Adding HRVB to CBT or Third Wave Therapies for Anxiety/Depression

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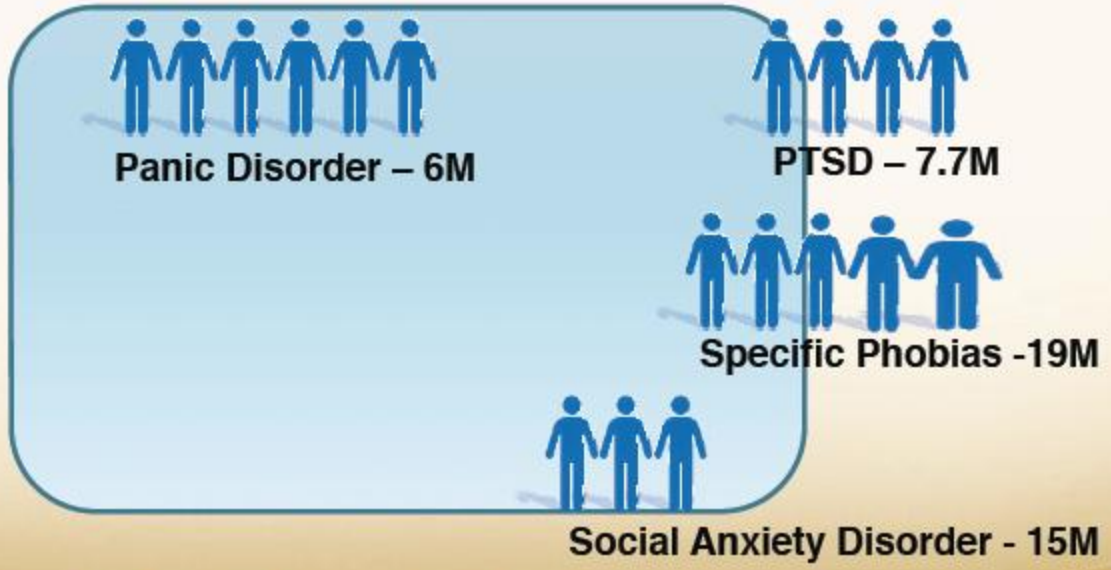
AI Recreation of the
Evian Gordon Original (Left)
In the style of **Salvador Dali**

AI Recreation of the
Evian Gordon Original (Left)
In the style of **Salvador Dali**

The Problem: Who is Affected by Anxiety Disorders?

40 Million U.S. adults annually

27 million adults have Panic Attacks annually



Anxiety Disorders on the Rise

- "…when surveyed, almost 90% of college counseling centers in the United States reported a rise in the number of students seen for anxiety disorders compared to five years previous."
    - Gallagher R P. National survey of college counseling centers 2014. The International 551 Association of Counseling Services, Inc. 2015.

- "Anxiety is increasing among adults under age 50 in the US, with more rapid increase among young adults. To prepare for a healthier adulthood and given direct and indirect (via 24/7 media) exposure to anxiety-provoking world events, prophylactic measures that can bolster healthy coping responses and/or treatment seeking seem warranted on a broad scale."

    - Goodwin, R. D., Weinberger, A. H., Kim, J. H., Wu, M., & Galea, S. (2020). Trends in anxiety among adults in the United States, 2008–2018: Rapid increases among young adults. Journal of psychiatric research, 130, 441-446.

“The Anxious Generation” Jonathon Haight

- Play-based vs. phone-based childhood
- Intensive Parenting vs. Authoritative Trusting Parenting
  - Also known as Helicopter, Snowplow. Preventive, Parenting
- Tidal wave of anxiety and other mental health issues

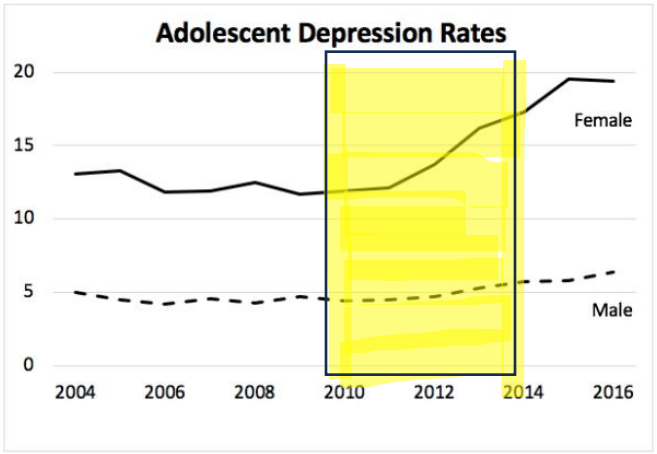


FIGURE 7.1. Percent of adolescents aged 12–17 who had at least one major depressive episode in the past year. Rates have been rising since 2011, especially for girls. (Source: Data from National Survey on Drug Use and Health.)
[A slightly modified version of this figure appears on p. 149 of *The Coddling of the American Mind*, by Greg Lukianoff and Jonathan Haidt. Published by Penguin Press, 2018]

Yellow shading represents the introduction of smart phones/social media

Interestingly, Externalizing disorders decreased during this same period

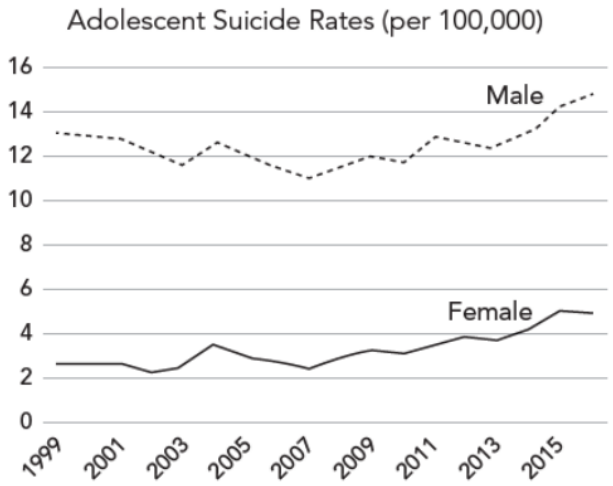


FIGURE 7.2. Suicide rate per 100,000 population, ages 15–19, by sex. (Source: CDC, Fatal Injury Reports, 1999–2016.)
[This figure appears on p. 151 of *The Coddling of the American Mind*, by Greg Lukianoff and Jonathan Haidt. Published by Penguin Press, 2018]

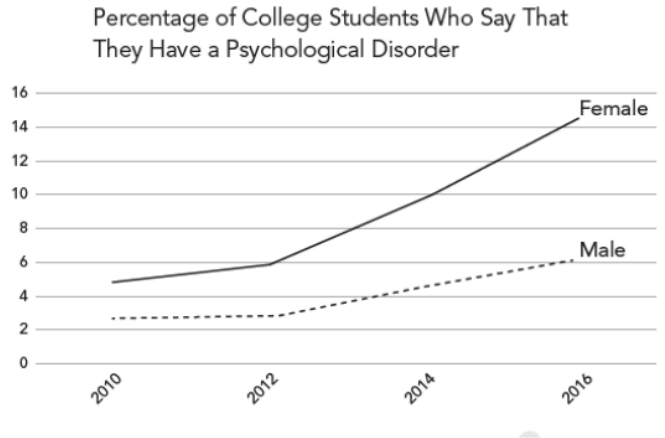
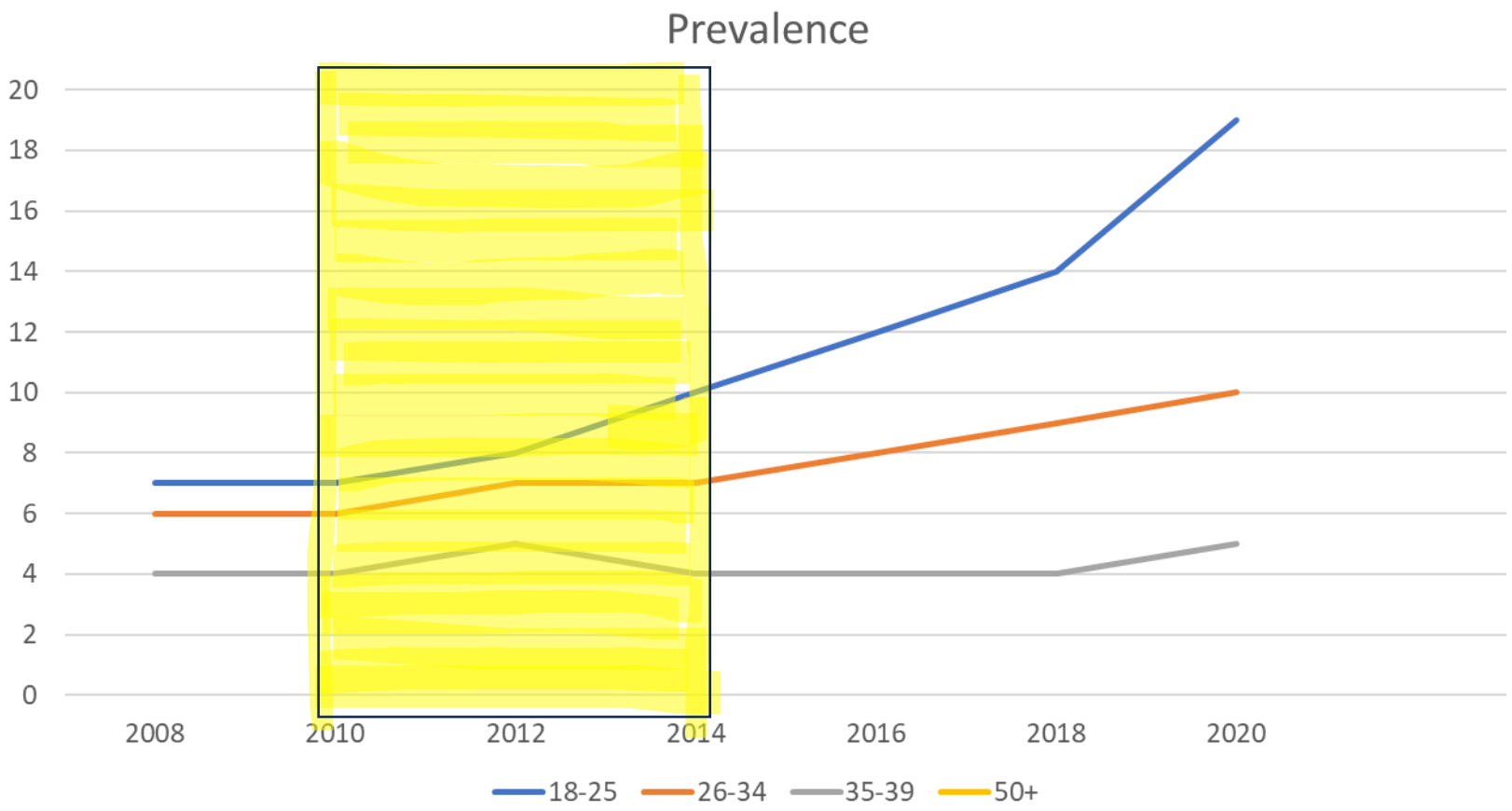


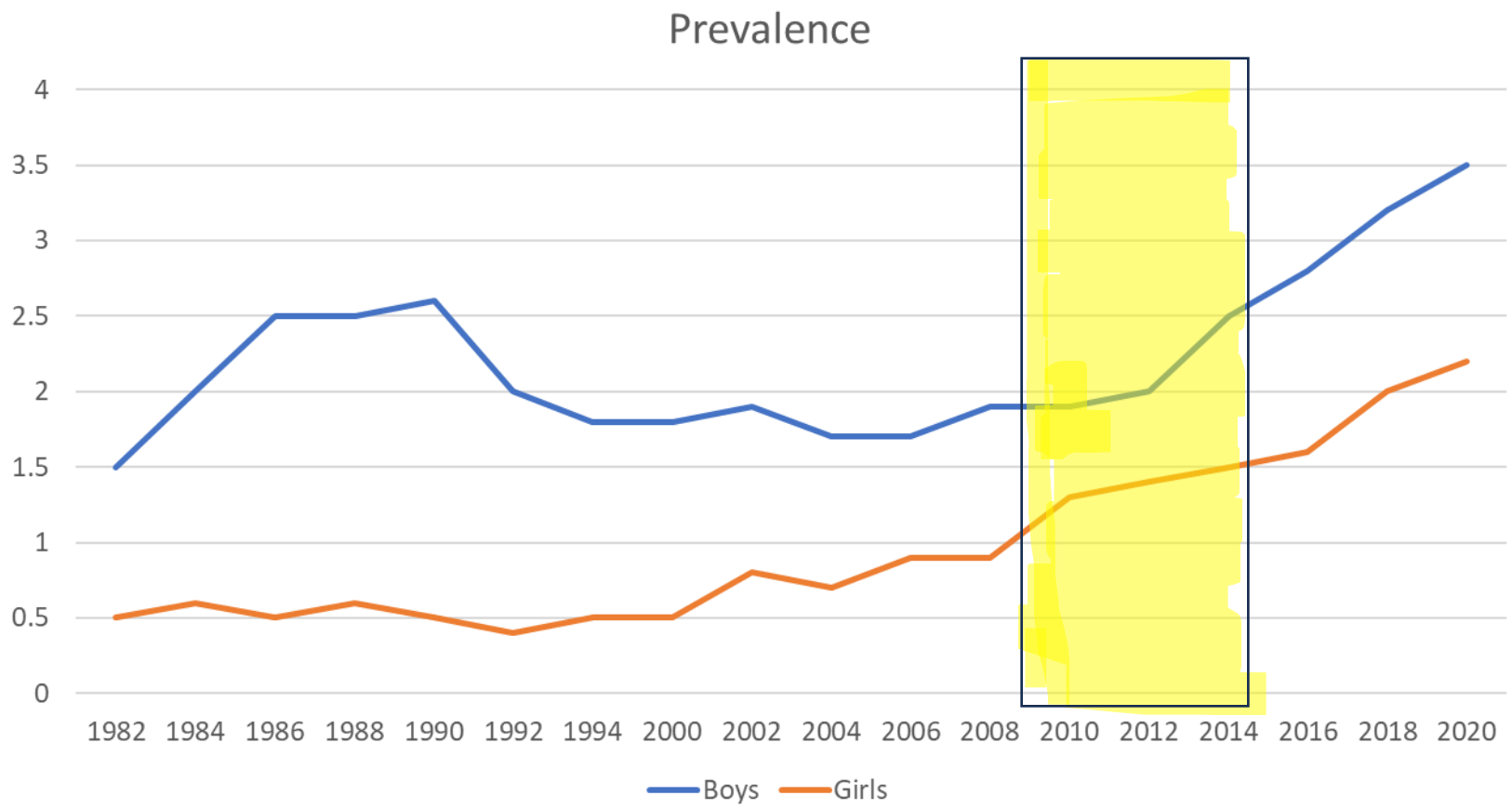
FIGURE 7.3. Percentage of college students responding "yes" to the question "Do you have [a] psychological disorder (depression, etc.)." (Source: Higher Education Research Institute.)
[This figure appears on p. 157 of *The Coddling of the American Mind*, by Greg Lukianoff and Jonathan Haidt. Published by Penguin Press, 2018]

Anxiety 2008 to 2020 by age



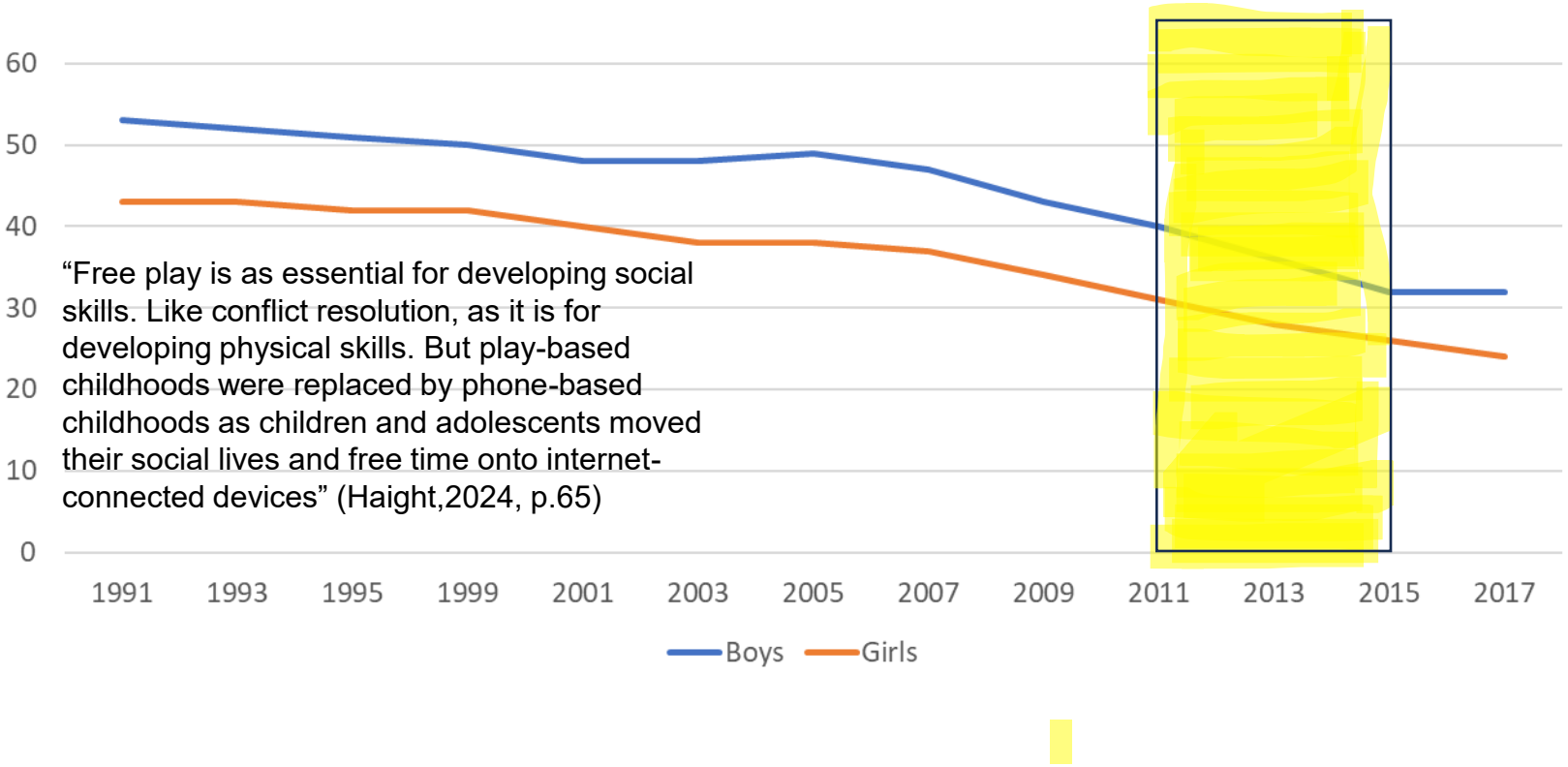
U.S. National Survey on Drug Use and Health

Anxiety 2008 to 2020 by age



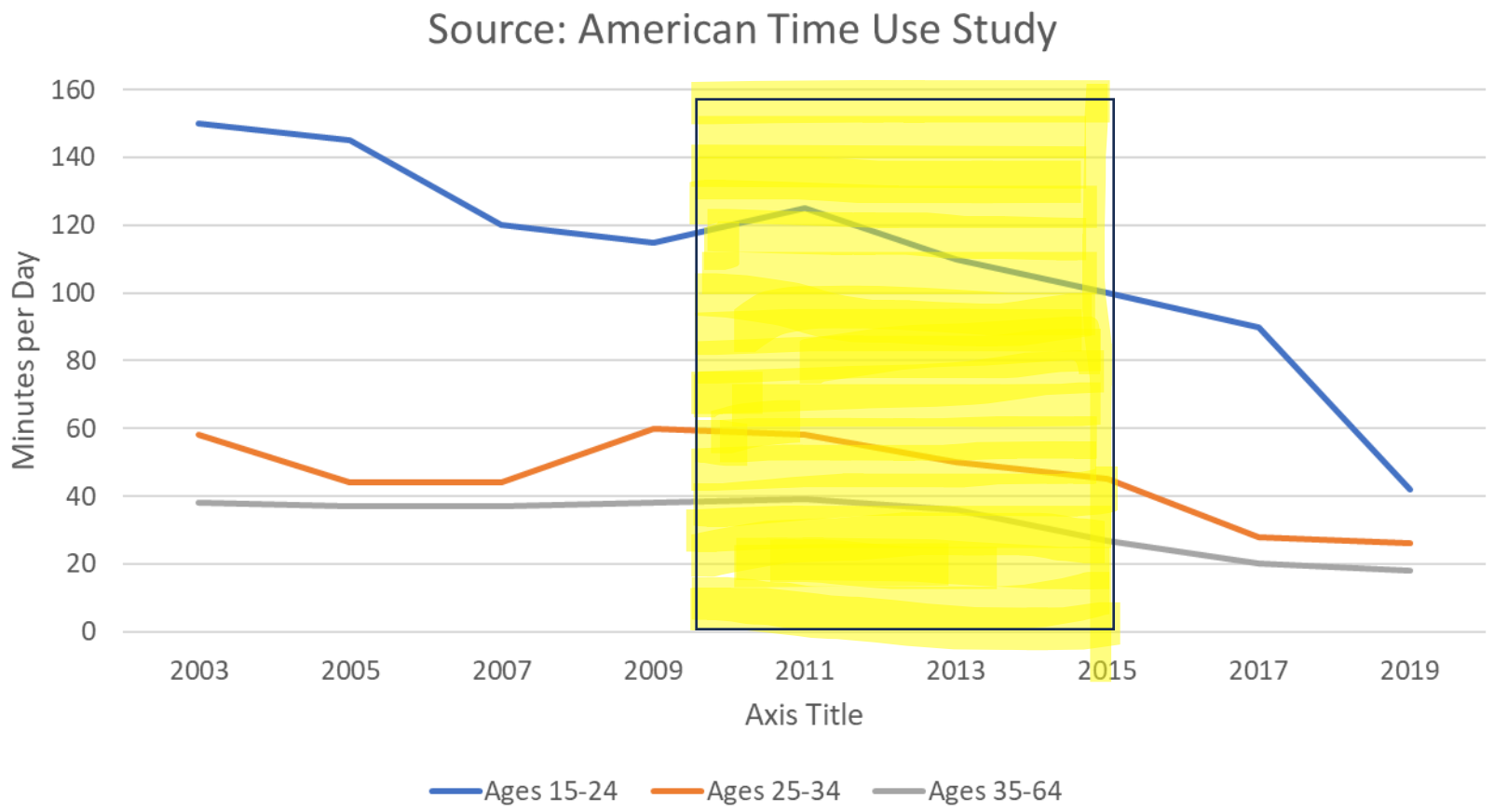
U.S. Centers for Disease Control, National Center for Injury Prevention and Control

Meet Up with Friends Daily

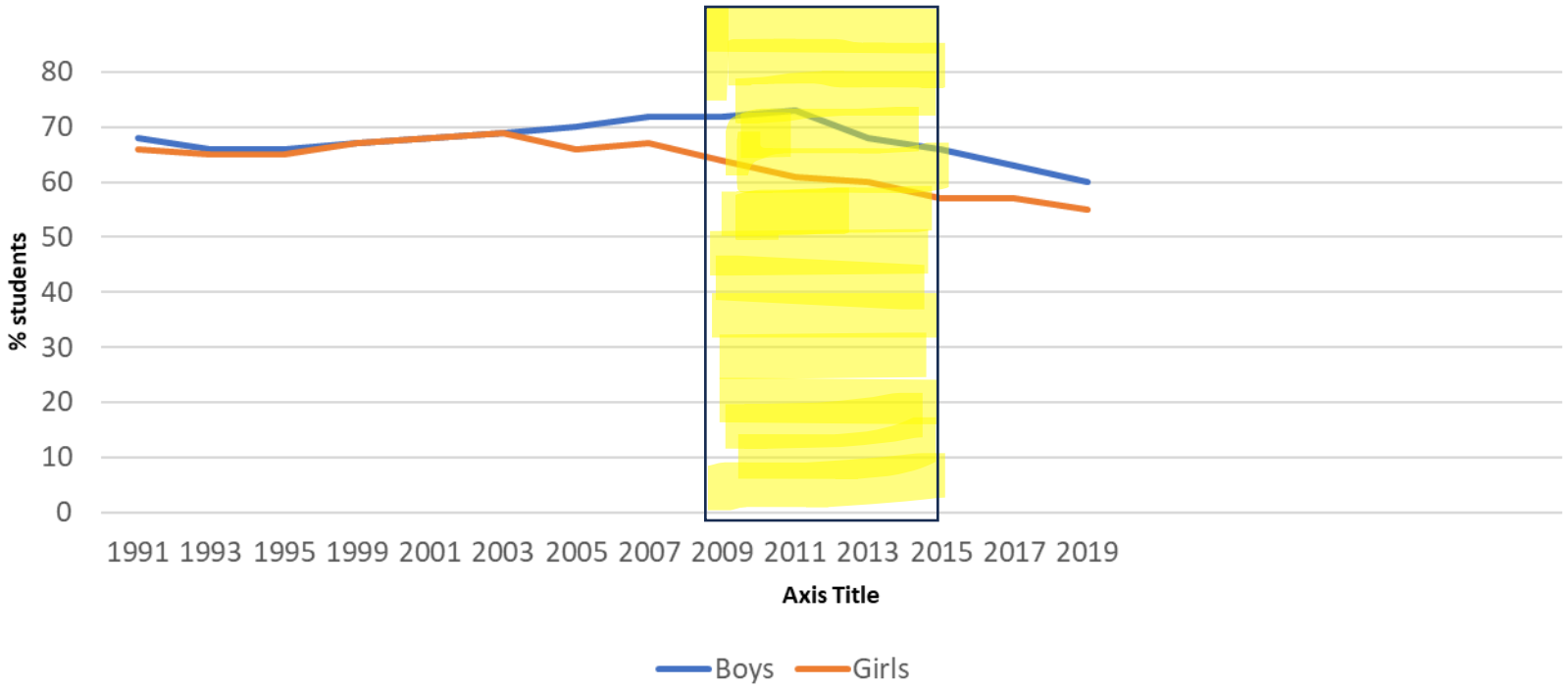


"Free play is as essential for developing social skills. Like conflict resolution, as it is for developing physical skills. But play-based childhoods were replaced by phone-based childhoods as children and adolescents moved their social lives and free time onto internet-connected devices" (Haight,2024, p.65)

Daily Time with Friends by Age Group



Satisfied with Oneself
(Source: Monitoring the future)



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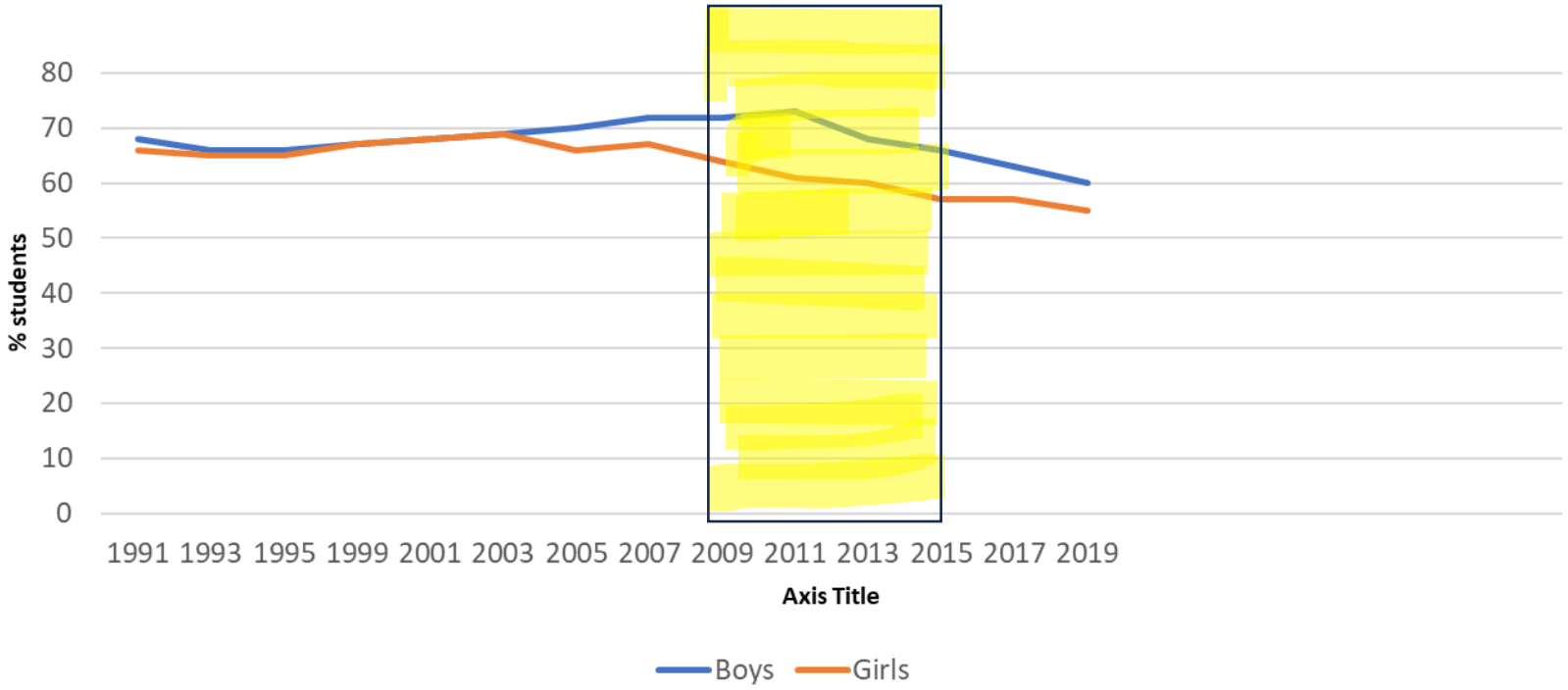
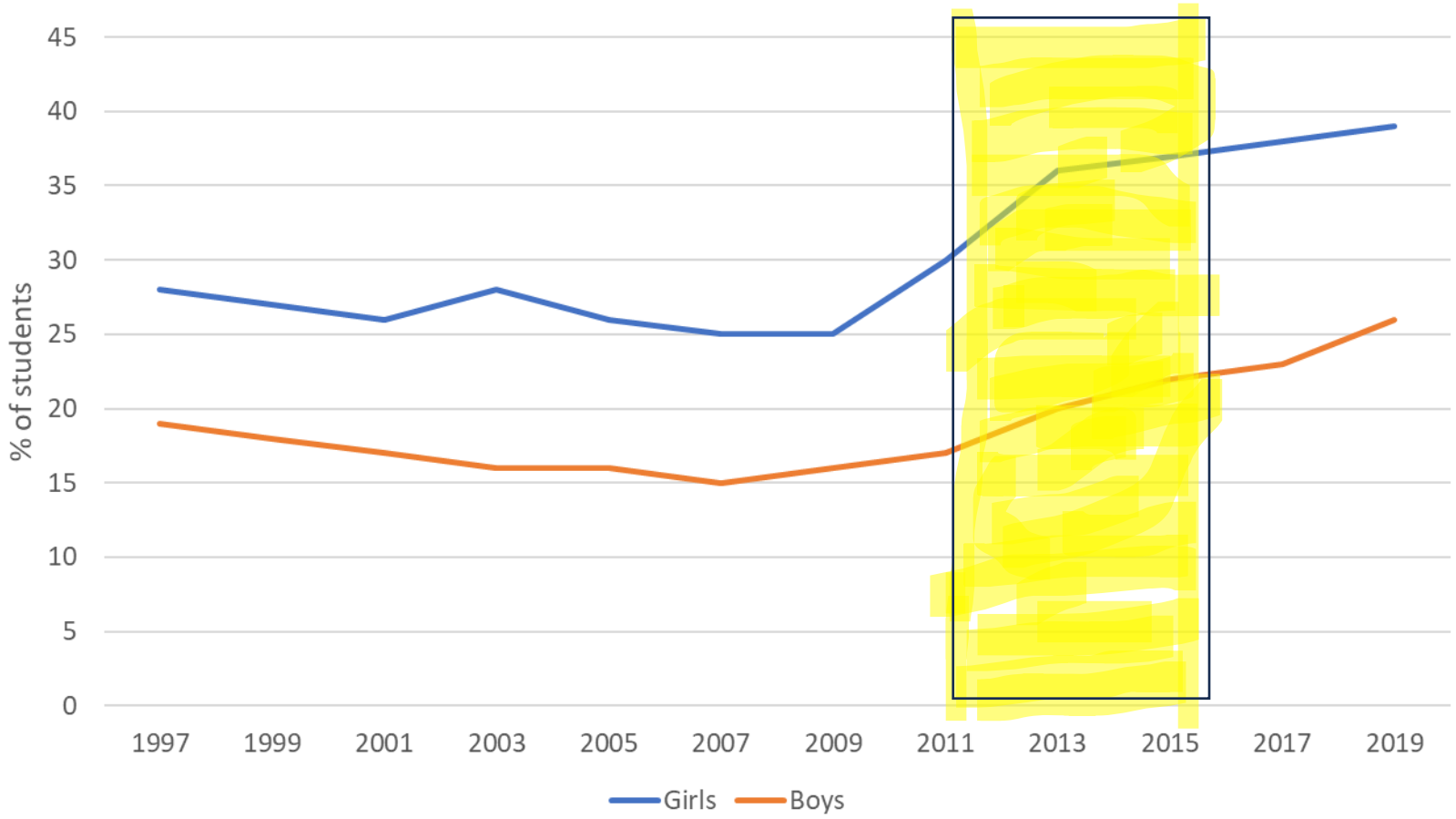


Often Feel Lonely

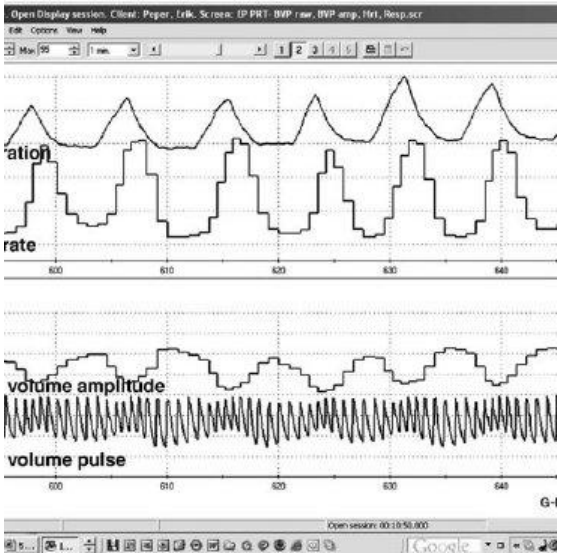


Assessing Vagal Tone from Beat-to-Beat Heart Rate

If you trace beat to beat heart rate (HR) (or Inter-beat-interval) over time, you notice that HR goes up during inhalation and down during exhalation. This rhythm, called Respiratory Sinus Arrhythmia (or RSA) is mediated by the vagus nerve. Therefore, by quantifying the valley to peak amplitude you can estimate “vagal tone” and thus “vagal withdrawal”.

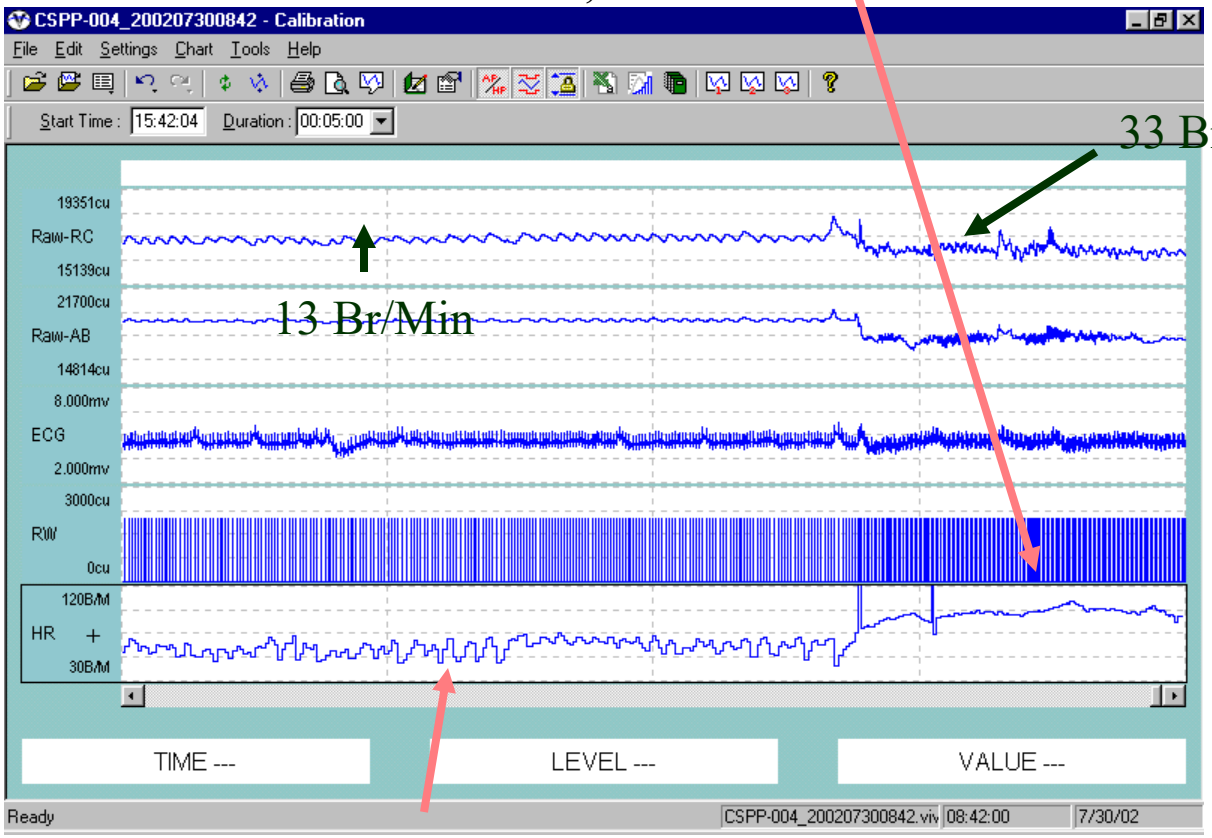
Respiration

Heart Rate (HR)



VAGAL Withdrawal

Worrying about being late for an appointment.
Notice the elevated, flattened HR



Beat by beat HR during driving to appointment.

Vagal Withdrawal During Social Media Usage

- Social interaction skill is important for psychological wellbeing, stress regulation, protection from disability and overall life satisfaction. Increase in activity of the vagus nerve, measured by heart rate variability (HRV), is associated with social interaction skill and decreased stress. In this meta-analysis we collated statistics from thirteen studies consisting of 787 participants who were participating in social interactions while HRV was simultaneously collected. Results revealed that while dyadic social interactions do not increase HRV generally from a baseline state, negative dyadic social interactions decrease HRV in a manner similar to the Trier Social Stress Task. Further, participants with psychopathology do not show cardiac autonomic flexibility during social interactions as indicated by reductions under stress and increases with subsequently positive social interactions. The role of age, gender and HRV index were also examined as potential moderators of HRV. Implications for health and wellbeing resulting from exposure to negative social interactions are discussed.

Shahrestani, S., Stewart, E. M., Quintana, D. S., Hickie, I. B., & Guastella, A. J. (2015). Heart rate variability during adolescent and adult social interactions: A meta-analysis. Biological psychology, 105, 43-50.

Trier Social Stress Test (TSST)

Vagal Withdrawal

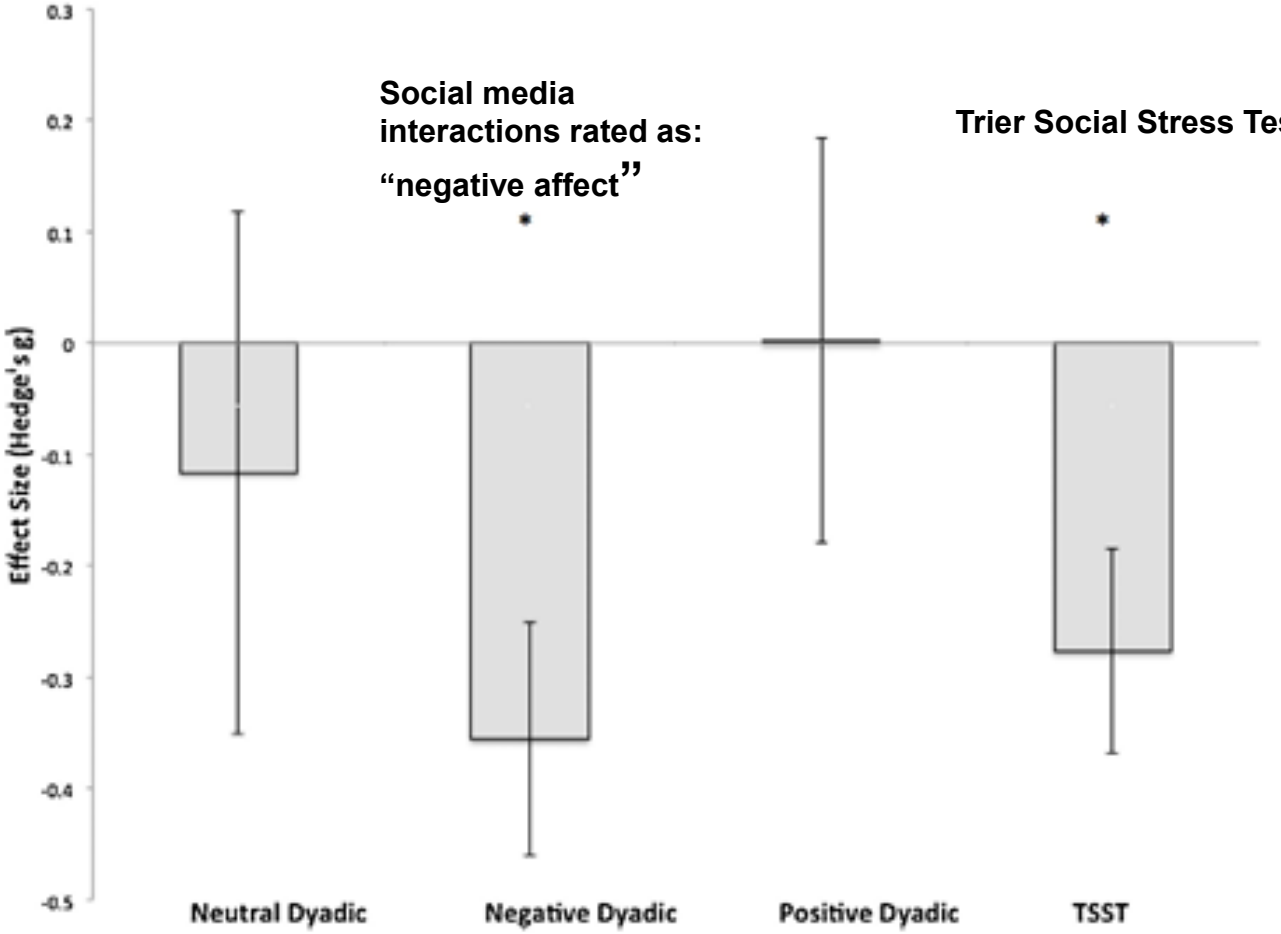


Fig. 2. Effect size and standard error for valence during dyadic tasks and Trier Social Stress Task. Error bars represent standard error.

It was found that during social interactions **RSA** changed significantly relative to baseline ($g = -0.35$, $p < 0.001$, 95% CI −0.403, −0.136). During the TSST it was -0.27.

Empirically Based Therapies: How well are we doing?

- Compared to wait lists, pretty well
- Compared to placebo, not very well
- Exceptions (Restraint and Exposure for OCD)
- Need enhancements
- Poor understanding of mechanisms
- CNS mechanisms: fMRI, EEG, etc.
  - Autonomic Mechanisms: HRV, etc.
  - Psychological constructs: mindfulness, acceptance, reframing, etc.
  - Therapeutic alliance has a stronger effects size than any particular therapy

COGNITIVE-BEHAVIORAL THERAPY FOR ADULT ANXIETY DISORDERS: A META-ANALYSIS OF RANDOMIZED PLACEBO-CONTROLLED TRIALS

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[2]Department of Psychology, Southern Methodist University, Dallas, Texas

J Clin Psychiatry. 2008 April; 69(4): 621–632

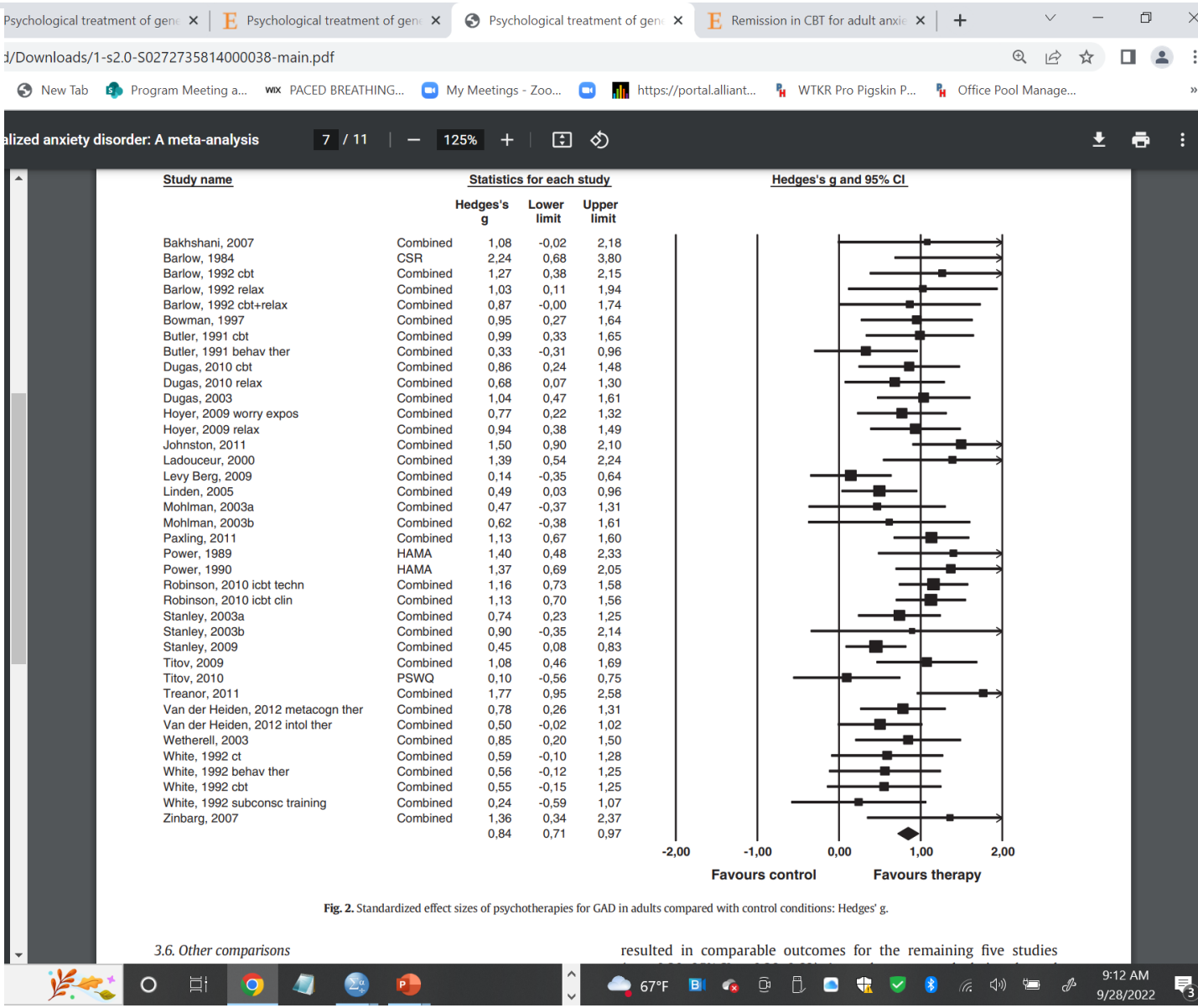
Our review of randomized placebo-controlled trials indicates that CBT is efficacious for adult anxiety disorders. There is, however, considerable room for improvement. Also, more studies need to include intent-to-treat analyses in the future.

"From the initial 228 abstracts reviewed by the authors, 100 articles were retained. The overall mean remission rate was 51.0%. Remission rates were highest when remission was defined as good end state functioning or no longer meeting criteria for the primary diagnosis. Studies of posttraumatic stress disorder had the highest remission rates, while those of obsessive-compulsive disorder and social anxiety disorder had the lowest remission rates… Although CBT is an empirically supported treatment for anxiety disorders, it is clear that there is room for improvement, as many patients do not achieve remission status."

Springer, K. S., Levy, H. C., & Tolin, D. F. (2018). Remission in CBT for adult anxiety disorders: a meta-analysis. *Clinical psychology review*, *61*, 1-8.

Cuijpers, P., Sijbrandij, M., Koole, S., Huibers, M., Berking, M., & Andersson, G. (2014). Psychological treatment of generalized anxiety disorder: a meta-analysis. *Clinical psychology review*, *34*(2), 130-140.

Mostly compared CBT to waitlist. Effect sizes were much smaller when CBT was compared to and active control or placebo



Military PTSD (Strong Star Consortium)

- Litz, B. T., Berke, D. S., Kline, N. K., Grimm, K., Rusowicz-Orazem, L., Resick, P. A., ... & Borah, A. M. (2019). Patterns and predictors of change in trauma-focused treatments for war-related posttraumatic stress disorder. *Journal of consulting and clinical psychology, 87(11)*, 1019.

	Recovered	Unchanged	N
Completers	34.18%	48.2%	614
Intent to Treat	31.5%	54.6%	614

50% of adolescents who receive gold-standard treatments will relapse within two years of recovery

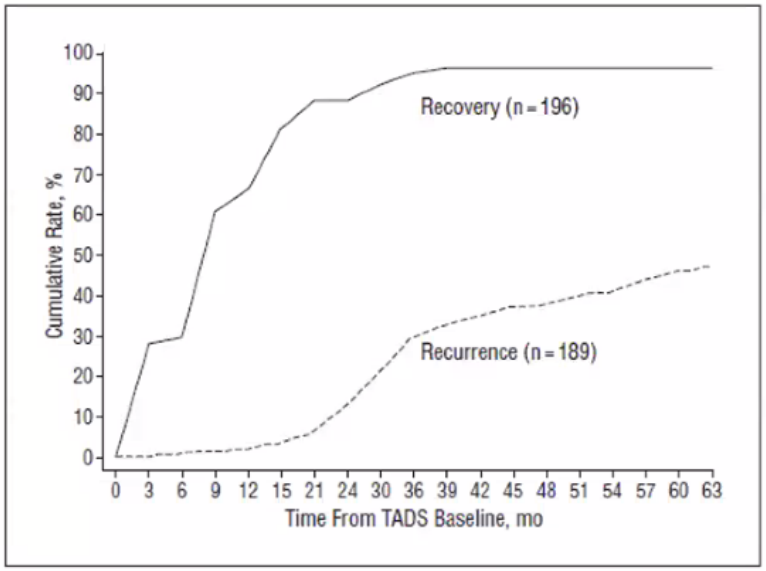


Figure 2. Cumulative recovery and recurrence rates. TADS indicates Treatment for Adolescents With Depression Study.

The clinical problem

Curry et al., 2011

Curry, J., Silva, S., Rohde, P., Ginsburg, G., Kratochvil, C., Simons, A., ... & March, J. (2011). Recovery and recurrence following treatment for adolescent major depression. *Archives of general psychiatry*, *68*(3), 263-269.

HRV and Anxiety Disorders: A Review

An autonomic flexibility–neurovisceral integration model

of anxiety and cardiac vagal tone

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Accepted 16 August 2005

Available online 27 October 2006

Across literature reviewed in this paper, a predominant trend emerges: anxiety in its phasic, tonic, and pathologic forms is marked by aberrant ANS cardiac control. A range of HRV indices converge to implicate low vagal and elevated sympathetic activity in anxiety. These findings fit a theoretical model that views anxiety as a systemic inflexibility grounded in poor inhibition. Moreover, these data are compatible with systems models of biological stability that stress the importance of a wide range of responsiveness for maximal adaptation and resiliency.

Front Psychiatry. 2014; 5: 80.
Published online 2014 Jul 11. Prepublished online 2014 Jun 2. doi: 10.3389/fpsyt.2014.00080
PMCID: PMC4092363

Anxiety Disorders are Associated with Reduced Heart Rate Variability: A Meta-Analysis

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Edited by: Silvia Raquel Soares Ouakinin, University of Lisbon, Portugal
Reviewed by: Nathalie Michels, Ghent University, Belgium; Angela Marie Lachowski, Ryerson University, Canada

Table 1 | Summary of studies reporting comparisons in HRV between patients with anxiety disorders and controls.

Study	HRV measures	Participants with anxiety disorder	Healthy control subjects	Sig. diff between groups	Major finding
PANIC DISORDER (PD)					
Alvargenga et al. (36)[a]	HF, LF	25	20	+	Lower HF power in PD compared with controls
Chang et al. (37)[a]	HF, LF, TD	48	202	+	Lower HRV in PD patients compared with controls in all measures
Cohen et al. (30)[a]	HF, LF	11	25	+	Lower HF power and higher LF power in PD relative to controls
Garakani et al. (31)[a]	HF, LF, TD	43	11	+	Lower PNN 50% in PD relative to controls. HF and LF power non-significant between groups
Ito et al. (38)[a]	HF, LF	8	13	–	No differences in HF and LF power between PD and controls
Kang et al. (39)[a]	HF, LF, TD	45	30	+	Lower HF power and higher LF power in PD relative to controls. All TD measures non-significant
Kikuchi et al. (40)[a]	HF, LF, TD	17	15	–	No differences between PD and controls on all measures
Lavoie et al. (41)[a]	HF, LF	20	22	–	LF and HF power non-significant (but lower LF/HF ratio in PD relative to controls)
Martinez et al. (42)[a]	HF, LF, TD	30	10	+	Higher LF power and LF/HF ratio in PD relative to controls; lower PNN50 in PD
McCraty et al. (43)[a]	HF, LF	38	38	+	LF/HF ratio and LF power lower in PD relative to controls; higher HF power in PD
Melzig et al. (44)[a]	TD	9	15	+	Lower RMSSD in PD relative to controls
Middleton and Ashby (45)[a]	TD	12	12	–	No differences in HF power between groups. Reduced HR standard deviation in PD
Pittig et al. (29)[a]	HF	39	39	+	Lower HF HRV in PD patients
Prasko et al. (46)[a]	HF, LF	52	104	+	Lower LF/HF ratio and SDNN in PD relative to controls
Slaap et al. (47)[a]	HF	24	24	–	No differences on any HRV measure between PD and controls
Wang et al. (48)[a]	HF, LF	27	20	–	No difference between PD patients and controls
Wise et al. (49)[a]	TD	30	20	+	Lower R–R variance in PD compared to controls
Yeragani et al. (50)[a]	TD	21	21	+	Lower HR standard deviation in PD relative to controls
Yergani et al. (51)[a]	HF, LF	6	11	–	No differences between PD and controls on all measures at baseline
Asmundson and Stein (52)[b]	RSA	15	15	–	No differences in parasympathetic nervous system function between PD and controls
Blelchert et al. (53)[b]	RSA	26	32	–	No differences in parasympathetic nervous system function between PD and controls
Klein et al. (54)[b]	HF	10	14	+	Lower HF power in PD relative to controls
Petrowski et al. (55)[b]	TD	14	14	–	No differences in TD measures between PD and controls
Yergani et al. (56)[b]	TD	29	23	–	Lower absolute ULF in PD relative to controls
POST-TRAUMATIC STRESS DISORDER (PTSD)					
Agorastos et al. (57)[a]	TD	7	8	–	Reduced HRV in PTSD patients, but did not reach significance
Cohen et al. (58)[a]	HF, LF	9	9	+	Lower HF and higher LF power in PTSD relative to controls
Hauschildt et al. (59)[a]	HF, LF, TD	26	18	+	Lower HF power and RMSSD in PTSD relative to controls. LF power non-significant
Keary et al. (60)[a]	HF, LF	20	20	–	No differences at baseline between PTSD and controls
Lakusic et al. (61)[a]	HF, LF, TD	34	34	+	Lower HF power and RMSSD in PTSD relative to controls; higher LF power in PTSD

Table 1 | Continued

Study	HRV measures	Participants with anxiety disorder	Healthy control subjects	Sig. diff between groups	Major finding
Norte et al. (62)[a]	TD	19	16	+	Lower HRV in PTSD patients
Shah et al. (63)[a]	HF, LF	31	385	+	Lower HF and LF HRV in PTSD patients
Tucker et al. (64)[a]	HF, LF	13	32	+	Higher LF power and LF/HF ratio in PTSD relative to controls
Wahbeh and Oken (65)[a]	HF, LF	52	29	+	Reduced HF and LF in PTSD patients relative to controls
Blechert et al. (53)[b]	RSA	23	32	+	Lower parasympathetic nervous system function in PTSD relative to controls
Cohen et al. (30)[b]	HF, LF, TD	14	25	+	Lower HF and higher LF power in PTSD relative to controls
Cohen et al. (66)[b]	HF, LF	16	16	+	Lower HF and higher LF power in PTSD relative to controls
Shaikh Al Arab et al. (67)[b]	TD	7	11	+	Lower RMSSD in PTSD relative to controls
GENERALIZED ANXIETY DISORDER (GAD)					
Hammel et al. (68)[a]	HF, LF, TD	16	19	–	No differences in any HRV measure between GAD patients and controls
Lyonfields et al. (24)[a]	TD	15	15	+	Lower mean successive differences in GAD relative to controls
Pittig et al. (29)[a]	HF	26	39	–	Borderline lower HF HRV in GAD patients ($p = 0.06$)
Thayer et al. (25)[a]	HF, LF, TD	34	32	+	Lower HF power in GAD compared to control
Kollai and Kollai (69)[b]	RSA	19	18	+	Lower RSA in GAD compared to control
OBSESSIVE–COMPULSIVE DISORDER (OCD)					
Pittig et al. (29)[a]	HF	17	39	+	Lower HF HRV in OCD patients
Slaap et al. (47)[a]	HF, LF	26	24	–	No differences between OCD and controls
SPECIFIC PHOBIA					
Bornas et al. (70)[a]	HF, LF, TD	61	58	+	Difference in TD HRV between flight phobics and controls, but not HF and LF HRV
SOCIAL ANXIETY DISORDER					
Alvares et al. (71)[a]	HF, LF, TD	53	53	+	Significant reductions in HF HRV and RMSSD for social phobics relative to controls
Gaebler et al. (72)[a]	HF	21	21	+	Lower HF HRV in social phobics
Pittig et al. (29)[a]	HF	29	39	+	Lower HF HRV in social phobics
Asmundson and Stein (52)[b]	RSA	15	15	–	No differences in parasympathetic activity between social phobics and controls
MIXED ANXIETY DISORDER					
Einvik et al. (73)[a]	HF, LF, TD	20	231	–	No differences in HF or LF power, or SDNN between anxiety patients and controls
Licht et al. (74)[a]	TD, RSA	1159	616	+	Lower SDNN and RSA in anxiety patients relative to controls. Effect disappears when controlling for psychotropic use
Martens et al. (75)[a]	HF, LF, TD	7	59	+	Lower RMSSD in anxiety patients relative to controls

TD, time domain; HF, high frequency; LF, low frequency; RSA, respiratory sinus arrhythmia.

[a] *Study included in meta-analysis.*

[b] *Study excluded from meta-analysis.*

“**Conclusion:** Anxiety disorders are associated with reduced HRV, findings associated with a small-to-moderate effect size. Findings have important implications for future physical health and well-being of patients, highlighting a need for comprehensive cardiovascular risk reduction.”

Argument so far:

1) Anxiety is on the rise and represents a significant burden on western societies and especially youth.
2) A prominent physiological biomarker of anxiety/depression is Vagal Withdrawal
3) The most commonly used treatments are only mildly effective and ignore autonomic physiology.
4) There is some evidence that gains from talk therapies are correlated with gains in vagal tone.
5) Persons with anxiety and depression have clearly been shown to have lower HRV (lower vagal tone/ prolonged vagal withdrawal)
6) Chronic hyperventilation is an overlooked strong predictor of dropout and poor outcomes.
    1) Disorders with poor effect sizes that have clear autonomic components.
        Panic and Trauma

Panic Disorder

- Lifetime Prevalence of 4.7%
  - Kessler, R. C., W. T. Chiu, et al. (2006). "The epidemiology of panic attacks, panic disorder, and agoraphobia in the National Comorbidity Survey Replication." Arch Gen Psychiatry **63(4): 415-24.**
- Only 11% of patients receive SSRIs, similar for CBT
  - Bruce, S. E., R. G. Vasile, et al. (2003). "Are benzodiazepines still the medication of choice for patients with panic disorder with or without agoraphobia?" Am J Psychiatry **160(8): 1432-8.**
  - Goisman, R. M., M. G. Warshaw, et al. (1999). "Psychosocial treatment prescriptions for generalized anxiety disorder, panic disorder, and social phobia, 1991-1996." Am J Psychiatry **156(11): 1819-21.**
- Increased risk of Coronary Artery Disease
  - Gomez-Caminero, A., W. A. Blumentals, et al. (2005). "Does panic disorder increase the risk of coronary heart disease? A cohort study of a national managed care database." Psychosom Med **67(5): 688-91.**

Respiratory and Physical Symptoms

- The cardio-respiratory symptoms of panic mimic heart disease and often lead to care-seeking in emergency departments (Fleet 2003, 1996) and cardiology settings (Dammen 1999).
- Deacon et al (2008) reported that patients with PD visited family medicine and cardiology practices, and emergency departments with greater frequency than those with other anxiety disorders.
- Barsky (1999) reported that patients with PD averaged 10.6 physician visits in one year versus 4.4 visits for patients without PD
- Retrospective claims analyses by Health Lumen and Highmark Health found that patients with PD represented 2-5 times higher costs than matched controls without PD (Highmark Health Panic Disorder Prevalence Analysis: High Level Cost and Count Overview & Matched Cohort Analysis. Unpublished Study 2015).

Panic Disorder Has a Physiological (in addition to psychological) Component That Can Be Addressed

- Many individuals with Panic Disorder breathe differently than other people all the time (not just when exhibiting PD symptoms).
  - They chronically "hyperventilate" which causes lower exhaled CO2 levels, and/or
  - They exhibit irregular and unstable breathing patterns and I/E imbalance
- Research has shown that:
  - Faulty respiratory control mechanisms play a role in the pathophysiology of Panic Disorder
  - Resetting (i.e., normalizing) an individual's Exhaled CO_2 level to normal reduces or eliminates panic attacks and symptoms of Panic Disorder
  - Addressing irregular breathing reduces or eliminates panic attacks and symptoms of Panic Disorder
- *The Canary Breathing System trains patients to normalize their respiratory pattern and normalize their exhaled CO2.*

HRV and Panic I

- Panic and reduced HRV
  - Reduced overall HRV, reduced HF, Increased LF (high sympathovagal tone)
    - Malliani, A., F. Lombardi, et al. (1994). "Power spectral analysis of cardiovascular variability in patients at risk for sudden cardiac death." J Cardiovasc Electrophysiol **5(3): 274-86.**
    - Piccirillo, G., S. Elvira, et al. (1997). "Abnormal passive head-up tilt test in subjects with symptoms of anxiety power spectral analysis study of heart rate and blood pressure." Int J Cardiol **60(2): 121-31.**
    - Yeragani, V. K., R. Berger, et al. (1992). "Effects of yohimbine on heart rate variability in panic disorder patients and normal controls: a study of power spectral analysis of heart rate." J Cardiovasc Pharmacol **20(4): 609-18.**
  - "These findings suggest a decrease in cholinergic and a relative increase in adrenergic responsiveness in panic disorder patients compared with control subjects."
    - Yeragani, V. K., R. Pohl, et al. (1993). "Decreased heart rate variability in panic disorder patients: a study of power-spectral analysis of heart rate." Psychiatry Res **46(1): 89-103.**

HRV and Panic II

- “ Our study replicated the finding that increased HR and decreased HRV occur in PD patients. Given the evidence of cardiac risk related to HRV, CBT appears to have additional benefits beyond symptom reduction.”
- “…treatment related increase in HRV.”

- Garakani, A., J. M. Martinez, et al. (2009). "Effect of medication and psychotherapy on heart rate variability in panic disorder." Depress Anxiety **26(3): 251-8.**

Chronic Hyperventilation and Therapy Outcomes

Low baseline pCO_2 predicts poorer outcome from behavioral treatment: Evidence from a mixed anxiety disorders sample

Carolyn D. Davies, , Michelle G. Craske,

Psychiatry Research

Volume 219, Issue 2, 30 October 2014, Pages 311–315

- End-tidal pCO2 was a significant overall predictor of MASQ-GA outcome (z=-2.17, p=.05, R^2=0.12), with lower levels of pCO2 associated with poorer outcome overall.
- For each1 S.D. (3.79 mmHg)decrease in pCO2, MASQ-GA scores were 0.25 S.D.s (1.79points) greater across the three follow-up time points.

Tolin, D. F., Billingsley, A. L., Hallion, L. S., & Diefenbach, G. J. (2017). Low pre-treatment end-tidal CO 2 predicts dropout from cognitive-behavioral therapy for anxiety and related disorders. *Behaviour Research and Therapy*, *90*, 32-40.

Table 3
Relationship between pre-treatment variables and dropout.

	Completers	Dropouts	*t*	*d* (95% CI)	χ^2	OR (95% CI)
Age [M (SD)]	37.92 (13.46)	34.76 (15.04)	0.92	−0.22 (−0.70–0.25)		
Female [N (%)]	22 (55.0%)	16 (55.2%)			0.00	1.01 (0.39–2.63)
Nonwhite [N (%)]	3 (7.5%)	11 (37.9%)			9.63*	7.54 (1.87–30.42)
DASS-Anxiety [M (SD)]	7.71 (4.86)	6.61 (3.87)	0.92	−0.25 (−0.72–0.22)		
DASS-Depression [M (SD)]	7.89 (5.76)	6.52 (5.48)	0.91	−0.24 (−0.72–0.23)		
DASS-Stress [M (SD)]	8.58 (4.96)	8.61 (4.86)	0.02	0.01 (−0.47–0.48)		
Anxiety disorder [N (%)]	33 (82.5%)	22 (75.9%)			0.46	0.67 (0.21–2.17)
Panic disorder [N (%)]	19 (47.5%)	8 (27.6%)			2.80	0.42 (0.15–1.17)
Agoraphobia [N (%)]	14 (35.0%)	5 (17.2%)			2.66	0.39 (0.12–1.24)
Social phobia [N (%)]	11 (27.5%)	7 (24.1%)			0.10	0.84 (0.28–2.51)
Generalized anxiety disorder [N (%)]	12 (30.0%)	8 (27.6%)			0.05	0.89 (0.31–2.56)
Specific phobia [N (%)]	4 (10.0%)	2 (6.9%)			0.20	0.67 (0.11–3.91)
Obsessive-compulsive disorder [N (%)]	11 (27.5%)	11 (37.9%)			0.84	1.61 (0.58–4.35)
Posttraumatic stress disorder [N (%)]	3 (7.5%)	0 (0.0%)			2.27	–
Depressive disorder [N (%)]	15 (37.5%)	13 (44.8%)			0.37	1.35 (0.51–3.58)
Substance use disorder [N (%)]	3 (7.5%)	3 (10.3%)			0.17	1.42 (0.27–7.61)
Number of diagnoses [M (SD)]	2.58 (1.52)	2.10 (1.05)	1.44	0.37 (−0.11–0.84)		
Medicated [N (%)]	29 (72.5%)	14 (48.3%)			4.20*	0.35 (0.13–0.97)
SSRI/SNRI [N (%)]	18 (45.0%)	11 (37.9%)			0.34	0.75 (0.28–1.98)
Benzodiazepine [N (%)]	20 (50.0%)	6 (20.7%)			6.15*	0.26 (0.09–0.78)
$ETCO_2$ [M (SD)]	39.91 (3.09)	37.79 (3.29)	2.74*	−0.66 (−1.14–−0.18)		
RR [M (SD)]	13.28 (4.69)	14.58 (4.93)	1.12	0.27 (−0.20–0.74)		

*$p < 0.05$. DASS = Depression Anxiety Stress Scales. $ETCO_2$ = end-tidal CO_2. RR = respiration rate. OR = odds ratio. CI = confidence interval.

Table 4
Logistic regression predicting dropout.

Block 1	B	S.E.	95% CI	Wald	Sig.	Exp(B)
Nonwhite	1.71	0.74	0.26–3.16	5.38	0.02	5.51
Benzodiazepine	0.97	0.59	−0.19–2.13	2.71	0.10	2.63
Constant	−1.29	0.48	−2.23–−0.35	7.39	0.01	0.28
Block 2	**B**	**S.E.**		**Wald**	**Sig.**	**Exp(B)**
Nonwhite	2.09	0.83	0.46–3.72	6.37	0.01	8.12
Benzodiazepine	0.73	0.62	−0.49–1.95	1.38	0.24	2.07
$ETCO_2$	−0.23	0.09	−0.41–−0.05	6.21	0.01	0.79
Constant	7.81	3.64	0.68–14.94	4.60	0.03	2473.95

$ETCO_2$ = end-tidal CO_2. CI = confidence interval.

The significant Odds ratio for $ETCO_2$ would translate to 2.20. That means that for every 1 mmHG lower level of $ETCO_2$ (at baseline) we would predict a 2.2 to 1 greater dropout rate, with race and Benzodiazepine use held constant

“The present results, along with previous clinical trial data, suggest that lower pre-treatment $ETCO_2$ is a negative prognostic indicator for CBT for anxiety-related disorders. It is suggested that patients with lower $ETCO_2$ might benefit from additional intervention that targets respiratory abnormality.”

Physiologic Instability in Panic Disorder and Generalized Anxiety Disorder

Frank H. Wilhelm, Werner Trabert, and Walton T. Roth

"Conclusions: Respiration is particularly unstable in panic disorder, underlining the importance of respiratory physiology in understanding this disorder. Whether our findings represent state or trait characteristics is discussed. "

Biol Psychiatry 2001;49:596–605

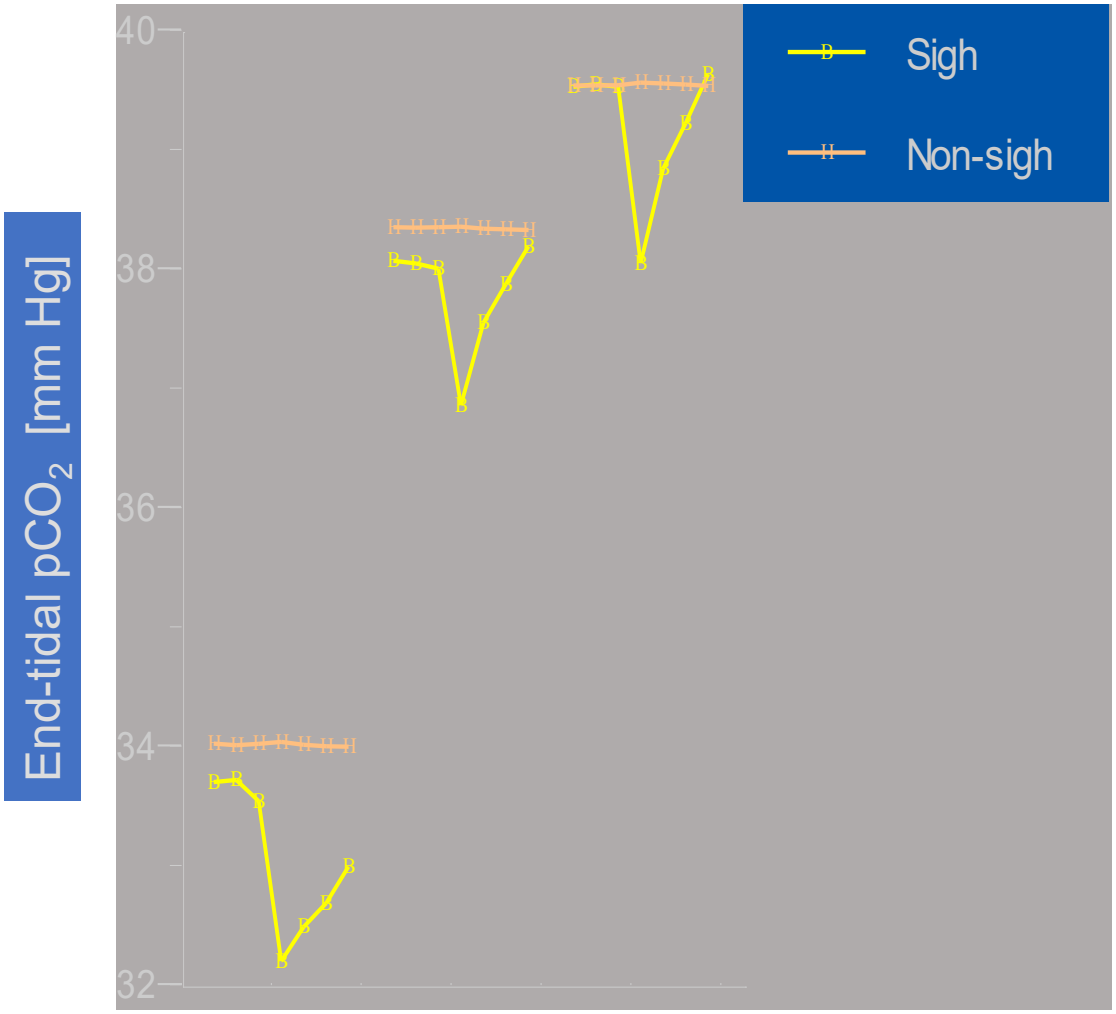
Activation and Deactivation Dynamics in Response to Hyperventilation in Panic Disorder and Social Phobia

Frank H. Wilhelm, PhD, Walton T. Roth, MD

Stanford University, Palo Alto, CA, USA,
and VA Health Care System, Palo Alto, CA, USA

Supported by NIH Grant MH56094
and the Department of Veterans Affairs.

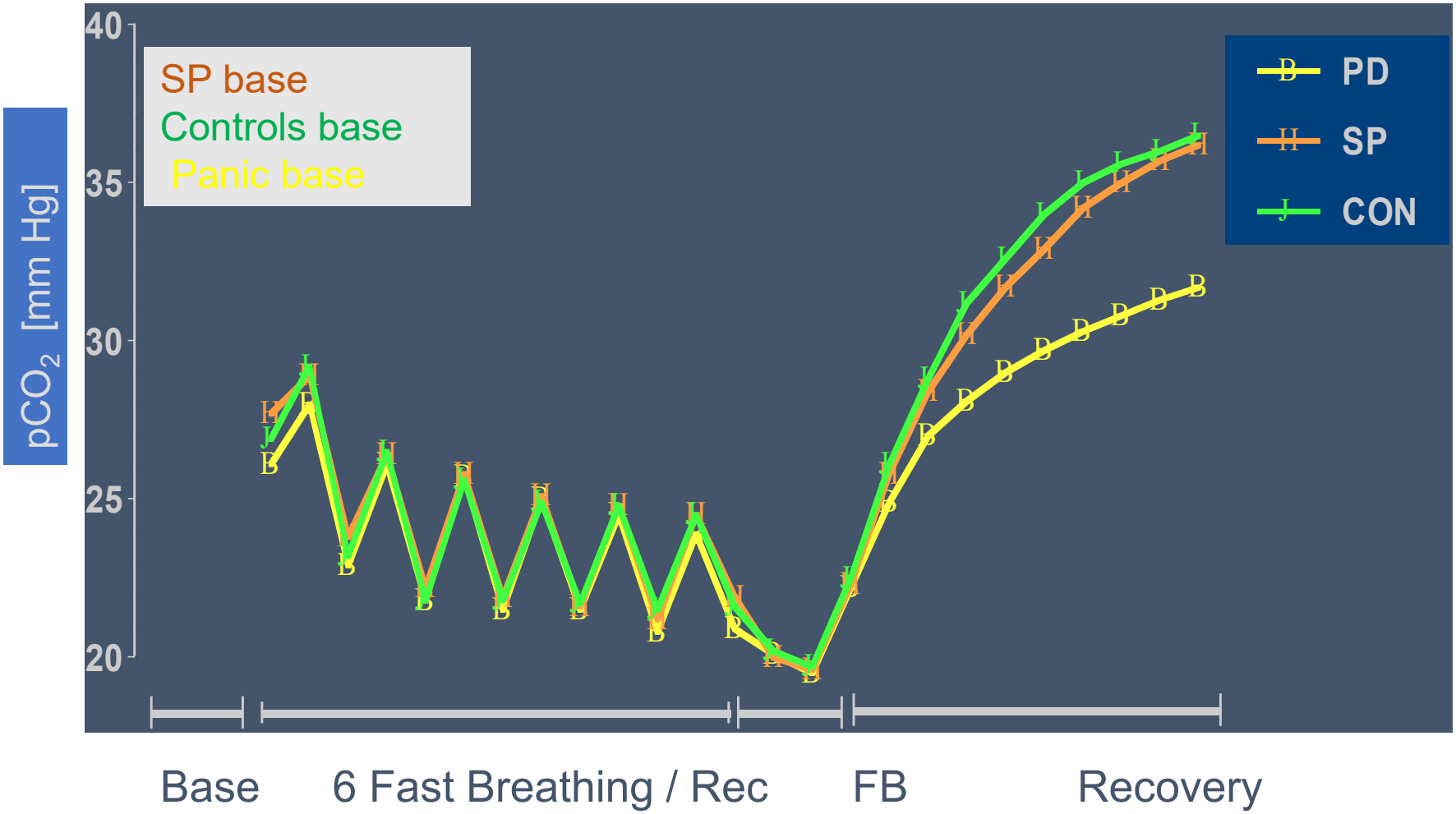
pCO_2



Post-sigh: less recovery for PD ($p<.04$)

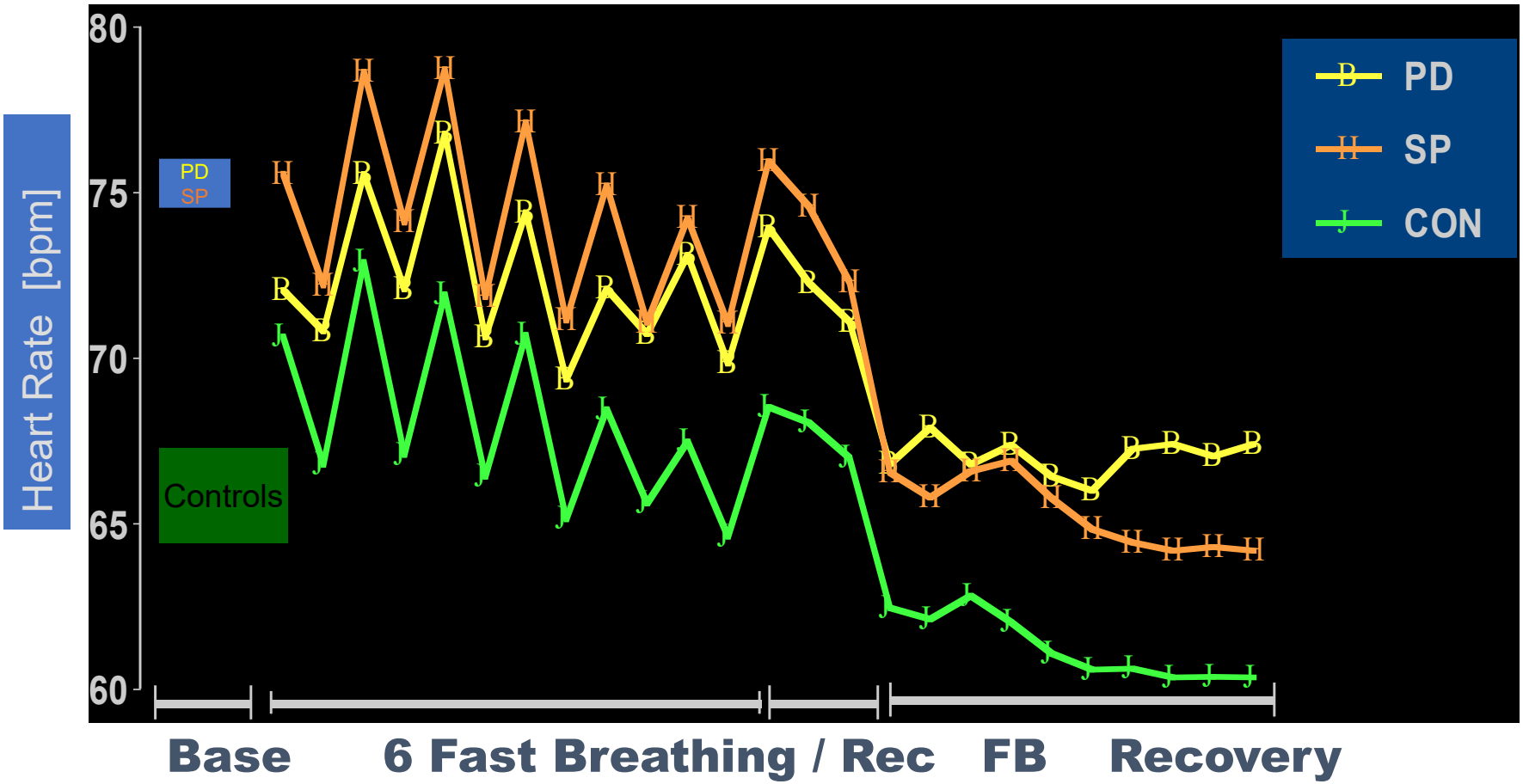
The pCO_2 level dropped with sighs about equally in all groups, but it returned to baseline slower in the PD patients.
This is especially noteworthy, since levels were already lower in PD patients, and one might think that there would be a stronger tendency to reestablish normal levels.
This slow recovery is the opposite of what we expected, since it indicates reduced peripheral CO_2 sensitivity.
Also unexpectedly, before sighs, pCO_2 was not increased but at baseline levels or slightly lower.

These are the results for pCO_2.
It shows the minute-by-minute levels for the 3 groups, panic disorder, social phobia, and controls, during the baseline, and 6 repetitions of one-minute trials of fast breathing followed by one-minute recoveries.
Then came a 3-minute intensive fast breathing and 10 minutes of recovery from it.
As you can see, subjects were not different in pCO_2 at baseline, and their levels decreased equally during the repeated fast breathing trials until they reached the targeted 20 mmHg during the 3-minute trial.
What stands out is that the groups differed in their pCO_2 recovery pattern. While social phobics and controls returned to baseline within the 10-minutes, panic patients showed a markedly slower recovery.



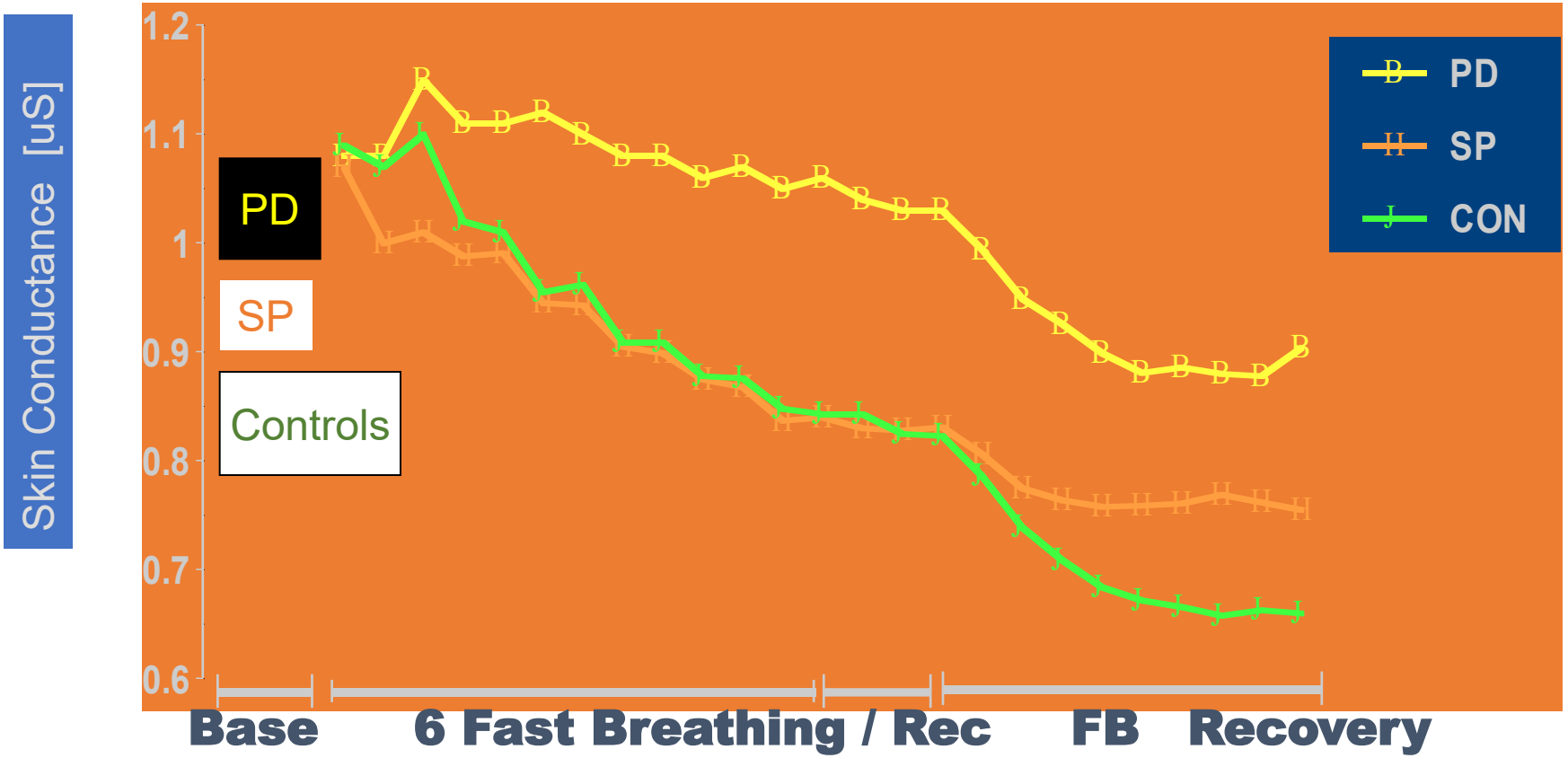
Heart Rate

Here you can see that heart rate increased by about 5 beats per minute during each hyperventilation period, which is, of course largely explained by the physical effort of fast and deep breathing, and thus not an indication of emotional activation. Average HR decreased for all groups during the repetitions, but not much. What is most interesting is that during the 10-min recovery, HR decreased well below baseline levels in social phobics and controls but remained elevated in panic patients.



Skin Conductance (adjusted)

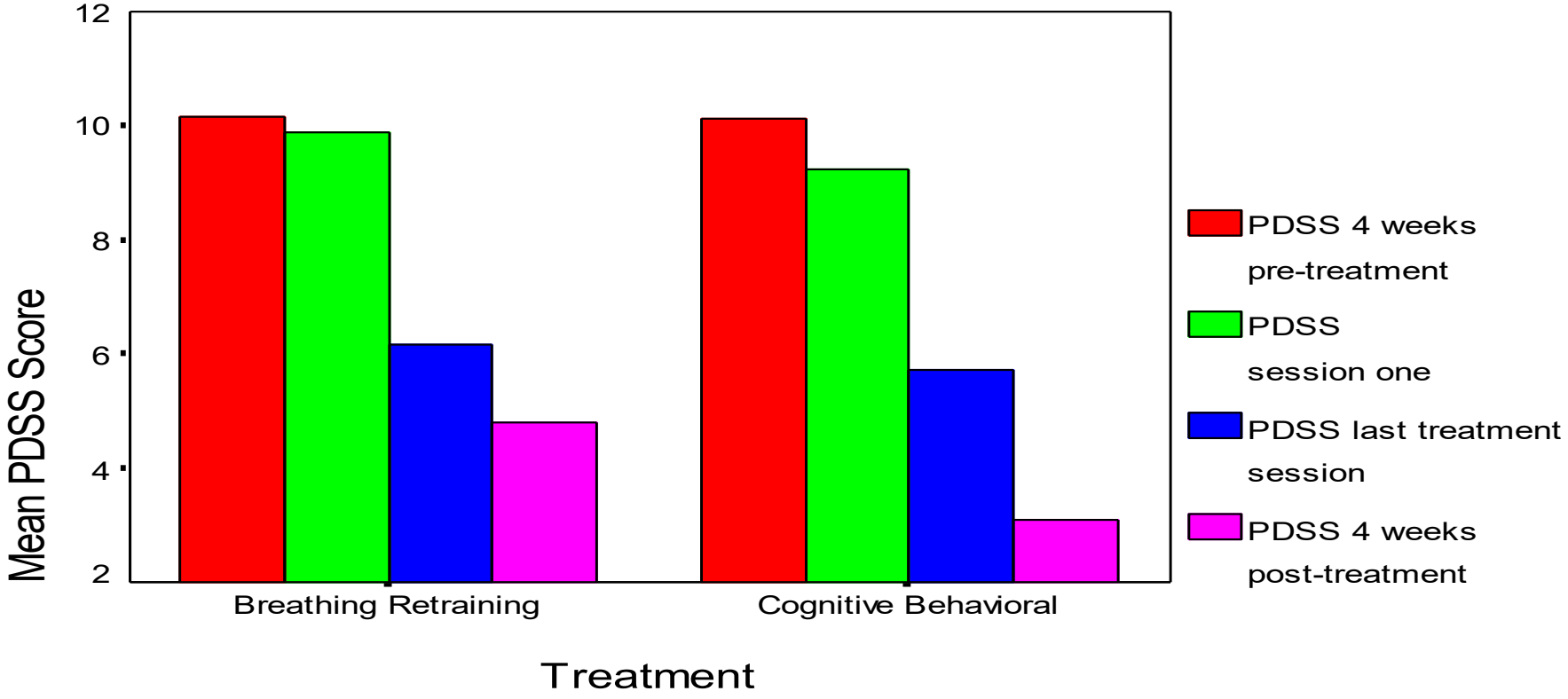
Skin conductance was adjusted in this graph so that between group effects are more visible
For this, we simply set the levels right before the first fast breathing trial to 1 or 100% for each individual.
Statistically, skin conductance activation to the first fast breathing trial was the same across groups.
Then the level decreased markedly over the repetitions of fast breathing in social phobia patients and controls, but much less in panic patients, a clear sign of reduced habituation in this group.
As a result, skin conductance was higher during the intensive 3-minute fast breathing in panic patients. It declined about equally in all groups during recovery.



Creager-Berger and Gevirtz, (2000)

- CBT v. BR
- Design
  - Craske and Barlow protocol vs. DeGuire et al. protocol (breathing retraining [BT])
  - 10 weeks for CBT vs. 6 weeks for BT
  - CO_2 measurement/Respiratory Rate
  - 4-week pre/post
  - Outcome measures

Panic Disorder Severity Scale (PDSS): 4 Week Pre-Treatment, Session 1, Last Session, and 4- Week Post Treatment Scores



Note. There was no significant interaction between the two treatment groups, F (3,19) = .57, p = .640. A main effect was found for Time, F(3,19) = 40.17, p <.001. There were no significant post treatment differences between the treatment groups when measured at the last treatment session or 4 weeks post-treatment, F (1,19) = .067, p = .799; F (1,19) = .350, p = .561, respectively..

Respiratory Psychophysiology of Panic

Papers of Alicia Meuret on Panic

- Meuret, A.E., Rosenfield, D., Wilhelm, F.H., Zhou, E., Conrad, A., Ritz, T., & Roth, W.T. (2011).
  Do unexpected panic attacks occur spontaneously? *Biological Psychiatry, 70, 985-91.*
- Meuret, A.E., Rosenfield, D., Seidel, A., Bhaskara, L. & Hofmann, S.G. (2010). Respiratory and cognitive mediators of treatment change in panic disorder: Evidence for intervention specificity. *Journal of Consulting and Clinical Psychology, 78*, 691-704.
- Meuret, A. E., Wilhelm, F. H., Ritz, T., & Roth, W. T. (2008). Feedback of end-tidal pCO2 as a therapeutic approach for panic disorder. Journal of psychiatric research, 42(7), 560-568.
- Meuret, A. E., Wilhelm, F. H., Ritz, T., & Roth, W. T. (2008). Feedback of end-tidal pCO2 as a therapeutic approach for panic disorder. *Journal of psychiatric research*, *42*(7), 560-568.
- Meuret, A. E., Wilhelm, F. H., Ritz, T., & Roth, W. T. (2008). Feedback of end-tidal pCO2 as a therapeutic approach for panic disorder. *Journal of psychiatric research*, *42*(7), 560-568.

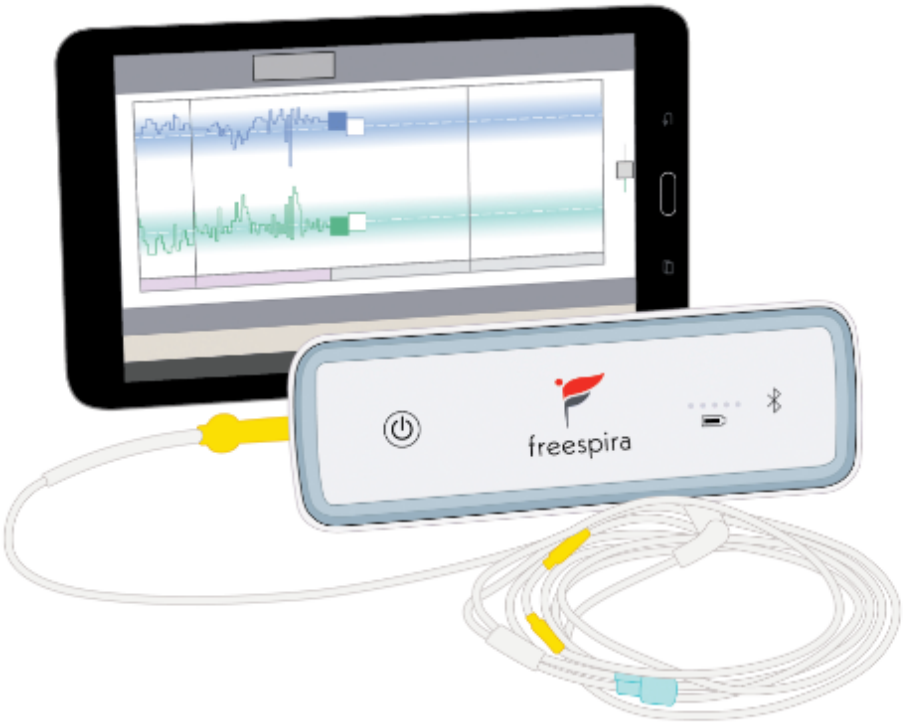
Based on the recognition in PD sufferers of subtle respiratory irregularities associated with hyperventilation, and carbon dioxide sensitivity, Meuret and colleagues (2008) developed a breathing intervention focused on normalizing both exhaled carbon dioxide levels ($ETCO_2$) and respiratory rate. The protocol provided breath-to breath feedback of $ETCO_2$, while modeling paced breathing at four different respiratory rates. Administered as twice daily, 17-minute sessions over a four-week period, the authors reported that by study end, 86% of subjects reported zero weekly panic attacks; improvement that was durable over time, as 73% reported zero weekly attacks one-year post-treatment.

HOW FREESPIRA WORKS

It starts with CO_2

Unlike medication or talk therapy, Freespira teaches you to regulate your breathing patterns. That's because breathing differences, and hypersensitivity to CO_2, are often linked with panic and PTSD symptoms. The Freespira process includes:

- Two 17-minute sessions per day
- Training and weekly check-ins with a coach
- Small breathing sensor
- Tablet with real-time feedback



Leased to therapist and patients: $850-$1000

Target Respiratory Rate and $EtCO_2$

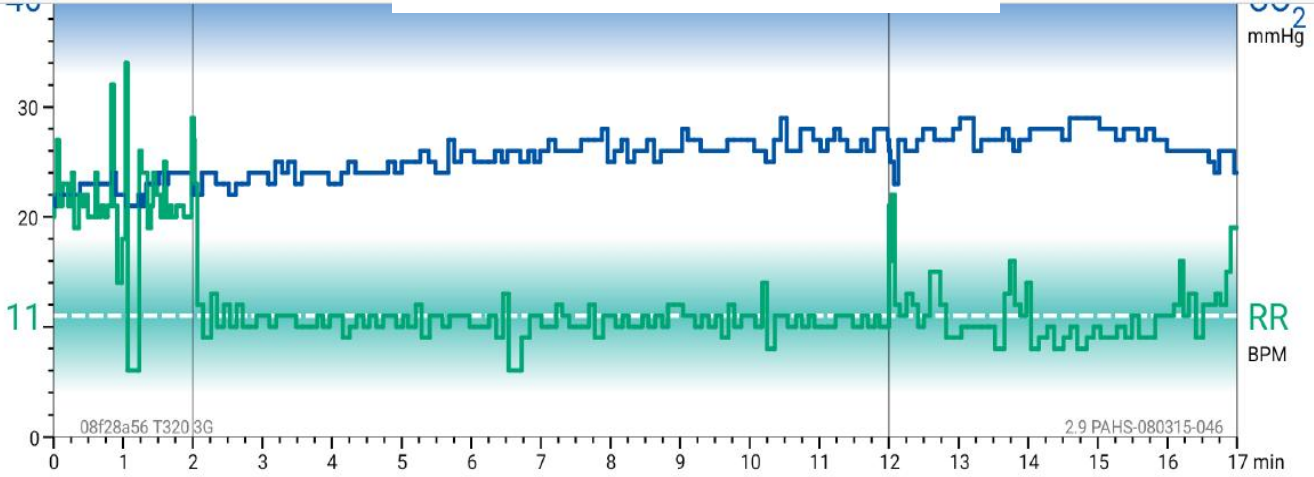
Current $ETCO_2$

Target Level $ETCO_2$

Current Respiration rate

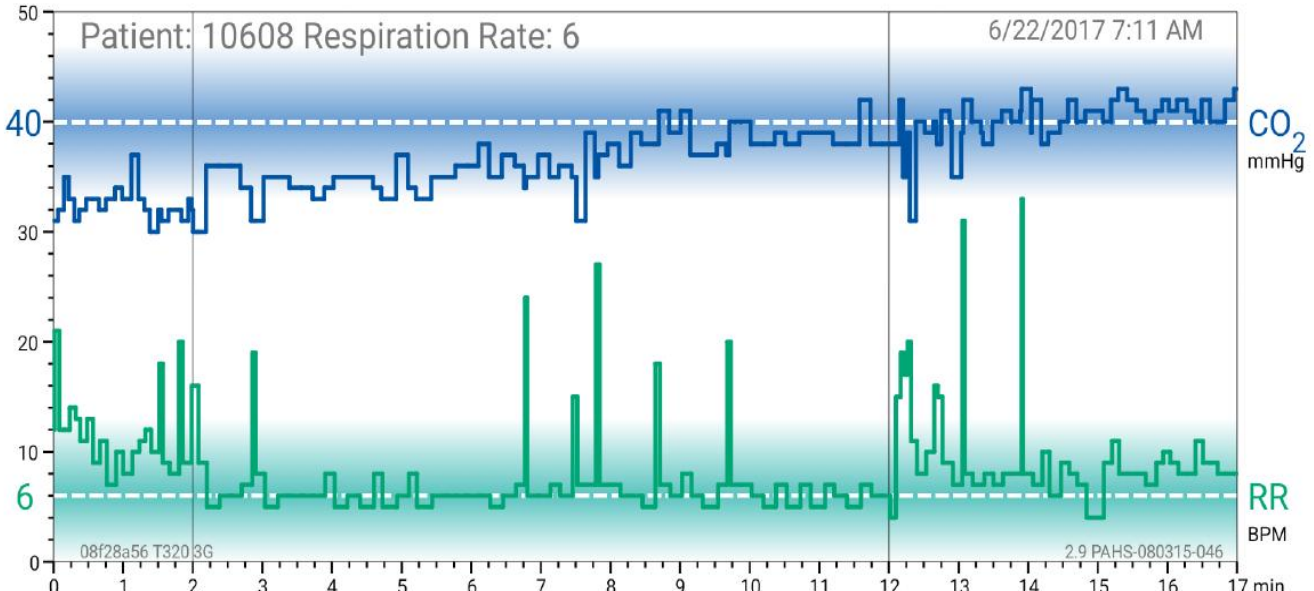
Target Respiration rate

First Session Chart



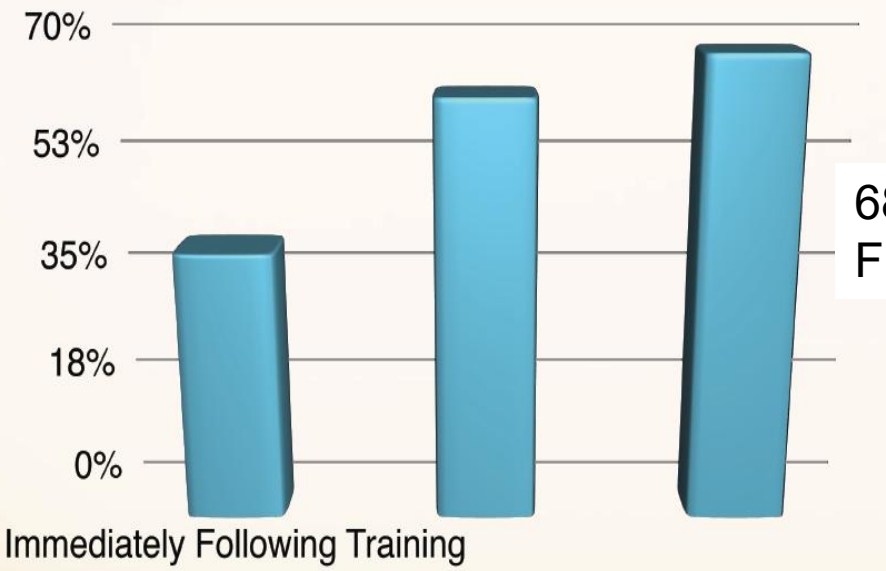
Avg	Baseline	Pacing Stage	Transition Stage	Target
CO_2	23	25	27	40
RR	22	11	11	11

Last Session Chart



% Tx Subjects Panic Free

68% of Patients Panic-Attack Free at 12 Months

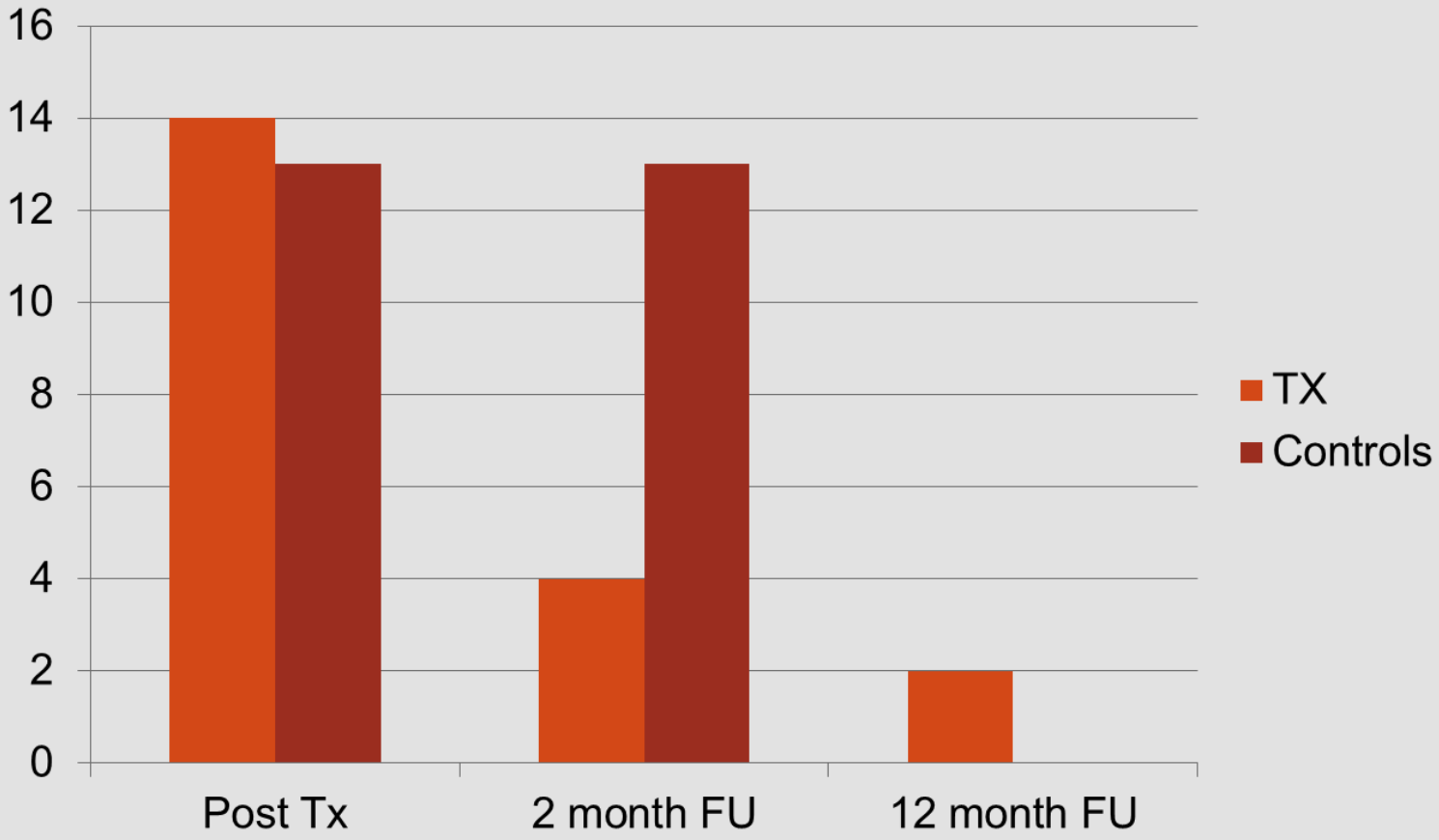


68% Tx Subjects Panic Free

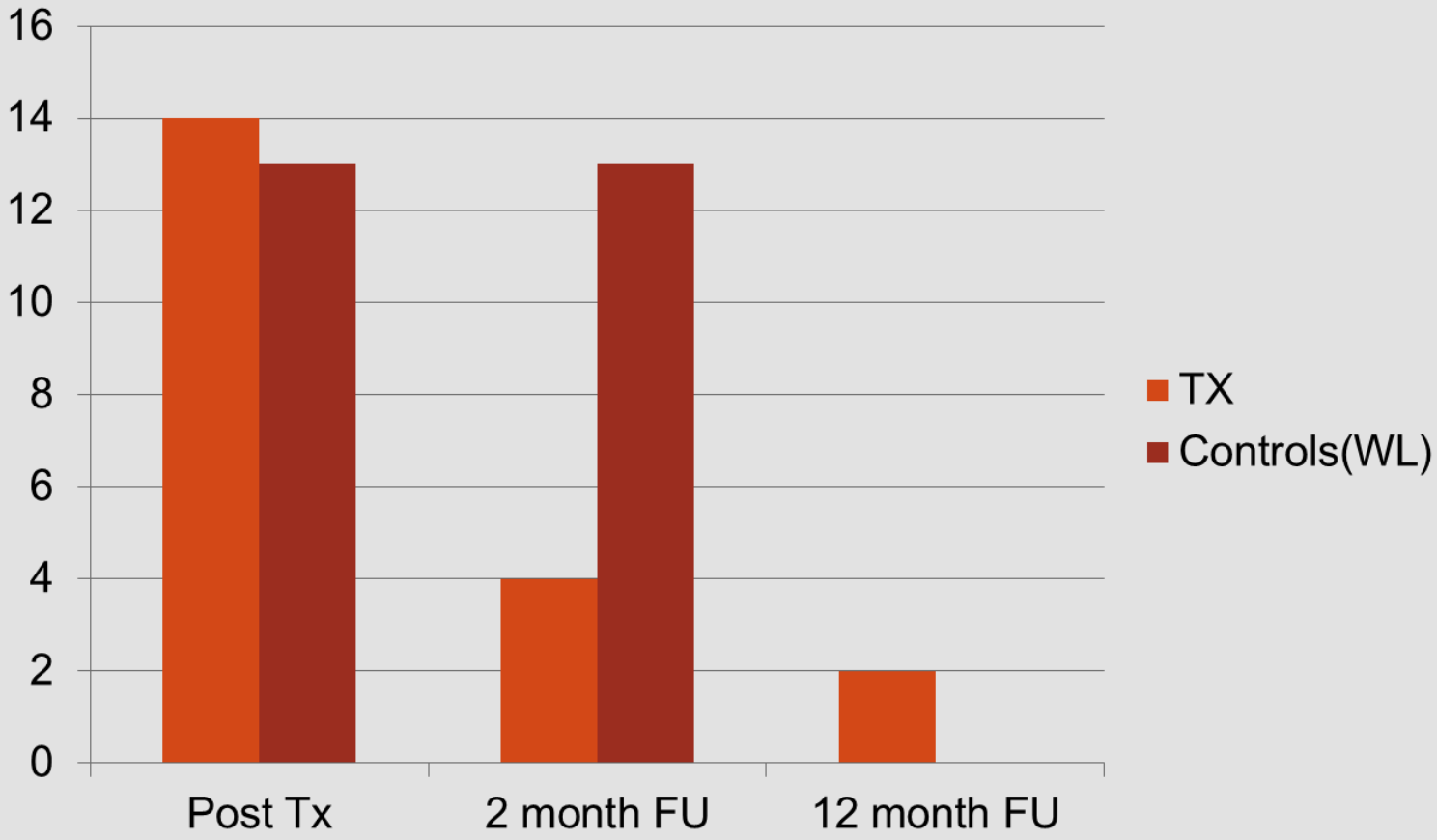
- 40% Panic-Attack free immediately following the 4-week treatment
- Increasing to 62% at 2-months post-treatment
- Sustaining through the 12-month follow-up period at 68%

A.E. Meuret et al. / Journal of Psychiatric Research 42 (2008) 560–568

% Ss with >40% Reduction in PDSS Scores (Meuret, 2008)



PDSS Scores Across Time (Meuret, 2008)

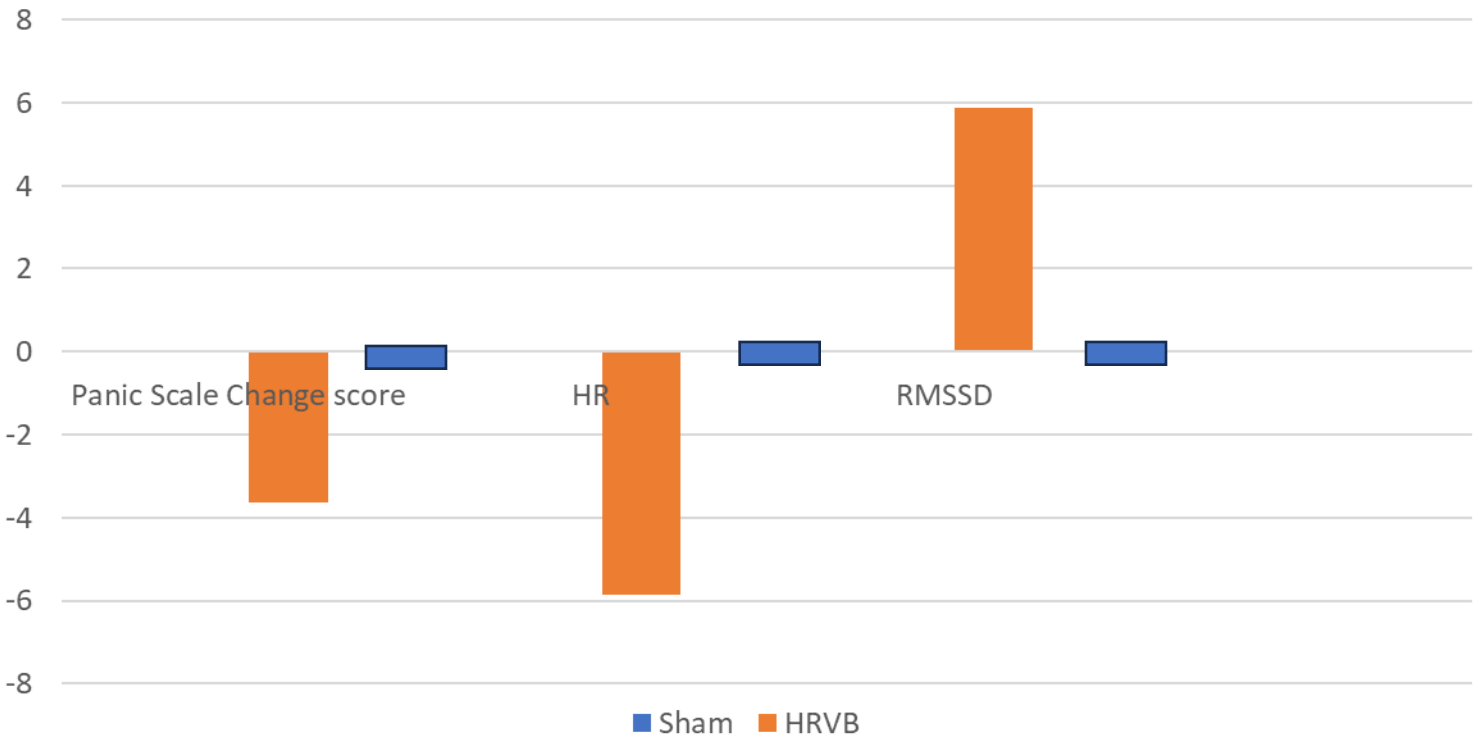


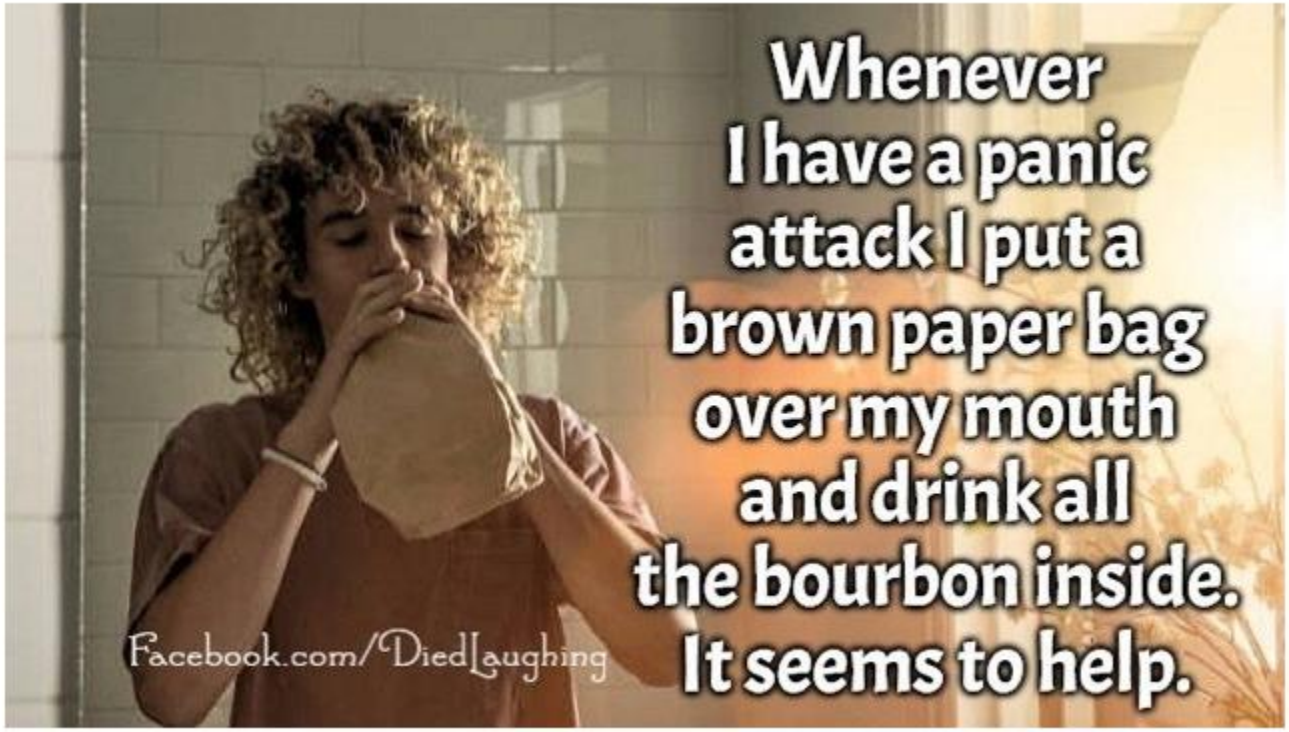
Tolin (2017) used the same twice-daily, four-week protocol and described the treatment as *Capnometry Guided Respiratory Intervention* (CGRI). Patients were treated in four nonacademic outpatient clinics. This trial reported that 71% of participants who completed treatment were panic attack free immediately post treatment, and 79% were panic attack free at one-year post-treatment. At one-year post treatment, 82% of participants achieved treatment response (defined as at least 40% reduction in Panic Disorder Severity Scale scores). Tolin additionally benchmarked this study against Meuret's (2008) and found similar reductions on the Anxiety Sensitivity Index and Sheehan Disability Scale. Both papers reported favorable side effect profiles, limited primarily to transitory sensations of light-headedness and dizziness.

Effect of a Biofeedback Intervention on Heart Rate Variability in Individuals With Panic Disorder: A Randomized Controlled Trial

Herhaus, Benedict PhD; Siepmann, Martin MD; Kahaly, George J. MD; Conrad, Rupert PhD, MD; Petrowski, Katja PhD
Author Information
Psychosomatic Medicine: 2/3 2022 - Volume 84 - Issue 2 - p 199-209
doi: 10.1097/PSY.0000000000001031

Change in Panic Scores, HR, and RMSSD (no change was reported for the sham feedback group)




Whenever
I have a panic
attack I put a
brown paper bag
over my mouth
and drink all
the bourbon inside.
It seems to help.
Facebook.com/DiedLaughing

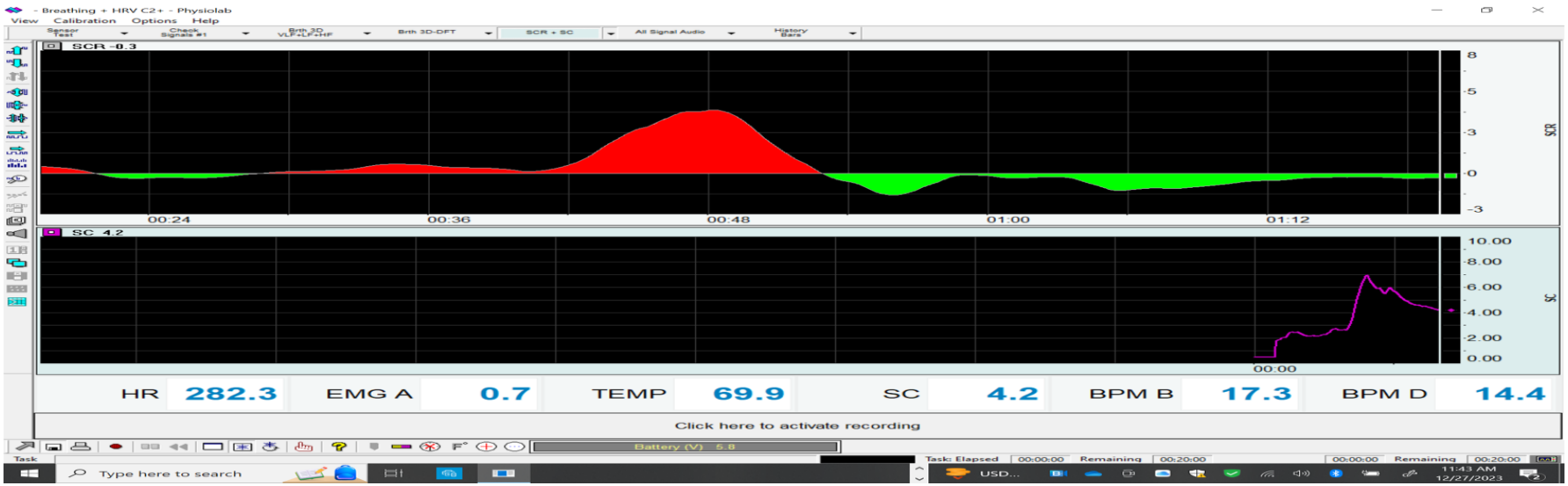
Emerging Applications of Heart Rate Variability Biofeedback: Trauma

Richard Gevirtz, Ph.D., BCIAC
CSPP@ AIU, San Diego, CA
rgevirtz@alliant.edu

Physiological Tracking
Adding tools for the Trauma Clinician

Yang, M., Mady, N., & Linnaranta, O. (2021). Utility of Psychophysiological Metrics in Guiding Treatment of Trauma Symptoms: A Systematic Review. *Journal of Behavioral and Cognitive Therapy*.

"The current findings stress a need for the development of a psychophysiological methodology that is feasible and reliable during experimental and clinical procedures to elucidate the effects of trauma intervention on emotional processing."



Skin Conductance levels during therapy

- "…when people are reminded of personal trauma, they activate brain regions that support intense emotions, while decreasing activity in brain structures involved in the inhibition of emotions and the translation of experience into communicable language." (p.278)
- Van Der Kolk, 2006
- Therefore,talk therapy has built in limitations

Mathersul, D. C., Dixit, K., Schulz-Heik, R. J., Avery, T. J., Zeitzer, J. M., & Bayley, P. J. (2022). Emotion Dysregulation and Heart Rate variability Improve in US Veterans Undergoing Treatment for Posttraumatic Stress Disorder: Secondary Exploratory Analyses from a Randomised Controlled Trial.

Figures

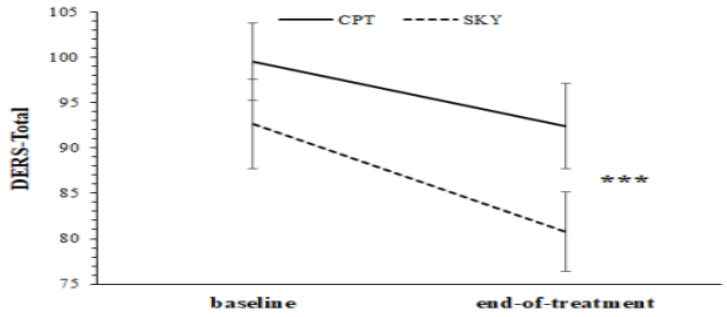
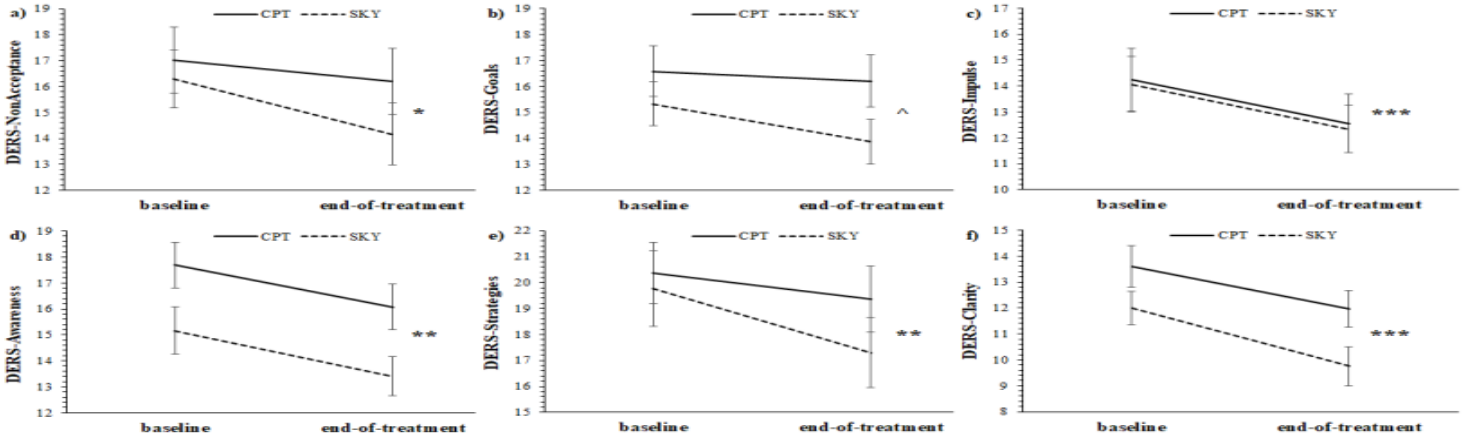


Figure 1

Mean total score on the Difficulties in Emotion Regulation Scale (DERS-Total) at baseline and end-of-treatment for Veterans who received either Sudarshan kriya yoga (SKY) or cognitive processing therapy (CPT) for PTSD (per protocol). *Lower values reflect better emotion regulation.* *** denotes significant ($p < .001$) main effect of time.



Schneider M, Schwerdtfeger A (2020). Autonomic dysfunction in posttraumatic stress disorder indexed by heart rate variability: a meta-analysis. Psychological Medicine 1–12. https://doi.org/10.1017/S003329172000207X

Results. Random-effects meta-analyses for HRV parameters at rest revealed significant group differences for RMSSD and HF-HRV, suggesting lower parasympathetic activity in PTSD. The aggregated effect size for SDNN was medium, suggesting diminished total variability in PTSD. A small effect was found for LF-HRV. A higher LF/HF ratio was found in the PTSD sample as compared to controls. Individuals with PTSD showed significantly higher HR. During stress, individuals with PTSD showed higher HR and lower HF-HRV, both indicated by small effect sizes. Conclusions. Findings suggest that PTSD is associated with ANS dysfunction.

Vagal Break Concept:
Exercise recovery of LnHf after gentle exercise (Dale et al., 2009)

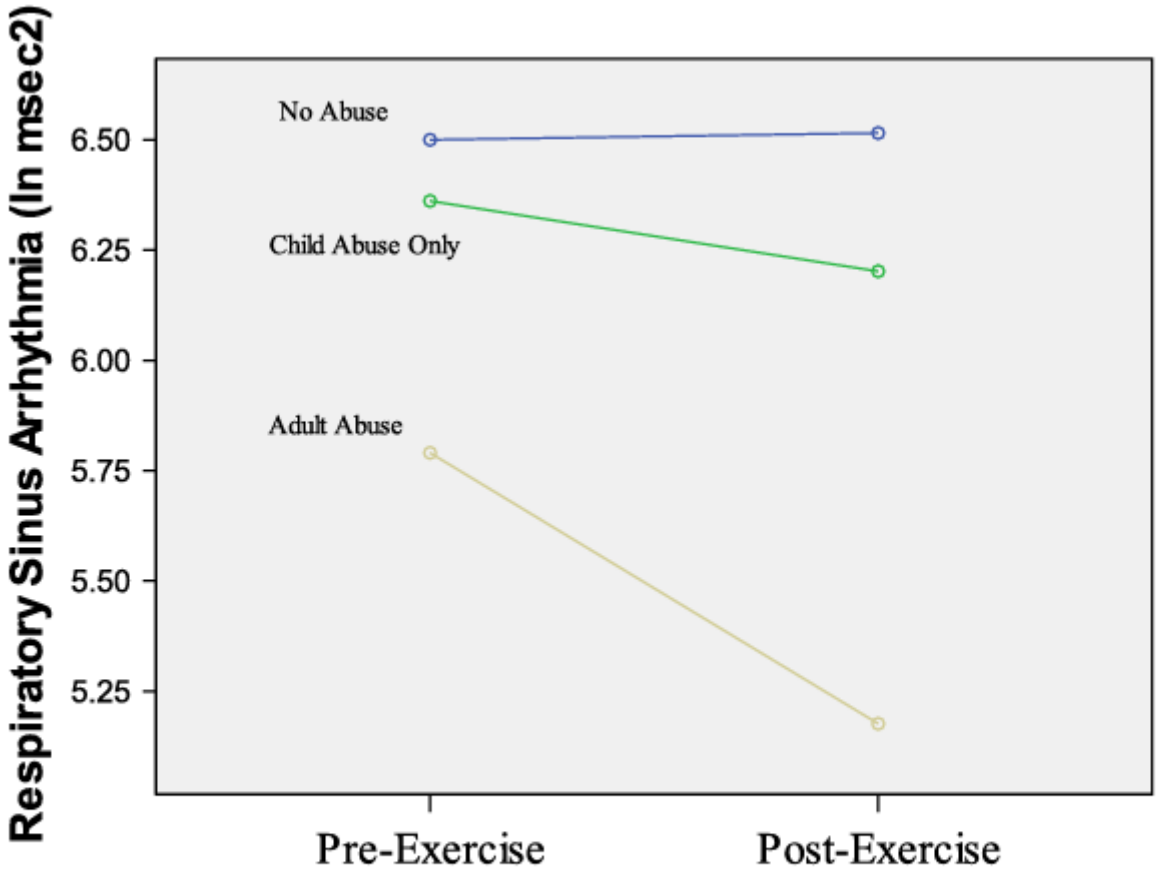


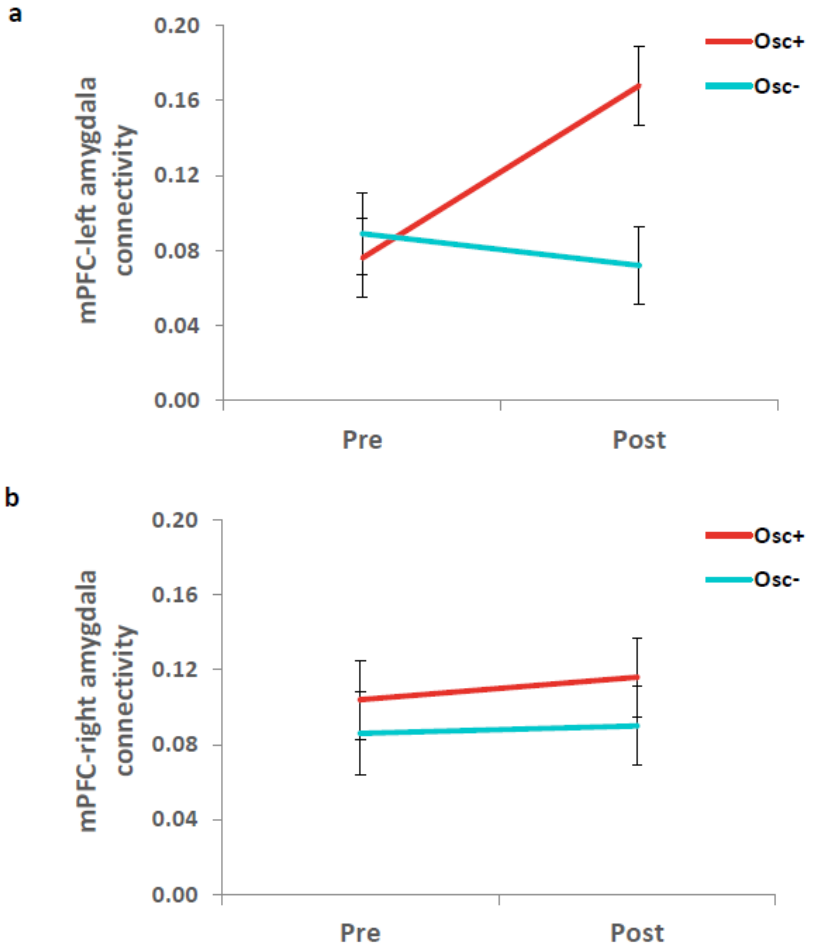
Fig. 3 Respiratory sinus arrhythmia (RSA) reactivity to exercise as a function of recency of abuse history

Implications for treatment

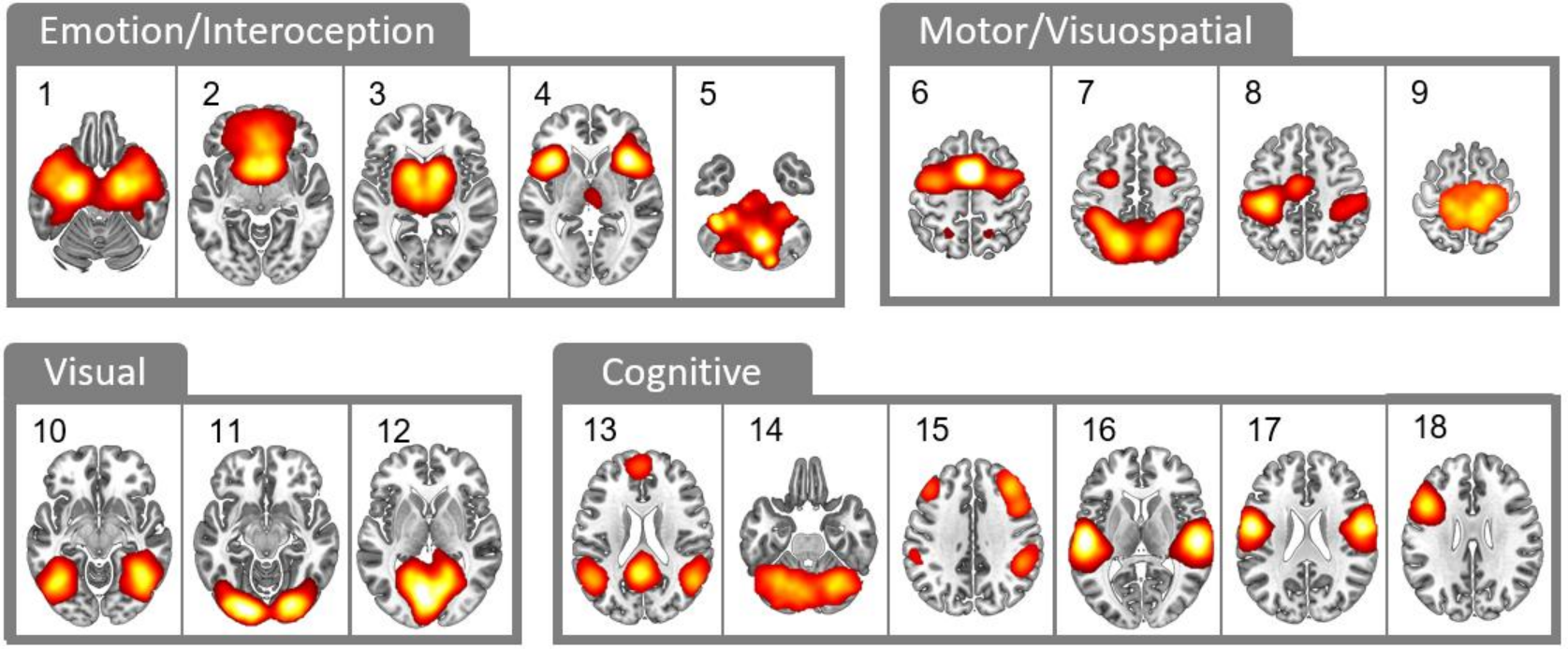
- The only empirically based treatments to date are CBT, CBT/PE, and CPT.
  - Though meta-analyses show that these therapies are better than placebo, they leave "much room for improvement"
  - Effect sizes are small Hofmann, 2008
- "One thing is clear: the rational, executive brain, the mind, the part that needs to be functional in order to engage in the process of psychotherapy, has very limited capacity to squelch sensations, control emotional arousal, or change action patterns" Van der Kolk, 2006, p.281
- A somatic intervention might be a necessary component for PTSD treatment
- Interventions that prompt behavioral action may be superior

HRVB's Potential Role in Enhancing Inhibitory Learning

The Osc+ group showed more left amygdala-mPFC resting-state functional connectivity after five weeks of biofeedback training than before.

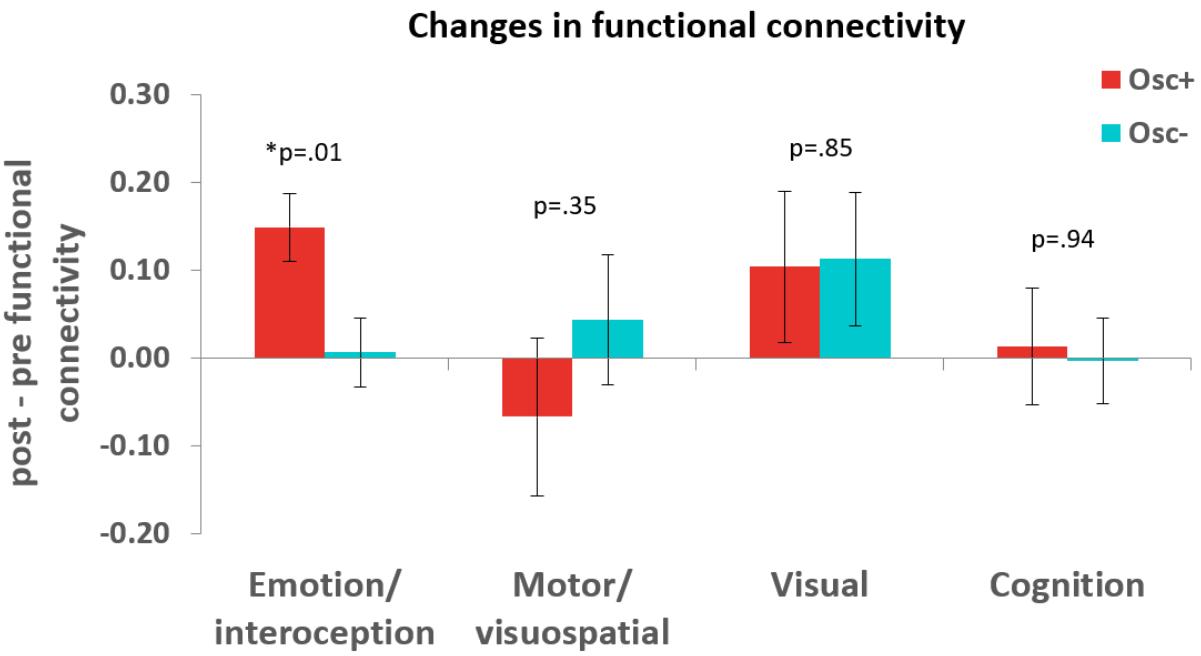


Canonical resting-state networks include some related to emotion/interoception



Laird et al., (2011).

The Osc+ group showed increased functional connectivity within networks involved in emotion/interoception



Exposure Therapies are among our most reliable tools to treat a variety of anxiety disorders:

Anxiety
Specific phobias
Social Phobias
PTSD

1. Arch JJ, Craske MG. First-line treatment: a critical appraisal of cognitive behavioral therapy developments and alternatives. Psychiatr Clin North Am. 2009;32(3):525–47. https://doi.org/10.1016/j.psc.2009.05.001.
2. Olatunji BO, Cisler JM, Deacon BJ. Efficacy of cognitive behavioral therapy for anxiety disorders: a review of meta-analytic findings. Psychiatr Clin North Am. 2010;33(3):557–77. https://doi.org/10.1016/j.psc.2010.04.002.
3. McKay D, Sookman D, Neziroglu F, Wilhelm S, Stein DJ, Kyrios M, et al. Efficacy of cognitive-behavioral therapy for obsessive-compulsive disorder. Psychiatry Res. 2015;227(1):104–13. https://doi.org/10.1016/j.psychres.2015.02.004.
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6. McLean CP, Levy HC, Miller ML, Tolin DF. Exposure therapy for PTSD in military populations: a systematic review and meta-analysis of randomized clinical trials. J Anxiety Disord.

It is now accepted that the mechanism of action is Inhibitory Learning.

Craske, M. G., Liao, B., Brown, L., & Vervliet, B. (2012). Role of inhibition in exposure therapy. *Journal of Experimental Psychopathology*, *3*(3), 322-345.

Heart rate variability predicts therapy outcome in anxiety disorders: The role of inhibitory learning

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Darcianne K. Watanabe[2]
Julian Koenig[3]
Matthew Free[4]
Russell H. Fazio[5]
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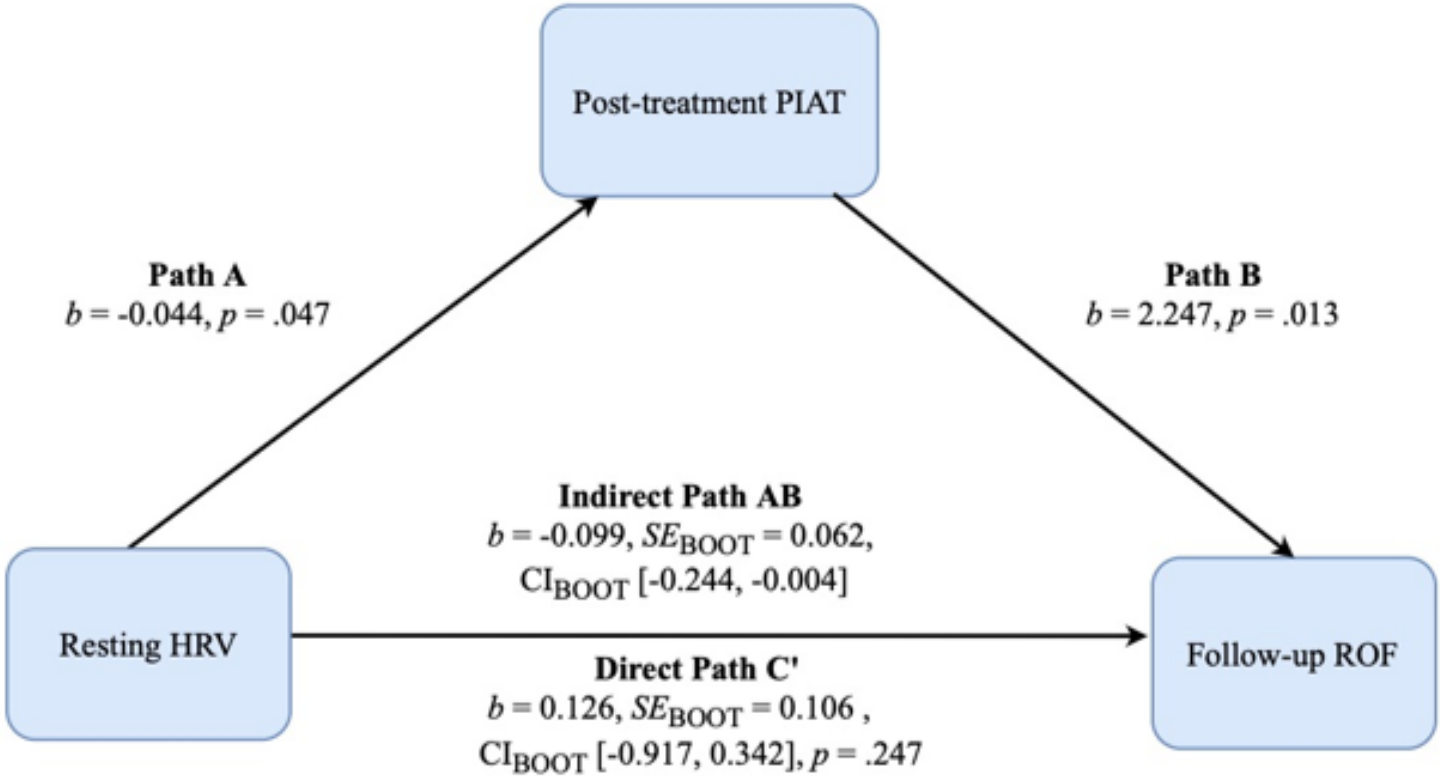
"Taken together these results support exposure therapy models that emphasize the importance of inhibitory learning in extinction and are consistent with research linking HRV to inhibition."

Return of symptoms at follow-up after exposure therapy for social phobia.



Note. Bootstrap sample size = 20,000. Pre-treatment resting high-frequency heart rate variability (resting HRV). Follow-up return of fear (ROF) measured 1 month post-treatment. Covariates included in the model: pre-treatment personalized IAT (PIAT) scores, aggregated and averaged composite z-scores of state anxiety ratings before and during the speech behavioral approach task at pre- and post-treatment, and low-frequency HRV. *b* = unstandardized regression coefficient; *SE* = standard error; SE_{BOOT} = bootstrapped SE; CI_{BOOT} = bias-corrected bootstrapped 95% confidence intervals. Model summary for dependent variable model: R^2=0.85, F (6,29) = 27.573, p <0.001.

HRVB added to PE or CPT

- Begin with HRVB
  - Before trauma scripts or any real exposure
- Daily practice until mastery is demonstrated
  - Must be able to:
    - Produce a smooth sine wave that matches resp
    - Produce a single LF peak
    - Show some evidence of finger temp increase
    - Show some evidence of SC decrease
- Now begin exposure using HRVB as a safety net.
  - Take care to assure arousal
  - Watch SUDS and physiology
  - Emphasize recovery skills
- Progress with ACT or CBT training
  - Introduce CBT or ACT principles using the premise that prolonged vagal withdrawal (or hyperventilation) is produced by dysfunctional cognitions or Fusion. Thus, the purpose of the talk therapy is to avoid the dysfunctional physiology causing the problem.

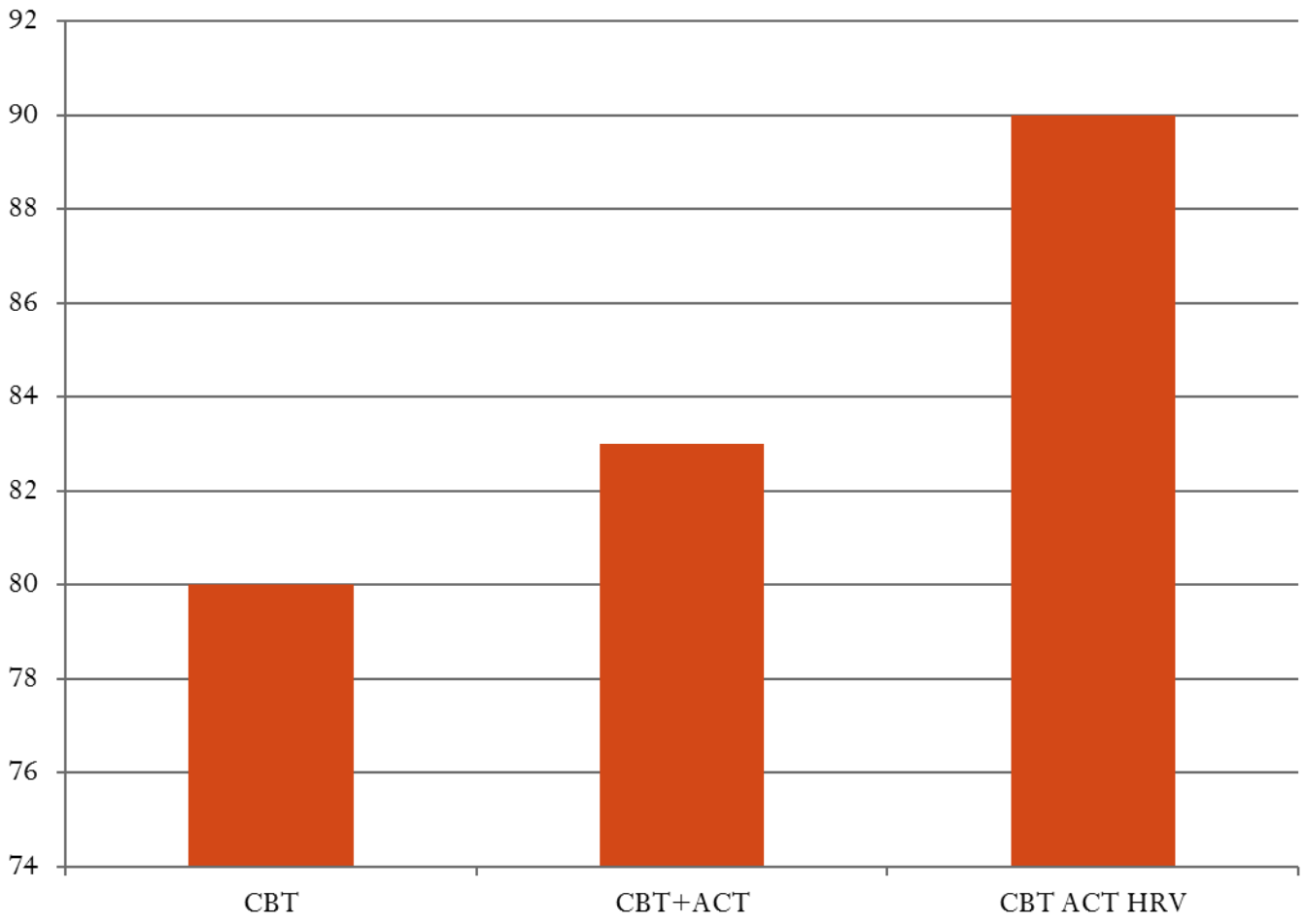
SUDS results from client (Dalenberg)

Event	SUDS 1	SUD2	SUDS3	SUDS4
1	25	15	5	0
2	35	0	5	0
3	55	35	5	5
4	65	55	15	5
5	75	75	45	5
6	85	85	45	25
7	90	90	40	30

Dalenberg, 2008

Rx	N	Dropout	% nonclin	% subjective
PE	189	14 (7%)	81	71
PE+ACT	74	10 (14%)	83	82
PE+ ACT + HRV	77	4 (5%)	94	88

Treatment success over time (Dalenberg, 2008)



Heart Rate Variability (HRV) and Posttraumatic Stress Disorder (PTSD): A Pilot Study

Gabriel Tan · Tam K. Dao · Lorie Farmer · Roy John Sutherland · Richard Gevirtz

Published online: 3 August 2010

Abstract Exposure to combat experiences is associated with increased risk of developing Post Traumatic Stress Disorder. Prolonged exposure therapy and cognitive processing therapy have garnered a significant amount of empirical support for PTSD treatment; however, they are not universally effective with some patients continuing to struggle with residual PTSD symptoms. Heart rate variability (HRV) is a measure of the autonomic nervous system functioning and reflects an individual's ability to adaptively cope with stress. A pilot study was undertaken to determine if veterans with PTSD (as measured by the Clinician-Administered PTSD Scale and the PTSD Checklist) would show significantly different HRV prior to an intervention at baseline compared to controls; specifically, to determine whether the HRV among veterans with PTSD is more depressed than that among veterans without PTSD. The study also aimed at assessing the feasibility, acceptability, and potential efficacy of providing HRV biofeedback as a treatment for PTSD. The findings suggest that implementing an HRV biofeedback as a treatment for PTSD is effective, feasible, and acceptable for veterans. Veterans with combat-related PTSD displayed significantly depressed HRV as compared to subjects without PTSD. When the veterans with PTSD were randomly assigned to receive either HRV biofeedback plus treatment as usual (TAU) or just TAU, the results indicated that HRV biofeedback significantly increased the HRV while reducing symptoms of PTSD. However, the TAU had no significant effect on either HRV or symptom reduction. A larger randomized control trial to validate these findings appears warranted.

Keywords Heart rate variability · Posttraumatic stress disorder

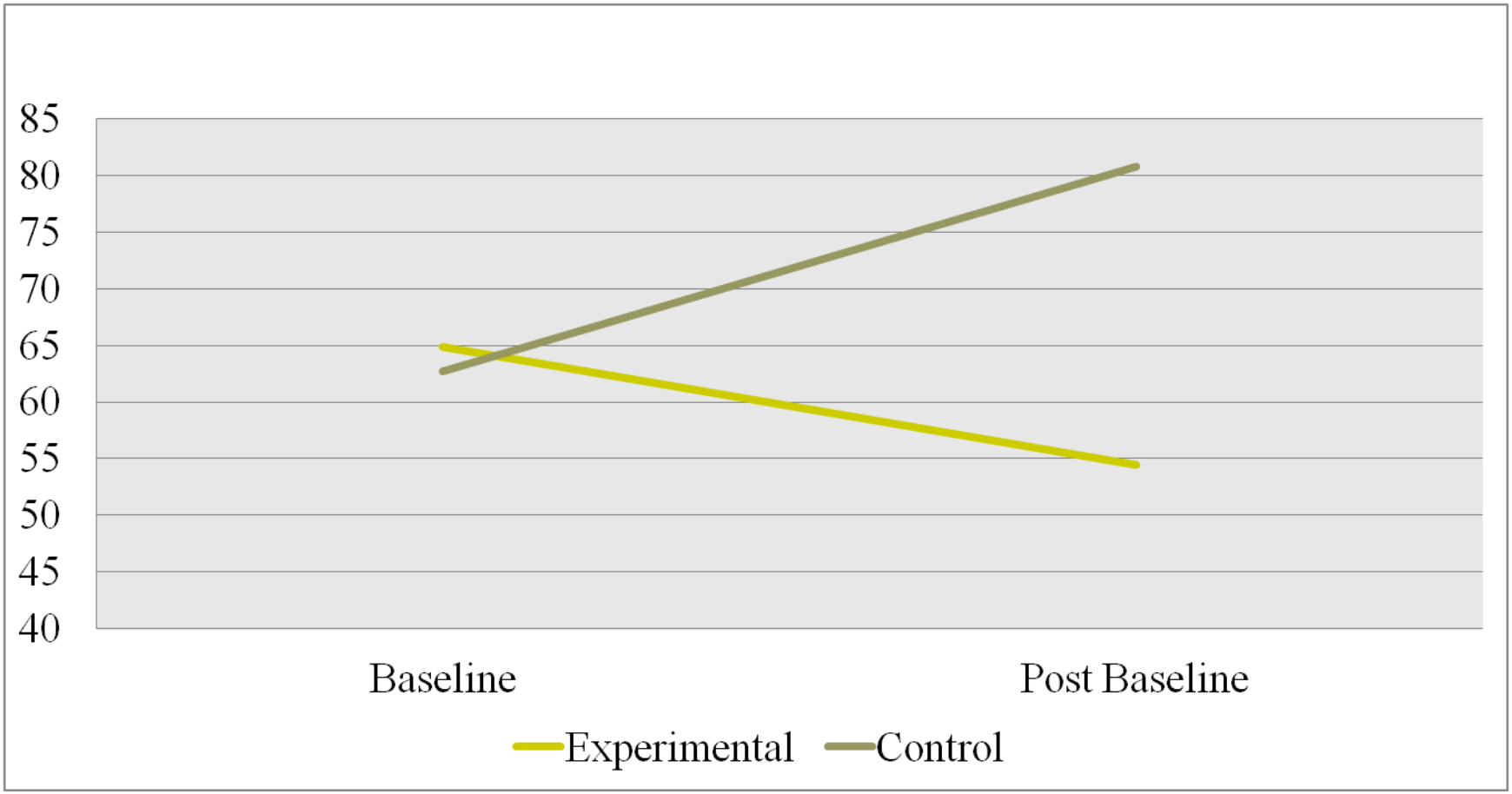
Introduction

Post Traumatic Stress Disorder (PTSD) is an anxiety disorder resulting from exposure to a traumatic event in which both of the following occurred: (1) the person experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of the self or others; and (2) the person's response involved intense fear, helplessness or horror. In addition to exposure, the diagnosis according to

G. Tan · L. Farmer · R. J. Sutherland

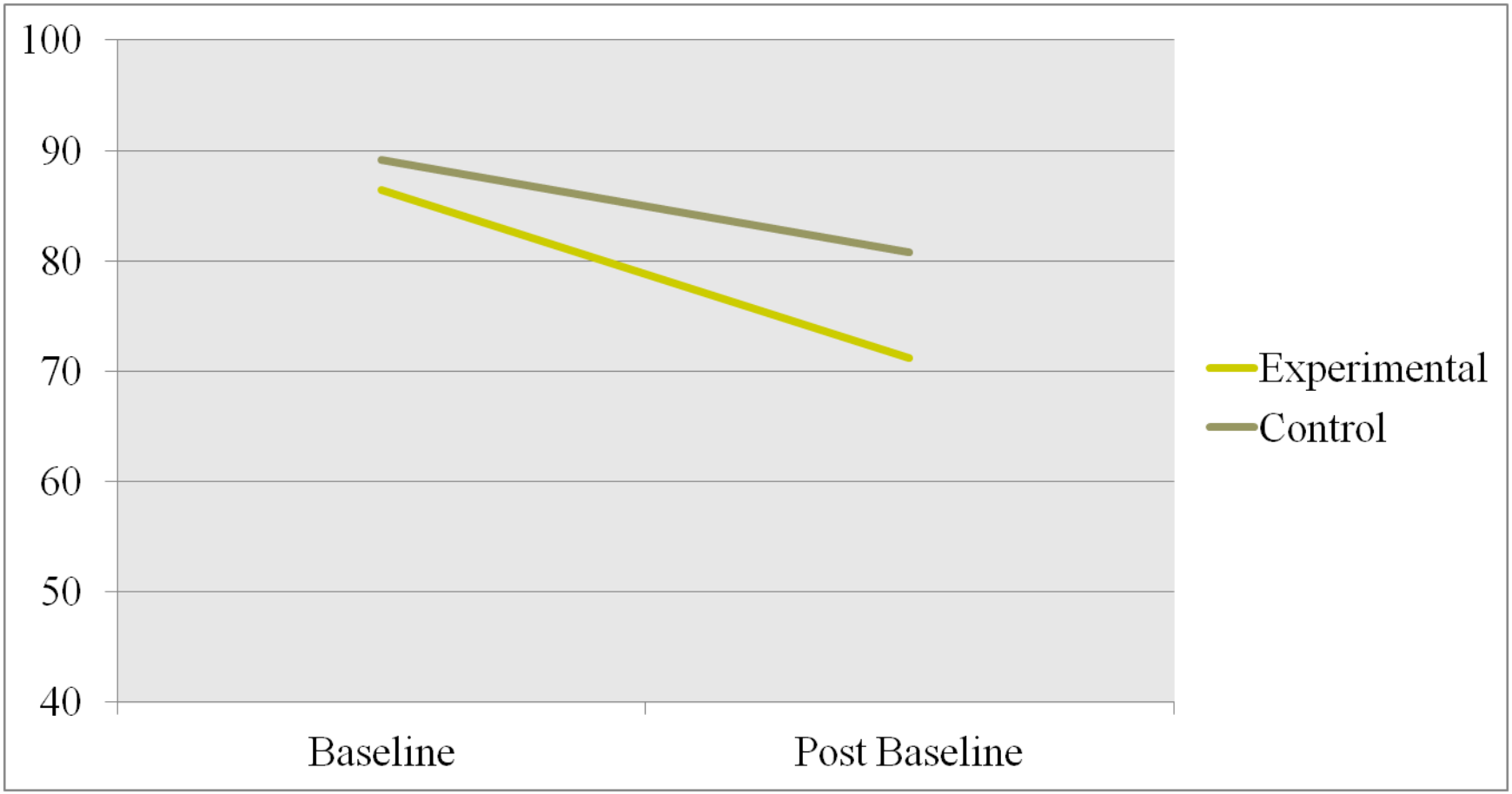
CAPS scores across time by group

Tan, Dao, Farmer, Sutherland, & Gevirtz (2011)



PCL-S scores across time by group

Tan, Dao, Farmer, Sutherland, & Gevirtz (2011)



SPECIAL REPORT

Cognitive Behavioral Therapy with Heart Rate Variability Biofeedback for Adults with Persistent Noncombat-Related Posttraumatic Stress Disorder

Shawn R Criswell, MA, PhD, LPC; Richard Sherman, MS, PhD; Stanley Krippner, MS, PhD

Perm J 2018;22:17-207

E-pub: 09/27/2018

https://doi.org/10.7812/TPP/17-207

ABSTRACT

Objective: To test the effectiveness of a mental health therapy designed to reduce noncombat-related persistent posttraumatic stress disorder (PTSD) symptoms in 30 adult outpatients with a diagnosis of PTSD. The individual treatment offered modules to address PTSD nightmare distress, dissociation, general core skills, alterations in arousal and reactivity, avoidance, intrusion, and negative alternations in cognitions and mood. The therapeutic approach centered on cognitive behavioral therapy and heart rate variability biofeedback.

Methods: The study had 2 components: The quality improvement project that performed the treatment within a standard care environment, and a retrospective medical chart review process that analyzed the results. The Clinician-Administered PTSD Scale for the *Diagnostic and Statistical Manual, Fifth Edition*, was used to confirm the initial PTSD diagnosis and was the primary measure used to monitor change in the diagnosis following treatment.

Results: None of the patients who completed the PTSD treatment met criteria for a PTSD diagnosis in the posttreatment assessment. A 1-sample test of proportions, with a 95% confidence interval and a significance level of $p < 0.05$, showed $p = 0.0008$, and that the proportion of patients who would not have PTSD if the study was repeated would be 86.77% to 100.00%. The treatment dropout rate was 13% (4 patients).

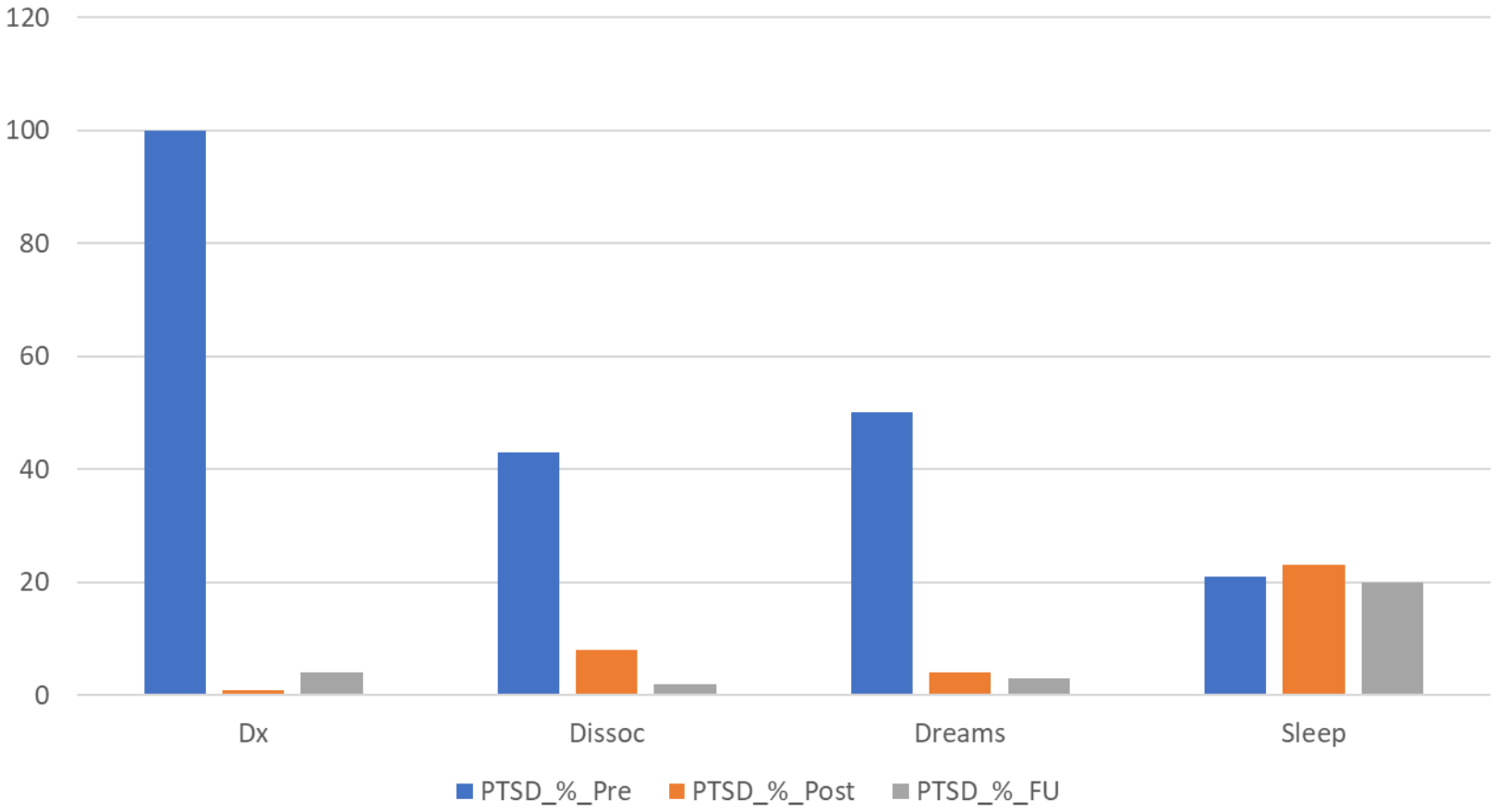
Conclusion: The study findings suggest that this intervention is an effective treatment for helping adult patients, including those with a history of childhood abuse, remit their PTSD diagnosis.

be related to a more complex picture.[9-12] Having treatments to efficiently and effectively address the suffering and costs of PTSD is of great importance.

The objective of this study was to examine the effectiveness of a PTSD treatment that was designed to help clinicians incorporate the important lessons gained from research with the unique needs of individual patients, all within the context of a fast-paced, real-world practice. Because this study took place in a setting where it was not possible to have a control group, it was important to select patients who were not likely to have their condition change simply owing to the passing of time. In their epidemiology study, Kessler et al[1] report that most people who have been through a traumatizing event have their symptoms disappear within months, but if those symptoms persist for a year, people are less likely to remit from their PTSD diagnosis. In our study, all of the patients had PTSD symptoms for more than a year, with 29 of 30 dealing with those symptoms for more than 5 years. The intention of this study was to create a flexible protocol that could be used by a range of licensed mental health clinicians without prolonged additional training and supervision and still be effective with patients with co-occurring issues and other complexities, such as early age of exposure to traumatic events and a persistence of PTSD symptoms over time. This article describes the procedure of the study in extended detail to enable clinicians to replicate and more fully understand the treatment.

There is no one specific standard to determine whether mental health treatment for PTSD is effective. One credible way to

Percent of Patients Meeting CAPS criteria Pre, Post, and Follow-up



CONCLUSION This study found that the PTSD treatment provided using the protocol to treat 30 adult outpatients was effective in remitting the PTSD diagnosis for those patients who completed the program. The 3-month follow-up data showed that only 1 patient returned to a PTSD diagnosis, but that patient just barely met the criteria. Each patient left our study with many personalized written materials from the skills acquisition portions of the study. We hope that these materials, along with the skills, resources, and experiences they gained during the study will help patients who completed the study to maintain long term remission of their PTSD diagnosis.

Schuman, D. L., Killian, M. O., Butler, B., & Elliott, K. M. (2017, June). Pilot Study: Effects of a Single Session Heart Rate Variability Biofeedback Intervention on Posttraumatic Stress Symptoms in Veterans. In *APPLIED PSYCHOPHYSIOLOGY AND BIOFEEDBACK* (Vol. 42, No. 2, pp. 153-153).

One group (n = 6) received training in diaphragmatic breathing and heart rate variability biofeedback, augmented by twice-daily practice using a smart phone and breath pacing app. A second group (n = 6) received only a single session of diaphragmatic breathing training. After 4 weeks, participants in the second group (n = 5) received the full intervention. HRVB significantly reduced global posttraumatic stress symptoms, whereas diaphragmatic breathing alone did not. Further, veterans found the approach acceptable, as demonstrated by a high degree of adherence with prescribed practice, low study attrition, and continued use over time. Results of this pilot study warrant further refinement of a protocol utilizing mHealth to treat posttraumatic stress symptoms in military populations.

Lee, J., Kim, J. K., & Wachholtz, A. (2015). The benefit of heart rate variability biofeedback and relaxation training in reducing trait anxiety. *Han'guk Simni Hakhoe chi. Kon'gang= The Korean journal of health psychology*, *20*(2), 391.

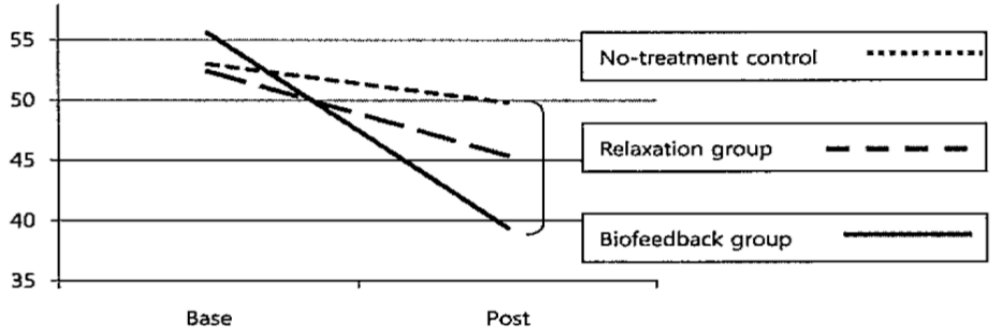
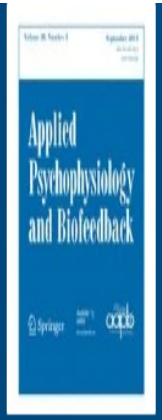


Figure 1.
Trait Anxiety change score across group
Note: Purple line shows the point where the significant difference was found (i.e., the post-treatment scores between no-treatment control group and biofeedback group). Base = baseline anxiety score, Post = post - treatment anxiety score

The Effects of Respiratory Sinus Arrhythmia Biofeedback on Heart Rate Variability and Posttraumatic Stress Disorder Symptoms: A Pilot Study



Published: 25 April 2009

Volume 34, pages 135–143, (2009) Cite this article

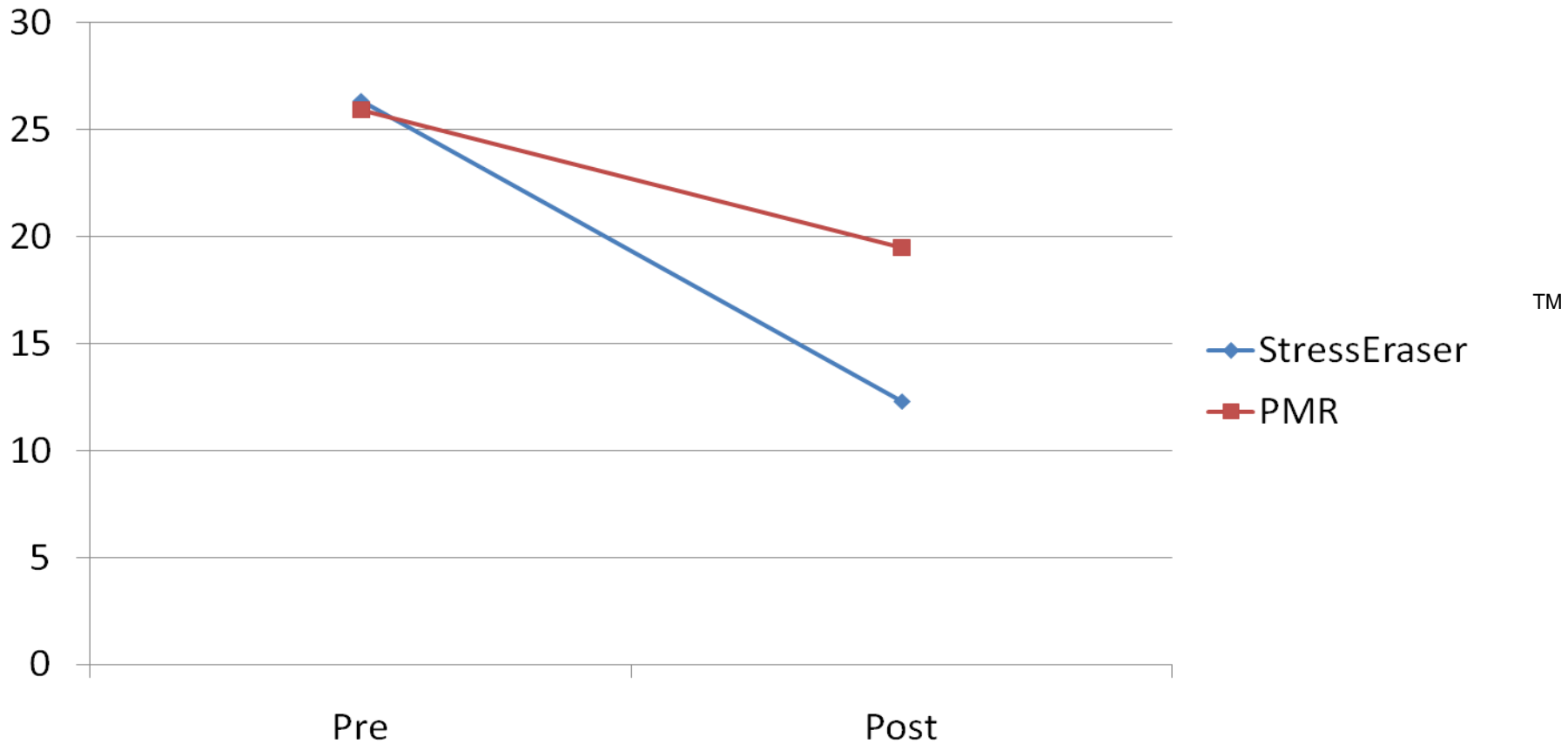
Applied Psychophysiology an
Biofeedback

Aims and scope →

Submit manuscript →

Terri L. Zucker ✉, Kristin W. Samuelson, Frederick Muench, Melanie A. Greenberg & Richard N. Gevirtz

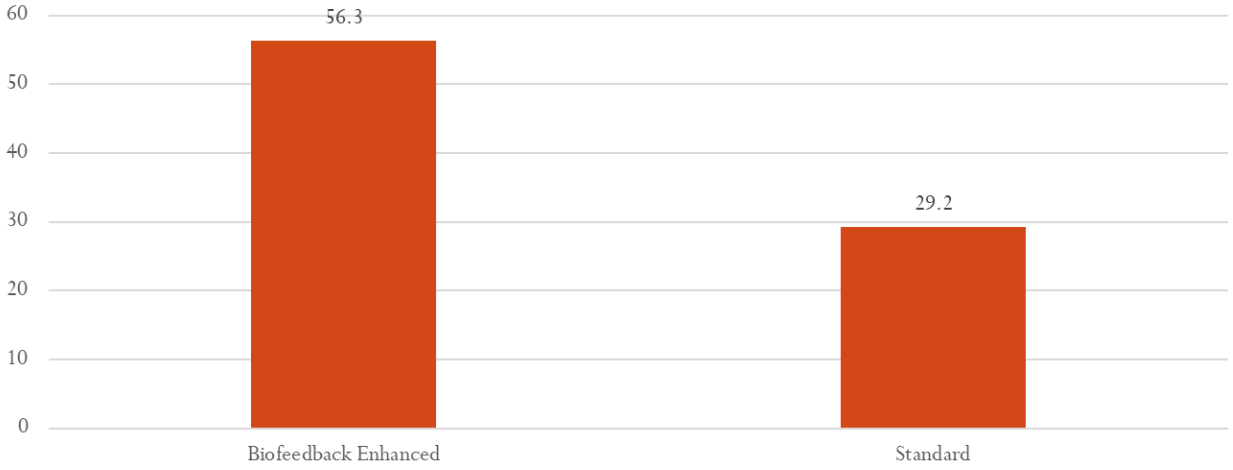
BDI-II Score Pre to Post for the two Groups
(Zucker et al., 2008)



TM

Percent Reporting Significant Clinical Improvement

Marcos Economides , Paul Lehrer , Kristian Ranta , Albert Nazander , Outi Hilgert , Anu Raevuori , Richard Gevirtz , Inna Khazan , & Valerie L. Forman-Hoffman, (2020). Feasibility and efficacy of the addition of heart rate variability biofeedback to a remote digital health intervention for depression. *Applied Psychophysiology & Biofeedback*



Our findings suggest that adding HRV-B to an app-based, smartphone-delivered, remote intervention for depression is feasible and may enhance treatment outcomes.

Original Article
https://doi.org/10.9758/cpn.2019.17.2.222 pISSN 1738-1088 / eISSN 2093-4327
Clinical Psychopharmacology and Neuroscience 2019;17(2):222-232

Heart Rate Variability Biofeedback Increased Autonomic Activation and Improved Symptoms of Depression and Insomnia among Patients with Major Depression Disorder

I-Mei Lin[1,2,*], Sheng-Yu Fan[3,*], Cheng-Fang Yen[4,5], Yi-Chun Yeh[4,5], Tze-Chun Tang[4,6], Mei-Feng Huang[4,5], Tai-Ling Liu[4,5], Peng-Wei Wang[4,5], Huang-Chi Lin[4,5], Hsin-Yi Tsai[1,4], Yu-Che Tsai[1]

[1]Department of Psychology, College of Humanities and Social Sciences, Kaohsiung Medical University, Departments of [2]Medical Research and [4]Psychiatry, Kaohsiung Medical University Hospital, Kaohsiung City, [3]Institute of Gerontology, College of Medicine, National Cheng Kung University, Tainan City, [5]Graduate Institute of Medicine and Department of Psychiatry, School of Medicine, College of Medicine, Kaohsiung Medical University, [6]Dr. Tang's Psychiatric Clinic and Mind Center, Kaohsiung City, Taiwan

Objective: Autonomic imbalance is considered a psychopathological mechanism underlying major depressive disorder (MDD). Heart rate variability (HRV) is an index for autonomic activation. Poor sleep quality is common among patients with MDD. HRV biofeedback (BF) has been used for regulating autonomic balance among patients with physical illness and mental disorders. The purpose of present study was to examine the effects of HRV-BF on depressive symptoms, sleep quality, pre-sleep arousal, and HRV indices, in patients with MDD and insomnia.

Methods: In this case-controlled study, patients with MDD and Pittsburgh Sleep Quality Index (PSQI) score higher than 6 were recruited. The HRV-BF group received weekly 60-minute protocol for 6 weeks, and the control group who have matched the age and sex received medical care only. All participants were assessed on Beck Depression Inventory-II, Back Anxiety Inventory, PSQI, and Pre-Sleep Arousal Scale. Breathing rates and electrocardiography were also performed under resting state at pre-testing, and post-testing conditions and for the HRV-BF group, also at 1-month follow-up.

Results: In the HRV-BF group, symptoms of depression and anxiety, sleep quality, and pre-sleep arousal were significantly improved, and increased HRV indices, compared with the control group. Moreover, in the HRV-BF group, significantly improved symptoms of depression and anxiety, decreased breathing rates, and increased HRV indices were detected at post-testing and at 1-month follow-up, compared with pre-testing values.

Conclusion: This study confirmed that HRV-BF is a useful psychosocial intervention for improving autonomic balance, baroreflex, and symptoms of depression and insomnia in MDD patients.

KEY WORDS: Heart rate variability biofeedback; Major depressive disorder; Insomnia.

INTRODUCTION

The World Health Organization estimates that depressive disorders by 2030.[1] Insomnia and poor sleep quality are common in patients with the major depressive disorder (MDD). According to the Sequenced Treatment Alterna-

Lin, I. M., Fan, S. Y., Yen, C. F., Yeh, Y. C., Tang, T. C., Huang, M. F., . . . Tsai, Y. C. (2019). Heart Rate Variability Biofeedback Increased Autonomic Activation and Improved Symptoms of Depression and Insomnia among Patients with Major Depression Disorder. Clin Psychopharmacol Neurosci, 17(2), 222-232. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6478078/

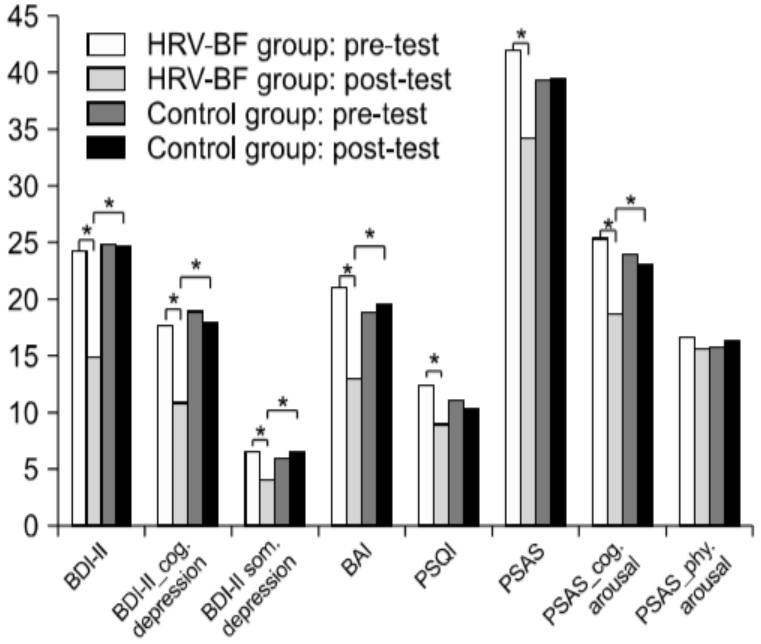


Fig. 1. The psychological questionnaires at pre- and post-tests for the heart rate variability biofeedback (HRV-BF) and control groups. BDI-II, Beck Depression Inventory-II; cog., cognitive; som., somatic; BAI, Beck Anxiety Inventory; PSQI, Pittsburgh Sleep Quality Index; PSAS, Pre-Sleep Arousal Scale; phy., physical. *p<0.05.

The HRV group improved significantly on: Depression, Anxiety, and Sleep, The control group (medical care only) produced no significant changes for any measure.

pleted pre-testing and post-testing, along with a 1-month

Post-training during HRV-BF Sessions

Conclusions

- I have tried to make the case that:
  - Current treatments for Anxiety/Depression leave much to be desired.
  - There is solid evidence for autonomic involvement in these disorders
  - Adding HRVB to empirically based talk therapies makes a meaningful difference
  - But the above argument is still poorly recognized and its up to us to get this message out to our colleagues in the mental health community and the public in general.

Moderate to Severe Anxiety

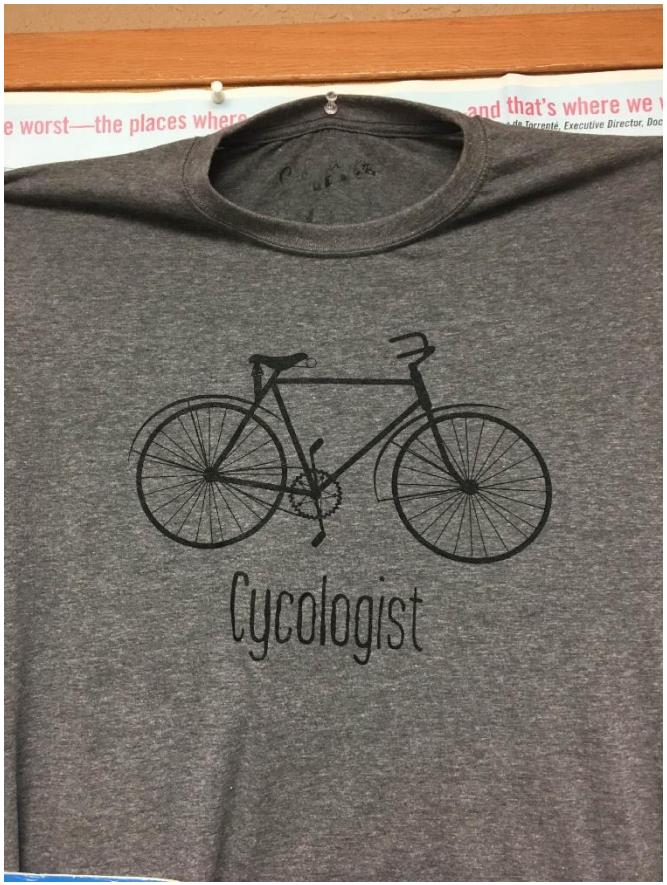
What are the signs of anxiety?

Anxiety affects people differently, and every anxiety disorder has its own signs and symptoms. But for most people, anxiety involves:

- Anxious thoughts that are hard to control — like a constant worry that something bad might happen
- Physical symptoms — like a pounding or fast heartbeat, aches and pains with no obvious cause, or trouble sleeping
- Behavior changes — like avoiding everyday activities that you used to do.
- Ask your doctor if HRV Biofeedback is right for you?

- List of possible side effects: .....None? 😊 😊 😊


Speaking of anxiety, where
the *&#$ are they taking me?
Luchon-Superbagnères, Pyrenees,
7415 ft.


e worst—the places where
and that's where we
Cycologist