Overview

1. What is an ERP?
2. ERP markers of PTSD
3. Neurofeedback for PTSD
4. STARTTS' research
5. Clinical use of ERPs
1. What is an ERP?

Event-related potentials
- Waveform time locked to a stimulus
- Components are peaks and troughs

ERP components are defined by:
- When they occur (ms)
- Where on the scalp it is measured from (maximal)
- The direction of the peak - Positive or Negative

ERP components are characterized by:
- Amplitude (microvolts); and
- Latency (milliseconds)
Some components of interest…

<table>
<thead>
<tr>
<th>Task/Probe</th>
<th>Process</th>
<th>Component</th>
<th>Abnormal in…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual stimuli</td>
<td>Perceptual organization</td>
<td>P120</td>
<td></td>
</tr>
<tr>
<td>Facial Expressions of Emotion</td>
<td>Faces, emotional valance</td>
<td>VPP ‘Vertex Positive Potential’ / N170</td>
<td>Affective disorders</td>
</tr>
<tr>
<td>Mismatch Negativity – two auditory stimuli</td>
<td>Habituation or gating</td>
<td>P50/N100/P200</td>
<td>Increased ratio in Psychosis</td>
</tr>
<tr>
<td>Oddball – detecting a deviant stimulus</td>
<td>Attention</td>
<td>P300 at Pz</td>
<td>psychiatric populations</td>
</tr>
<tr>
<td>Continuous performance task (or n-back)</td>
<td>Working memory or expectancy</td>
<td>P500 (‘Contingent Negative Variation’)</td>
<td>psychiatric populations</td>
</tr>
</tbody>
</table>

Visual Continuous Performance Task (VCPT)

Four trial types:

- **Stimulus 1**
  - A
  - GO
  - NOGO

- **Stimulus 2**
  - A
  - P

- **Response**
  - PRESS
  - Do not PRESS

Task length = 20mins

EEG data was collected on the 19 channel Mitsar amplifier
Presented using PsyTask software
ERP measures were calculated using WinEEG software

Kropotov, Mueller et al., 2011 ERP-Based Endophenotypes
ERPs markers of PTSD

Posttraumatic Stress Disorder (PTSD) is characterized by symptoms of hyperarousal, avoidance and intrusive trauma-related memories

Cognition:
- Reduced P3 Oddball: controlled attention
- Reduced CNV during working memory updating
- Reduced P3 to novelty

Emotion:
- Increased P3 to trauma related stimuli

- Javanbakht et al 2011 – review including 17 studies of ERPs in PTSD
- Johnson et al 2013 – meta-analysis of P3 components in PTSD

EEG Neurofeedback for PTSD

The choice of neurofeedback training protocols is guided by the difficulty of PTSD clients in regulating arousal.

Protocols aim to quieten fear and to improve cognitive clarity.


These processes can be examined using ERPs during cognitive control and emotional stimuli.
Proposal RCT of neurofeedback for PTSD in refugees

N=80 STARTTS clients; 21-65yrs, PTSD, refugee background

Assessment 1: Baseline and randomisation

Neurofeedback + Trauma Counselling
30 sessions (2x per week)

Assessment 2: Post-intervention

Lifestyle intervention + Trauma Counselling
30 sessions (2x per week)

Assessment 3: 3-month follow-up

RCT of neurofeedback for PTSD in refugees

N=80 STARTTS clients; 21-65yrs, PTSD, refugee background

Assessments (Baseline, Post-intervention, 3-month follow-up)

1. Symptoms: PTSD, depression, anxiety, sleep, functioning
2. EEG recording: Resting state (EO, EC) ERPs (VCPT, Facial Expressions of Emotion)

3-month follow-up
Table 1. Previous trials evaluating neurofeedback interventions for PTSD

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Neurofeedback Protocol</th>
<th>Control intervention</th>
<th>Outcomes*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peniston &amp; Kulkosky, 1991</td>
<td>army veterans</td>
<td>30 sessions</td>
<td>trauma counselling</td>
<td>↓ PTSD symptoms, depression and nightmares; Even at 30 month follow-up</td>
</tr>
<tr>
<td></td>
<td>n=15 /14</td>
<td>Occipital, Alpha (8-12Hz) /Theta (4-8Hz)</td>
<td></td>
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<tr>
<td>Peniston et al., 1993</td>
<td>army veterans with comorbid alcohol abuse, n=20/-</td>
<td>20 sessions</td>
<td>Alpha/Theta and 'abreactive therapy'</td>
<td>↑theta ↓alpha synchrony; no relapse after 26 months in n=16</td>
</tr>
<tr>
<td>Van der Kolk et al., 2016</td>
<td>community treatment resistant</td>
<td>24 sessions</td>
<td>waitlist (TAU)</td>
<td>↓ PTSD symptoms</td>
</tr>
<tr>
<td></td>
<td>n=28/24</td>
<td>Right temporal (T4)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Alpha (13-15Hz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gapen et al., 2016</td>
<td>community treatment resistant</td>
<td>40 sessions</td>
<td>-</td>
<td>↓ PTSD symptoms; Improved affect regulation (questionnaire)</td>
</tr>
<tr>
<td></td>
<td>n=17/-</td>
<td>T3-T4 or T4-P4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Alpha (12-15Hz)</td>
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**n**: number in group; **NF**: group receiving the neurofeedback intervention; *Outcomes describe NF group post intervention relative to pre-intervention or control group where relevant; “↓”: decrease in; “↑”: increase in
NFB induces enhanced P3 NOGO in n=13 refugees with PTSD

Figure 1. Normalization of P3 NOGO wave of Event-Related Potentials (ERPs) in the treatment group. i) ERPs for NOGO trials of the GO/NOGO Visual Continuous Performance Task for 13 clients pre-(dotted line) and post-(black line) neurofeedback therapy (NFT) and in healthy controls (grey line) from the Human Brain Institute’s (HBI) normative database. ii) Maps for the P3 NOGO component peaks for NFT pre- and post-therapy, and HBI. This figure is available in colour online.
The Neurofeedback group had reduced symptoms of Trauma, Anxiety and Depression from Pre to Post assessments compared with the waiting list control group.

![Graph showing reduced symptoms](image)

M. Askovic et al. / submitted to Clinical EEG and Neuroscience

**Case Study**

**Demographics:** 54 year-old male  
**Country of Birth:** Iraq  
**Diagnosis:** PTSD, Major Depression  
**Symptoms:** headaches, back pain, insomnia, rumination  
**Trauma History:** torture and war trauma  
**Neurofeedback:** 36 sessions focusing on mood stabilization, tension reduction and sleep enhancement; included frontal downtraining and temporal enhancement of alpha

Interindividually Variability

Human Brain Indices (HBI) reference database:
- 1000 healthy control, 7-90 years of age (43±12 per age window of ≤5 years)
- Individual compared to group through estimation of p-values and z-scores

ERPs vary substantially from person to person
- Anatomical folding patterns
- Differences in information processing

ERPs are ‘quite’ reliable measures of brain functioning
- P3 auditory oddball: Test-retest reliability of .50 to .86
- Brunner ... Kropotov et al. 2013. P3 NOGO: 0.8

[Graph of ERP waves]
Clinical Utility of ERPs

- Diagnosis and identification of subgroups
- Determining targets for an intervention, or predicting the suitability of an intervention
- Determining whether a therapy influences a specific process

Thank you!

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