Fear Potentiated Startle and the Relation to Emotion Dysregulation in a Sample of Undergraduate Women Exposed to a Campus Mass Shooting

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Fear-Potentiated Startle (FPS)

- FPS based on classical conditioning principles
- FPS is defined by the relative increase in the amplitude of the acoustic startle reflex when a subject sees a conditioned stimulus (CS+) that predicts an aversive unconditioned stimulus (US; Jovanovic et al., 2011)
  - This is compared to startle amplitude elicited in the absence of that cue (NA – noise alone)
Fear Inhibition

• Fear inhibition involves learning safety signals, i.e. the ability to discriminate between danger and safety cues and suppressing fear responses in the presence of safety cues
  – In the lab, this is usually measured by pairing one cue with a fearful event and another that signals the absence of that event
FPS and PTSD

• Individuals with greater PTSD symptoms demonstrate stronger FPS responses to both danger (CS+) and safety (CS-) signals when compared to controls (Jovanovic et al., 2009; Norrholm et al., 2010)

• There may not be significant differences in discrimination between CS+ and CS- (Jovanovic et al., 2009)

• During early and middle extinction, individuals with PTSD appear to have increased FPS responses to the previously reinforced CS+ compared to healthy controls (Norrholm et al., 2010)

• Pole et al. (2009) assessed FPS longitudinally in police officers
  – Greater subjective fear predicted more severe PTSD symptoms one year following exposure to police-related trauma

• Many individuals with PTSD have elevated FPS and greater inability to inhibit fear responses in the presence of safety signals. Safety signal learning (or lack thereof) may be a specific marker of vulnerability for developing PTSD
• Emotion regulation has consistently been implicated as a risk and maintaining factor for PTSD (Bardeen et al., 2013; Tull et al., 2007)

• Avoidance and suppression have been associated with increased PTSD symptoms and greater sympathetic nervous system activation (Ehring & Quack, 2010; Hagemann et al., 2006)

• Therefore, reported emotion dysregulation may be related to physiological responding during fear conditioning.
Hypotheses

• Higher levels of PTSD symptoms shortly following the campus mass shooting, will be associated with:
  – greater FPS to the CS+ and CS- during fear conditioning acquisition.
  – greater FPS to the previously reinforced CS+ compared during early and middle stages of extinction

• Higher levels of emotion dysregulation will be associated with greater FPS to the CS+ and CS-, particularly in PTSD+ women
Methods

• Participants
  – A subset of women who participated in a longitudinal study following the mass shooting at NIU on 2/14/08 (current $N = 75$; $Mage = 19.40$, $SD = 2.53$ prior to shooting)
  – All participants had previously provided questionnaire data related to emotion regulation, trauma, and PTSD symptoms prior to the shooting, and at multiple time points afterwards. Participants also completed a self-report pre-survey online prior to the FPS session (e.g., mental health, trauma exposure, etc.)
Methods

- **Time 1** (pre-shooting): August 2006 to Spring 2008 (ending February 14, 2008). 1,045 females completed pre-shooting assessment and 885 consented to be recontacted.
- **Time 2**: online survey opened March 2, 2008, Completed by 691 of 812 eligibles (85%).
- **Time 3**: survey opened September 2008 (7.5 months post-shooting) – 588 participants completed online surveys (85% of the Time 2 sample).
- **Time 4**: survey opened March 2009 (1 year since Time 2) – 591 participants completed online surveys (85% of the Time 2 sample).
- **Time 5**: survey opened September 2009 (19.5 months post-shooting) – 586 participants completed online surveys (85% of the Time 2 sample).
- **Time 6**: survey opened March 2010 (2 years since Time 2) – 578 participants completed online surveys (84% of the Time 2 sample).
- **Time 7**: survey opened September 2010 (31.5 months post-shooting) – 559 participants completed online surveys (81% of the Time 2 sample).
- Fear conditioning experiment started March 2013, ongoing
Methods

• PTSD
  – Assessed with Distressing Events Questionnaire for DSM IV (Kubany et al). A cut off of 18 and above used to indicate probable PTSD.

• Emotion Dysregulation
  – Difficulties in Emotion Regulation Scale (DERS) (Gratz et al)
  – Acceptance and Action Questionnaire (AAQ-II) (Bond et al)
Methods

• Informed consent, auditory screening, questions about vision, stimulants, estrogen
• Blood draw and saliva sample
• Heart rate
• Skin conductance
• Respiration
• EMG response of right orbicularis oculi
• Headphones for sound burst
  – 108-dB for 40ms
• Camelbak for airblast
  – 140 psi for 250ms
Methods

• Dark-enhanced session (5 minutes)
  – Habituation phase: noise alone (NA), one minute (light)
  – Two light and two dark phases, each lasting one minute
  – 3 startle probes in each phase
  – Counterbalanced order
• Acquisition session (20 minutes)
  – Habituation phase: noise alone (NA)
  – 3 blocks of four trials of each type: NA, CS+, CS- (i.e., 12 total trials in each block)
  – CS+ paired with UCS (airblast)
• Extinction session (25 minutes)
  – 6 blocks of four trials of each type
  – CS+ no longer paired with UCS
Results

• Level of symptomatology over time in the full sample
  • Probable PTSD
    • T1: 19%
    • T2: 52% mass shooting referent, 53% any
    • T3: 13%, 15%
    • T4: 10%, 14%
    • T5: 6%, 10%
    • T6: 5%, 10%
    • T7: 5%, 8%
  • Subsample (n = 75)
    • Probable PTSD at T2/mass shooting referent: 56%
      • No (n = 33) Yes (n = 42)
    • Current probable PTSD at time of FPS:
      • No PTSD at T2 (n = 31), 1 participant with probable PTSD at FPS
      • Yes PTSD at T2 (n = 38) 5 participants with probable PTSD at FPS
Eyeblink Magnitude for Acquisition

Block, $F_{(3, 219)} = 5.91^{**}$
Block X PTSD, $F_{(3, 219)} = 1.82$ (Cubic $F_{(1, 73)} = 4.22^*$)
Trial Type, $F_{(2, 146)} = 28.68^{***}$
Trial Type X PTSD, $F_{(2, 146)} = 1.75$
Block X Trial Type, $F_{(6, 438)} = 1.69$
Block X Trial Type X PTSD, $F_{(6, 438)} = 1.04$
Eyeblink Magnitude for Extinction

Startle magnitude to CS+, CS−, and NA during all blocks of extinction

**Block**, $F_{(5, 355)} = 18.68^{***}$

**Block X PTSD**, $F_{(5, 355)} = 0.27$

**Trial Type**, $F_{(2, 142)} = 42.89^{***}$

**Trial Type X PTSD**, $F_{(2,142)} = 1.54$

**Block X Trial Type**, $F_{(10, 710)} = 2.97$

**Block X Trial Type X PTSD**, $F_{(7, 710)} = 0.71$
Fear-Potentiated Startle For Acquisition

Block, $F_{(2, 146)} = 3.08^*$
Block X PTSD, $F_{(2, 146)} = 0.28$
Trial Type, $F_{(1, 73)} = 0.01$
Trial Type X PTSD, $F_{(1, 73)} = 0.07$
Block X Trial Type, $F_{(2, 146)} = 0.92$
Block X Trial Type X PTSD, $F_{(2, 146)} = 1.0$
Fear-Potentiated Startle For Extinction

Block, $F_{(2, 142)} = 10.79^*$
Block X PTSD, $F_{(2, 142)} = 0.28$
Trial Type, $F_{(1, 71)} = 4.72^*$
Trial Type X PTSD, $F_{(1, 71)} = 0.62$
Block X Trial Type, $F_{(2, 142)} = 0.54$
Block X Trial Type X PTSD, $F_{(2, 142)} = 1.66$
### FPS, PTSD, and Emotion Regulation

<table>
<thead>
<tr>
<th></th>
<th>Late Acquisition</th>
<th>Extinction</th>
<th>CS+</th>
<th>Extinction</th>
<th>CS+</th>
<th>Extinction</th>
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<tbody>
<tr>
<td></td>
<td>CS+</td>
<td>CS-</td>
<td>Early Extinction</td>
<td>Middle Extinction</td>
<td>Late Extinction</td>
<td>Early Extinction</td>
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<tr>
<td>T2 PTSD Count</td>
<td>.276*</td>
<td>.292*</td>
<td>.304**</td>
<td>.199</td>
<td>.178</td>
<td>.212</td>
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<tr>
<td>T3 PTSD Count</td>
<td>.182</td>
<td>.262*</td>
<td>.210</td>
<td>.144</td>
<td>.126</td>
<td>.218</td>
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<tr>
<td>T1 Experiential Avoidance</td>
<td>-.061</td>
<td>-.071</td>
<td>.076</td>
<td>.116</td>
<td>-.004</td>
<td>-.047</td>
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<tr>
<td>T1 DERS Nonacceptance of Emotional Responses</td>
<td>.160</td>
<td>-.000</td>
<td>.071</td>
<td>.125</td>
<td>-.041</td>
<td>.022</td>
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<tr>
<td>T1 DERS Difficulty Engaging in Goal Directed Behavior When Upset</td>
<td>.140</td>
<td>.147</td>
<td>.194</td>
<td>.287*</td>
<td>.227</td>
<td>.135</td>
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<tr>
<td>T1 DERS Impulse Control Difficulties When Upset</td>
<td>.096</td>
<td>.095</td>
<td>.171</td>
<td>.124</td>
<td>.022</td>
<td>.171</td>
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<tr>
<td>T1 DERS Lack of Awareness of Emotions</td>
<td>-.041</td>
<td>-.066</td>
<td>-.028</td>
<td>-.019</td>
<td>-.099</td>
<td>-.006</td>
</tr>
<tr>
<td>T1 DERS Limited Access to Strategies for Regulation</td>
<td>.131</td>
<td>.093</td>
<td>.178</td>
<td>.276*</td>
<td>.083</td>
<td>.159</td>
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<tr>
<td>T1 DERS Lack of Emotional Clarity</td>
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<td>.007</td>
<td>.065</td>
<td>.094</td>
<td>-.055</td>
<td>.014</td>
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<td>.061</td>
<td>.147</td>
<td>.210</td>
<td>.032</td>
<td>.111</td>
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<tr>
<td>T2 Peritraumatic Dissociation</td>
<td>.265*</td>
<td>.238*</td>
<td>.240*</td>
<td>.160</td>
<td>.138</td>
<td>.244*</td>
</tr>
</tbody>
</table>

PTSD count variable is count of the number of the 17 symptoms endorsed at moderate or higher. Red correlations are significant at $p < .05$ while green correlations are trending ($p < .10$). T1 was collected before the mass shooting on 2/14/08.
Based on the correlation matrix, exploratory regression analyses were conducted:

- DV = mid to late extinction variables for CS+ and CS- (4 regressions)
- IV Step 1 = T1 DERS Goals
- IV Step 2 = T2 PTSD Count
- IV Step 3 = DERS X PTSD interaction
- Interaction was nonsignificant for all.
Discussion

• Fear conditioning paradigm demonstrated expected effects in our sample
• PTSD reported shortly post-shooting in 2008 was demonstrating some relationships with key fear conditioning variables, more so in the continuous PTSD variable vs. dichotomous
  – Late acquisition for CS+ and CS-
  – Early and middle extinction for CS+
  – Early and late extinction for CS-
  – For T3 (6m post-shooting), PTSD count related to CS- acquisition and late extinction for CS-
Discussion

• Thus, results with PTSD are generally consistent with literature suggested impaired safety signal learning and extinction.

• Emotion regulation, measured by DERS, was not correlated overall with FPS variables although several subscales showed significant correlations (Goals, Strategies).

• Based on preliminary analyses, relationship between PTSD and FPS was not moderated by emotion regulation.
Limitations & Future Directions

• Limitations
  – Only at half of targeted sample size.
  – Not a clinical sample, however this sample has a strength of a generally homogenous trauma exposure that is largely immune to the problem of gene-environment correlation by nature of the random act of mass violence that occurred at NIU.

• Exploring PDEQ

• Specific aims of grant will expand the analyses reported here to include genetic and peripheral blood level markers (e.g., PACAP)
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