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, believes, 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 trail
- Small number of studies
- Sometimes not state of the art therapy

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

- 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.

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 though 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

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:
  \[ D = \frac{\mu_1 - \mu_2}{\sigma}. \]
- Cohen's D: weighted average mean
### Aggregated results (grouped by disorder)

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

<table>
<thead>
<tr>
<th>Study</th>
<th>Disorder</th>
<th>Treatment</th>
<th>Comparison</th>
<th>N</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rothbaum et al.</td>
<td>Fear of flying</td>
<td>VRE+CBT</td>
<td>Waitlist</td>
<td>54</td>
<td>0.47</td>
</tr>
<tr>
<td>Rothbaum et al.</td>
<td>Fear of flying</td>
<td>VRE+CBT</td>
<td>Waitlist</td>
<td>30</td>
<td>0.64</td>
</tr>
<tr>
<td>Wallach et al.</td>
<td>Social phobia</td>
<td>VRE+CBT</td>
<td>Waitlist</td>
<td>58</td>
<td>0.85</td>
</tr>
<tr>
<td>Krijn et al.</td>
<td>Acrophobia</td>
<td>VRE+CBT</td>
<td>Waitlist</td>
<td>28</td>
<td>1.11</td>
</tr>
<tr>
<td>Robillard et al.</td>
<td>Social phobia</td>
<td>VRE+CBT</td>
<td>Waitlist</td>
<td>29</td>
<td>1.34</td>
</tr>
<tr>
<td>Botella et al.</td>
<td>Panic disorder/agoraphobia</td>
<td>VRE+CBT</td>
<td>Waitlist</td>
<td>25</td>
<td>1.74</td>
</tr>
<tr>
<td>Difede et al.</td>
<td>PTSD</td>
<td>VRE+BT</td>
<td>Waitlist</td>
<td>21</td>
<td>1.82</td>
</tr>
<tr>
<td>García-Palacios et al.</td>
<td>Arachnophobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>40</td>
<td>-0.45</td>
</tr>
<tr>
<td>Choi et al.</td>
<td>Panic disorder/agoraphobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>32</td>
<td>-0.26</td>
</tr>
<tr>
<td>Michaliszyn et al.</td>
<td>Arachnophobia</td>
<td>VRE+CBT</td>
<td>IVE+GrCBT</td>
<td>36</td>
<td>-0.18</td>
</tr>
<tr>
<td>Klinger et al.</td>
<td>Social phobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>24</td>
<td>-0.16</td>
</tr>
<tr>
<td>Botella et al.</td>
<td>Panic disorder/agoraphobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>54</td>
<td>-0.06</td>
</tr>
<tr>
<td>Rothbaum et al.</td>
<td>Fear of flying</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>31</td>
<td>0.01</td>
</tr>
<tr>
<td>St-Jacques et al.</td>
<td>Arachnophobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>30</td>
<td>0.12</td>
</tr>
<tr>
<td>Rothbaum et al.</td>
<td>Fear of flying</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>27</td>
<td>0.15</td>
</tr>
<tr>
<td>Robillard et al.</td>
<td>Social phobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>33</td>
<td>0.24</td>
</tr>
<tr>
<td>Pitti et al.</td>
<td>Panic disorder/agoraphobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>28</td>
<td>0.33</td>
</tr>
<tr>
<td>Emmelkamp et al.</td>
<td>Acrophobia</td>
<td>VRE+BT</td>
<td>IVE</td>
<td>30</td>
<td>0.46</td>
</tr>
<tr>
<td>Peñate et al.</td>
<td>Panic disorder/agoraphobia</td>
<td>VRE+CBT</td>
<td>IVE+CBT</td>
<td>45</td>
<td>0.41</td>
</tr>
<tr>
<td>Wallach et al.</td>
<td>Social phobia</td>
<td>VRE+CBT</td>
<td>IMEx+CBT</td>
<td>58</td>
<td>0.34</td>
</tr>
<tr>
<td>Wiederhold et al.</td>
<td>Fear of flying</td>
<td>VRE+BT</td>
<td>IMEx</td>
<td>30</td>
<td>0.46</td>
</tr>
<tr>
<td>Krijn et al.</td>
<td>Fear of flying</td>
<td>VRE+BT</td>
<td>CBT</td>
<td>37</td>
<td>1.28</td>
</tr>
<tr>
<td>Mühlberger et al.</td>
<td>Fear of flying</td>
<td>VRE+CBT</td>
<td>CBT</td>
<td>37</td>
<td>1.28</td>
</tr>
</tbody>
</table>
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


- http://www.virtualresearch.com/Acrobat_files/V6MANUAL.PDF


References
