What We Are Learning About Brain Biology and Borderline Personality Disorder

Anthony C. Ruocco, Ph.D., C.Psych
Departments of Psychology and Psychological Clinical Science
University of Toronto

Acknowledgements

The Brain & Behavior Research Foundation and
Families for Borderline Personality Disorder Research
(https://familiesforbpdresearch.org)

Dr. Z. Jeff Daskalakis and Dr. Daniel Blumberger, Centre for Addiction & Mental Health, Temerty Centre for Therapeutic Brain Intervention

Dr. Shelley McMain, Head, BPD Clinic, Centre for Addiction & Mental Health

Dr. Jenna Traynor and Dr. Nicola Hermanto, Postdoctoral Fellows

Acknowledgements

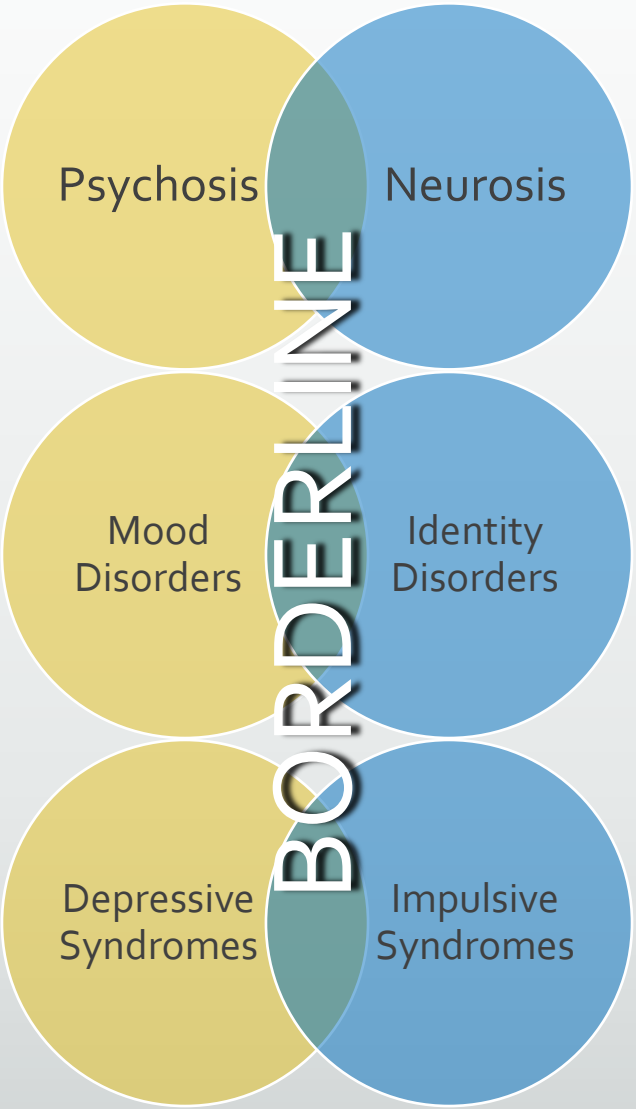
Current and Former Graduate Students: Alex Daros, Achala Rodrigo, Katherine Gardhouse, Dean Carcone, Jacob Koudys, Tahira Gulamani, and Cody Cane

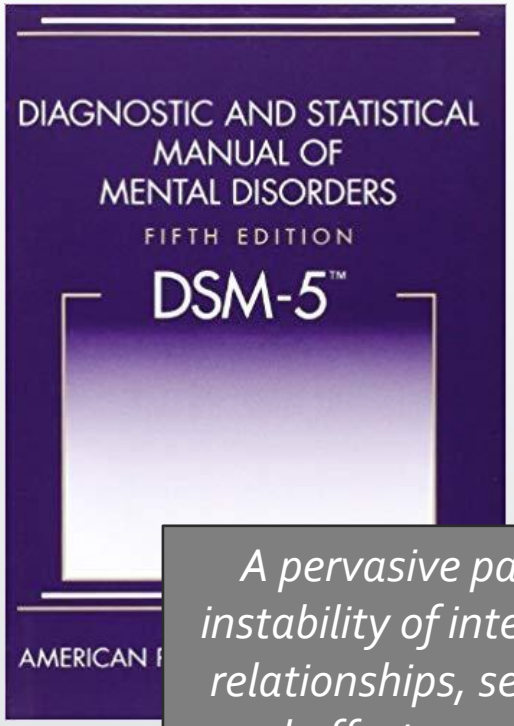
Community Organization: The Sashbear Foundation

Funding: Brain & Behavior Research Foundation, Canadian Institutes of Health Research, Province of Ontario, and American Foundation for Suicide Prevention

What Is Borderline Personality Disorder?

What's in a Name?





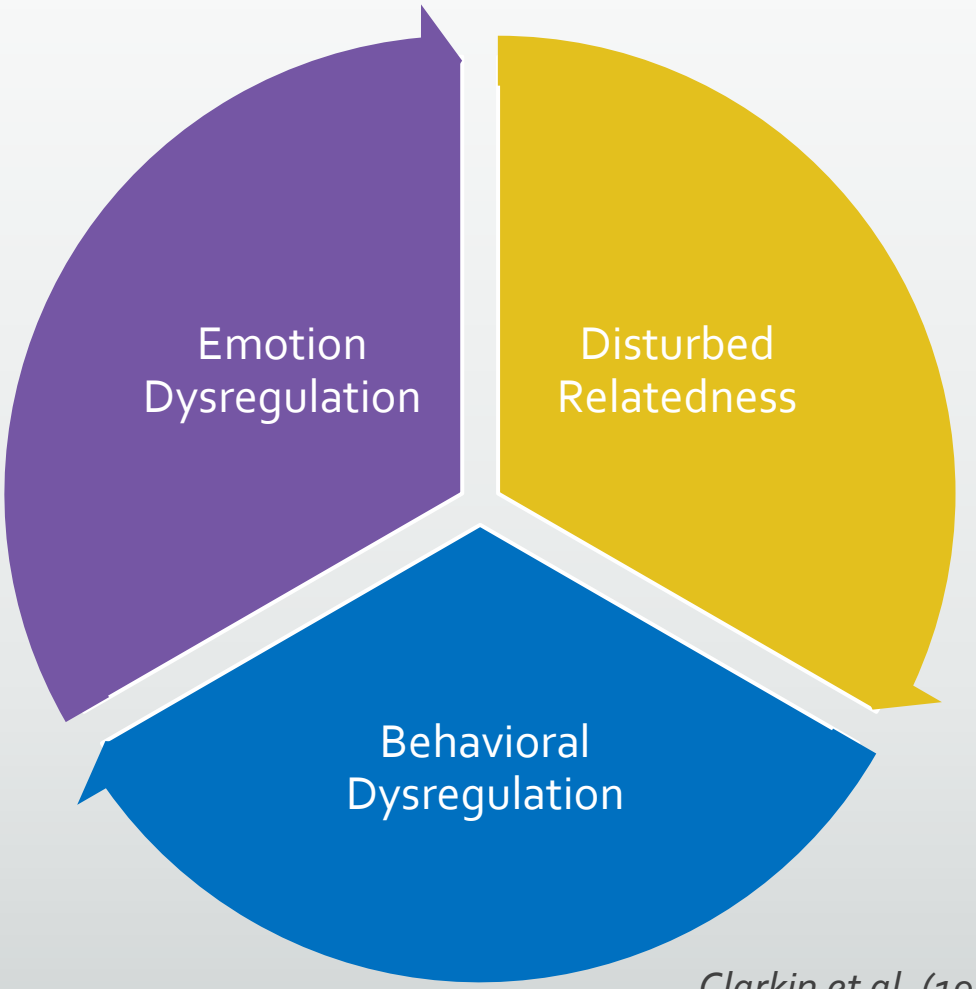
A pervasive pattern of instability of interpersonal relationships, self-image, and affects, and marked impulsivity

Tyrer (2009)

Challenges with Diagnosing BPD

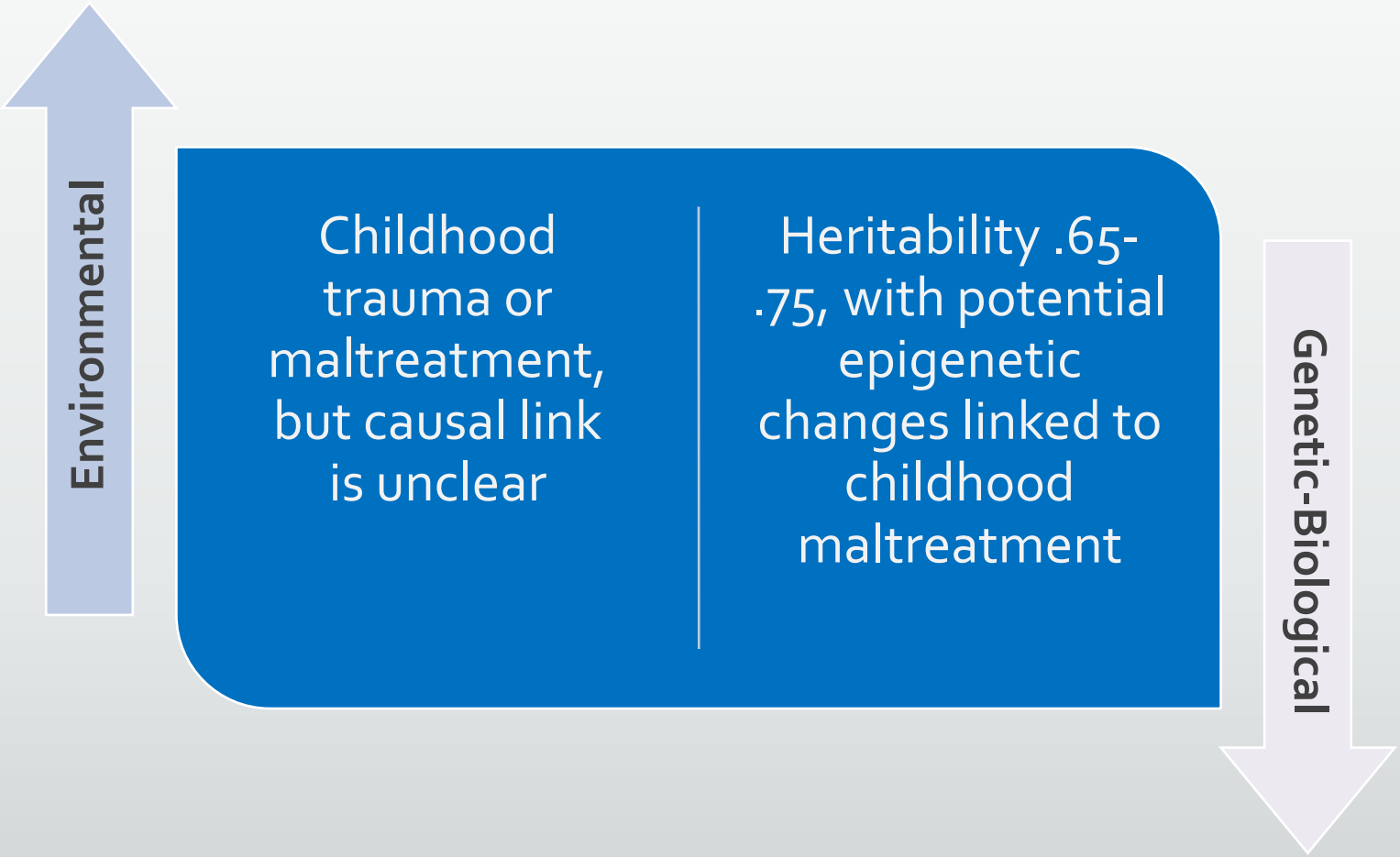
- There is not always sufficient time for clinicians to conduct a comprehensive assessment of personality disorders.
- People with BPD frequently have other co-occurring psychiatric diagnoses (e.g., major depression, substance use disorders, posttraumatic stress disorder), which may be the initial focus of clinical attention.
- When an individual's presenting problem is another mental health concern, BPD (and other personality disorders) may be overlooked and could lead to underdiagnosis.
- Two individuals with BPD may have only one symptom in common (yet have the same diagnosis).

Core Symptom Domains of BPD

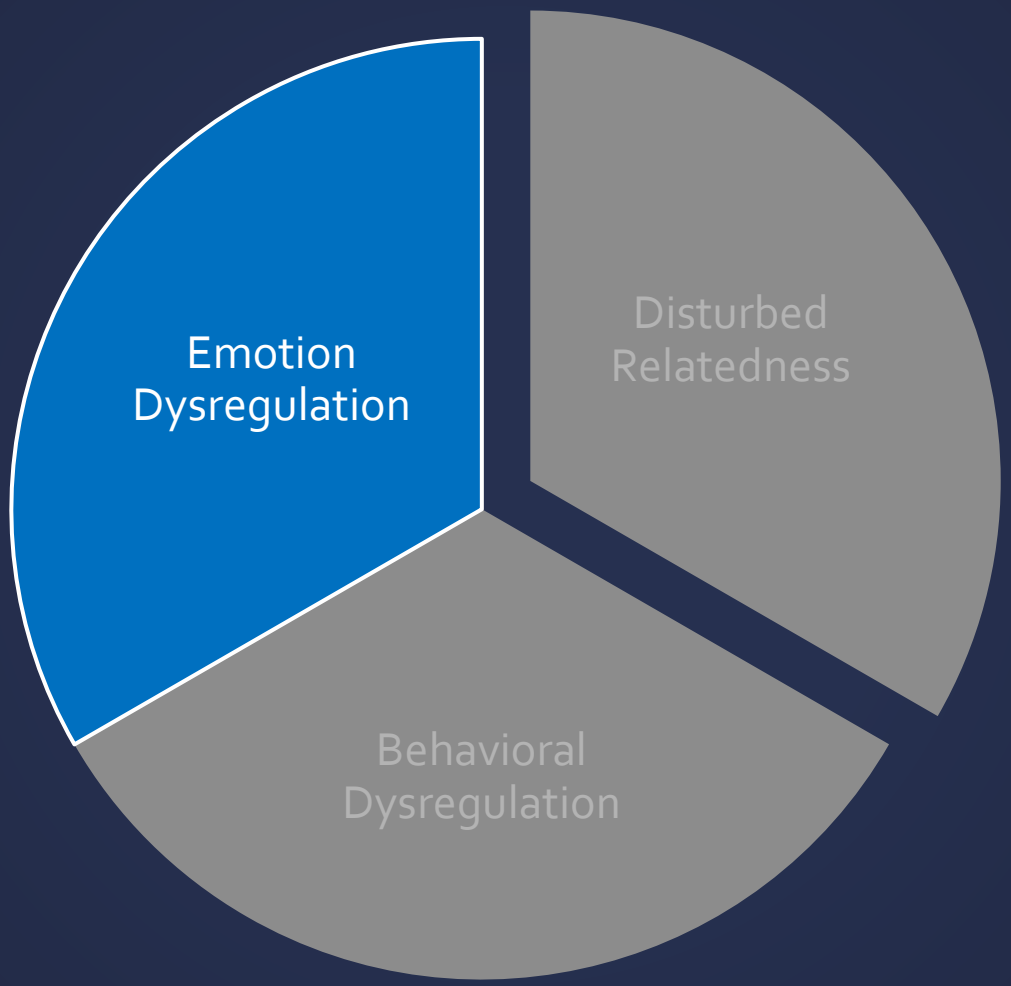


Clarkin et al. (1993); Sanislow et al. (2000)

Factors That Cause And Maintain BPD



Brain Biology


Emotion Dysregulation
Disturbed Relatedness
Behavioral Dysregulation

Emotion Regulation Strategies In BPD

Used More Frequently in BPD

Suppression	Rumination	Avoidance

↑ Rumination, ↓ Problem-Solving → Potentially Harmful Behaviours

Used Less Frequently in BPD

Cognitive Reappraisal	Problem-Solving	Acceptance

Daros, A. R., Guevara, M. A., Uliaszek, A. A., McMain, S. F., & **Ruocco, A. C.** (2018). Cognitive emotion regulation strategies in borderline personality disorder: Diagnostic comparisons and associations with potentially harmful behaviors. *Psychopathology, 51*, 83-95.

Family Study of BPD

BPD	Relatives	Controls
N=99	N=103	N=74
30.2 years	39.8 years	30.0 years
91.3% women	51.4% women	93.9% women

Ruocco, A. C., Daros, A. R., Chang, J., Rodrigo, A. H., Lam, J., Ledochowski, J., & McMain, S. F. (2019). Clinical, personality and neurodevelopmental phenotypes in borderline personality disorder: A family study. *Psychological Medicine*, *49*, 2069-2080.

Psychiatric Diagnoses in Families

Major Depression (Past)

- BPD: 43%
- Relatives: 27%

Alcohol Dependence (Past)

- BPD: 35%
- Relatives: 12%

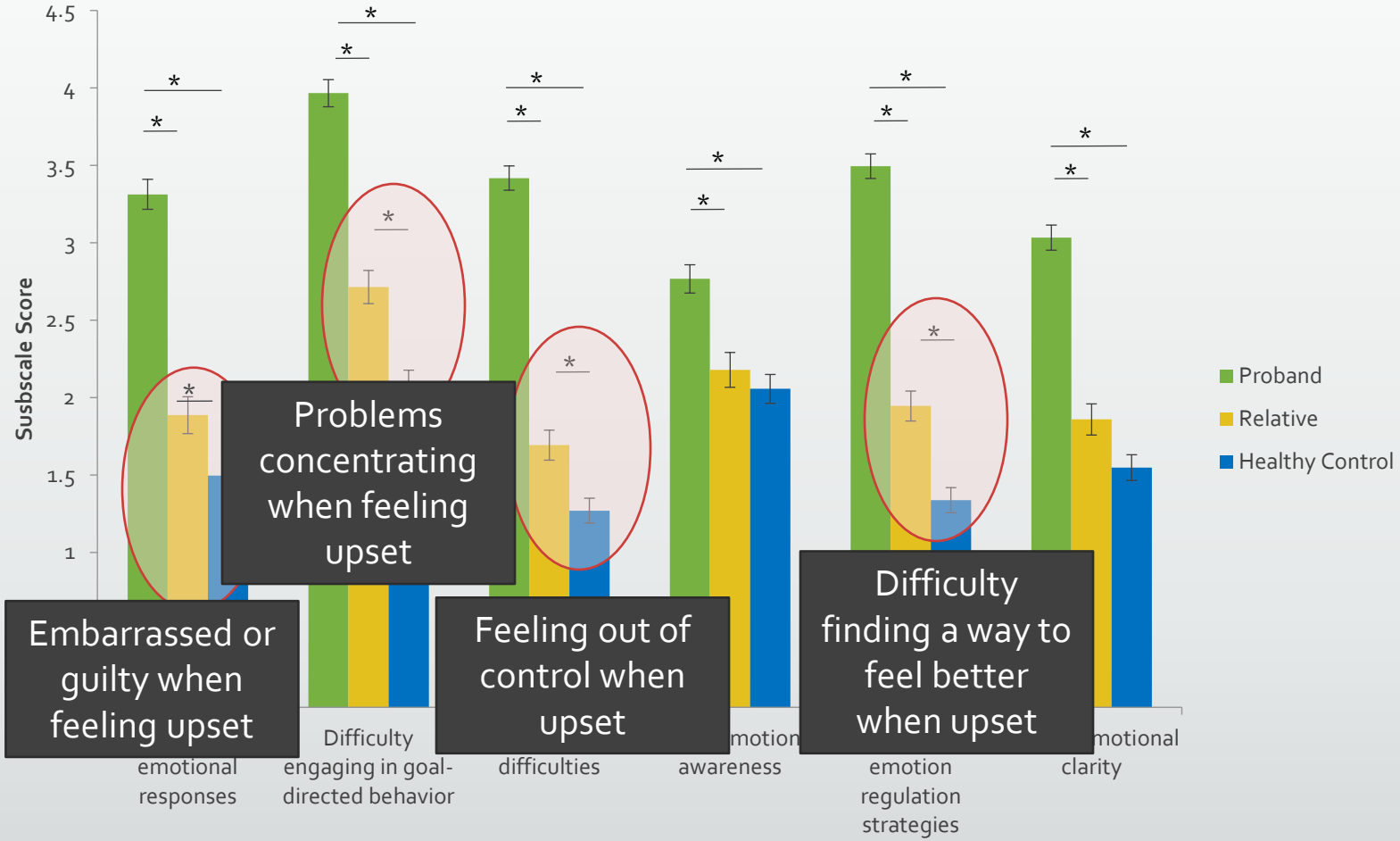
Social Anxiety Disorder (Current)

- BPD: 18%
- Relatives: 4%

PTSD (Current)

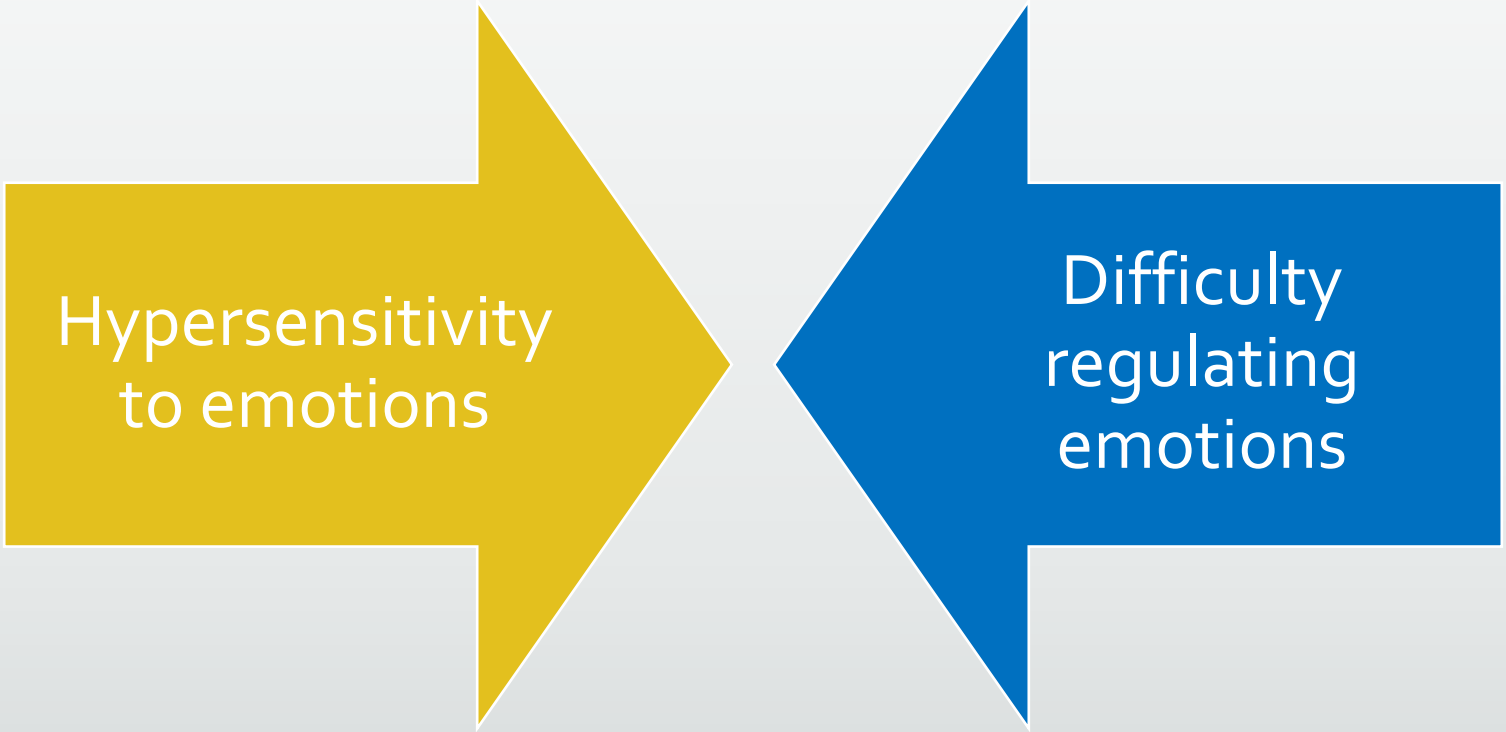
- BPD: 23%
- Relatives: 5%

Familial Aggregation of Difficulties in Emotion Regulation

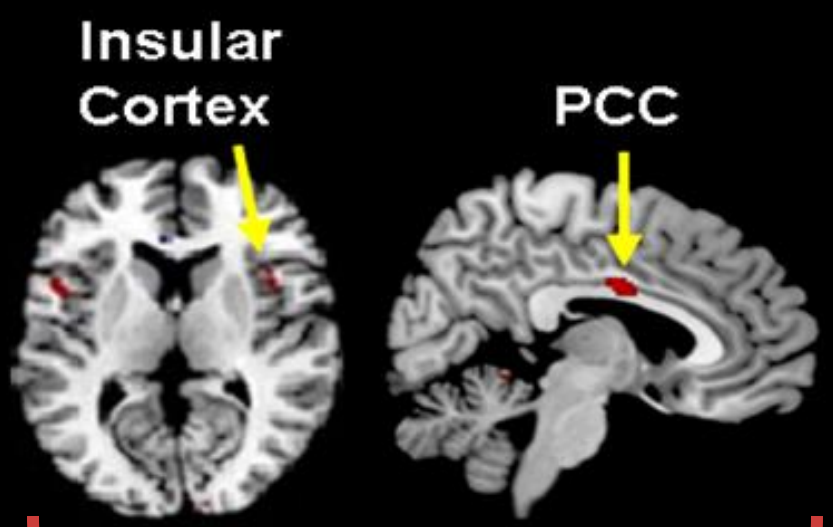


Ruocco, A. C., Daros, A. R., Chang, J., Rodrigo, A. H., Lam, J., Ledochowski, J., & McMain, S. F. (2019). Clinical, personality and neurodevelopmental phenotypes in borderline personality disorder: A family study. *Psychological Medicine*, *49*, 2069-2080.

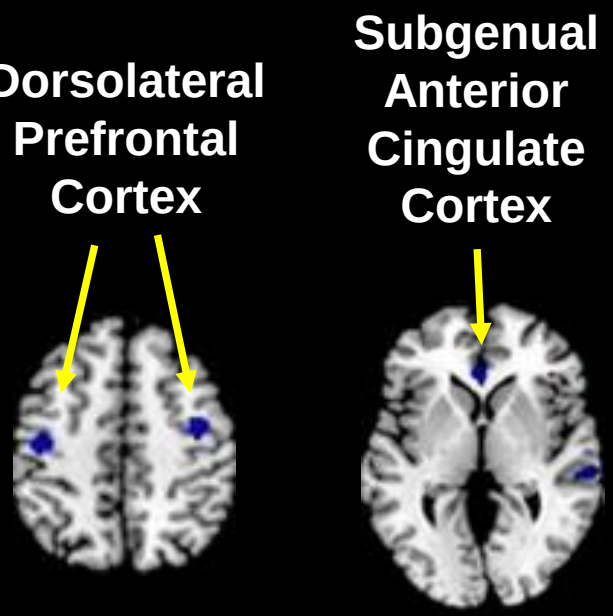
Theory of Emotion Dysregulation In BPD



Neural Activity Associated With Negative *Versus* Neutral Emotional Items



BPD (n=153) > Controls (n=150)



BPD (n=153) < Controls (n=150)

Ruocco, A. C., Amirthavasagam, S., Choi-Kain, L. W., & McMain, S. F. (2013). Neural correlates of negative emotionality in borderline personality disorder: An activation-likelihood-estimation meta-analysis. *Biological Psychiatry, 73,* 153-160.

Are Neutral Faces Really "Neutral" for People with BPD?

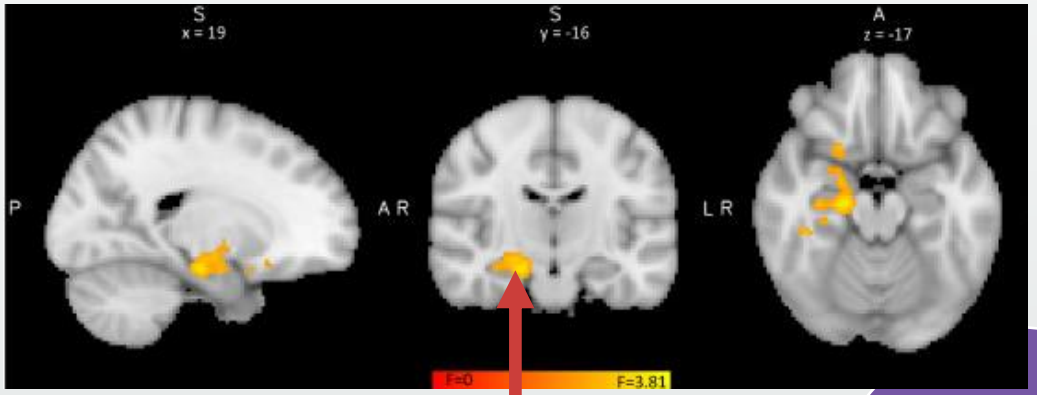
Better emotion recognition at lower levels of intensity

Worse emotion recognition at higher levels of intensity

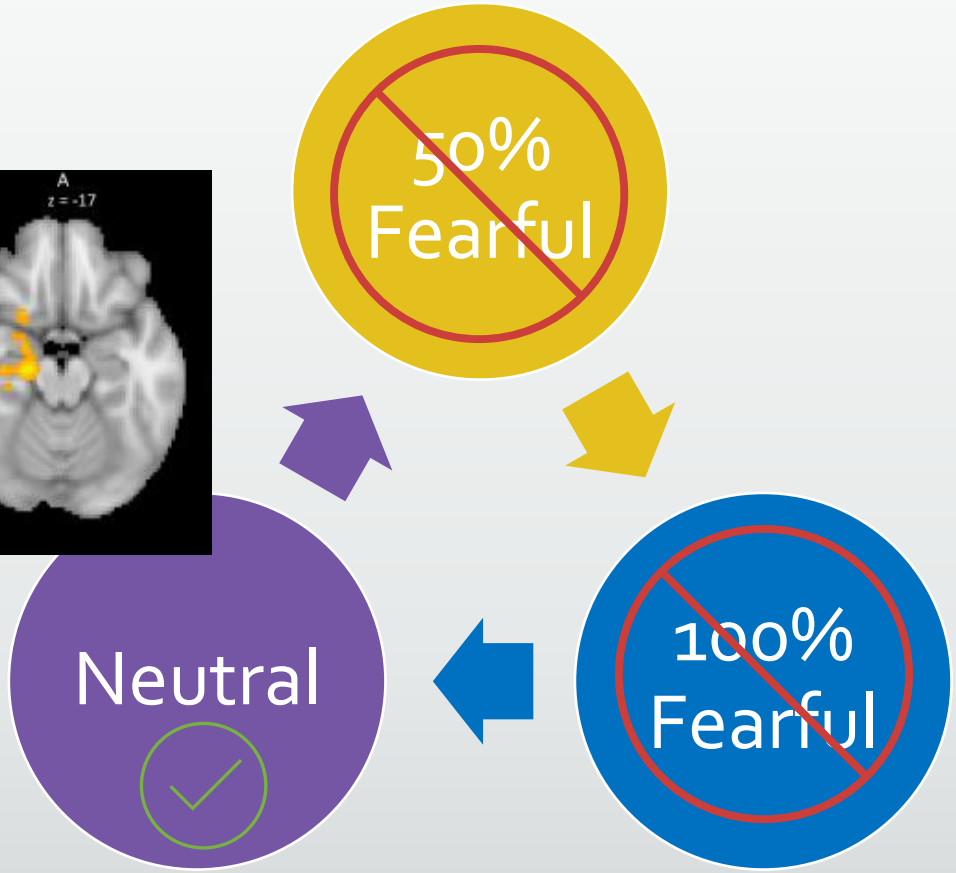
Intensity

Lynch et al. (2006)

Brain Activation and "Neutral" Facial Expressions in BPD



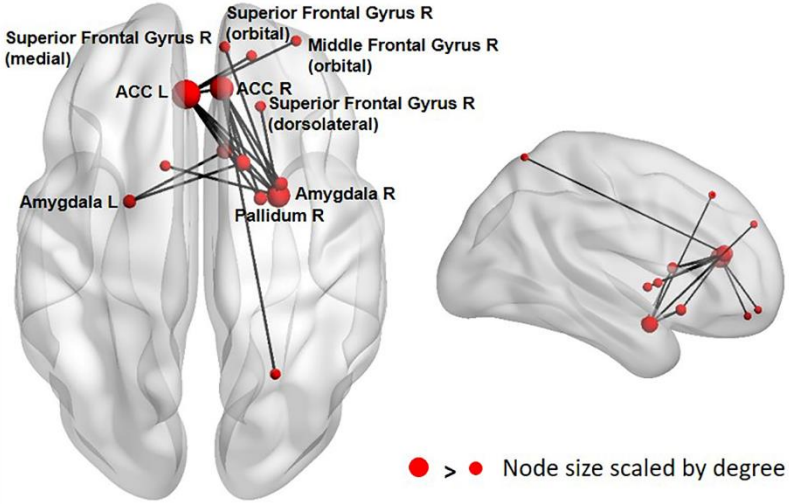
Higher Amygdala Activation Compared to Controls

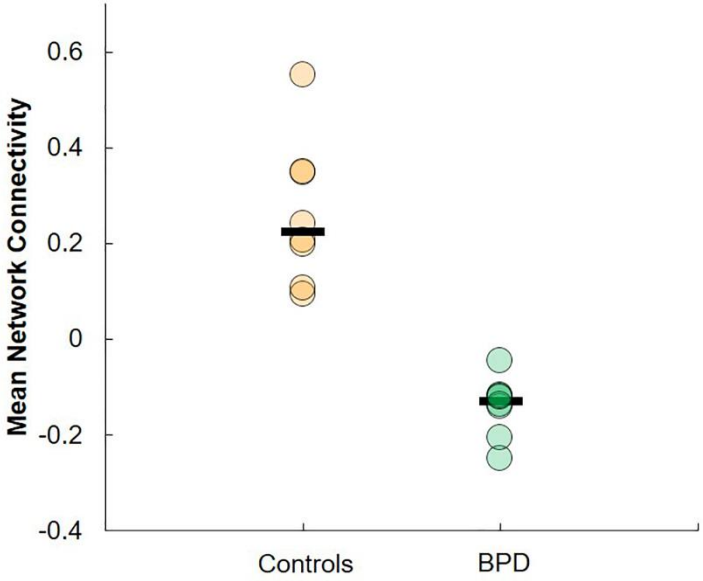


Wrege, J., **Ruocco, A. C.**, et al. (2021). Facial emotion perception in borderline personality disorder: Differential neural activation to ambiguous and threatening expressions and links to impairments in self and interpersonal functioning. *Journal of Affective Disorders, 284*, 126-135.

Do Adolescents with BPD Traits Show the Same Neural Differences as Adults?

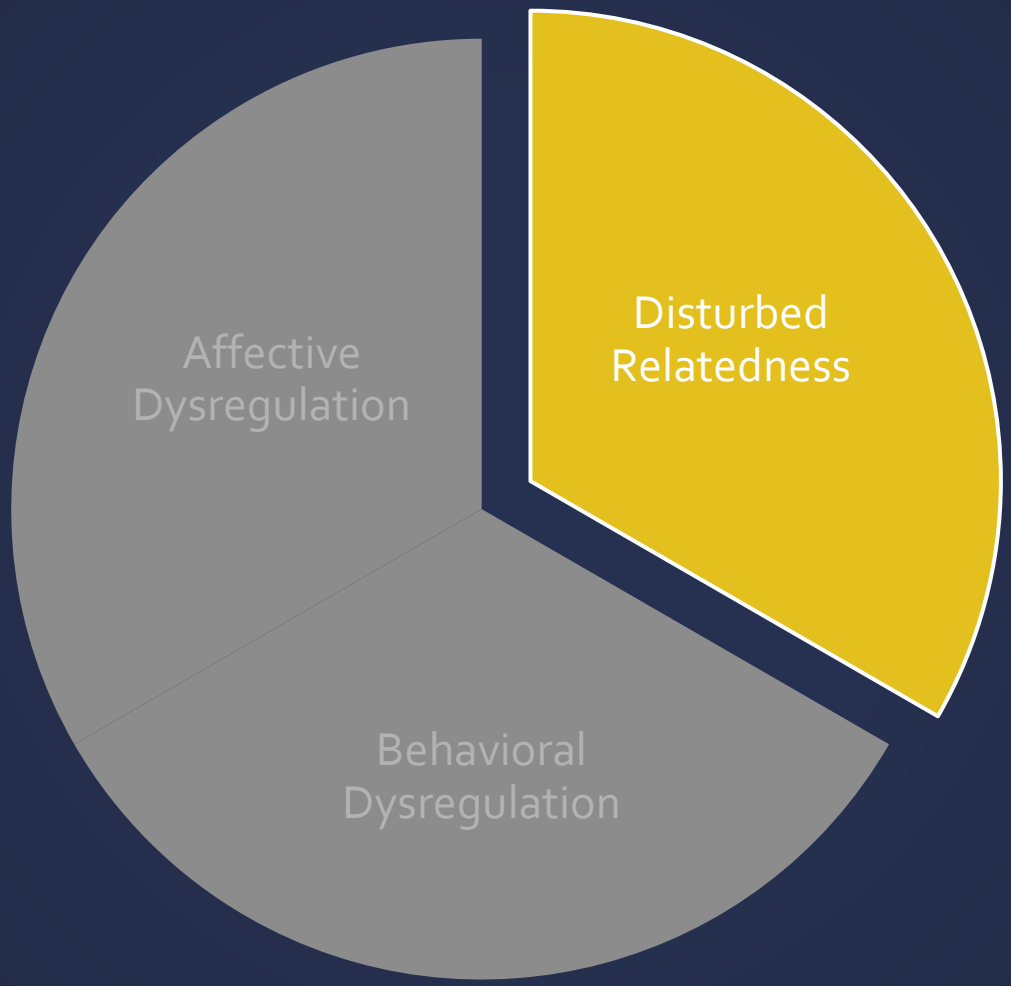
Controls > BPD traits





During implicit angry face perception, we identified a ***hyposynchronous*** fronto-limbic circuit, which included connections among bilateral amygdalae and bilateral anterior cingulate cortex.

*Safar, K., Sato, J., **Ruocco, A. C.**, Korenblum, M. S., O'Halpin, H., & Dunkley, B. T. (2019). Disrupted emotional neural circuitry in adolescents with borderline personality traits. Neuroscience Letters, 701, 112-118.*


Disturbed Relatedness
Affective Dysregulation
Behavioral Dysregulation

Are Neutral Faces Really "Neutral" for People with BPD?

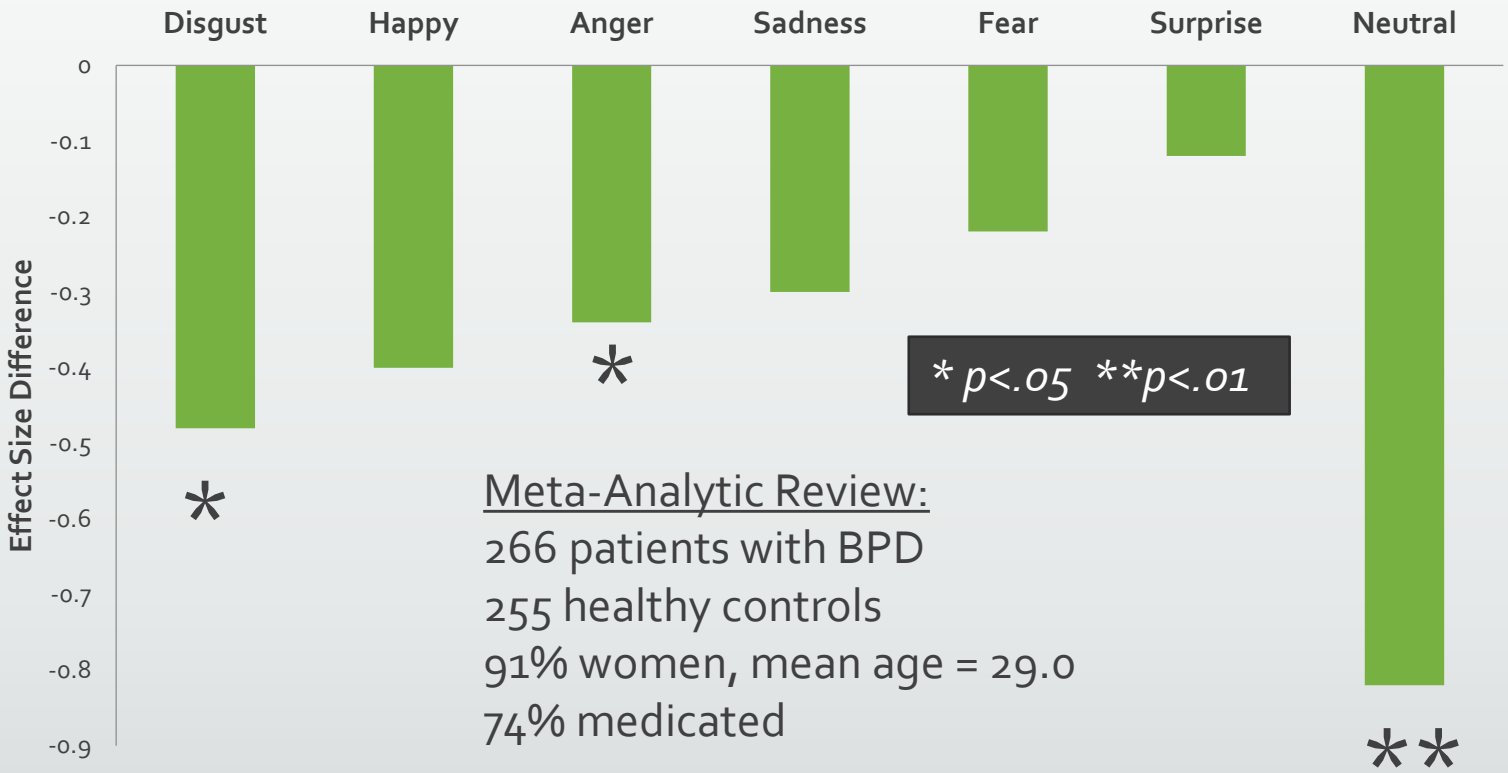
Better emotion recognition at lower levels of intensity

Worse emotion recognition at higher levels of intensity

Intensity

Lynch et al. (2006)

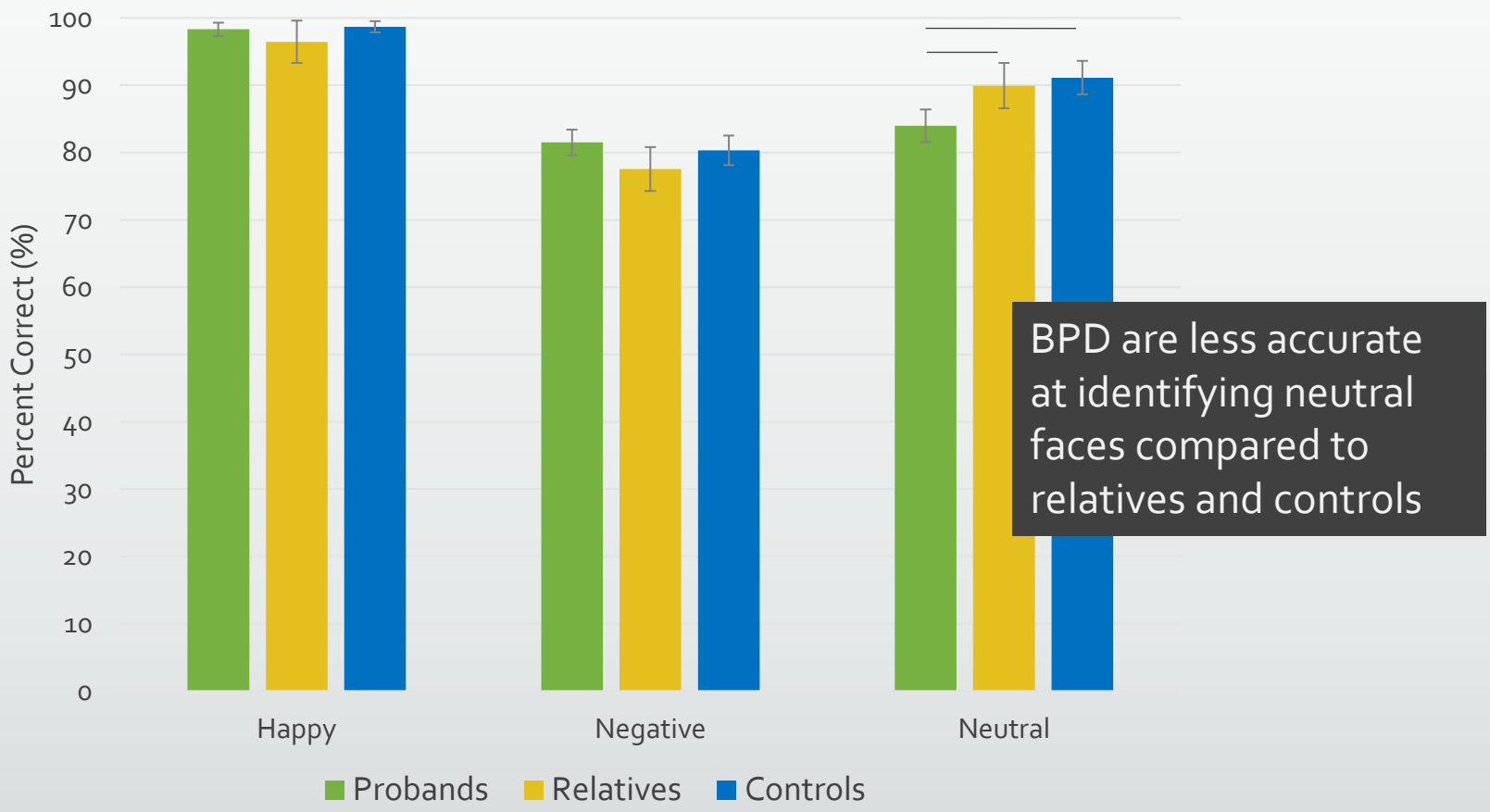
People with BPD Make More Errors Recognizing Highly Arousing Negative Emotions and Neutral Expressions



Meta-Analytic Review:
266 patients with BPD
255 healthy controls
91% women, mean age = 29.0
74% medicated

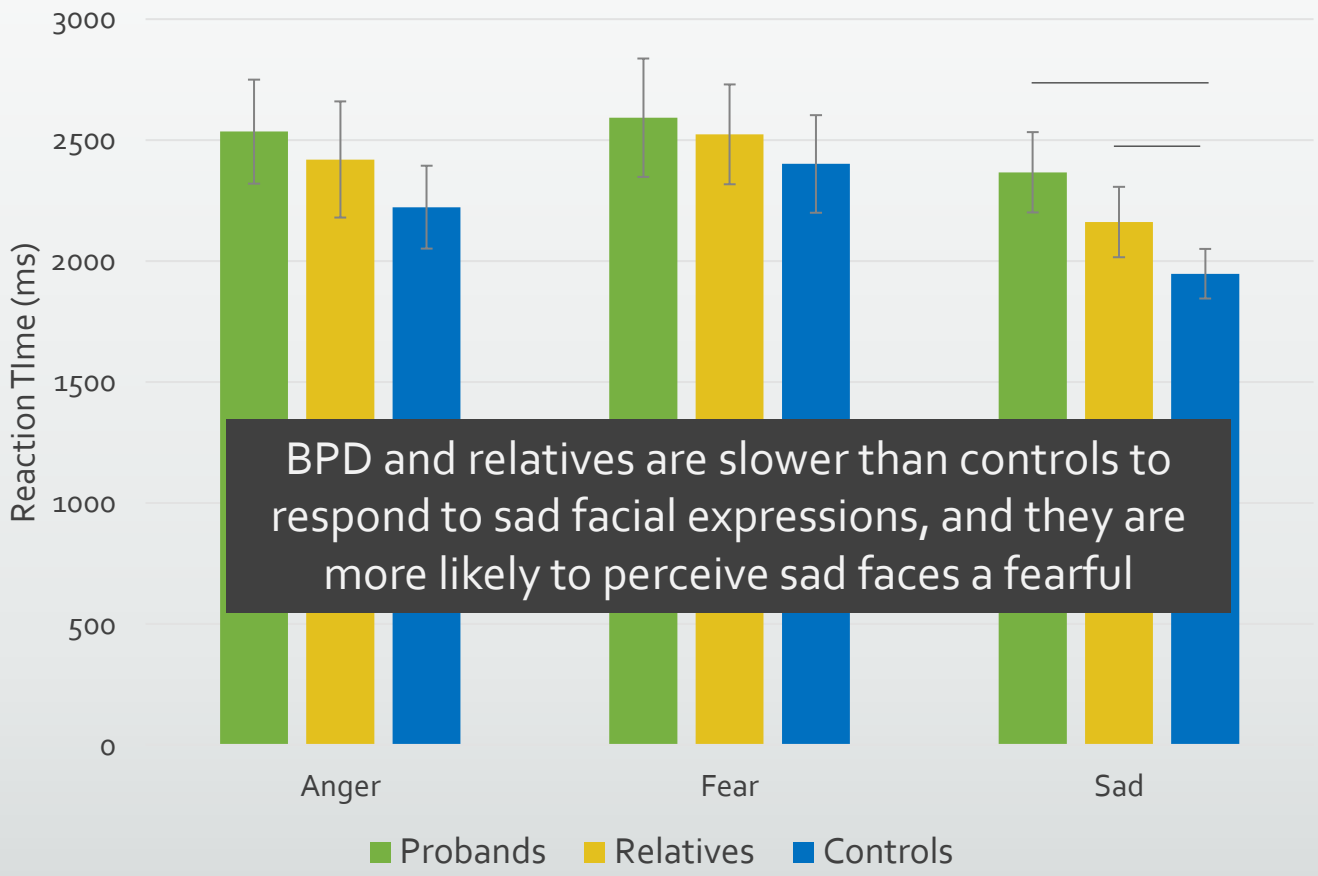
Daros, A., Zakzanis, K. K., & **Ruocco, A. C.** (2013). Facial emotion recognition in borderline personality disorder. *Psychological Medicine*, *43*, 1953-1963.

Emotion Recognition in Families with BPD



Gulamani et al. (in press). Facial emotion recognition biases in probands with borderline personality disorder and first-degree biological relatives. *Journal of Personality Disorders.*

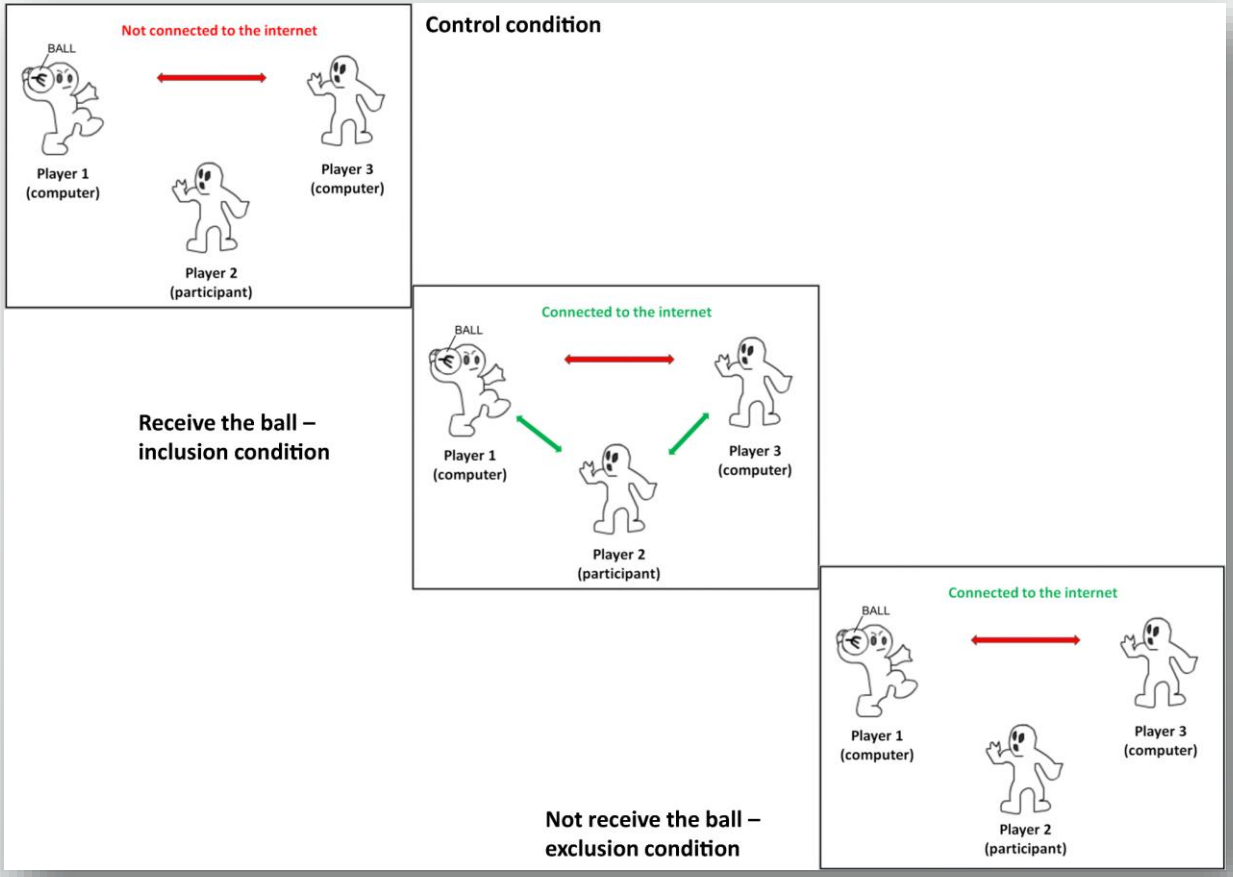
Response Speeds and "Misperceptions" of Specific Emotions



BPD and relatives are slower than controls to respond to sad facial expressions, and they are more likely to perceive sad faces a fearful

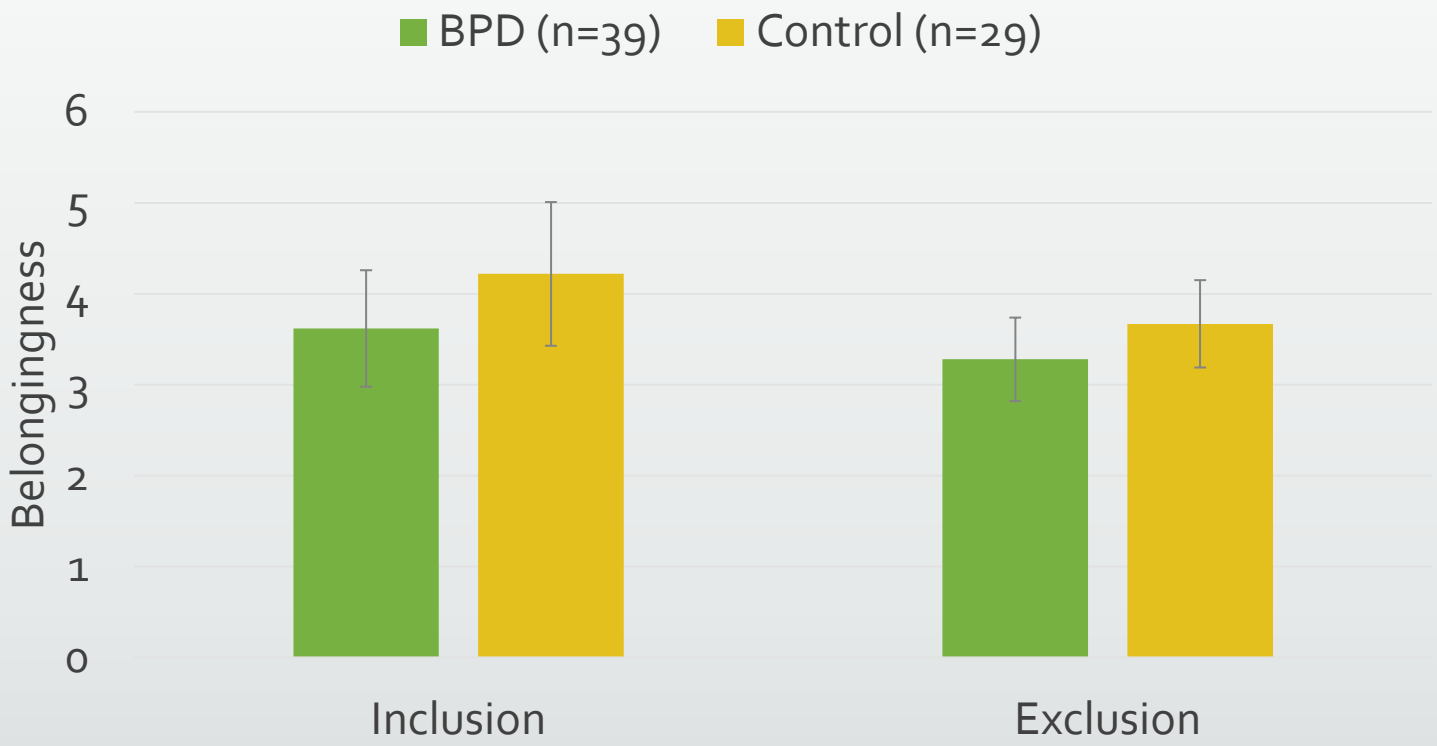
Gulamani et al. (in press). Facial emotion recognition biases in probands with borderline personality disorder and first-degree biological relatives. *Journal of Personality Disorders.*

Cyberball—A Task for Studying Interpersonal Ostracism



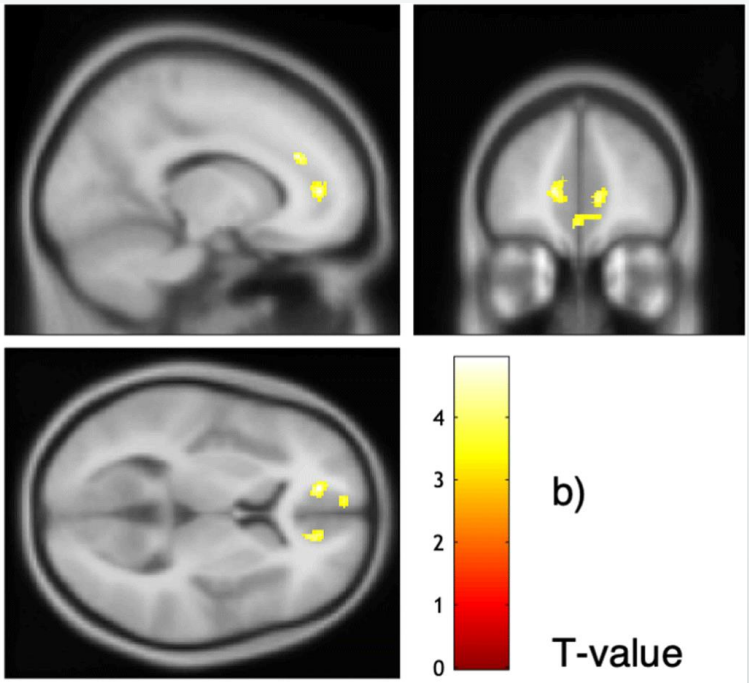
Williams et al. (2000)

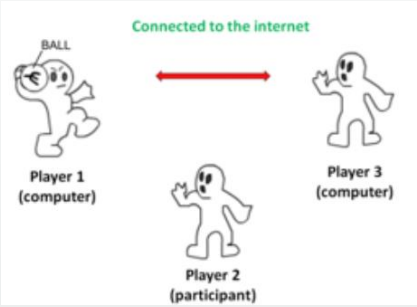
People with BPD are Sensitive to Interpersonal Exclusion



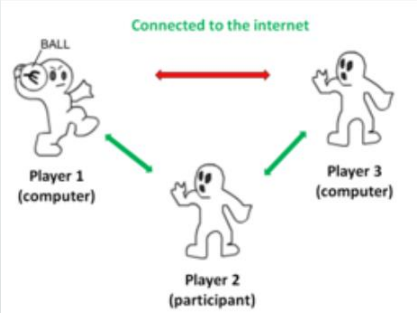
Wrege, J., **Ruocco, A. C.**, Euler, S., Preller, K., Busmann, M., Lenz, C., Meya, L., Schmidt, A., Lang, U. E., Borgwardt, S., & Walter, M. (2019). Negative affect moderates the effect of social rejection on frontal and anterior cingulate cortex activation in borderline personality disorder. *Cognitive, Affective, & Behavioral Neuroscience*, *19*, 1273–1285.

People with BPD Show Higher Frontal Cortex and ACC Activity during Social Exclusion

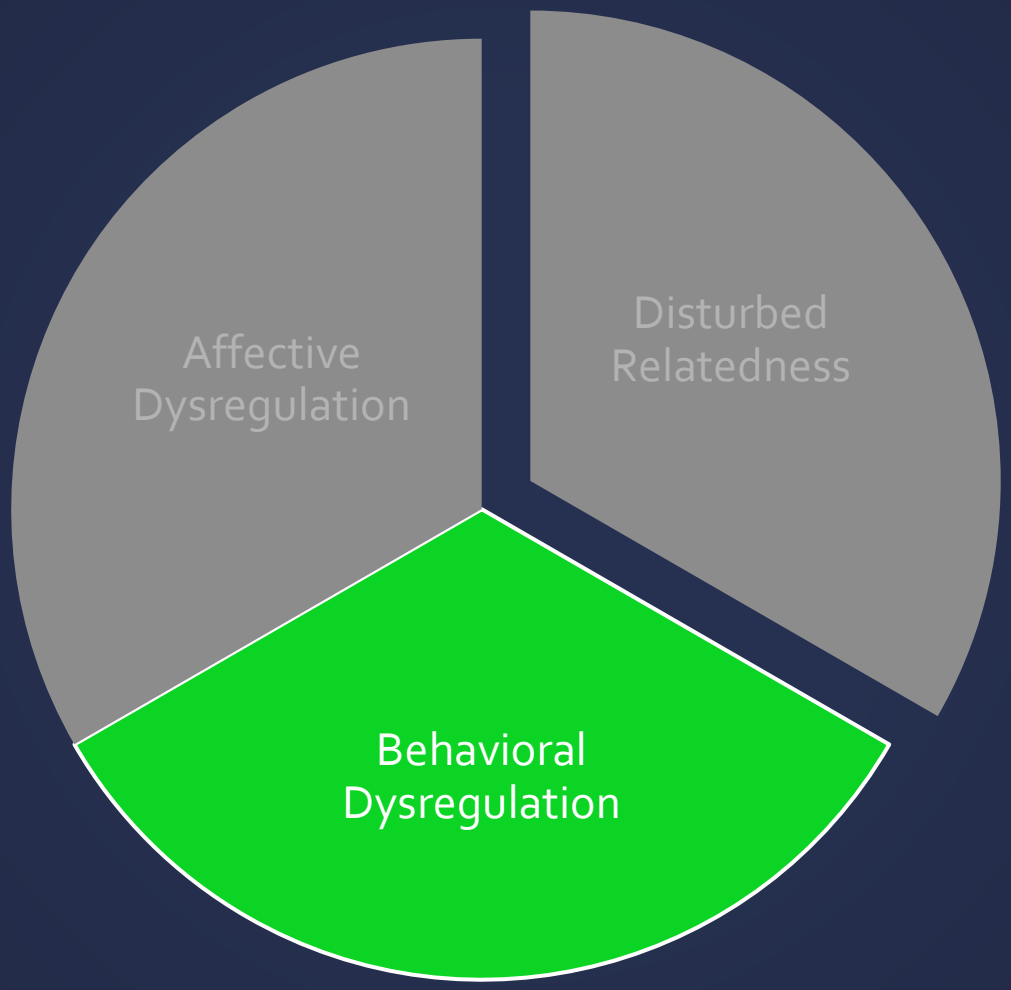




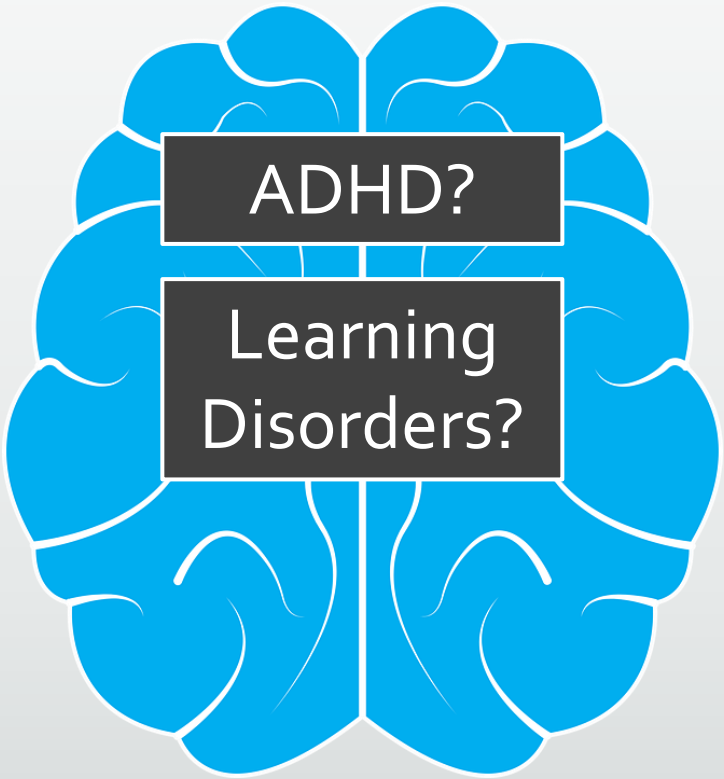
>



Wrege, J., **Ruocco, A. C.**, Euler, S., Preller, K., Busmann, M., Lenz, C., Meya, L., Schmidt, A., Lang, U. E., Borgwardt, S., & Walter, M. (2019). Negative affect moderates the effect of social rejection on frontal and anterior cingulate cortex activation in borderline personality disorder. *Cognitive, Affective, & Behavioral Neuroscience*, *19*, 1273–1285.

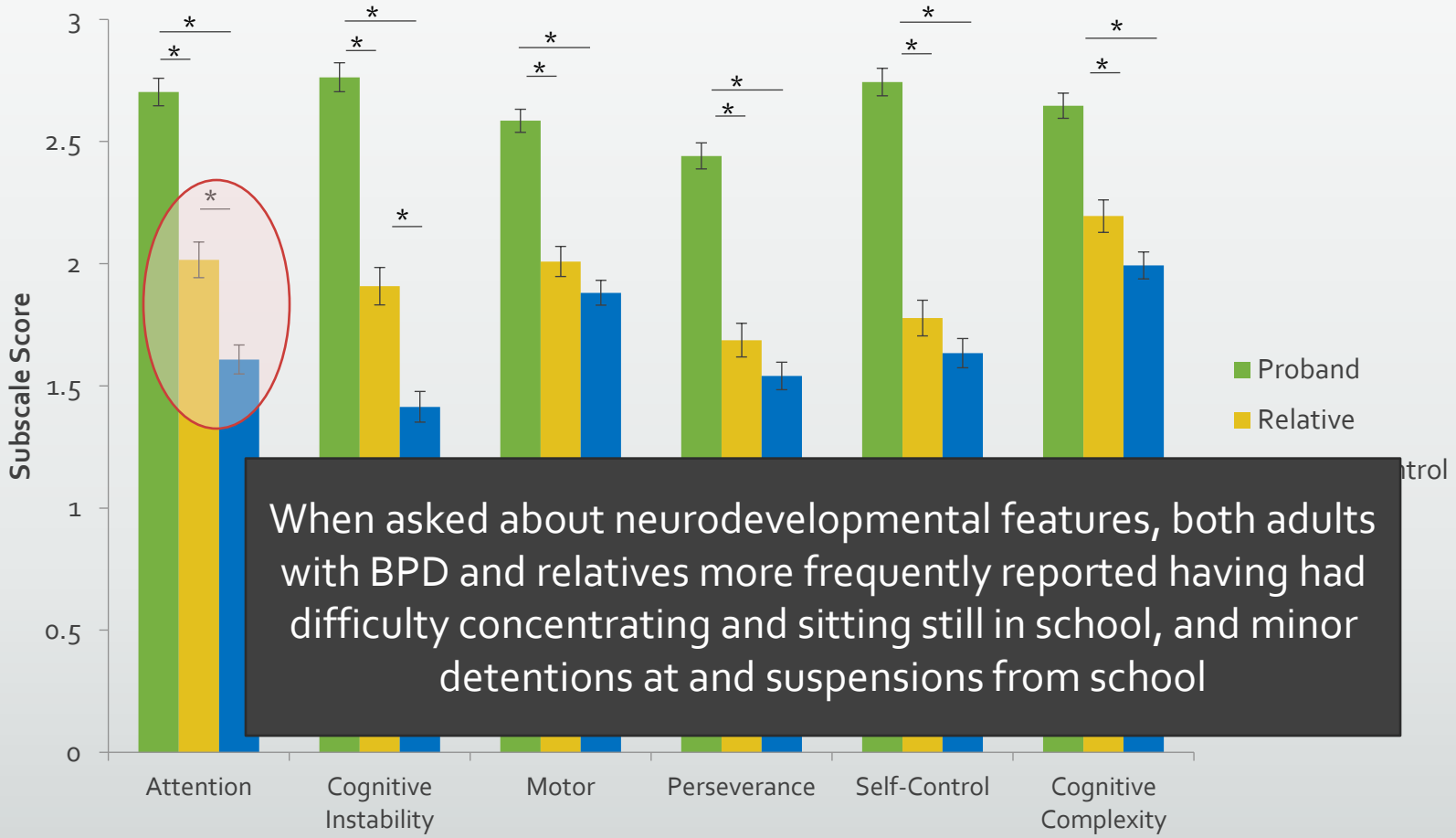

Affective Dysregulation
Disturbed Relatedness
Behavioral Dysregulation

Neurocognitive Domains



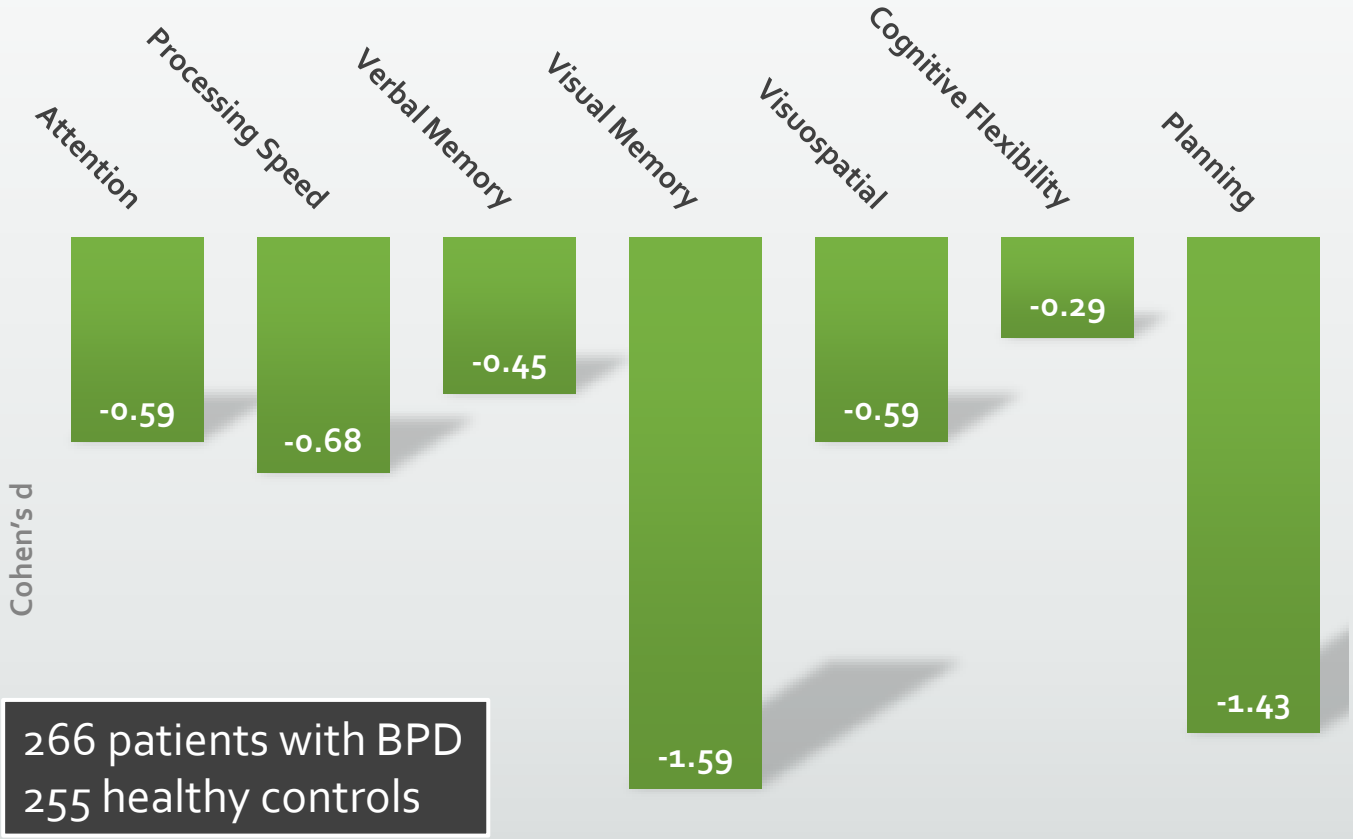
- Attention
- Working Memory
- Learning and Memory
- Visuospatial Ability
- Language
- Psychomotor Speed
- Executive Functions

Self-Reported Attention and BPD in Families



When asked about neurodevelopmental features, both adults with BPD and relatives more frequently reported having had difficulty concentrating and sitting still in school, and minor detentions at and suspensions from school

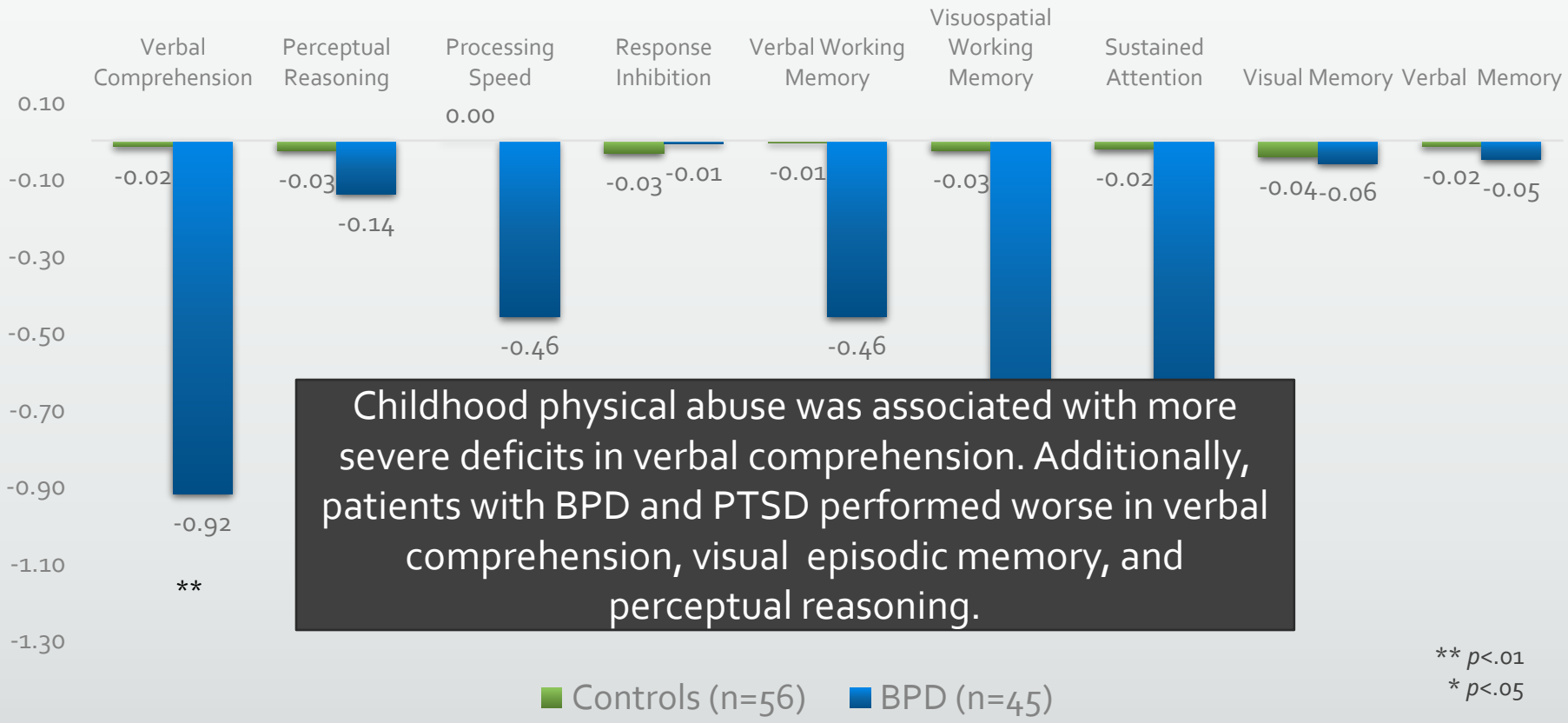
Multiple Neurocognitive Domains are Affected in BPD



266 patients with BPD
255 healthy controls

Ruocco, A. C. (2005). The neuropsychology of borderline personality disorder: A meta-analysis and review. *Psychiatry Research*, *137*, 191-202.

Neurocognitive Deficits Are Associated with Trauma in BPD

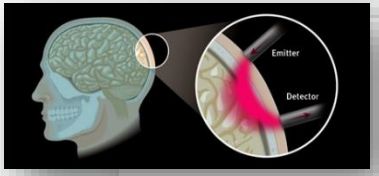


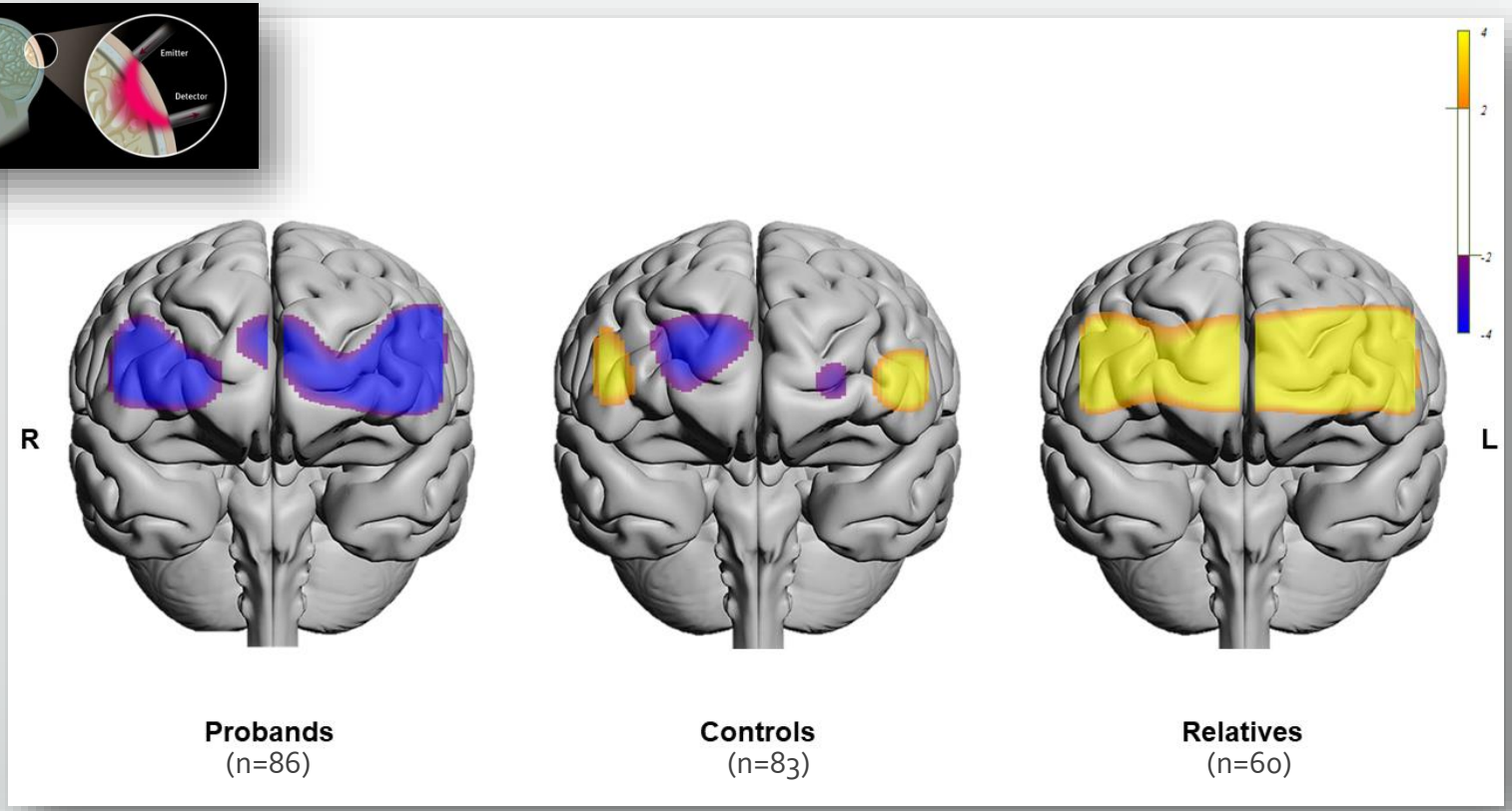
Childhood physical abuse was associated with more severe deficits in verbal comprehension. Additionally, patients with BPD and PTSD performed worse in verbal comprehension, visual episodic memory, and perceptual reasoning.

** $p<.01$
* $p<.05$

Thomsen, M. S., **Ruocco, A. C.**, Carcone, D., Mathiesen, B. B., & Simonsen, E. (2017). Neurocognitive deficits in borderline personality disorder: Associations with childhood trauma and dimensions of personality psychopathology. *Journal of Personality Disorders, 31*, 503-521.

Prefrontal Cortex Activation during Response Inhibition in Families with BPD



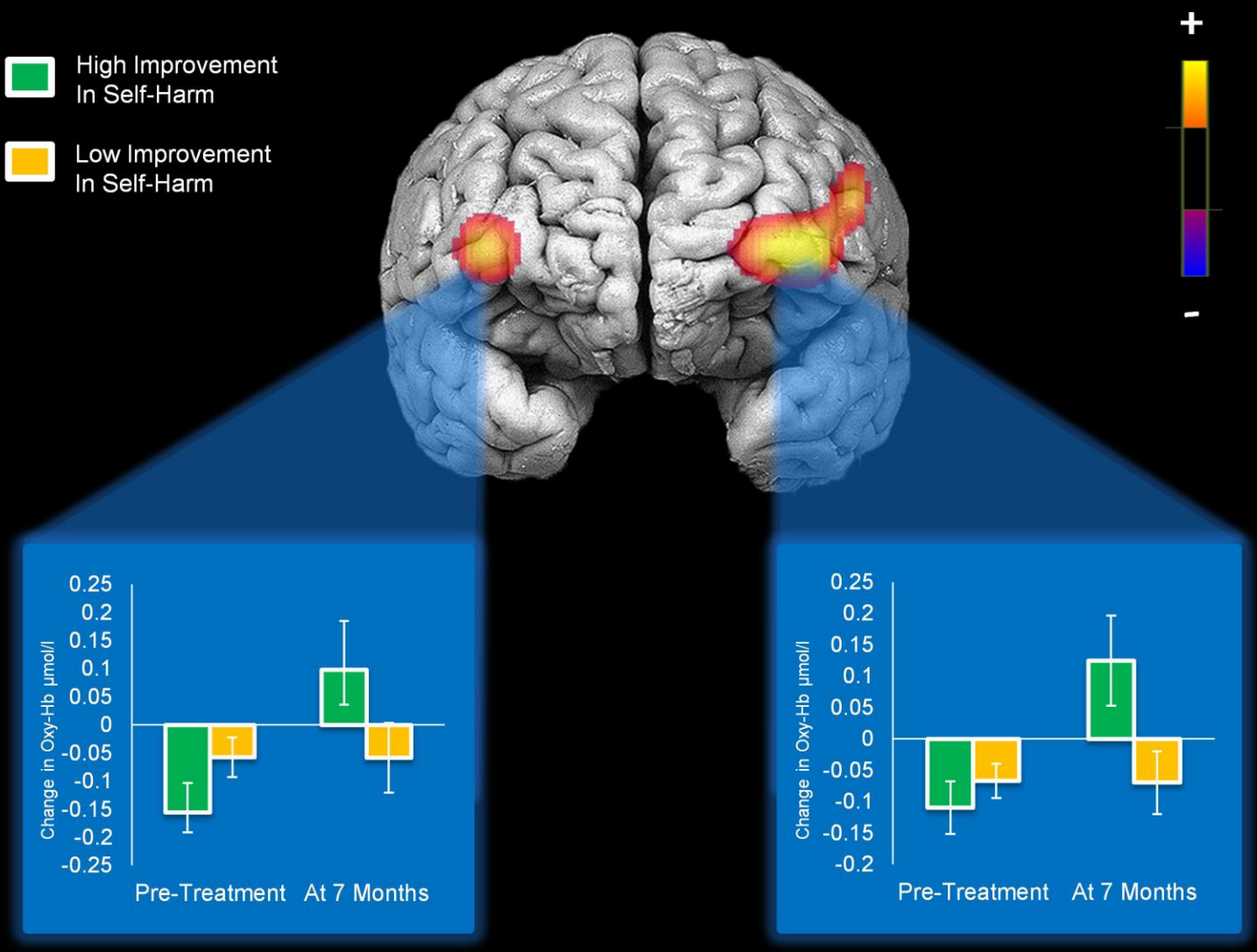


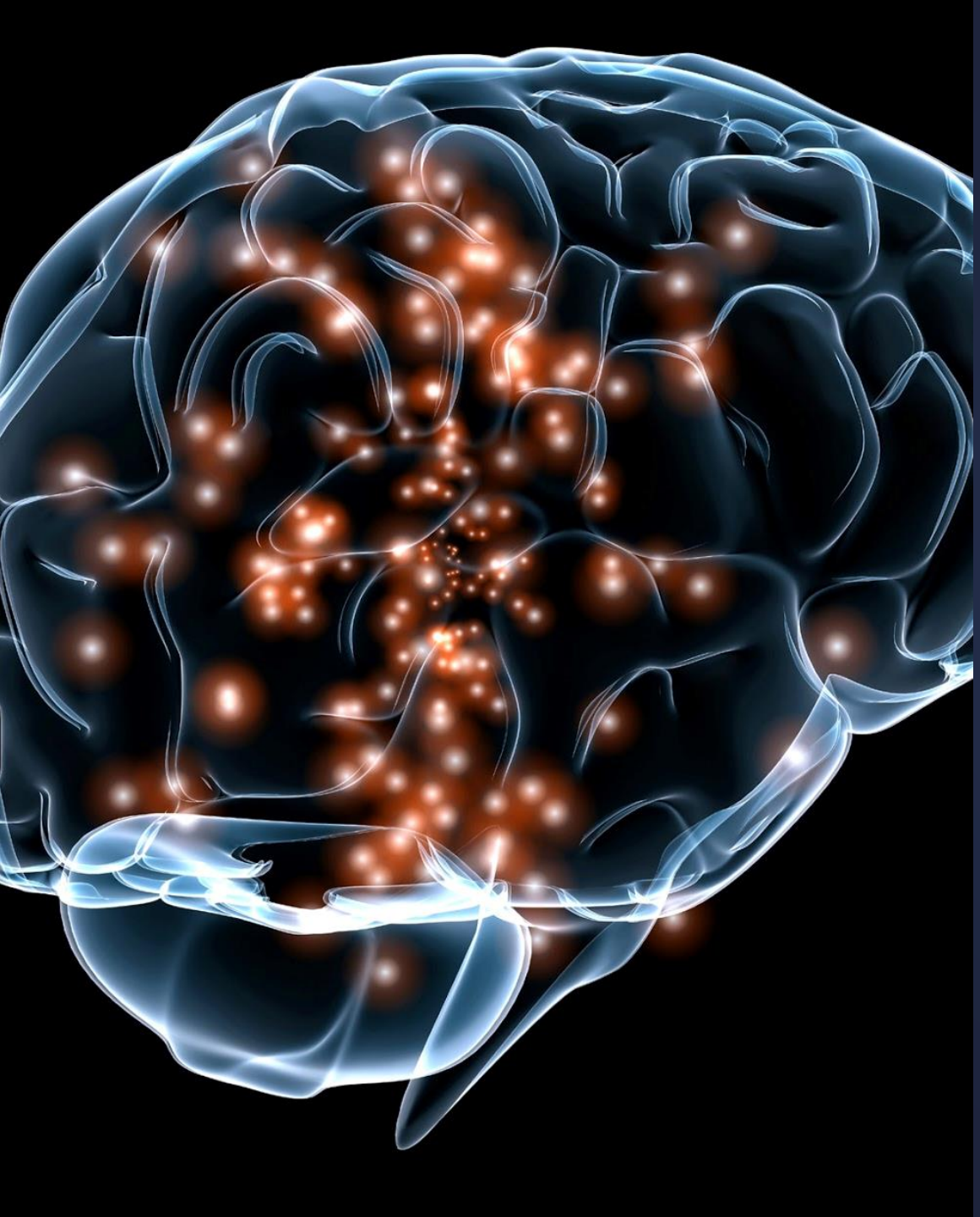
Ruocco, A. C., Rodrigo, A. H., Lam, J., Ledochowski, J., Chang, J., Wright, L., & McMain, S. F. (in press). Neurophysiological biomarkers of response inhibition and the familial risk for borderline personality disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry.*

Changes In Monthly Rates of Self-Harm After 7 Months of DBT

Cumulatively, rates of self-harm reduced after 7 months of treatment (p = .001), especially burning, hitting and "other" forms of self-harm

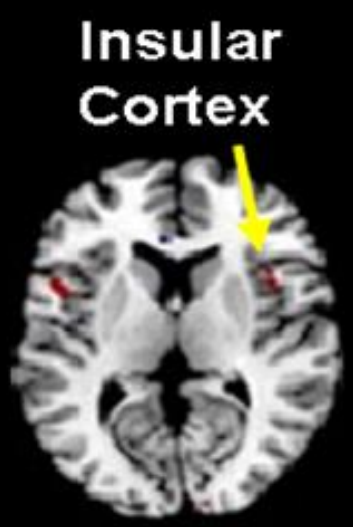
Ruocco, A. C., Rodrigo, A. H., McMain, S. F., Page-Gould, E., Ayaz, H., & Links, P. S. (2016). Predicting treatment outcomes from prefrontal cortex activation for self-harming patients with borderline personality disorder: A preliminary study. *Frontiers in Human Neuroscience, 10*.

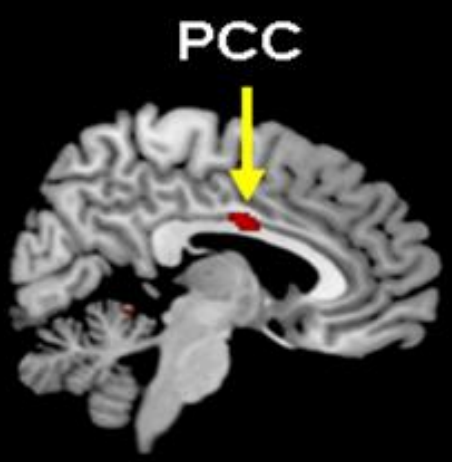

High Improvement
In Self-Harm
Low Improvement
In Self-Harm
+
-
Change in Oxy-Hb µmol/l
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
Pre-Treatment
At 7 Months
Change in Oxy-Hb µmol/l
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
Pre-Treatment
At 7 Months

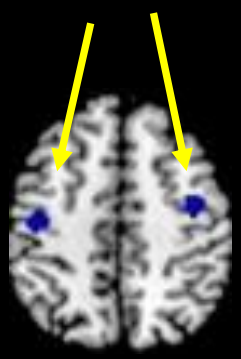


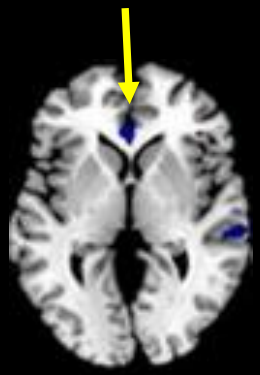
Brain Stimulation Treatment

Can We Use What Is Known About The Brain In BPD To Inform Treatment?









Ruocco, A. C., Amirthavasagam, S., Choi-Kain, L. W., & McMain, S. F. (2013). Neural correlates of negative emotionality in borderline personality disorder: An activation-likelihood-estimation meta-analysis. *Biological Psychiatry, 73,* 153-160.

Magnetic Seizure Therapy for Suicidal Ideation and Depression in BPD

MST induces seizures by applying magnetic stimulation to the brain, and may be an alternative to ECT. Provided under general anesthesia.

Magnetic Seizure Therapy (MST)

- An innovative, non-invasive, convulsive therapy that uses high-frequency repetitive magnetic stimulation.
- Demonstrated safety and efficacy for treatment-resistant unipolar and bipolar depression (Kayser et al., 2011; Sun et al., 2016; Tang et al., 2020; Weissman et al., 2020).
- Associated with fewer cognitive side effects compared to electroconvulsive therapy (Daskalakis et al., 2019; Tang et al., 2018; 2020).

Is MST Safe and Effective for Treating Suicidal Ideation and Depression in BPD?

- MST has shown promise for reducing suicidal ideation when stimulation is applied to the dorsolateral prefrontal cortex (DLPFC) (Sun et al., 2016; Weissman et al., 2020).
- To date, MST not been studied in people with comorbid treatment-resistant MDD and BPD.

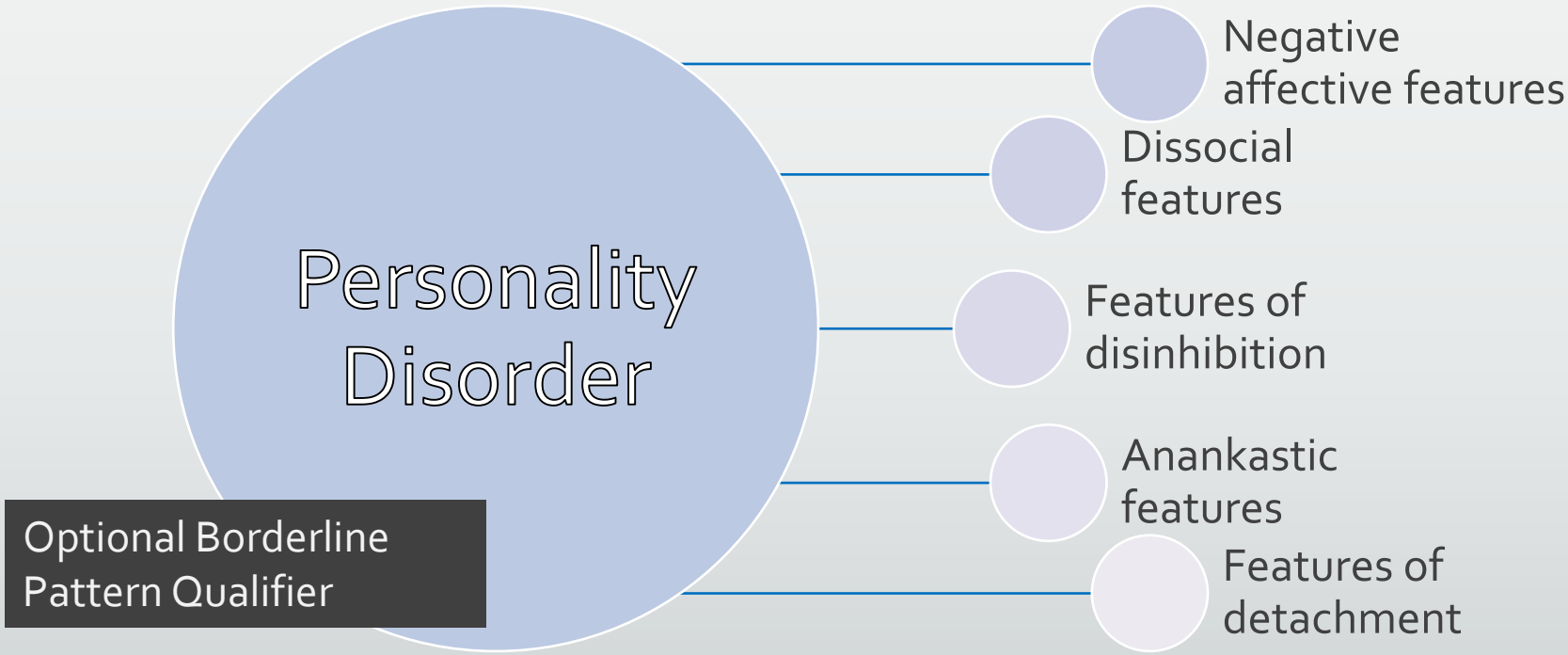
Future Directions

Suicide and Treatments

- We are about to begin a new study funded by the American Foundation for Suicide Prevention to understand how brain-based biomarkers of decision-making place people at risk for suicide attempt, including people with BPD.
- We are systematically reviewing and synthesizing the existing research literature on brain stimulation treatments and their effects on suicide-related outcomes (e.g., suicidal ideation, self-harm).

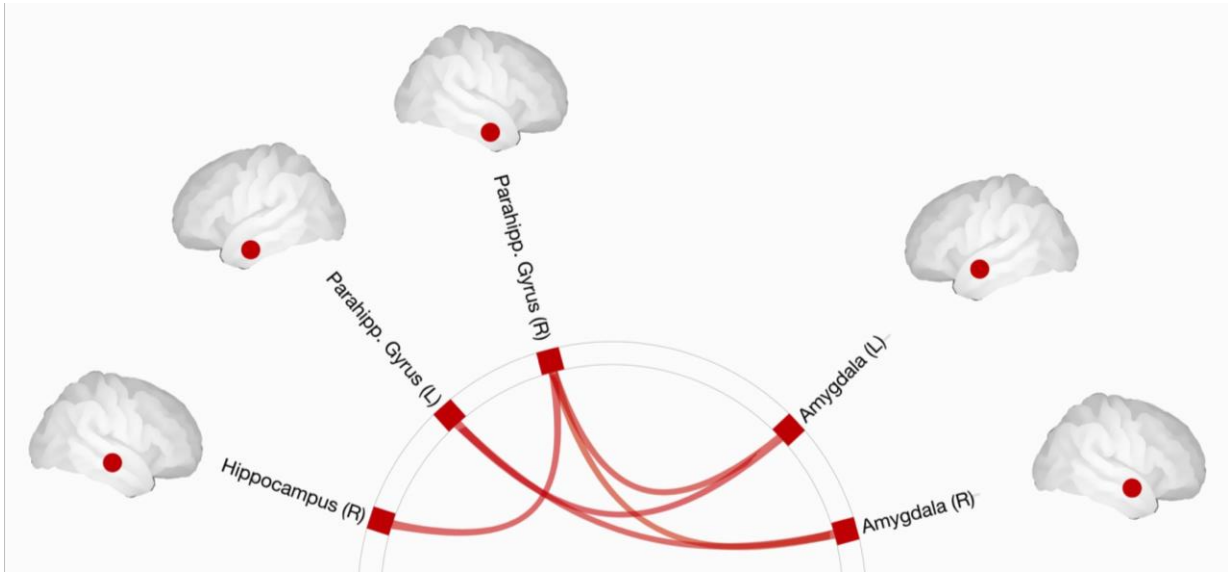
Alternative Models of Personality Disorder: The WHO's ICD-11 Diagnosis

- ICD-11 proposes to replace the previous edition's diagnostic categories with a dimensional trait model, along with an overall level of severity of personality dysfunction (self/interpersonal).



Alternative Models of Personality Disorder: Resting State Connectivity, Personality Disorder, and Personality Impairment

- More severe self-interpersonal impairment was associated with stronger intra-limbic connectivity



ROI-to-ROI contrast, PD > controls, $p < 0.05$ FDR

Traynor, J. M., Wrege, J., Walter, M., & **Ruocco, A. C.** (under review). *Dimensional personality impairment is associated with disruptions in intrinsic intralimbic functional connectivity.*

Thank you!

Learn More: www.ClinicalNeurosciences.ca

BPD Resources:

Families for BPD Research (https://familiesforbpdresearch.org)
The Sashbear Foundation (https://sashbear.org)
National Educational Alliance BPD
(https://www.borderlinepersonalitydisorder.org)
TARA4BPD (https://www.tara4bpd.org)
Emotions Matter (https://emotionsmatterbpd.org)