CARDIAC VAGAL TONE AS A PSYCHOPHYSIOLOGICAL INDEX OF FRONTO-LIMBIC DYSFUNCTION DURING EMOTION REGULATION IN BORDERLINE PERSONALITY DISORDER.

Wainsztein A.^{1,3}, Goldberg X.⁴, Alvarez Mercé R.¹, Camacho V.^{1,5}, Vulcano M.², Abulafia C.^{1,3,5}, Vigo D.^{3,5}, Villarreal M.^{1,5}, Cardoner N.⁴, Nemeroff C.⁶, Castro M.^{1,5}, Soriano-Mas C.⁷, Guinjoan S.^{1,2,5}.

¹Grupo INAAC, Fleni, Buenos Aires, Argentina; ²Department of Psychiatry, Fleni, Buenos Aires, Argentina; ³Institute for Biomedical Research, School of Medical Sciences, Universidad Católica Argentina, Buenos Aires, Argentina; ⁴Parc Tauli University Hospital, Universitat Autònoma de Barcelona, Spain; ⁵Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, Argentina; ⁶Institute for Early Life Adversity Research, Dell Medical School, The University of Texas at Austin, USA; ⁷Bellvitge Biomedical Research Institute-IDIBELL Barcelona, Spain.

Introduction

Autonomic network overlaps with brain regions that command executive, cognitive, behavioral and emotional processes. Thus, heart rate variability (HRV) has been studied during resting states in emotional disorders. We examined functional neuroimaging and autonomic correlates during emotion regulation in Borderline Personality Disorder (BPD) and Healthy Controls (HC).

Methods

Thirty-nine right-handed subjects (HC, n=20; BPD, n=19) matched for age and gender (Table 1), were trained on emotion regulation strategies (e.g. cognitive reappraisal) and performed an emotional task (OBSERVE, MAINTAIN and REGULATE, Fig 1). We used a 3T-GE MRI and simultaneous BIOPAC-HRV acquisition. BOLD signal was analyzed using SPM12. HRV-time-domain variables (mmR, SDNN, RMSSD) were calculated using Kubios software. Self-reported questionnaires on Adverse Childhood Experiences (ACE) and difficulties in emotion regulation (DERS) were assessed.

Figure 1. Block design paradigm of emotion regulation.

Figure 2. Brain activation during REGULATE task in HC vs. BPD (HC>BPD). HC display activation of left supplementary motor area (MNI coordinates: x=-6, y=-6, z=64; K=67; Z=3.42) in contrast to patients. All results FWE corrected p<0.05 across small volume correction. L-SMA: Left Supplementary Motor Area.

Table 1. Clinical and Demographic characteristics of study groups.

	Controls (n=20)	BPD (n=19)	Statistics	p
Age (years)	35 ± 10	38 ± 11	t = -.823	.416
Women	75%	52.6%	χ² = 2.119	.146
Education (years)	18 ± 3	15 ± 3*	t = 3.717	.001
ACE score	1 ± 2	5 ± 4*	t = -3.673	.001
DERS score	58 ± 15	97 ± 33*	t = -3.042	<.001
MSI-BPD	1 ± 1	6 ± 2*	t = -11.33	<.001

* Different from controls.
ACE: Adverse Childhood Experiences score; DERS: Difficulties in emotion regulation score; MSI-BPD: McLean Screening Instrument for Borderline Personality Disorder severity score. All values are showed as n (N) or mean ± SD.

Results

Deficit of activation in the left supplementary motor area (L-SMA; p=0.024) was found during REGULATE condition in BPD patients (Fig 2). During this task, HC showed a positive correlation between RMSSD with brain activation in L-SMA (p=0.035), right superior frontal gyrus (R_SFG; p=0.017) and left dorsolateral prefrontal cortex areas (L_DLPFC; p=0.017, Fig 2). Left amygdala, hippocampus and anterior cingulate were negatively correlated with RMSSD in the BPD group during REGULATE task (L_AMG: p=0.018; L_HIP: p=0.021; L_ACC: p=0.018 respectively, Fig 3); neglect and household dysfunction ACE subscores had significant influence in controlling for the latter.

Figure 3. Cardiac vagal tone and ROIs activity during REGULATE task in HC and BPD subjects. HC group showed significantly positive correlations between RMSSD and A) right SFG (R-SFG), B) left DIPFC (L-DLPFC) and C) left SMA (L-SMA) in contrast to patients. BPD group showed a significant negative correlation between RMSSD and D) left amygdala (L-AMG), E) left hippocampus (L-HIP) and F) left anterior cingulate (L-ACC) during emotion regulation task. Childhood neglect affected CNS-ANS relationship at left amygdala, hippocampus and ACC, while household dysfunction influenced hippocampal-vagal negative correlation in the BPD group.

Conclusions

Activation deficit of L-SMA suggests an abnormal pattern of conscious emotion regulation process in BPD patients compared to healthy subjects. Lower cardiac vagal tone during regulation of emotional stimuli could represent a psychophysiological biomarker of inadequate frontal-limbic interaction and hence, a less adaptive emotion regulation capacity in BPD individuals. Childhood traumatic events modulate this CNS-ANS interrelations. Future research directions attempt to explore the profound effects of early life stress on brain development and emotional behavior in this population.

Augustina Wainsztein - awainsztein@gmail.com