Boosting extinction learning during exposure with Vagal Nerve Stimulation

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Conclusion

Stimulating the vagus nerve accelerates the extinction of fear and may therefore improve treatment effectiveness of exposure therapy for anxiety in otherwise difficult-to-treat persons
Content

• Background
  Exposure therapy, Extinction learning
  Vagus Nerve Stimulation

• Empirical Studies
  o Transcutaneous vagal nerve stimulation (tVNS)
  o Nutrients
"Nervous little dogs 'face their fears' at an anxiety management seminar."
What Is Exposure Therapy?

Exposure therapy is a psychological treatment that was developed to help people confront their fears. When people are fearful of something, they tend to avoid the feared objects, activities or situations. Although this avoidance might help reduce feelings of fear in the short term, over the long term it can make the fear become even worse. In such situations, a psychologist might recommend a program of exposure therapy in order to help break the pattern of avoidance and fear. In this form of therapy, psychologists create a safe environment in which to "expose" individuals to the things they fear and avoid. The exposure to the feared objects, activities or situations in a safe environment helps reduce fear and decrease avoidance.

Exposure therapy has been scientifically demonstrated to be a helpful treatment or treatment component for a range of problems, including:

- Phobias
- Panic Disorder
- Social Anxiety Disorder
- Obsessive-Compulsive Disorder
- Posttraumatic Stress Disorder
- Generalized Anxiety Disorder
Effect size estimates (Hedges’ g) and 95% confidence intervals (CI) for acute efficacy of CBT relative to placebo on diagnosis-specific symptom measures.

Overall performance of CBT was significantly better than placebo for anxiety and depression symptoms, as indicated by the effect size estimates (Hedges’ g) and 95% confidence intervals (CI) for various anxiety and depression symptom measures. The data suggest that CBT is an effective treatment for these symptoms, with effect sizes ranging from moderate to large in magnitude.

Carpenter et al., 2018
Exposure Therapy - Challenges

- Relapse: return of fear

- 50% of the patients who enter Exposure Therapy fail to achieve clinically significant improvements

- Anxiety patients with comorbid depression benefit less
  (Higher chronicity, severity, disability, early life adversity)

Exposure therapy: Mechanism of Action?

- Extinction learning
- Self-Efficacy
- Acceptance
- Emotional processing
- Cognitive restructuring
- ...

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Fear Acquisition

- Learning to predict & prepare for danger

Dental drill - sharp pain

\rightarrow \text{FEAR MEMORY}
\rightarrow \text{fear response to CS}
\rightarrow \text{motivation to avoid}

Fear Extinction

- Learning the CS is no longer predictive of US

CS – noUS

\rightarrow \text{EXTINCTION MEMORY}
\rightarrow \text{inhibition of fear response to CS}

- Exposure therapy
  \rightarrow \text{disconfirmation of beliefs}
  \rightarrow \text{opportunities to learn inhibiting fear response to CS}
Competing Memories

FEAR MEMORY CS - US

(fragile) EXTINCTION MEMORY CS - no US
Invasive VNS
Non-invasive VNS
What about Humans?

You are not a 70kg rat
Fear extinction in healthy humans
3 collaborative studies
General Design 3 studies


- **Acquisition**
  
  CS
  
  US
  
  30 s
  
  30 s

- **Extinction:** CS - no US
  1 group: tVNS
  1 group: sham
EXTINCTION learning findings

**Study 1**

**Study 2**
EXTINCTION learning findings

**Study 3**

![Graph showing learning findings](image)
<table>
<thead>
<tr>
<th></th>
<th>CS</th>
<th>US</th>
<th>background noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>study 1</td>
<td>geometrical shape</td>
<td>electrical shock</td>
<td>no</td>
</tr>
<tr>
<td>study 2</td>
<td>geometrical shape</td>
<td>white noise 95dB</td>
<td>no</td>
</tr>
<tr>
<td>study 3</td>
<td>spider pictures</td>
<td>electrical shock</td>
<td>yes</td>
</tr>
</tbody>
</table>

- Higher arousal state in study 3 (ceiling effect)?

- Extinction is optimal at ‘moderate’ levels of arousal; **inverted U-shape** (Giustino, T. F., & Maren, S. (2018). Front Behav Neurosci, 12(43), 1-20.)
Future studies


- Arousal is needed for optimal extinction learning (Giustino, T. F., & Maren, S. (2018). *Front Behav Neurosci*, 12(43), 1-20.)

→ Especially patients with blunted stress reactivity may benefit from tVNS during exposure therapy?
How to stimulate the VN during exposure therapy/extinction learning?

- Electrically (tVNS)
- Slow Deep Breathing
- Nutrients?
Dietary influences on extinction learning

• Regular consumption of perilla oil (50% ALA) accelerates extinction learning in rats
  
  (Yamamoto et al., 1988)

• Goal: to explore the effects of the acute consumption of polyunsaturated versus saturated fat on predictive learning in healthy humans

Method

- Randomized, double blind, placebo-controlled between subject design
- N = 59 students (22 men)
- 3 milk shakes: Cream / Walnut oil / Control

Extinction

Conclusion

Stimulating the vagus nerve accelerates the extinction of fear and may therefore improve treatment effectiveness of exposure therapy for anxiety in otherwise difficult-to-treat persons.
Take home general statement

“Cognitive-affective processes at the core of mental health are modulated by bodily inputs that have a clear potential as add-ons to psychological treatment.”
Collaborators (past, current, future)

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• Martina D’Agostini
• Prof. Bram Vervliet
• Dr. Holly C. Miller

Faculty of Medicine, KULeuven
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• Boushra Dalile

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• Andreas M Burger
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Thank YOU
For your attention