Distinct neurobiological pathways in psychopathy

Edelyn Verona
"I struggled for years to understand what motivates me to do the things I do. Only took the jury five minutes."
Outline of Talk

1. Summarize focus of research and define key constructs: psychopathy, externalizing, and antisocial personality disorder

2. Provide overview of existing research on cognitive and emotional processing in psychopathy

3. Review two studies from our lab on cognition-emotion processing associated with distinct psychopathic/antisocial traits
Focus of Research

- Heterogeneity in persons engaging in chronic substance use, violence and criminality (i.e., “antisocial personalities”; Lykken, 1995)

- Interest in using that heterogeneity to uncover distinct pathways to such behaviors
Focus of Research

1. Externalizing syndromes (e.g., risk taking/disinhibition underpinnings)
   - Substance use and dependence
   - Antisocial behavior and syndromes (e.g., antisocial personality disorder)
   - Aggression and violence
Focus of Research

1. Externalizing syndromes (e.g., risk taking/disinhibition underpinnings)
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2. Psychopathy
   - Disproportionate burden on legal system!
   - Typically engage in externalizing behaviors (e.g., illegal, aggressive, substance use)
   - Distinct affective and interpersonal features
Focus of Research

- **Antisocial Personality Disorder (APD)** but not Psychopathy in Diagnostic and Statistical Manual of Mental Disorders (DSM-5)
- Only ~20% of individuals with APD also have psychopathy
  - More emphasis on emotional deficits and manipulative personality traits in psychopathy
APD part of externalizing spectrum

Primary psychopathy does not fall into the EXT spectrum

Krueger (1999), Krueger et al. (2002)
Patrick et al. (2005)
Psychopathy is a multidimensional construct (Psychopathy Checklist or PCL; Hare, 2003; Rogers et al., 2000):

- **Interpersonal-affective features (Factor 1)**
  - Interpersonal (e.g., deceit, conning, charm)
  - Affective (e.g., shallow emotions, callousness)

- **Impulsive-antisocial features (Factor 2)**
  - Impulsive lifestyle (e.g., recklessness, lack goals)
  - Antisocial behavior (e.g., violence, criminal versatility)
  - Factor 2 overlaps with Antisocial Personality and Externalizing (Patrick et al., 2005; Verona et al., 2001)

- Two factors correlated $r_s = .5 - .6$, at least using the PCL instruments
Focus of Research

Approaches to multidimensionality of psychopathy:

- Total score, common variance

- Additive or interactive effects of factors (Fowles & Dindo, 2006; Hill, Neumann, & Rogers, 2004; Lynam, 2002; Patrick et al., 2009)

- Unique variance of each factor (Verona & Miller, in press)
  - Extract “neurobehavioral trait constructs”?
Focus of Research

Classic theories suggest that there are at least 2 psychopathy phenotypes (Karpman 1941; Lykken, 1995)

- **Primary psychopathy**
  - Interpersonal-affective \(\rightarrow\) impulsivity and antisocial behaviors

- **Secondary psychopathy**
  - Impulsive-antisocial traits \(\rightarrow\) interpersonal manipulation and callousness

Support for these subtypes exist among people high in total psychopathy (Falkenbach, Stern, & Creevy, 2014; Hicks, Markon, Patrick, Krueger, & Newman, 2004; Skeem, Johansson, Andershed, Kerr, & Louden, 2007)
Overview of Research on Psychopathy

Psychopathy factors show distinct emotional and cognitive processes

**Interpersonal-affective traits (Factor 1)/ Primary Psychopathy**
- Low neuroticism/anxiety (e.g., Hicks & Patrick, 2006)
- Deficits in emotional processing and reduced fear-potentiated startle (e.g., Benning et al., 2005; Levenston et al., 2000; Verona et al., 2004)
- Intact executive functioning, sometimes enhanced (Carlson & Thai, 2010; Sellbom & Verona, 2007)
- Abnormal selective attention (Carlson & Thai, 2010; Newman, 2006; Sadeh & Verona, 2008)

**Impulsive-antisocial traits (Factor 2)/ Antisocial Personality**
- High neuroticism (e.g., Hicks & Patrick, 2006)
- Emotional dyscontrol (Raine et al., 1998; Sprague et al., 2012; Verona et al., 2001)
- Impairments in executive function, cognitive control, and response inhibition (Morgan & Lilienfeld, 2000; Ross, Benning, & Adams, 2007)

Much of prior work has focused on emotional deficits or cognitive deficits but not cognition-emotion interactions
Overview of Research on Psychopathy

Etiological Models of Psychopathy

- Fearlessness hypothesis (e.g., Lykken, 1995)
  - Diminished emotional reactivity, amygdala dysfunction
  - Reduced fear-potentiated startle (Levenston et al., 2000; Patrick et al., 1993) and deficient fear conditioning (e.g., Hare, 1965)
  - Neuroimaging evidence: deficient limbic activation to emotional stimuli (e.g., Kiehl et al., 2001)
Overview of Research on Psychopathy

Etiological Models of Psychopathy

- Attentional bottleneck/response modulation (e.g., Newman, 1998; Patterson & Newman, 1993)
- Passive avoidance errors when reward-seeking (e.g., Newman & Kosson, 1986)
- Decreased distractor processing/attentional capacity (e.g., Hiatt et al., 2004; Jutai & Hare, 1983; Sadeh & Verona, 2008)
- Attentional abnormalities may explain emotional deficits (e.g., Dvorak-Bertsch et al., 2009; Newman et al., 2010)
Cognition can affect emotion

- Reduced emotional processing at level of amygdala under high attentional load in unselected participants (Pessoa & Ungerleider, 2004)
- This process may be heightened in the case of psychopathy (Newman et al., 2010)

Emotion can disrupt cognitive and behavioral control

- Emotional prioritization or “low road” reactions to ambiguous situations
- Hallmark of certain personality disorders (e.g., Howard, 2009; Silbersweig et al., 2007)
- Cluster B (e.g., borderline/antisocial) personality traits associated with inhibitory control disruptions under negative emotional word blocks (Sprague & Verona, 2010)
In two studies we focused on cognition-emotion interactions in psychopathy

- Differentiate processing in primary psychopathic traits vs. impulsive antisocial traits
- Measured event-related potentials and/or startle in paradigms that challenge cognitive and affective systems
Study 1

Interactive effects of inhibitory control and emotion processing among offenders with APD vs. Psychopathy

- Go/no-go task involving negative emotional vs. neutral word blocks

45 participants (74% male) from parole/probation
Psychopathy Checklist: Screening Version (PCL: SV)

Offender Groups:
- Psychopathy (n = 14): PCL:SV Total ≥ 18; F1 > 5; APD+
- APD-only (n = 16): PCL:SV Total < 18; F1 < 5; APD+
- Controls (n = 15): PCL:SV Total < 12; F1 < 5; F2 < 7; APD-

Study 1

- Emotional-linguistic Go/No-Go Task (Goldstein et al., 2007)

  - Inhibitory Control manipulation:
    - Press button for words in normal font (“go” trial; 69 per block)
    - Inhibit button response for words in italicized font (“no-go” trial; 27 per block)
      - Infrequency of no-go to establish a dominant response set (Munro et al., 2007)

  - Emotion Word manipulation:
    - Blocks of neutral (NEU), general negative (GNEG), offender-specific negative words (OFF-NEG)
Emotional-linguistic Go/No-Go Task

Block 1
Block 2
Block 3
Block 4
Block 5
Block 6

NEU
32 Trials
(23 go, 9 no-go)
Examples:
(“umbrella”, “table”)  

GNEG
32 Trials
(23 go, 9 no-go)
Examples:
(“poison”, “rabies”)  

OFF-NEG
32 Trials
(23 go, 9 no-go)
Examples:
(“jail”, “addict”)  

Words chosen from Affective Norms for English Words (ANEW; Bradley & Lang, 1999) and validated in Sprague & Verona (2010)

Words matched on word frequency and length and two negative word categories matched on normed valence ratings.
Study 1

ERP methods
- P3 or Late Positivity, occurring 350-650 ms following word onset
- Frontal/Fronto-central (Fz, FCz)

- No-Go P3: Inhibitory control processing
- Emotion P3: emotion processing
Study 1
Grand Average Waveform – FCZ

Group x Emotion Word Block x Trial Type (No-Go vs. Go)
Enhanced processing of emotion words in go but suppressed in no-go
Psychopathic Emotion Word, $p = .51$

No Emotion Word effect in either trial condition
Emotion Word, p<.01

Enhanced processing of emotion words in both go and no-go.
### Study 1
Specific psychopathy factors

- Partial correlations across all participants (Ns = 56-59):

<table>
<thead>
<tr>
<th></th>
<th>No-Go P3</th>
<th>Emotion P3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpersonal</td>
<td>.33*</td>
<td>.09</td>
</tr>
<tr>
<td>Affective</td>
<td>-.16</td>
<td>-.30*</td>
</tr>
<tr>
<td><strong>Factor 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulsive Lifestyle</td>
<td>-.03</td>
<td>.44**</td>
</tr>
<tr>
<td>Antisocial</td>
<td>-.19</td>
<td>-.05</td>
</tr>
</tbody>
</table>

+ p = .05; * p < .05; ** p < .001

*No-Go P3 = no-go - go trials*

*Emotion P3 = negative emotion – neutral word blocks*
In controls, inhibitory control demands suppressed emotional processing of words (cf., Pessoa et al., 2002)

Disruptions in interaction of inhibitory control and emotion characterize psychopathy and antisocial but differentially:

- Psychopathic offenders show deficient emotional categorization across trials
  - Affective features of psychopathy (e.g., lack of empathy, shallow affect) related to reduced emotional processing
  - Interpersonal features (e.g., conning, charm) related to more cognitive control or no-go processing

- APD offenders fail to modulate emotional processing under inhibitory control demands
  - Impulsive-antisocial traits related to enhanced emotional processing overall, and marginally to reduced cognitive control
  - Reflects real life impairments in inhibitory control under emotional situations
Study 2

- Examine the unique and interactive contributions of emotional and attentional processes to psychopathy factors
  - Does perceptual complexity that compromises attentional capacity impact level of emotional processing of and defensive reactivity to unpleasant stimuli in psychopathy

- 63 participants (83% male) from parole/probation
  - Scores on Factor 1 (Interpersonal-Affective) and Factor 2 (Impulsive-antisocial)

_Sadeh & Verona (2012). Cognitive, Affective, & Behavioral Neuroscience_
Study 2

International Affective Picture System
(IAPS; Lang et al., 2005)

- Modified picture-viewing paradigm from Bradley et al. (2007)
- Disentangles emotion & visual complexity
- 128 IAPS slides
  - Neutral & unpleasant slides matched on visual complexity
  - 32 slides per condition
Study 2
Dependent Variables

- **N1**: ERP sensitive to perceptual load, larger to complexity
- Complexity effect may be exacerbated in psychopathy if abnormal selective attention
- Measured over occipital areas
Study 2
Dependent Variables

- **LPP**: ERP sensitive to emotional properties
- Emotion effect may be diminished in psychopathy if blunted emotional reactivity

- Measured over centroparietal sites
Study 2
Dependent Variables

- **Startle**: EMG sensitive to both attention & emotion
  - Larger blink to Unpleasant vs. Neutral slides; smaller blink to High vs. Low complexity slides

- **Visual N1**
- **Late Positive Potential**
- **Picture Onset**: 0 - 105-165 ms
- **Startle Reflex**: 400-700 ms
- **Startle Probe**: 2500-3500 ms

- Measured on orbicularis oculi muscle
Visual N1 Results

- Psychopathy F1 x Complexity x Emotion
  - F1 related to greater orienting to negative pictures under high complexity

![Graph showing the relationship between Visual N1 Emotion Effect and PCL SV Affective-Interpersonal Residual]

- Visual N1

- Picture Onset

- 0 105-165 ms

- Low Complex
- High Complex

- \( r = .29^* \)
Visual N1 Results

• Psychopathy F2 x Complexity
  • F2 related to less orienting to complexity

$r = -.29^*$
Late Positive Potential Results

- Psychopathy F1 x Emotion
  - F1 related to decreased processing of negative pictures

Graph: LPP Emotion Effect (Unpleasant - Neutral) vs. Psychopathy F1 Residual
Startle Reflex Results

- Psychopathy F1 x Emotion x Complexity
  - F1 related to decreased fear-potentiated startle to High Complexity slides
Study 2
Conclusions

- Factor 1 (interpersonal-affective features)
  - N1: Allocated more early attentional resources to decipher negative emotional content when high complexity
  - LPP: Reduced emotion modulation, regardless of picture complexity
  - Startle: Defensive reactivity reduced to negative pictures high on complexity but not low complexity
  - More likely to show emotional deficits when attention is taxed? (cf. Newman et al., 2010)
  - Or deficits in bottom-up prioritization of motivationally-relevant stimuli by emotional systems?
Study 2
Conclusions

- Impulsive-Antisocial Features of Psychopathy (Factor 2)
  - N1: less sensitive to processing demands of high vs. low complexity pictures, regardless of emotion
  - LPP and Startle: No effects of Factor 2
    - Normal range emotional modulation of attention and defensive reflex
The different factors represent different pathways to antisocial and violent behavior:

**Factor 1/ primary psychopathy**
- Affective features (callousness)
  - Alterations in amygdala activity (Blair, 2000; Patrick, 1994)
  - Higher threshold for emotional activation, maybe exacerbated by attentional abnormalities
- Interpersonal dominance
  - Enhanced executive function (Carlson & Thai, 2010; Sellbom & Verona, 2007)
  - Larger no-go P3 and enhanced error monitoring and adjustment (post-error slowing, error related negativity/ERN) (Bresin, Finy, Sprague, & Verona, in press)
  - Makes them adept at conning, instrumental aggression?

**Factor 2/ antisocial-externalizing**
- Dysregulation of emotion and behavior – problems with adapting under emotional conditions
- Orbitofrontal cortex and top-down regulation circuits
- Deficient cognitive control (e.g., inhibitory control and working memory/attentional control)

### Implications
COMMON GENOTYPES AND ENVIRONMENT

F1
- e.g., efficient 5HT transport/txn, Reduced oxyroxin

F2
- e.g., low-activity 5HT & MAOA txn, childhood adversity

COGNITION-EMOTION MECHANISMS
- Deficits in bottom-up enhancement of emotion
- Decreased cognitive control over emotional reactivity

PERSONALITY
- Low Negative Emotionality; Social Potency
- High Negative Emotionality; Impulsiveness

Behaviors (subst use, viol, criminality)

References:

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