

Comparative Effectiveness of
Therapeutic Riding &
Stress Management Techniques
on Heart Rate Variability & Salivary Cortisol
in Adolescents on the Autism Spectrum

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Outcomes



- ❖ Describe the research on therapeutic riding and stress
- ❖ Explain the study methods
- ❖ List aspects of the groundwork, therapeutic riding, and HeartMath mindfulness protocol
- ❖ Describe the findings and conclusions of the study

Background

- ❖ 1 in 59 children with Autism Spectrum Disorder (CDC, 2018)
- ❖ Core Symptoms: communication deficits, sensory, distress reactions (APA DSMV, 2013)
- ❖ Adolescents with ASD experience stress and lack of coping skills (Plessow, Fischer, Kirschbaum & Goschke, 2011).
- ❖ Literature suggests people with ASD who participate in animal-assisted interventions...
 - ❖ Experience improvements in social interaction, positive emotions, stress, communication, and motor skills (Peters & Wood, 2017).

Background

- ❖ When compared to peers without ASD in the community...
 - ❖ Young adults with ASD have significantly higher perceived stress and stressful life events (Bishop-Fitzpatrick et al., [2017](#); Bitsika & Sharpley, [2015](#))
 - ❖ Poorer ability to cope with stress in everyday life (Hir-vikoski & Blomqvist, [2015](#); Tomarken et al., 2015).

Research Question

What is the comparative effectiveness of stress management mindfulness techniques (HeartMath) and therapeutic riding on stress levels of adolescents with ASD?

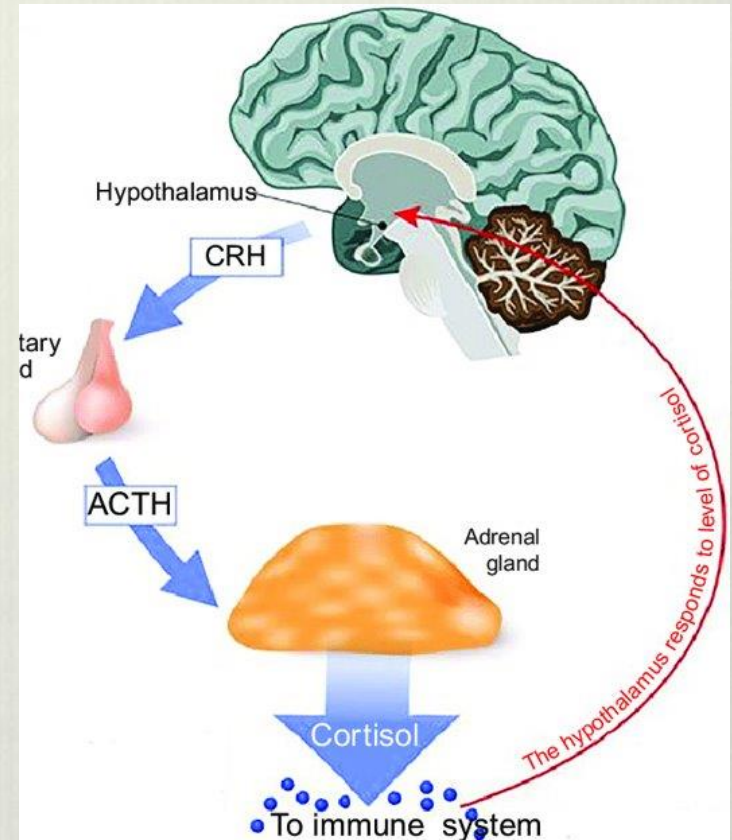


Significance

- ❖ No other study has compared therapeutic riding to mindfulness to control in the same individuals with autism in regard to cortisol and HRV (stress).
- ❖ Comparing youth with ASD to themselves allows for more validity.
- ❖ Self-report measures of stress may not be as valid as biometric measures (cortisol, coherence) for this population.

Why Cortisol?

- ❖ “Stress hormone” produced by adrenal glands
 - ❖ Released in response to physical or psychological threat
- ❖ Follows diurnal rhythm
 - ❖ Sharp increase 30 minutes after awakening (Pruessner et al., 1997)
 - ❖ Peaks in morning and declines throughout the day



Why Cortisol?

Youth with ASD may have...

- ❖ Abnormal cortisol variations within diurnal rhythm (Lam et al., 2006)
 - ❖ Abnormally elevated evening cortisol (Muscatello and Corbett, 2018)
- ❖ Elevated cortisol in response to social interaction (Corbett et al. 2012)



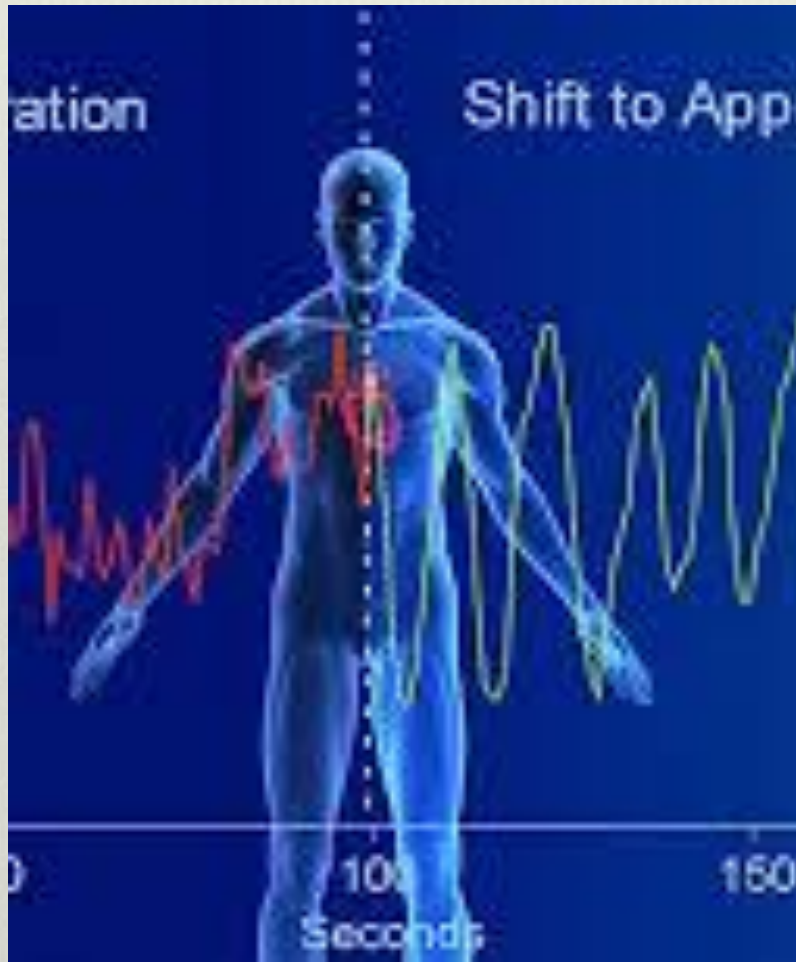
Why HeartMath?

- ❖ HeartMath is a method of mindfulness to promote coherence
- ❖ HeartMath Institute uses emwave pro sensors to measure heart rate variability



HeartMath Institute
<https://www.heartmath.org/>

Methodology



Crossover Design



Random assignment to groups

Demographics

Table 1 Participants' age (at start of study), gender, and ethnicity								
Age (years)	Male N	% of total males	Female N	% of total females	% of total participants	% Non-Hispanic black	% Hispanic	% Non-Hispanic white
12–15	7	25.93	2	28.57	7.40	11.11	11.11	77.78
16–18	7	25.93	4	57.14	14.82	0	0	100
19–21	6	22.22	1	14.29	3.70	0	0	100
12–21	20	74.08	7	100	25.92	3.7	3.7	92.6

Data Collection in Each Phase



Baseline



Before and
After Each
Session
10 weeks



Follow-
Up

Sampling (Humans)

Baseline and Follow-Up

Week before and week following

10-week intervention period

- Social Responsiveness Scale (SRS-2)
- Stress Survey for Persons with Autism
- Perceived Stress Scale (Cohen)
- Two consecutive days of saliva sampling
 - Waking
 - 30 minutes post waking
 - Scheduled time of intervention
 - Within 30 minutes of bed time

Pre and Post

Immediately prior to and immediately following each intervention session

- Saliva sampling
- Coherence (HRV) during session

Baseline

Pre and post (10x)

Follow-Up

Intervention

Sampling (Humans)

Baseline and Follow-Up

Week before and week following 10-week control period

- Social Responsiveness Scale
- Stress Survey for Persons with Autism
- Perceived Stress Scale
- **Two consecutive days of saliva sampling**
 - Waking
 - 30 minutes post waking
 - Scheduled time of intervention
 - Within 30 minutes of bed time

Baseline

Follow-Up

Control

Sampling (Horses)

Control

During lesson time on a day horse is not scheduled for lessons

-Saliva sampling

Pre and Post

Immediately prior to and immediately following each riding lesson

-Saliva sampling

Baseline

Pre and post (10x)

Follow Up

Therapeutic Riding
Lessons

Saliva Collection

- ❖ Horses: Oral swab under tongue for 60 seconds
- ❖ Humans: Saliva collection device or oral swab if unable to use collection device
- ❖ Participants and horses refrained from eating within 60 minutes prior to sampling times
- ❖ Swabs and collection devices from Salimetrics



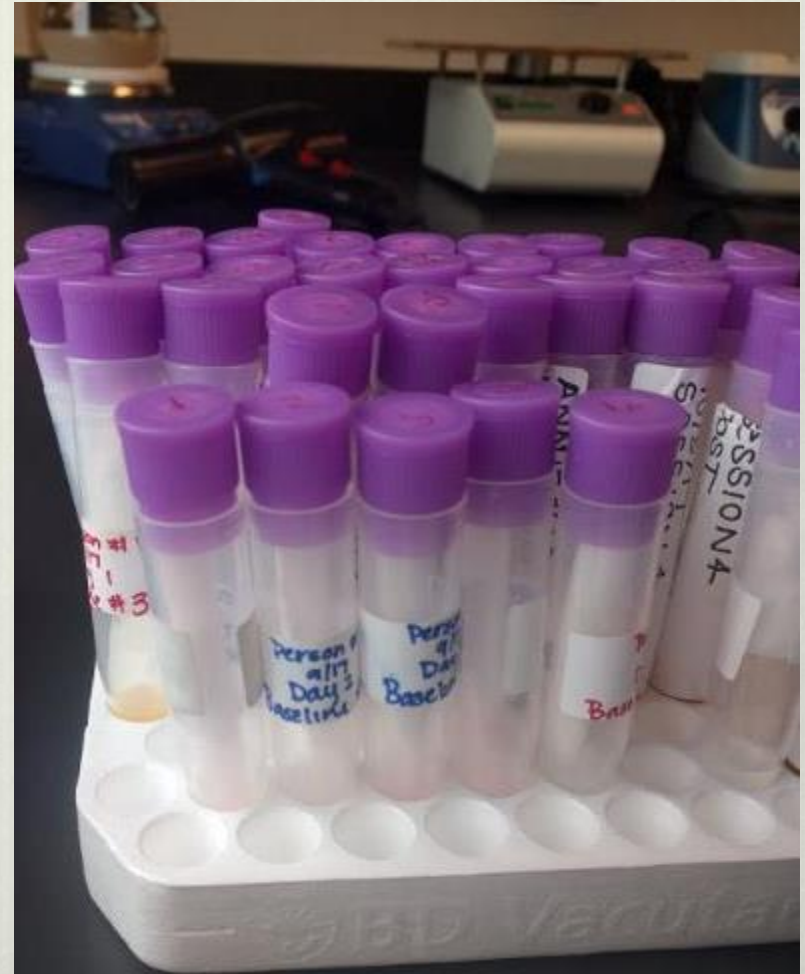
Salimetrics.com



Salimetrics.com

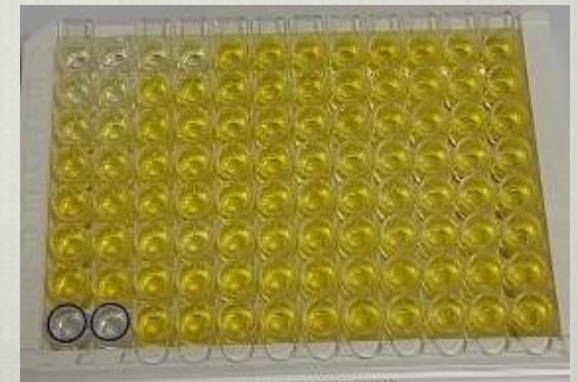
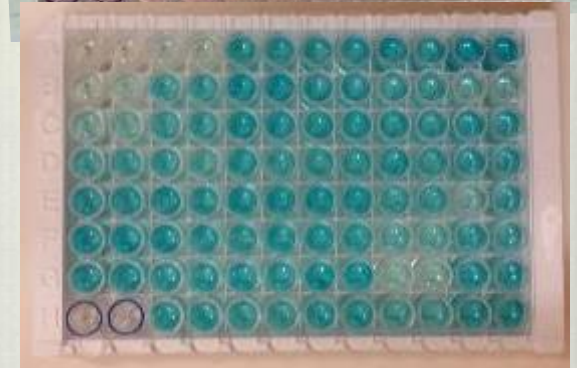
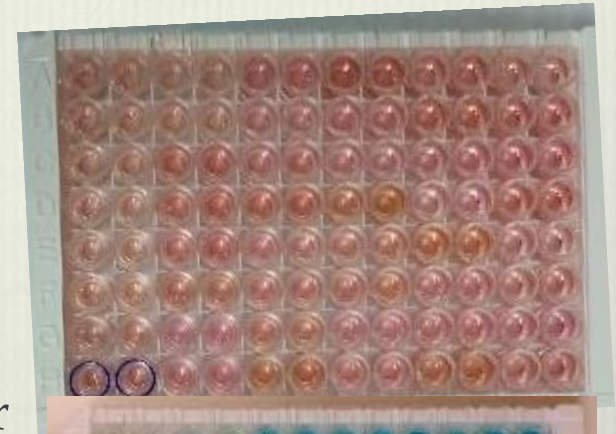
Salivary Cortisol Measurement

- ❖ Saliva stored at -20°C
- ❖ Saliva analyzed using Enzyme Linked Immunosorbent Assay (ELISA) kits (Salimetrics)



Salivary Cortisol Measurement

- ❖ 25 ul of standards, samples, or controls added to wells, tested in duplicate
- ❖ Enzyme conjugate (1:1600 dilution) and assay diluent (200 ul) added to each well
- ❖ Rocked for 5 minutes (500 rpm) and incubated for 1 hour at room temperature
- ❖ Washed 4 x with wash buffer
- ❖ 200 ul tetramethylbenzidine (TMB) substrate solution added to each well
- ❖ Rocked for 5 minutes (500 rpm) and incubated for 25 minutes in darkness
- ❖ 50 ul stop solution added, rocked for 3 minutes (500 rpm)



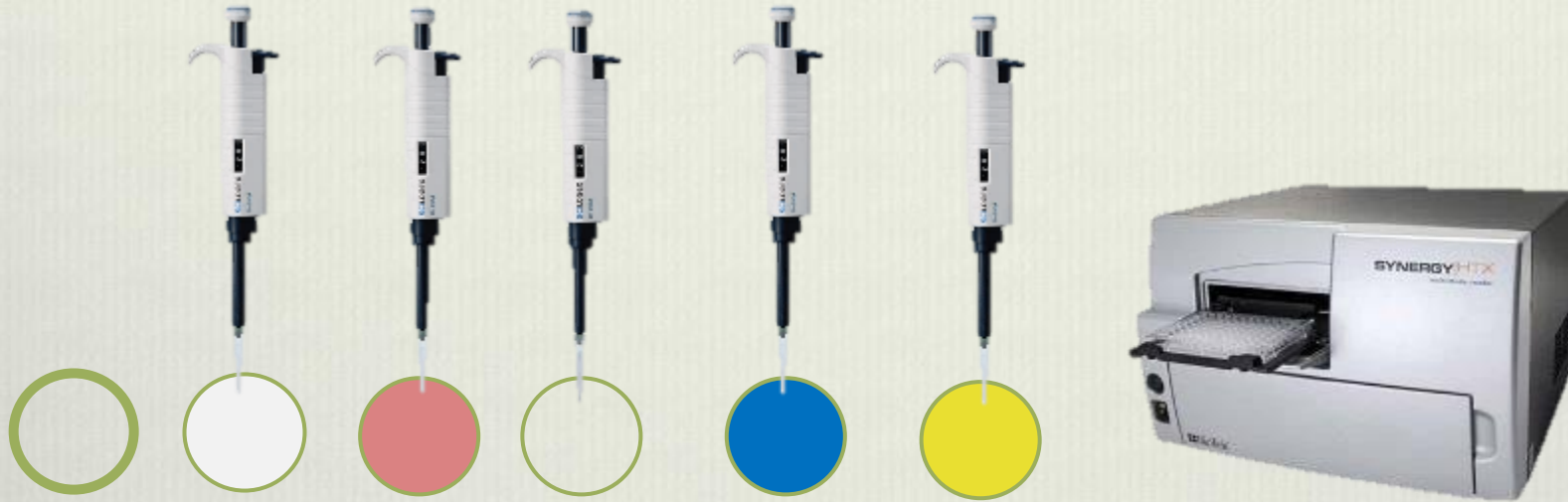
Salivary Cortisol Measurement



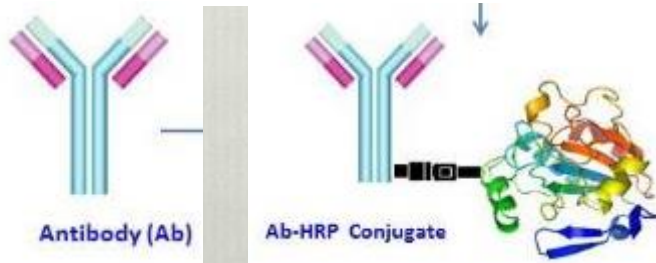
- ❖ Read with plate reader (Emax Plus) at 450 nm with 492 nm correction
- ❖ Results in ug cortisol/dL saliva



Competitive ELISA: How it works



Microplate reader measures how much light passes through each well. Darker wells=less salivary cortisol bound.





Coherence (HRV) Data Collection

Protocols

- Therapeutic riding facilitated by Certified Therapeutic Recreation Specialist (CTRS) who is PATH Registered Instructor
- Facilitated by CTRS who has HeartMath specialist certification
- Consistent over 3 phases
 - ⑩ instructor
 - ⑩ session content
 - ⑩ session times



GROUNDWORK PROTOCOL

- 1 Basic Grooming
- 2 Halter cleaning, Comb out mane and tail
- 3 Cold weather bath
- 4 Spray Condition, show grooming
- 5 Clipping, make a horse pizza
- 6 Quick bath with partners
- 7 Scavenger hunt game
- 8 Full bath, shedding
- 9 Make your own fly spray
- 10 Horse Painting

THERAPEUTIC RIDING PROTOCOL

- 1 Body posture and alignment, halting, Walk-halt-walk-transitions
- 2 Basic steering: weaving cones using direct rein, 2 pt. at the halt, Back up.
- 3 Trotting, basic steering: weaving cones using neck rein, Walk 2pt over poles
- 4 Walk-trot-walk transitions, changes in direction, Steering: wide spread cones using direct reining and neck reining
- 5 2 pt. at trot, trotting through corners, walk through obstacle course
- 6 2 pt. walk, steering, walk/trot large pattern, figure 8 serpentine, steering
- 7 No stirrup riding (walking/steering), Trot 20 meter circle
- 8 Independence at the trot, walking lateral movements, leg yield
- 9 Independent riding skills; Collected/extended trot
- 10 Independent riding skills, mock horse show

HEART MATH PROTOCOL

1 Heart Focused Breathing

2 Quick Coherence Technique 1

3 Quick Coherence Technique II

4 Identifying Positive or Negative Emotions

5 Inner Ease Technique

6 Inner Ease Technique II

7 Freeze Frame Technique

8 Inner Ease Technique III

9 Heart Lock In

10 Review of all Techniques

Statistics: Surveys and Coherence

- ❖ Normality of the scale variables was checked
- ❖ Compare Baseline and follow-up for each intervention and control for each computed scales of the self-report of stress survey schedule (SSS) for Autism (8 scales), Cohen's Perceived Stress Scale (one total score scale), and the Parent-report SRS-2 (5 scales and 1 total score) using two-way repeated measures ANOVA.
- ❖ Dependent variable was self-reported stress or parent-reported social responsiveness and the within-subjects' factors were treatment (THR, HM, and control), time (baseline and follow-up).
- ❖ Separate one-way ANOVAs were conducted to confirm main effect for interaction.
- ❖ Paired sample t-tests were used to compare the baseline and follow-up for each phase (THR, HM, Control) for each scale.
- ❖ Dependent t-tests were used to compare coherence levels (heart-rate variability) for HM and THR, both for the overall mean and the means for each session

Statistics: Human Cortisol

- ❖ Normality assumption checked, log10 transformed
- ❖ Three-way repeated measures ANOVA
 - ❖ Dependent variable: participant cortisol concentration
 - ❖ Within subjects factors: Treatment (THR, HM, control), Time (baseline, follow-up), Diurnal Sampling Time (awakening, 30-min post-awakening, session time, 30-min pre-bedtime)
 - ❖ Post-hoc tests with Bonferroni corrections
- ❖ Two-way repeated measures ANOVA
 - ❖ Dependent variable: participant CARi
 - ❖ Awakening – 30 min post awakening minus awakening
 - ❖ Within subjects factors: Time (baseline, follow-up), Treatment (THR, HM, control)
 - ❖ Post-hoc tests with Bonferroni corrections
- ❖ Wilcoxon signed rank test
 - ❖ Individual pre vs. post session comparisons

Equine Study Methods & Statistics

- ❖ 10 horses, various breeds, 16-33 years of age (mean=24 years)
- ❖ Saliva collected at 4:00 pm and 4:30 pm.
 - ❖ No access to hay or concentrates for 60 minutes prior
 - ❖ No riding or other activities prior to “pre” sample collection.
- ❖ **Therapeutic Riding:** Two sessions of nine 30-minute weekly lessons (18 total lessons)
- ❖ **Grooming:** Groomed for 30 minutes by volunteers. Performed twice within a 4-day span.
- ❖ **Control:** Remained stalled for 30 minutes. Performed twice within a 2-day span.
- ❖ **Statistics:** Pre-post values. Checked normality with Shapiro-Wilk. One-way repeated measures ANOVA (control, grooming, riding). Individual session pre-post compared with control using paired t-tests.

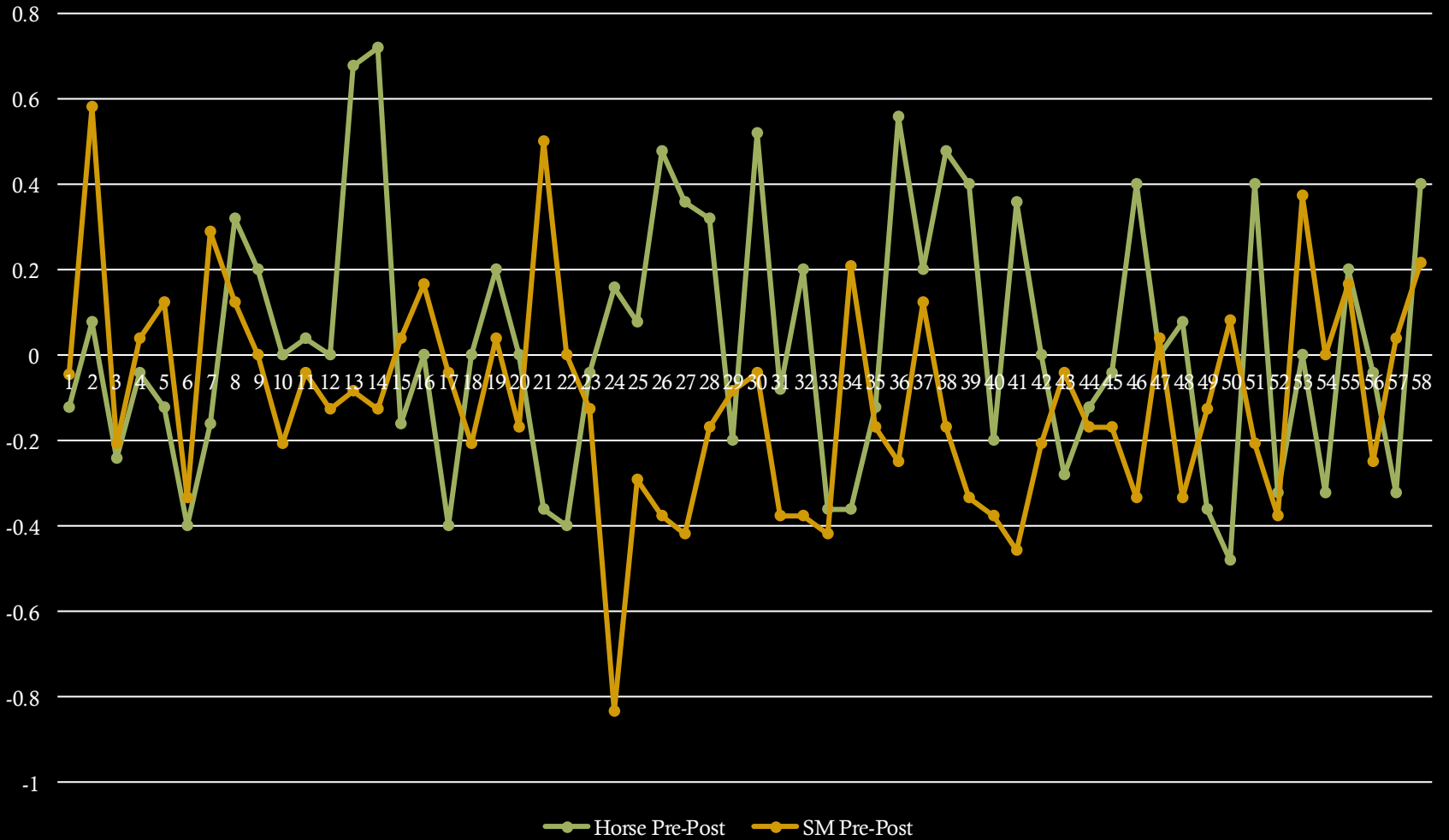


Results



Mean Difference (Pre-Post) for Therapeutic Riding, and Stress Management for the Self-Report Measure of Stress

Self-Reported Stress Level (Scale 1-5)



$t = 2.5766, df = 109.88, p\text{-value} = 0.0113$

Specific Items Therapeutic Riding

THR means > HeartMath means

- ❖ receiving a reprimand ($p=0.012$),
- ❖ receiving criticism ($p=0.022$),
- ❖ having something marked incorrectly ($p=0.044$),
- ❖ being unable to communicate needs ($p=0.038$),
- ❖ being able to assert oneself ($p=0.027$),
- ❖ participating in a group activity ($p = 0.039$),
- ❖ waiting for reinforcement ($p=0.039$), waiting for routine to begin ($p=0.025$).

THR means > Control means

- ❖ perception of stress in a group activity ($p=0.012$),
- ❖ having a change in staff, teacher, supervisor ($p=0.023$).



Specific Items

❖ HeartMath mean > control in "being prevented from carrying out a ritual" and "following a diet" ($p < .05$).

❖ Control mean > than THR mean with being prevented from carrying out a ritual ($p < .05$)

❖ Control mean > than HM in receiving a reprimand ($p=0.036$).



Parent report of SRS-2

No significant change occurred in any phase (THR, HM, Control)

No significant difference between THR, HM, and Control phases for overall parent-reported scales:

Awareness

Cognitive

Communication

Motivation

RRS

Total Score

Parent Report of SRS-2

Control phase

- ❖ “more fidgety in social situations” and difficulty relating to peers
- ❖ increase “doesn’t understand cause and effect”

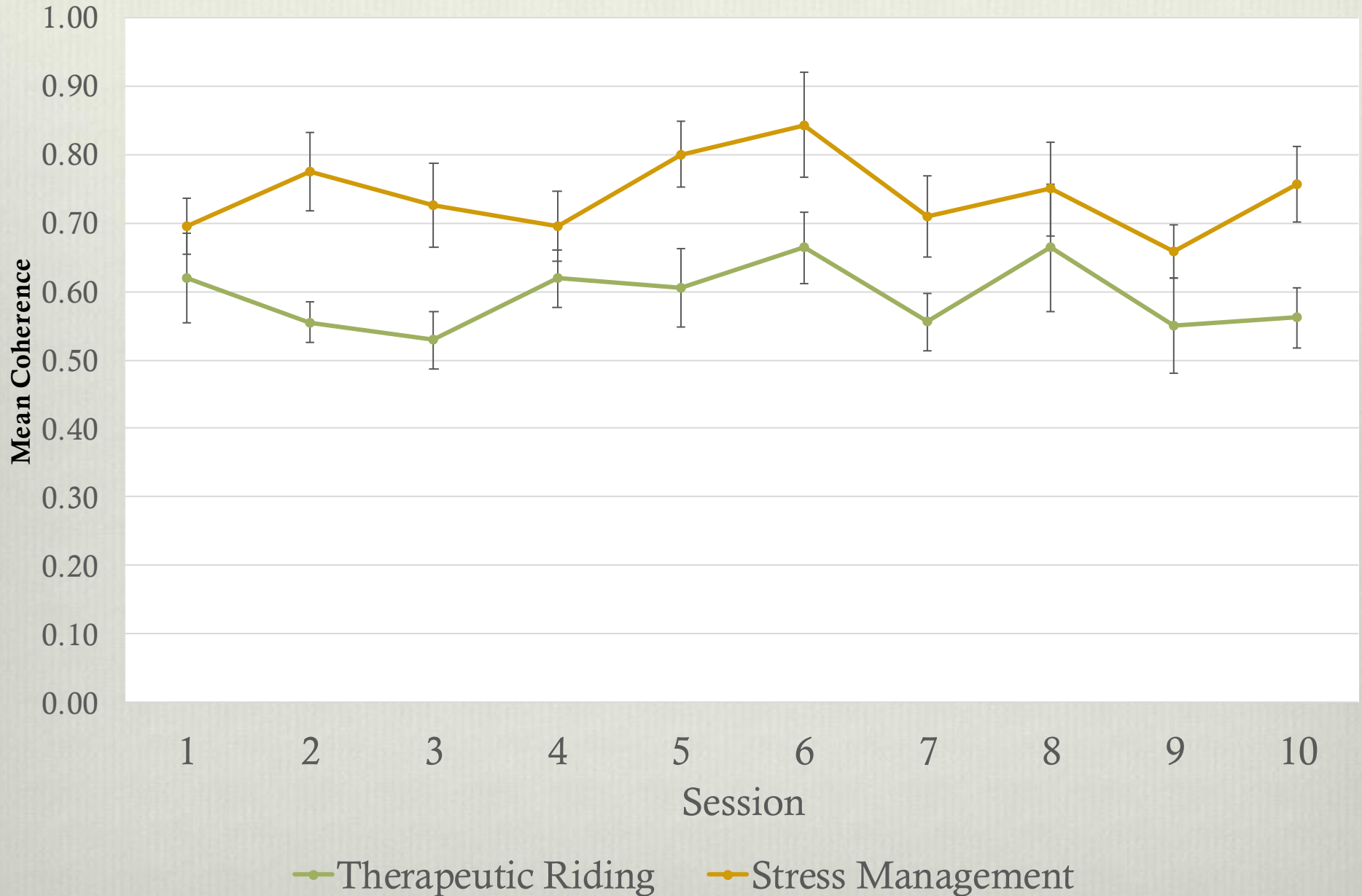
THR phase

- ❖ significantly improved ability to “recognize when something is unfair”
- ❖ decreased “avoidance of starting social interactions”

HM phase

- ❖ decrease in “behave in ways that are strange or bizarre”
- ❖ decrease in “difficulty in change in routine”
- ❖ decrease in “wandering aimlessly from one activity to another”

Heart Math Mean Coherence for Therapeutic Riding and Stress Management over 10 Sessions



Coherence Summary

- ❖ A comparison of the overall mean coherence values showed that HM mindfulness yielded a significant improvement in coherence levels when compared to THR
- ❖ Moreover, when individual sessions were compared, the mean of all participants' coherence values during sessions 2, 5, 7, 8, 9, and 10 was significantly higher for HM than THR.

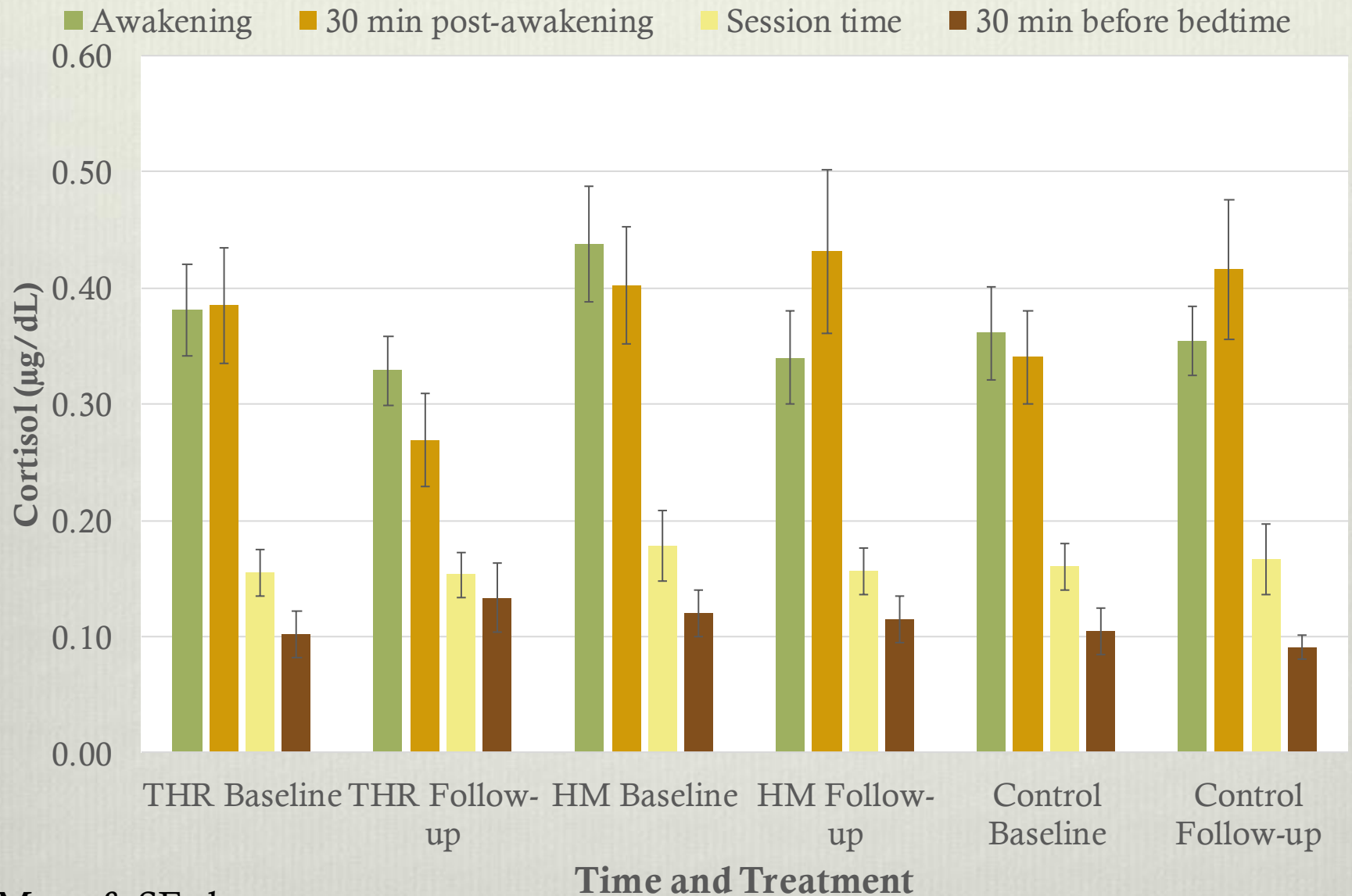
Human Cortisol Results: Baseline and Follow-Up

- ❖ Three-way repeated measures ANOVA
 - ❖ No statistically significant three-way or two-way interactions
- ❖ Diurnal sampling time of day: statistically significant main effect with large effect size ($F(3, 57) = 78, p < .001, \eta p^2 = .80$).
 - ❖ No statistical difference between awakening and 30-minutes post-awakening samples. All other sampling time of day comparisons $p < .001$
- ❖ Treatment: trend main effect with medium effect size ($F(1.4, 27) = 2.8, p = .093, \eta p^2 = .129$).
 - ❖ Post-hoc trend for significant difference between THR and SM ($p = .076$)

Human Cortisol Results: CARi

- ❖ Two-way repeated measures ANOVA
- ❖ No statistically significant interaction
- ❖ Time: statistically significant main effect with large effect size ($F(1, 19)=4.4$, $p = .049$, $\eta p^2=.189$)
 - ❖ Higher follow-up CARi values compared to baseline

Human Cortisol Results: Baseline & Follow-up



Mean & SE shown

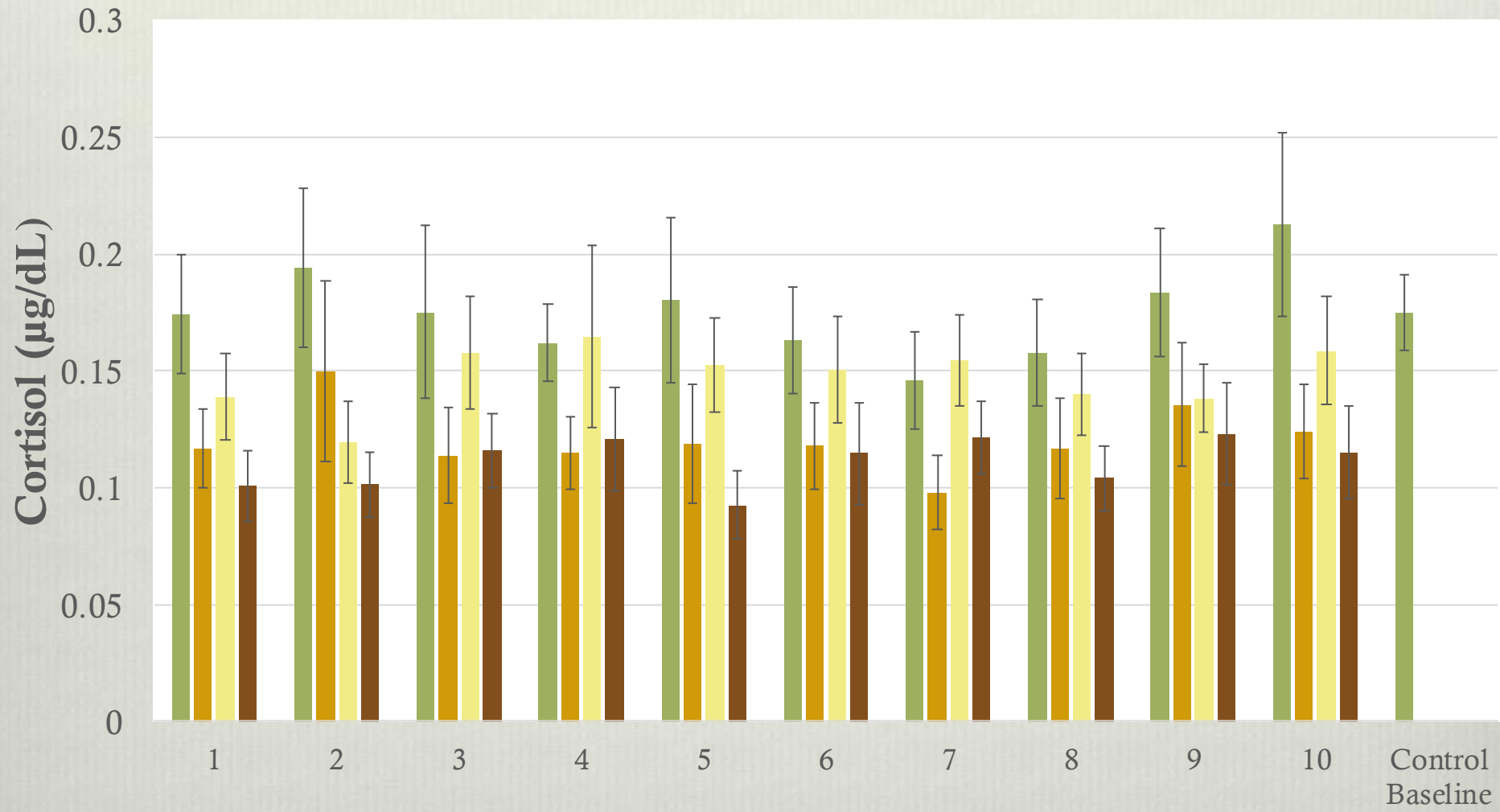
Human Cortisol Results: Individual Sessions

P<.05

- ❖ Individual sessions
 - ❖ Post median significantly lower than pre for all 10 THR sessions
 - ❖ Post median significantly lower than pre for 7 HM sessions (1, 3, 5, 6, 7, 8, 9, 10)
- ❖ Overall- sessions 1-10 combined median
 - ❖ No difference between overall pre HM and pre THR
 - ❖ No difference between overall post HM and post THR
 - ❖ Post significantly lower than pre for both HM and THR
- ❖ Control Baseline
 - ❖ No difference between control baseline and pre THR median
 - ❖ Overall pre HM, post HM, and post THR significantly lower than control baseline median

Human Cortisol Results: Individual Sessions

THR Pre THR Post HM Pre HM Post



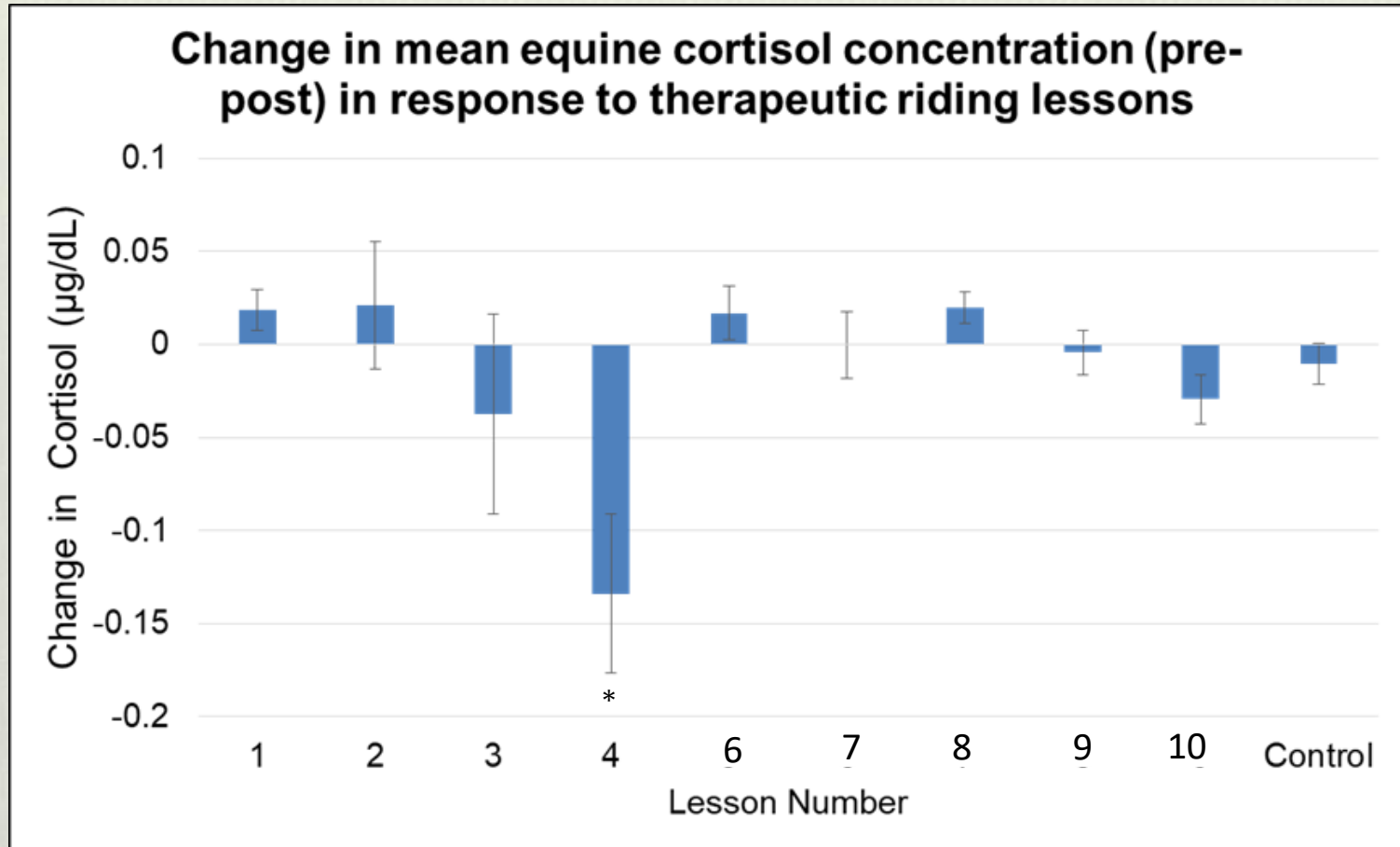
Mean & SE shown

Session

Equine Grooming Protocol

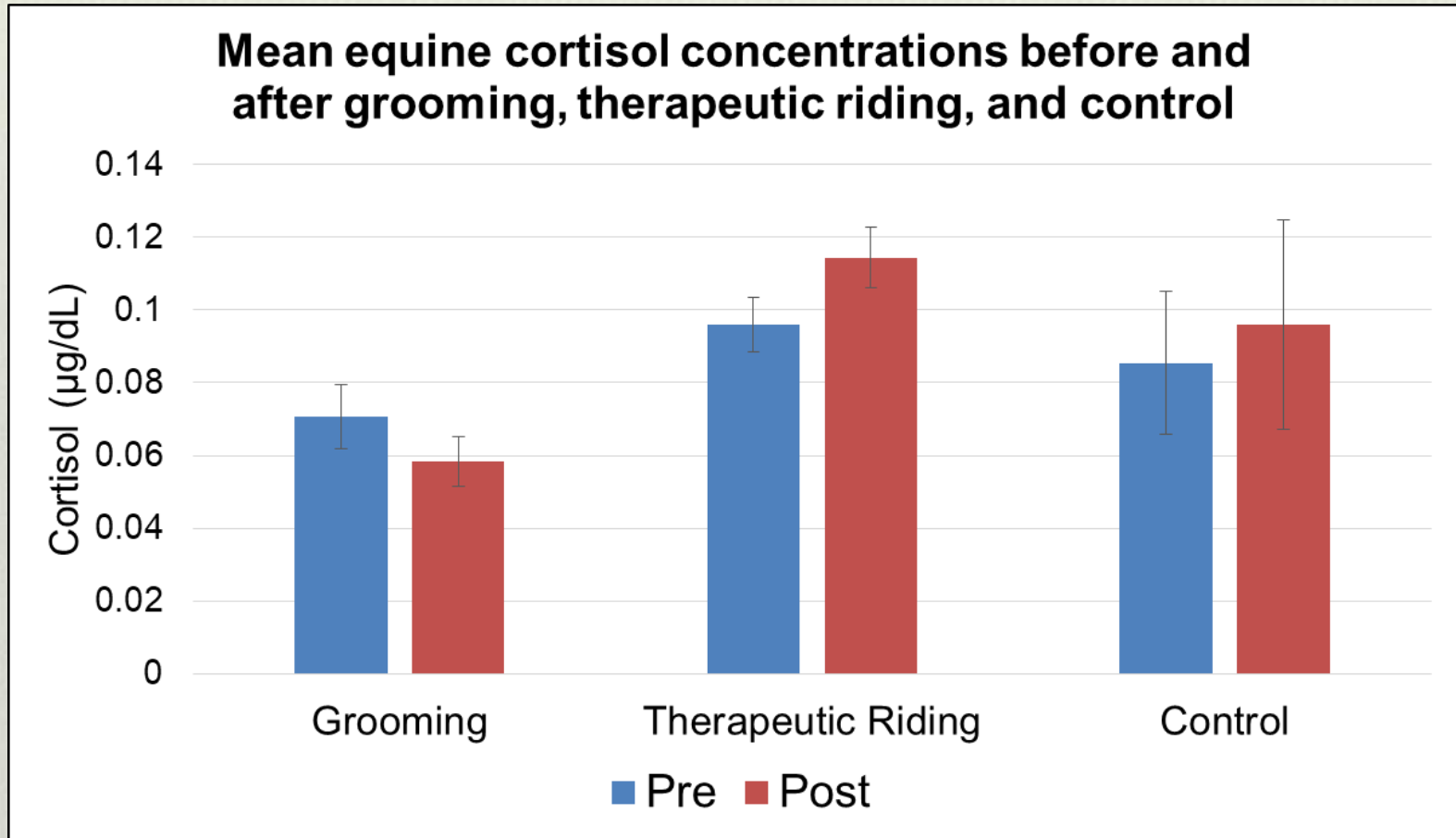
<u>TIME (PM)</u>	<u>GROOMING PROTOCOL</u>
4:00 – 4:01	Saliva collection (Pre)
4:01 – 4:05	Hoof picking
4:05 – 4:15	Curry with rubber curry comb
4:15 – 4:20	Brush with hard bristled brush
4:20 – 4:25	Brush with soft bristled brush
4:25 – 4:30	Gently comb out mane and tail with detangler
4:30 – 4:31	Saliva collection (Post)

Equine Cortisol Results: Individual Lessons



Change in mean equine salivary cortisol concentration (pre-post) over nine lessons with standard error. *Indicates $P < 0.05$ when compared with control. Lesson #5 excluded from analyses.

Equine Cortisol Concentration by Treatment



No significant differences were found for salivary cortisol change over time (pre-post) within therapeutic riding, grooming, and control samples.

Discussion Self-Report

Therapeutic Riding vs. HeartMath vs. Control

During THR phase, participants showed a decrease in the mean values for perceived stress while showing an increase in perceived stress during HeartMath and Control phase

Why? HeartMath focused on topic of stress, stress triggers, and may increase the awareness of stress in the individual.

While they have more awareness, they might not be able to practice stress reduction on their own after program ends.

But in THR, stress-reduction mechanism is more experiential. O'Haire (2017) reports positive outcomes from AAI related to natural interaction and positive emotions.

Discussion Parent Report

Control: increase in fidgetiness and relating to peers in control when there was no intervention

Why didn't the parent report and self-report match?

- ❖ Two different perspectives and constructs (self-report stress level vs. Behavior)
- ❖ Parents answered about past week and self-report may reflect how they felt in the moment

Therapeutic riding phase- Improvement in prosocial behavior and decrease in anti-social behavior (similar to Gabriels et al., 2015) findings with SRS.

Discussion: Human Cortisol

- ❖ CARi absent in THR and HM baseline, and THR follow-up
 - ❖ CARi absent when children with ASD placed with service dog, but present after service dog removed (Viau et al 2010)
 - ❖ Sleep quality (Viau et al., 2010)?
 - ❖ Motor exercise (Wegner et al., 2019)?
 - ❖ Increased physical fitness (Mücke et al., 2019)?
- ❖ No differences from baseline to follow-up when comparing treatments
- ❖ Significant decreases in cortisol concentration following sessions- acute effect of THR and HM

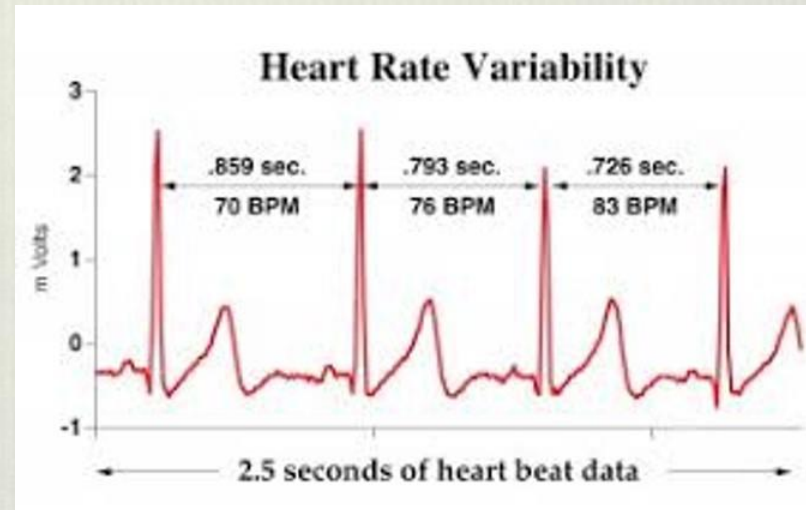
Discussion: Equine Cortisol

- ❖ No difference in equine cortisol concentrations when comparing therapeutic riding, grooming, or standing in a stall
 - ❖ THR did not appear to negatively impact horses
- ❖ Rider balance/skill -> increase in equine cortisol concentrations during walk/trot transitions lesson?



Discussion Coherence

- ❖ Mean coherence (heart rate variability readings) was better during HeartMath than THR
- ❖ The physical movement during THR may have impacted HRV readings
- ❖ Participants wore sensors in backpack while riding and could see lights on sensor in mindfulness sessions
- ❖ Some participants in the mindfulness sessions may have had improved HRV due to biofeedback effect.



Applications

Cortisol reduced with Therapeutic riding and HeartMath while self- and parent report indicated more response from THR based on individual items

- ❖ Equal reduction in cortisol immediately after HM and THR sessions
- ❖ Higher CARi following the control and HM phases and lower CARi following THR phase
- ❖ THR is effective despite verbal communication ability, but HM may be more effective for young adults with better receptive and expressive verbal skills.

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Publications & Presentations

- ❖ Published Original Research Article, Kemeny, B., Burk, S., Hutchins, D., Gramlich, C.E. 2021. Therapeutic riding or mindfulness: Comparative effectiveness of two recreational therapy interventions for adolescents with autism. *Journal of Autism and Developmental Disorders*. <https://doi.org/10.1007/s10803-021-05136-z>.
- ❖ Publish Abstract. Kemeny, E. Gramlich, C., Hutchins, D., Burk, S., Singhabahu, D., Dietrich, J., Jones, E., & Kronyak, A. (2019). Comparative Effectiveness of Therapeutic Riding and Stress Management Class on Cortisol Levels and HRV in Youth on the Autism Spectrum. *International Society on Autism Research Abstracts 2019*, International Society on Autism Research, Montreal, Canada.
- ❖ Published Abstract, Shields, M.M., Kemeny, E., Gramlich, C.E., Hutchins, D.A., Burk, S.V. 2019. The effect of grooming and therapeutic riding by adolescents with autism spectrum disorder on equine salivary cortisol concentrations. *Journal of Equine Veterinary Science*. 76:129.
- ❖ Published Abstract, Kemeny, E. Gramlich, C., Hutchins, D., Burk, S., Dietrich, J., Jones, E., and Kronyak, A. 2018. Comparative Effectiveness of Therapeutic Riding and Stress Management Class on Cortisol Levels and HRV in Youth on the Autism Spectrum. *ATRA Research Institute Research Poster Abstracts, Annual Therapeutic Recreation*, 26.
- ❖ Poster Presentation, Burk, S., Kemeny, E., Gramlich, C., Hutchins, D., Shields, M. The effect of grooming and therapeutic riding by adolescents with autism spectrum disorder on equine salivary cortisol concentrations. Animal Behavior Management Alliance Conference, April 6-12, 2019. Portland, OR.
- ❖ Oral Presentation, Shields, M., Kemeny, E., Gramlich, C.E., Hutchins, D.A., Burk, S.V. The effect of grooming and therapeutic riding by adolescents with autism spectrum disorder on equine salivary cortisol concentrations. *Equine Science Society Symposium June 3-6 2019 Asheville NC*

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