of the art therapy

- Meyerbröker K, Emmelkamp P. Virtual reality exposure therapy in anxiety disorders: a systematic review of process-and-outcome studies. *Depress Anxiety* 2010;27:933–944.
- Powers M, Emmelkamp P. Virtual reality exposure therapy for anxiety disorders: a meta-analysis. *J Anxiety Disord* 2008;22:561–569.

This meta-analysis

- VRET combined with CBT or BT
- Control:
 - Classic evidence based interventions
 - CBT / Group CBT
 - often combined with in vivo exposure
 - Imaginal exposure
 - Waitlist
- 21 Articles from 2000 - 2011

Primary outcomes

- Determine effects of therapy
- Behavioral measurements
 - e.g. actual flights
- Clinical improvement measures
 - Reduction of panic attacks in a timeframe
 - Reduction of severity of panic attacks
- Questionnaires and scales.

Fear of flight – primary outcomes

- Fear of flying inventory
- questionnaire on attitudes toward flying
- fear of flying scale
- general fear of flying questionnaire
- flight anxiety situations questionnaire
- flight anxiety modality questionnaire

Timeline

- 1995: Release Nintendo Virtual Boy
- 2000: Rothbaum B, Hodges L, Smith S, et al. A controlled study of virtual reality exposure therapy for the fear of flying. *J Consult Clin Psychol* 2000;68:1020–1026.
- 2009: Difede J, Cukor J, Jayasinghe N, et al. Virtual reality exposure therapy for the treatment of posttraumatic stress disorder following September 11, 2001. *J Clin Psychiatry* 2007;68:1639–1647.
- 2011: Tortella-Feliu M, Botella C, Llabre´s J, et al. Virtual reality versus computer-aided exposure treatments for fear of flying. *Behav Modif* 2011;35:3–30.
- 2012: Oculus Rift Kickstarter
- 2016: Release Oculus Rift CV1 and HTC vive

A controlled study of virtual reality exposure therapy for the fear of flying.

Rothbaum B, Hodges L, Smith S, et al.
J Consult Clin Psychol 2000;68:1020–1026.

Method

- 45 / 49 subjects completed (15 per group finished)
- 3 Groups, random assignment
 - VRET
 - Standard exposure
 - Waitlist
- Follow ups
 - Pen and Paper measures after 6 and 12 months
 - Actual 1,5h flight (group of 5)

Method

- 8 individual sessions over 6 weeks
- First 4 Sessions identical for VRET and in vivo
 - 1h each
 - Cognitive restructuring against irrational thoughts
 - "this plane is going to crash"
 - "I will panic and embarrass myself / have a heart attack"

VRET

- Sitting in Plane
 - Window seat
 - Look around
- Simulation
 - Take-off, landing
 - Flying in calm and stormy weather
 - Ambient sound
 - Weather, flight attendants,
 - Vibration through chair
- Allowed to progress at own pace



In vivo

- At airport
- 2 Sessions combined due to travel time
- Session 5, 6: Preflight stimuli
 - Ticketing, parked planes, waiting area
- Session 7, 8: on stationary airplane
 - Imagining takeoff, cruising, landing

Hardware

- Pentium II 300MHz
- 128 MB RAM
- Fire GL 1000 GPU
- Virtual Research VR6 HMD with headset
- ThunderSeat
 - embedded 100W Subwoofer
 - Noise and vibration
 - Airplane seatbelt

Virtual Research VR6

- 1998
- LCD 640x480 60hz non-interlaced, per eye
- Head tracking: 3rd Party solution, not included
- Focus plane: 3ft (91cm), fixed



ThunderSeat

- Developed for military air combat trainers
- 15-100W subwoofer in base for vibration



Virtual Reality Exposure Therapy for the Treatment of Posttraumatic Stress Disorder Following September 11, 2001

Difede J, Cukor J, Jayasinghe N, et al.
J Clin Psychiatry 2007;68: 1639–1647

Hardware

- Dell 530 workstation
- Dual 2 Ghz CPUs
- 2GB RAM
- Wildcat 5110 GPU
- Kaiser XL-50 VR helmet
- Polhemus Fastrak position tracking

Kaiser XL-50 VR helmet

- 1024x768 60hz LCD per eye
- 40° horizontal FOV, 30° vertical
- Tracking: not included



Polhemus Fastrak

- 6 DOF
- 120Hz update rate
- 4ms latency
- Accuracy: 0.03 inch (0.76mm) and 0,15°
- Standard range: 4-6ft, (122-182cm)
 - Extendible with long range transmitters
- Tracks with magnetic field

Method

- Waitlist
- VRET
 - Up to 14 sessions (mean= 7,5 StdDev=3,6)
 - Min 6 weeks
 - 45 min / session in VR
 - Asked to recite trauma as if it were happening again
 - Questions about experience from therapist

VRET scenarios

- Jet flies over WTC, no crash. Street sounds.
- Jet hits building,
 - no explosion
 - explosion, no sound effect
 - explosion with sound
- Burning and smoking building with hole
 - no screaming
 - Screaming
 - Screaming and people jumping
- 2nd plane in 2nd tower with audible explosion
- 2nd Tower collapses with dust cloud
- 1st Tower collapses with dust cloud
- Full Sequence

Result

- Treatment showed significant improvement over non-treatment (Waitlist)
- 5/10 patients had participated in imaginal exposure therapy without improvements before VRET. After VRET they showed over 25% in symptoms reduction.

Fear of public speaking

- VRET
 - Auditorium with audience and speaking podium
 - Significant improvements
 - Self report, heart rate
- Control
 - Trivial VR scene
 - No meaningful change

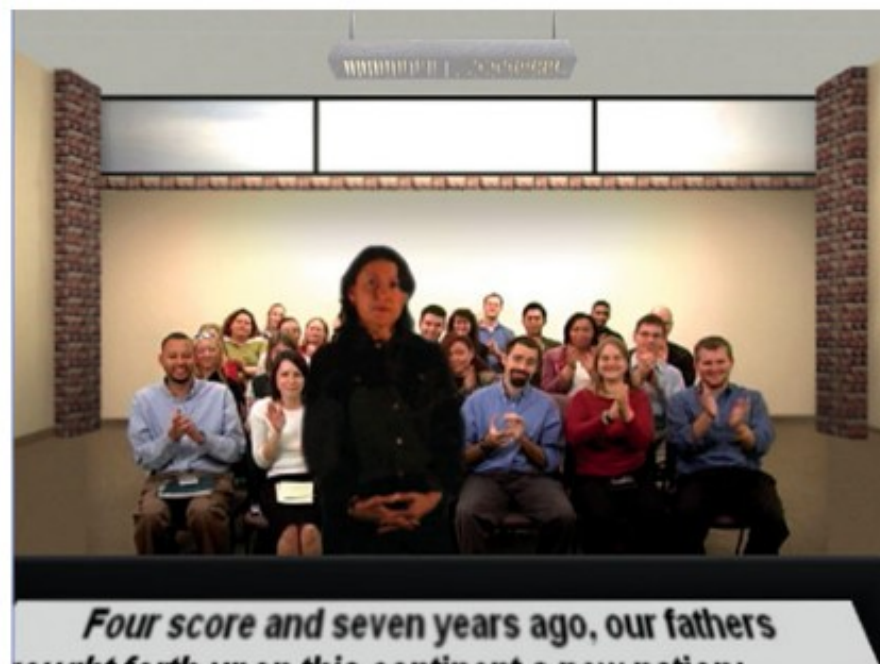


Fig. 2 Virtual classroom for the fear of public speaking (Courtesy of Virtually Better)

PTSD - Vietnam

- Virtual Jungle clearing
 - Jungle sounds
 - Gunfire
 - Helicopter
 - Screams
 - Explosions
- Interior of Huey helicopter
 - Flying over terrains



Fig. 3 Virtual Vietnam scenarios (Courtesy of Virtually Better)

Cohen's d

- No effect (0 – 0,2)
- Low effect (0,2 – 0,5)
- Medium effect (0,5 – 0,8)
- Large effect (>0,8)
- Groups of same size and variance:
- Cohen's D: weighted average mean



$$D = \frac{\mu_1 - \mu_2}{\sigma}$$

Aggregated results (grouped by disorder)

Study	Disorder	Treatment	Comparison	N	Cohen's d
Rothbaum et al.	Fear of flying	VRE+CBT	IVE+CBT	30	0,1
Rothbaum et al.	Fear of flying	VRE+CBT	Waitlist	30	0,64
Wiederhold et al.	Fear of flying	VRE+BT	IMEx	30	0,46
Mühlberger et al.	Fear of flying	VRE+CBT	CBT	37	1,28
Rothbaum et al.	Fear of flying	VRE+CBT	IVE+CBT	54	-0,06
Rothbaum et al.	Fear of flying	VRE+CBT	Waitlist	54	0,47
Krijn et al.	Fear of flying	VRE+BT	CBT	45	0,41
Choi et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	40	-0,45
Botella et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	24	-0,16
Botella et al.	Panic disorder/agoraphobia	VRE+CBT	Waitlist	25	1,74
Peñate et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	28	0,33
Pitti et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	27	0,15
Klinger et al.	Social phobia	VRE+CBT	IVE+GrCBT	36	-0,18
Wallach et al.	Social phobia	VRE+CBT	IMEx+CBT	58	0,34
Wallach et al.	Social phobia	VRE+CBT	Waitlist	58	0,85
Robillard et al.	Social phobia	VRE+CBT	IVE+CBT	30	0,12
Robillard et al.	Social phobia	VRE+CBT	Waitlist	29	1,34
García-Palacios et al.	Arachnophobia	VRE+BT	Waitlist	23	2,38
Michaliszyn et al.	Arachnophobia	VRE+CBT	IVE+CBT	32	-0,26
St-Jacques et al.	Arachnophobia	VRE+CBT	IVE+CBT	31	0,01
Emmelkamp et al.	Acrophobia	VRE+BT	IVE	33	0,24
Krijn et al.	Acrophobia	VRE+BT	Waitlist	28	1,11
Difede et al.	PTSD	VRE+BT	Waitlist	21	1,82

Aggregated results (grouped by comparison treatment)

Study	Disorder	Treatment	Comparison	N	Cohen's d
Rothbaum et al.	Fear of flying	VRE+CBT	Waitlist	54	0,47
Rothbaum et al.	Fear of flying	VRE+CBT	Waitlist	30	0,64
Wallach et al.	Social phobia	VRE+CBT	Waitlist	58	0,85
Krijn et al.	Acrophobia	VRE+BT	Waitlist	28	1,11
Robillard et al.	Social phobia	VRE+CBT	Waitlist	29	1,34
Botella et al.	Panic disorder/agoraphobia	VRE+CBT	Waitlist	25	1,74
Difede et al.	PTSD	VRE+BT	Waitlist	21	1,82
García-Palacios et al.	Arachnophobia	VRE+BT	Waitlist	23	2,38
Choi et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	40	-0,45
Michaliszyn et al.	Arachnophobia	VRE+CBT	IVE+CBT	32	-0,26
Klinger et al.	Social phobia	VRE+CBT	IVE+GrCBT	36	-0,18
Botella et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	24	-0,16
Rothbaum et al.	Fear of flying	VRE+CBT	IVE+CBT	54	-0,06
St-Jacques et al.	Arachnophobia	VRE+CBT	IVE+CBT	31	0,01
Rothbaum et al.	Fear of flying	VRE+CBT	IVE+CBT	30	0,1
Robillard et al.	Social phobia	VRE+CBT	IVE+CBT	30	0,12
Pitti et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	27	0,15
Emmelkamp et al.	Acrophobia	VRE+BT	IVE	33	0,24
Peñate et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	28	0,33
Wallach et al.	Social phobia	VRE+CBT	IMEx+CBT	58	0,34
Wiederhold et al.	Fear of flying	VRE+BT	IMEx	30	0,46
Krijn et al.	Fear of flying	VRE+BT	CBT	45	0,41
Mühlberger et al.	Fear of flying	VRE+CBT	CBT	37	1,28

Choi et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	40		-0,45
Peñate et al.	Panic disorder/agoraphobia	VRE+CBT	IVE+CBT	28		0,33



Choi et al. (2005)

- Evaluation (6 month follow-up)
 - End state functioning
 - 4 weeks panic free
 - panic severity rating < 2 / 9
 - Pen & Paper
 - Medication discontinuation
- Treatment
 - Panic Control Program (Control)
 - **12x 2h group** session, weekly
 - 1 - 9 theory / training
 - 10 - 12 in vivo
 - VRET
 - **4x 2h group**, weekly
 - + **3x 30 min VR** individually
 - Last session in vivo

Peñate et al. (2008)

- Evaluation
 - Pen & Paper
 - Physiological (pulse, skin resistance)
 - Behavioral avoidance
 - Time until in vivo aborted (max 10min)
- Treatment
 - Both 11x 45min individual sessions weekly
 - Session 1-3 theory / training
 - CBT (Control)
 - Sessions 4-11 in vivo
 - VRET
 - 2,5m x 2m 1024x768 projection screen + polarized 3D glasses
 - Sessions 4-11 alternating VR / IVE (4x each)
 - 15-20 min in VR each session

VRET vs. waitlist

- Overall large statistically significant effect.
D=1,12 Var D=0,34 P<5%
- Social phobia: D=1,01 Var D=0,05 P<5%
- Fear of Flight: D=0,53 Var D=0,007 P<5%

VRET vs. classic evidence based interventions

- Post treatment, Primary outcome level
 - No overall effect ($D=0,16$ Var $D=0,16$ $P>5\%$)
 - Positive effect in fear of flying ($D=0,4$ Var $D=0,01$ $P>5\%$)
 - Result not statistically significant
- Post treatment, behavioral level
 - No overall effect ($D=-0,03$ Var $D=0,07$ $P>5\%$)
 - Arachnophobia negative effect ($D=-0,27$ Var $D=0,07$ $P>5\%$)
 - Result not statistically significant
- Post treatment, real life assessment
 - Panic disorder ($D=-0,22$ Var $D=0,02$ $P<5\%$)
 - statistically significant, favoring classical interventions.

VRET vs. classic evidence based interventions

- Follow-up after 3 – 6 months, primary outcome
 - Overall no effect ($D=-0,02$ Var $D=0,18$)
- Follow-up after 12 months, primary outcome
 - Overall no effect ($D=-0,11$ Var $D=0,01$)
- Follow-up, behavioral level
 - Overall low effect ($D=0,24$ Var $D=0,09$ $P>5\%$)
 - Flight: $D=0,33$ Var $D=0,08$ $P<5\%$
- Follow up, clinical improvement
 - Panic disorder: $D=-0,2$ Var $D=0,02$ $P>5\%$

Dose response

- Linear relationship between number of sessions and effect size of each study
- Weighted linear regression
- Result:
 - Correlation between Sessions and effect size.

Dropout rate

- VRET: 16/174
- In vivo: 20/181
- Overall no difference

Conclusion

- Not meant to show effect of VRET by itself
- VRET together with evidence based interventions
- Similar results as evidence based interventions without VR component
 - Slight benefit for classic approach for clinical measures for panic disorders
 - Slight benefit for VRET for fear of flight in follow-ups for primary outcome and real life impact

Advantages VRET

- Can be performed in therapists office
 - Convenient, safe
 - Better control over content and pace
- Repeatable
- Customizable
- Cost effective (plane tickets)

Advantages VRET

- PTSD treatment
 - Help recall otherwise inaccessible traumatic memories required to solve problem
 - In vivo impossible (9/11, WTC no longer exists)
 - In vivo unsafe (combat related PTSD)
- Can increase likelihood to seek treatment
 - Seems less intimidating to face fears in VR than RL

Dropouts

- No significant difference between VRET and classical
- Reasons rarely mentioned in papers
- Sometimes no emotional reaction to the VR environment
 - Drop out or
 - Moved to in vivo
- Sometimes no reaction to classic therapy, but VR

References

- Parsons T, Rizzo A. Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: a meta-analysis. *J Behav Ther Exp Psychiatry* 2008;39:250–261.
- Powers M, Emmelkamp P. Virtual reality exposure therapy for anxiety disorders: a meta-analysis. *J Anxiety Disord* 2008;22:561–569.
- Rothbaum B, Hodges L, Smith S, et al. A controlled study of virtual reality exposure therapy for the fear of flying. *J Consult Clin Psychol* 2000;68:1020–1026.
- Gerardi M, Cukor J, Difede J, et al. Virtual Reality Exposure Therapy for Post-Traumatic Stress Disorder and Other Anxiety Disorders. *Curr Psychiatry Rep* (2010) 12:298–305
- http://www.virtualresearch.com/Acrobat_files/V6MANUAL.PDF
- <https://web.archive.org/web/19990220070722/http://www.thunderseat.net:80/thunder.htm>
- <http://www.mindflux.com.au/products/keo/xl50.html>
- http://polhemus.com/_assets/img/FASTRAK_Brochure_1.pdf

References

- Peñate W, Pitti C, Bethencourt J, et al. The effects of a treatment based on the use of virtual reality exposure and cognitive-behavioral therapy applied to patients with agoraphobia. *Int J Clin Heal Psychol* 2008;8:5–22.
- Choi YH, Vincelli F, Riva G, et al. Effects of group experiential cognitive therapy for the treatment of panic disorder with agoraphobia. *Cyberpsychol Behav* 2005;8:387–393.