Neurobiology of Self-Harm in Borderline Personality Disorder

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Non-suicidal self-injury (NSSI) in BPD

- **Non-suicidal self injury** (NSSI): deliberate destruction of body tissue without suicidal intent *(APA, 2013)*

- 50-80% of individuals with Borderline Personality disorder *(Snir, Rafaeli, Gadassi, Berenson, & Downey, 2015)* and 46.2-60% of mentally ill youth engage in NSSI *(Groschwitz et al., 2015; Kaess et al., 2013)*

- Long lasting damage for concerned individuals, higher risk for suicidal behavior *(Guan, Fox, & Prinstein, 2012)* and high costs for health care system *(Wunsch, Kliem, & Kroger, 2014)*
Overview

Emotion dysregulation

Social Interaction

Pain Processing
Non-suicidal self-injury in adolescence

NSSI

Borderline PD

Plener et al., 2015
Motives for NSSI in BPD

- Tension Release
- Reduce Unpleasant Feelings
- Self-Punishment
- Regain Control
- Regain Awareness of Physical Sensations
- Regain a Sense of Reality
- Gain Attention
- Improve Mood
- Demonstrate Level of Suffering
- Improve Concentration
- Achieve a Kick or High
- Experience Pleasure

Kleindienst et al., JNMD, 2008
Assessment of fluctuating data in daily life: EMA

Ecological momentary assessment (EMA)

- Real life and real time data
- Avoiding recall bias
- Accurate tracking of fluctuating variables (e.g. affect, hormones)

- e.g. Smartphone App based interventions, daily diary

- Different forms of assessment:
  - Random prompts
  - Event based prompts
  - Mixed design

Affective Dysregulation

Stiglmayr et al., Acta Psychiatr Scand 2005
Santangelo et al., J Abnorm Psychology 2015
Change in Emotions after NSSI

Kranzler et al. 2018
EMA- Study Design

Random Prompt:
MDBF
PANAS (selection)
DSS-4
Interpersonal events

NSSI urge (urge > 6 & nssi event > 1)

NSSI event (< 30 min.)

Control condition:
Saliva sample

NSSI act
Time passed by
Saliva sample
Method
Effect
Motive
Severity
Pain during NSSI/Actual Pain

Follow ups:
10, 20, 30 min. post
Affect, DSS-4
Saliva samples

Follow ups:
10, 20, 30 min. post
NSSI
Saliva samples
DSS-4/affect/pain

Pre NSSI saliva sample

Self-initiated prompt: NSSI act
PANAS, MDBF, DSS-4, Interpersonal events

End Random Prompt
NSSI and β-endorphin

• **Endogenous Opioid System (EOS):**

  • Three classes of opioids: β-endorphin, enkephalin and dynorphin (μ-, δ-, and κ-opioid receptors; Dhawan et al., 1996)

  • **Activation β-endorphin:** social, emotional, or physical pain/ emotionally or physically positive experiences (Bresin & Gordon, 2013 for an overview)

  • → Can disturbance in β-endorphin be related to NSSI?
Biosampling procedure
# EMA-Study – Interpersonal Findings

<table>
<thead>
<tr>
<th>Before I self-harmed/since the last prompt, someone</th>
<th>Total number</th>
<th>% of NSSI prompts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative events</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... criticised me</td>
<td>13</td>
<td>10.1%</td>
</tr>
<tr>
<td>... rejected/ excluded me</td>
<td>19</td>
<td>14.7%</td>
</tr>
<tr>
<td>... ignored my needs or feelings</td>
<td>24</td>
<td>18.6%</td>
</tr>
<tr>
<td>... behaved angry or aggressive towards me</td>
<td>14</td>
<td>10.9%</td>
</tr>
<tr>
<td>... let me down/ disappointed me</td>
<td>23</td>
<td>17.8%</td>
</tr>
<tr>
<td>... none of the above</td>
<td>90</td>
<td>69.8%</td>
</tr>
<tr>
<td><strong>Positive events</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>... supported/ helped me</td>
<td>3</td>
<td>2.3%</td>
</tr>
<tr>
<td>... showed me affection</td>
<td>10</td>
<td>7.8%</td>
</tr>
<tr>
<td>... respected my needs or feelings</td>
<td>6</td>
<td>4.7%</td>
</tr>
<tr>
<td>... gave me their attention or time</td>
<td>18</td>
<td>14.0%</td>
</tr>
<tr>
<td>... was interested in me, understood me</td>
<td>12</td>
<td>9.3%</td>
</tr>
<tr>
<td>... none of the above</td>
<td>110</td>
<td>85.3%</td>
</tr>
</tbody>
</table>

*Stoerkel et al., in preparation*
Hyp. 1: Negative interpersonal events predict higher probability of NSSI events.

Hyp. 2: NSSI reduces probability of negative social events (negative social reinforcement).

Hyp. 3: NSSI increases probability of positive social events (positive social reinforcement).
Borderline PD

PTSD

Major Depression

Meta-analysis of regions with positive (red) and negative (blue) response to emotional stimuli (significant with correction)

Schulze et al. 2019
Overview

Emotion dysregulation

Social Interaction

Pain Processing
Pain sensitivity and Stress in BPD

Bohus et al., Psychiatry Res 2000

Ludäscher et al., Psychiatry Res 2007
Cortisol-Stressreagibility and NSSI

TSST

Schmerz

Kaess et al. 2012

Koenig et al. 2017
# Meta-Analysis

## Pain sensitivity and NSSI

<table>
<thead>
<tr>
<th>Study</th>
<th>Symptom Group Mean</th>
<th>Symptom Group SD</th>
<th>Symptom Group Total</th>
<th>Healthy Control Group Mean</th>
<th>Healthy Control Group SD</th>
<th>Healthy Control Group Total</th>
<th>Weight</th>
<th>Std. Mean Difference IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>P Kemperman et al. 1997</td>
<td>3.49</td>
<td>1.8</td>
<td>26</td>
<td>3.7</td>
<td>0.49</td>
<td>7</td>
<td>5.3%</td>
<td>-0.13 [-0.96, 0.71]</td>
</tr>
<tr>
<td>Bungert et al. 2015</td>
<td>4.4</td>
<td>1.7</td>
<td>20</td>
<td>4.6</td>
<td>1.4</td>
<td>20</td>
<td>7.6%</td>
<td>-0.13 [-0.75, 0.49]</td>
</tr>
<tr>
<td>Smith 2014</td>
<td>32.71</td>
<td>18.36</td>
<td>17</td>
<td>36.68</td>
<td>19.26</td>
<td>22</td>
<td>7.4%</td>
<td>-0.21 [-0.84, 0.43]</td>
</tr>
<tr>
<td>P Hamza et al. 2014</td>
<td>8.19</td>
<td>1.98</td>
<td>56</td>
<td>8.88</td>
<td>1.3</td>
<td>26</td>
<td>9.7%</td>
<td>-0.38 [-0.85, 0.09]</td>
</tr>
<tr>
<td>P Weinberg &amp; Klorsky 2012</td>
<td>3.16</td>
<td>3.45</td>
<td>39</td>
<td>4.51</td>
<td>2.96</td>
<td>33</td>
<td>9.7%</td>
<td>-0.41 [-0.68, 0.06]</td>
</tr>
<tr>
<td>McCoy et al. 2010</td>
<td>48.64</td>
<td>21.69</td>
<td>11</td>
<td>58.55</td>
<td>21.11</td>
<td>33</td>
<td>6.7%</td>
<td>-0.46 [-1.15, 0.23]</td>
</tr>
<tr>
<td>Niedtfeld et al. 2010</td>
<td>5</td>
<td>1.2</td>
<td>23</td>
<td>5.5</td>
<td>0.77</td>
<td>26</td>
<td>8.2%</td>
<td>-0.49 [-1.06, 0.08]</td>
</tr>
<tr>
<td>Franklin et al. 2011</td>
<td>7.13</td>
<td>1.71</td>
<td>16</td>
<td>8.2</td>
<td>1.59</td>
<td>10</td>
<td>5.5%</td>
<td>-0.62 [-1.43, 0.19]</td>
</tr>
<tr>
<td>Franklin et al. 2012</td>
<td>7.04</td>
<td>1.81</td>
<td>25</td>
<td>8.32</td>
<td>1.37</td>
<td>47</td>
<td>9.2%</td>
<td>-0.82 [-1.33, -0.32]</td>
</tr>
<tr>
<td>Kluetsch et al. 2012</td>
<td>47.3</td>
<td>13.78</td>
<td>25</td>
<td>63.93</td>
<td>19</td>
<td>22</td>
<td>7.7%</td>
<td>-1.00 [-1.61, -0.39]</td>
</tr>
<tr>
<td>P Ludäscher et al. 2009</td>
<td>19.6</td>
<td>16.6</td>
<td>12</td>
<td>40.7</td>
<td>18.0</td>
<td>21</td>
<td>5.0%</td>
<td>-1.14 [-1.00, -0.37]</td>
</tr>
<tr>
<td>P Russ et al. 1999</td>
<td>3.87</td>
<td>1.89</td>
<td>41</td>
<td>6</td>
<td>1.5</td>
<td>20</td>
<td>8.1%</td>
<td>-1.19 [-1.76, -0.61]</td>
</tr>
<tr>
<td>Schmahl et al. 2006 *</td>
<td>44.2</td>
<td>2.08</td>
<td>12</td>
<td>46.7</td>
<td>1.30</td>
<td>12</td>
<td>4.8%</td>
<td>-1.36 [2.27, -0.46]</td>
</tr>
<tr>
<td>Schmahl et al. 2004</td>
<td>16.4</td>
<td>17.39</td>
<td>10</td>
<td>50.4</td>
<td>15.72</td>
<td>14</td>
<td>4.0%</td>
<td>-2.00 [-3.02, -0.98]</td>
</tr>
</tbody>
</table>

Total (95% CI) 333 313 100.0% -0.68 [-0.91, -0.44]

Heterogeneity: Tau² = 0.09, Chi² = 24.02, df = 13 (P = 0.03); I² = 47%

Test for overall effect: Z = 5.60 (P < 0.00001)

Kö nig et al. 2016
Neural Pain Processing in BPD

Schmahl et al., Arch Gen Psychiatry 2006
Emotion Regulation and Pain in BPD

Niedtfeld et al., Biol Psychiatry 2010
Emotion Regulation and Incision in BPD

Reitz et al., JPD 2012

Amygdala activity

Reitz et al.
Br Journal Psychiatry 2015
Role of Tissue Injury

Willis et al., Pain 2017
The role of seeing blood and perspective (self/other)

<table>
<thead>
<tr>
<th>Self-inflicted &amp; no blood (n=20)</th>
<th>Other-inflicted &amp; no blood (n=20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-inflicted &amp; blood (n=20)</td>
<td>Other-inflicted &amp; blood (n=20)</td>
</tr>
</tbody>
</table>

~45 min
Self-injury and Pain – Interim Summary

• Reduced pain sensitivity: yes
• Reduction of stress and amygdala activity by pain stimuli: yes
• Influence of tissue injury: (no)
• Influence of seeing blood: (yes)

• Role of perspective (self/other) : ?
Overview

Emotion dysregulation

Social Interaction

Pain Processing
Social Exclusion and BPD

Domsalla et al. 2014
Social Exclusion and NSSI

Groschwitz et al. 2016
Social Exclusion and Pain

Bungert et al. 2015
Can these mechanisms be modified?

- Emotion dysregulation
- Social Interaction
- Pain Processing
Pain sensitivity and Remission

29 current BPD
19 remitted BPD
22 healthy controls

Heat pain threshold (°C)

- cBPD
- rBPD
- HC

Bekrater-Bodmann et al., 2015, Pain
Changes of pain-related mechanisms in remission

- No strong increase of urge for NSSI after stress induction
- No relation between painfulness and stress reduction

Wilis et al., Brain Behav 2018
Changes of pain-related mechanisms after psychotherapy

Niedtfeld et al., SCAN 2017
Assessment of longitudinal changes

Genetic, endocrine and psychophysiological markers

300 NSSV

150 E-Treatment

150 Psychoedukation

150 HC

60 NSSF

60 HC

STAR

SELF-INJURY - TREATMENT ASSESSMENT RECOVERY

fMRI:
- Emotion regulation
- Social Exclusion

30 E-Treatment

30 Psychoedukation
Summary

• NSSI is clearly related to reduced pain sensitivity
• Underlying neural mechanisms point to a dysregulation of the prefrontal-amygdala axis
• Remission and psychotherapy can change these mechanisms (back to normal)
• Better understanding of neurobiological correlates of NSSI helps to de-stigmatize behavior and improve psychotherapy
Thanks to coworkers, collaborators and funders

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