Re-Wiring the Brain for Optimized Performance

Amy E Bair, PhD
Catherine P Starnes, PhD

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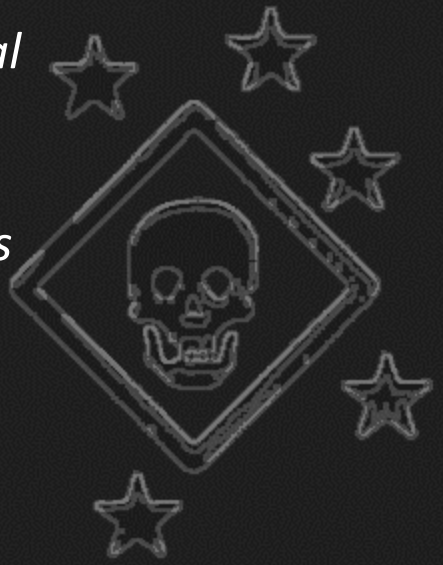


AGENDA

- SABRES Program Overview
- Nuts & Bolts of Neurofeedback
- Data Goals & Challenges
- Outcome Track Analyses
- Next Steps
- Conclusion
- Q&A

Special Operations

Assessment

Baselining

Readiness

Evaluation

System

LEVELS OF EVALUATION

- *Holistic Survey*
- *CNS Vital Signs*
- *Quantitative Electroencephalogram (qEEG)*
- *Review & Intervention*

PURPOSE

- *General Well-Being*
- *Objective Performance*
- *Objective Brain Physiology*
- *Actionable, Personalized Feedback*

NUTS & BOLTS OF NEUROFEEDBACK

How Neurofeedback Works:

- Identify brainwave activity outside of normative range
- Use operant conditioning with auditory/visual reinforcer
- Tie strategies learned in session to performance goals
- Various options:
  - **Neurotracker**- *3D activity to smooth out processing and improve focus capabilities*
  - **Surface**- *target Frontal lobe (focus, decision making), Parietal areas (processing, memory) or dysregulated brain activity related to sleep (Theta, Alpha)*
  - **Source**- *identify Brodmann areas associated with functionality symptoms*
- Pair with HRV Training to optimize mind-body connection

BENEFITS

- Individualized targeted intervention
- Tangible data that can be used to motivate and track change
- Broad utilization for intervention work
- Strong client commitment with 79% consistent weekly attendance (typically 15-20 session total)

WHY METRICS MATTER

DATA GOALS

- Triangulation of outputs, function and processes
- ID of patterns of overlap as well as anomalies
- Establish our population norms and compare against US population norms

LEVEL OF DETAIL

- Population Insight
- Individual Training Plans
- Coordinated Care
- Program Performance/Effectiveness

DATA CHALLENGES

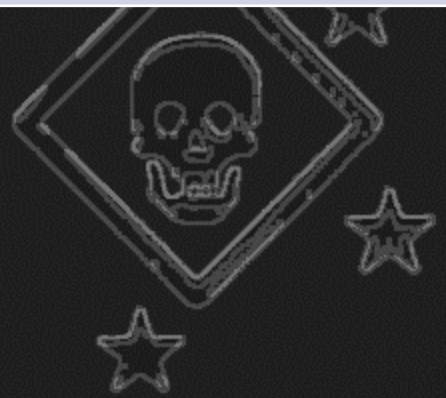
- Tremendous amount of data to manage
- Aggregation washes out highs and lows seen at individual level
- Many unique data combinations with multiple intervention options
- Repeated assessments

DATA ORGANIZATION

SLEEP/RECOVERY	OVERACTIVE BRAIN	STRESS	ATTENTION	MEMORY/PROCESSING
• ERP300a latency • HRV SDNN • Evoke Task Variability • Evoke Task Omission/Commission Errors • CNS Vital Signs (CNSVS) – reaction time – processing speed – executive function – cognitive flexibility – sustained attention	• Peak Alpha Frequency (PAF) • HRV SDNN • Theta/Beta wave ratio • Evoke Task Omission/Commission Errors • CNS Vital Signs (CNSVS) – reaction time – processing speed – executive function – cognitive flexibility	• Peak Alpha Frequency (PAF) • HRV SDNN • Theta/Beta wave ratio	• ERP300a latency • Theta/Beta wave ratio • Evoke Task Variability • CNS Vital Signs (CNSVS) – reaction time – executive function – cognitive flexibility	• Peak Alpha Frequency (PAF) • ERP300b latency • CNS Vital Signs (CNSVS) – processing speed – working memory

SAMPLE DESCRIPTION

Overall Sample Size	Subset Sample Size
Total NFB Participants: 68 Post-NFB Assessments: 38 Mid-point Protocol NFB Assessments: 43 Both Mid-point and Post NFB Assessments: 13	Sleep: 48 Memory/Processing: 50 Stress: 42 Attention: 37 Overactive Brain: 20
Participant Personnel Category	**Age at Baseline**
SOF Qualified Personnel: 28 Support Personnel: 40	Median: 36.0 IQR: (32.0, 39.0)



SLEEP/RECOVERY OUTCOME TRACK

SLEEP quantity and quality are essential elements for effective brain health and performance.

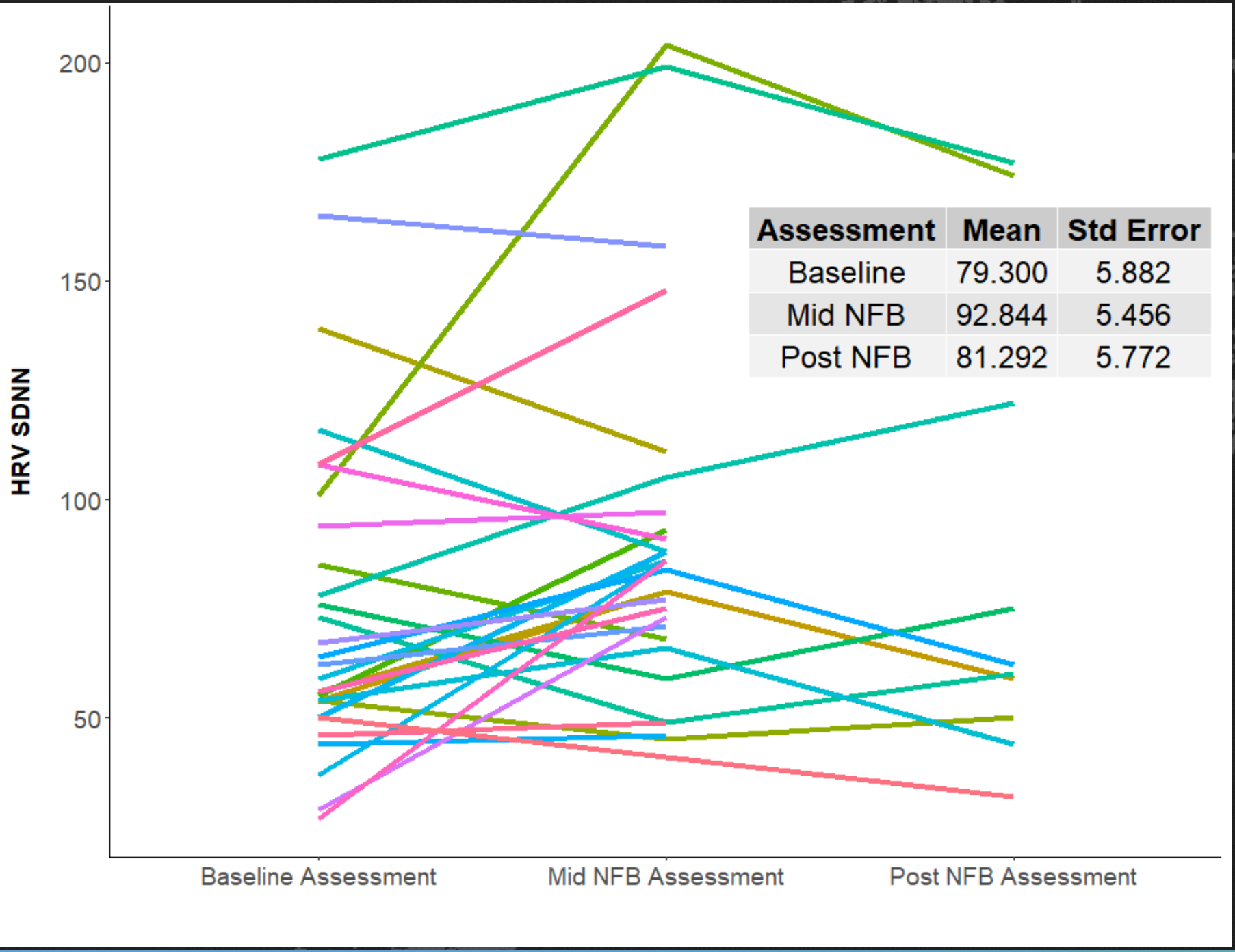
Impact of Chronic Fatigue/Sleep Impairment – *slow Reaction time and Executive Function/Cognitive Flexibility percentiles (28^{th}, 42^{nd}, 45^{th} percentiles, respectively)*

Sacrifice speed for high accuracy – *Reaction time and High Variability data*

Slight sympathetic and parasympathetic predominance of autonomic nervous system regulation– *Bimodal HRV frequency spectrums*

- HRV is highest of the subsets, but difficult to maintain consistency.
- Response time is quicker, and higher order thinking improves which is often the most impacted performance areas.

SLEEP/RECOVERY OUTCOME TRACK

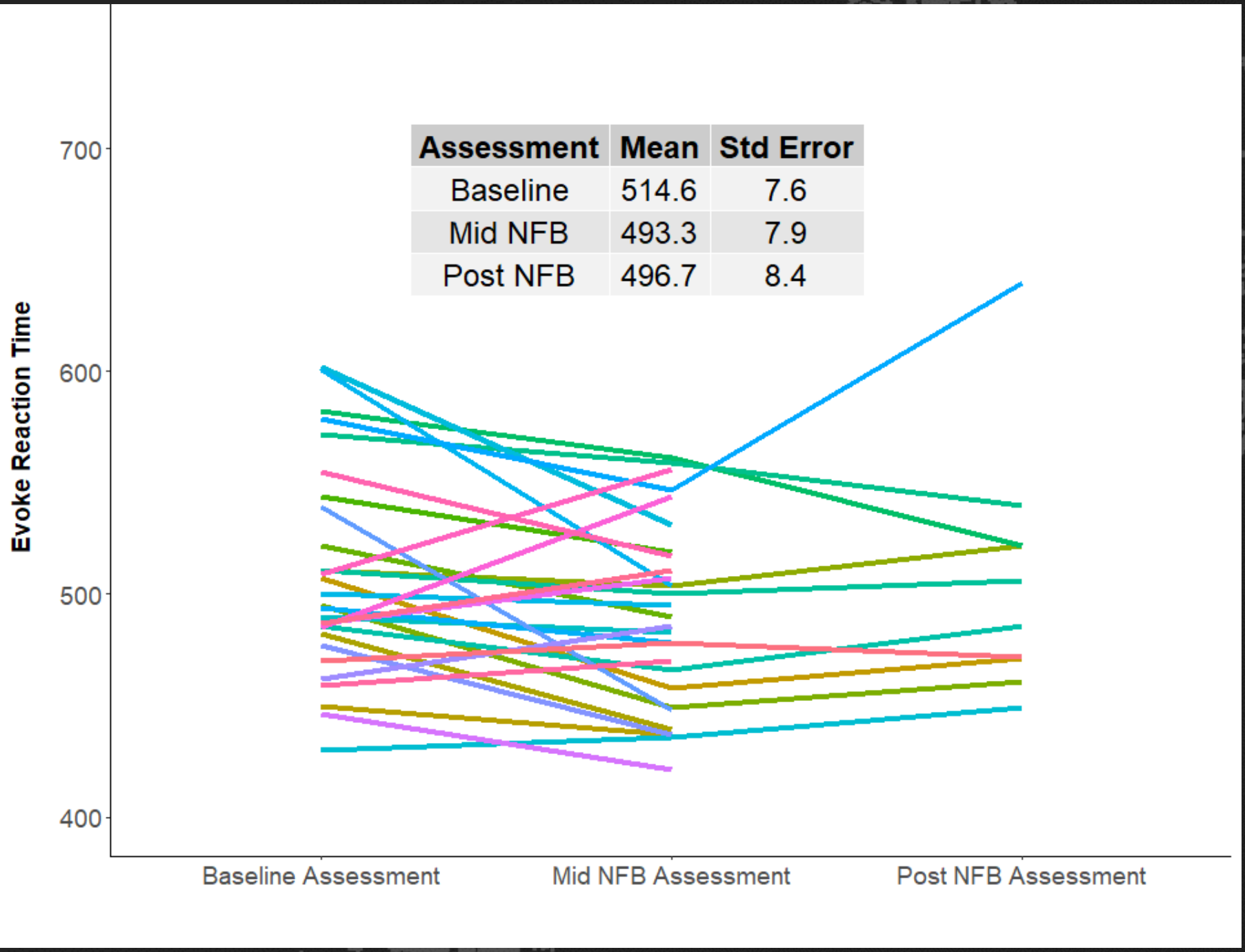


Assessment	Mean	Std Error
Baseline	79.300	5.882
Mid NFB	92.844	5.456
Post NFB	81.292	5.772

HRV is highest of the subsets, but difficult to maintain consistency.

SLEEP/RECOVERY OUTCOME TRACK

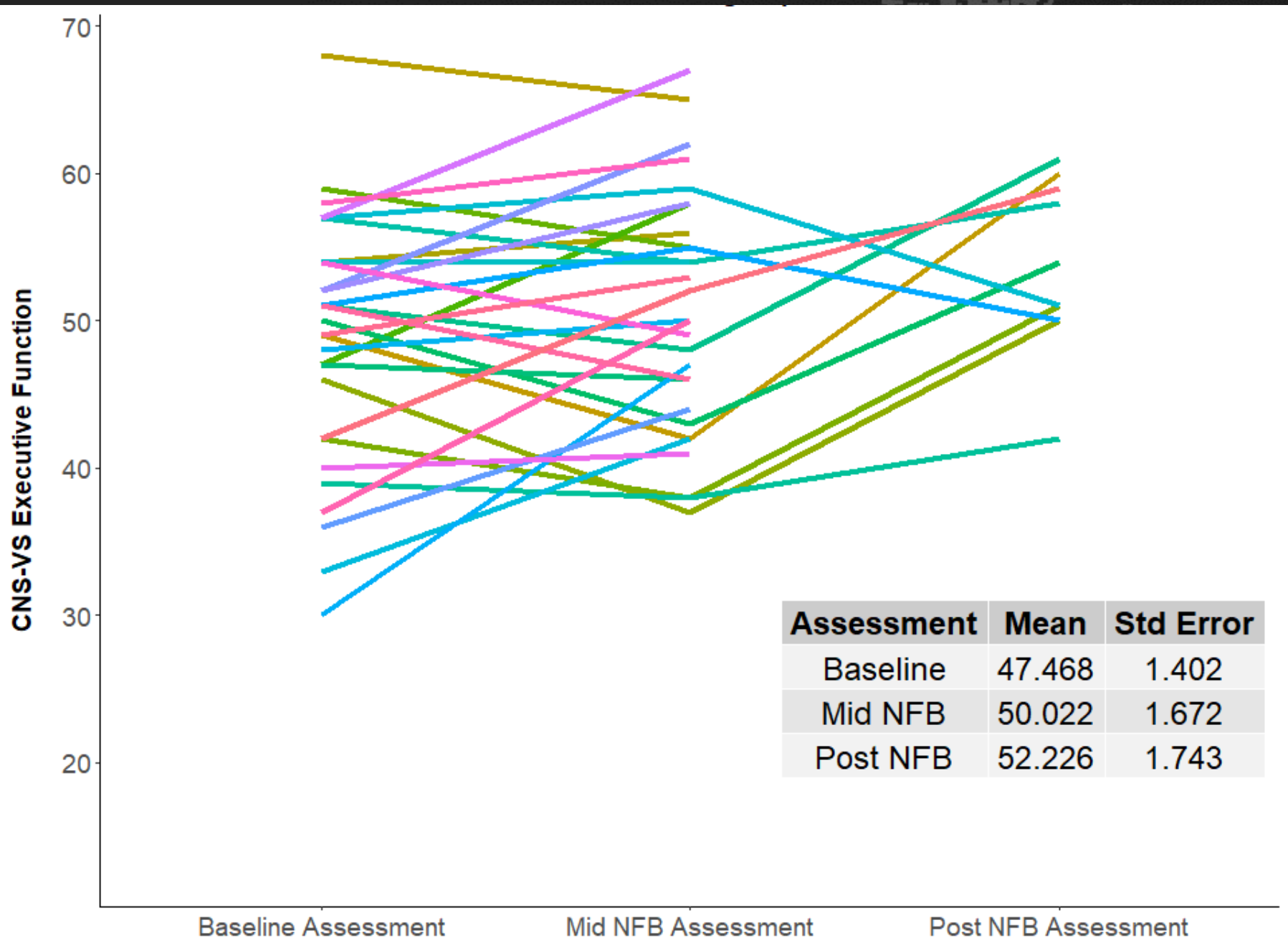
Assessment	Mean	Std Error
Baseline	514.6	7.6
Mid NFB	493.3	7.9
Post NFB	496.7	8.4



- Response time is quicker, and higher order thinking improves which is often the most impacted performance areas.
- Accuracy improved:
  - Omission = improved by an average of 2.5 responses
  - Commission = improved by an average of 1 response

SLEEP/RECOVERY OUTCOME TRACK

Higher order thinking improves which is often the most impacted performance areas.



Assessment	Mean	Std Error
Baseline	47.468	1.402
Mid NFB	50.022	1.672
Post NFB	52.226	1.743

OVERACTIVE BRAIN OUTCOME TRACK

OVERACTIVE BRAIN (Anxious thinking/Busy Brain) is when brain is on overdrive and does not attend to information coming in.

Impact of Chronic Fatigue/Sleep Impairment – *slow Reaction time and Executive Function/Cognitive Flexibility percentiles (28th, 42nd, 45th percentiles, respectively)*

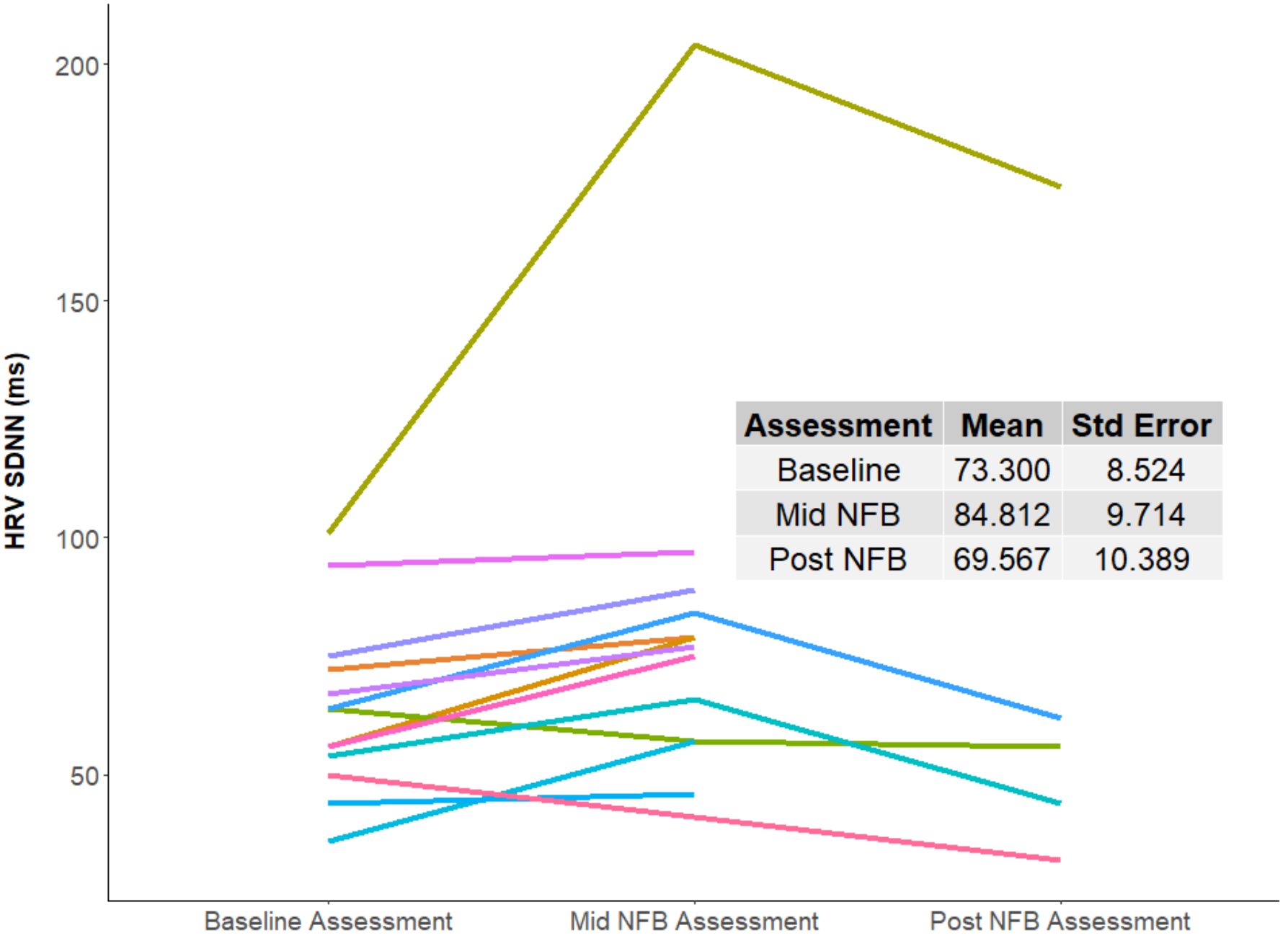
Slight sympathetic and parasympathetic predominance of autonomic nervous system regulation– *Bimodal HRV frequency spectrums*

Broad Situational awareness – *Theta/beta brainwave ratios (2.2 ± .53)*

Sacrifice speed for high accuracy **–** *Reaction time and High Variability data*

- Attention becomes more focused as HRV moves toward balanced state.
- Reaction time and processing performance improves with greater mental clarity and agility.

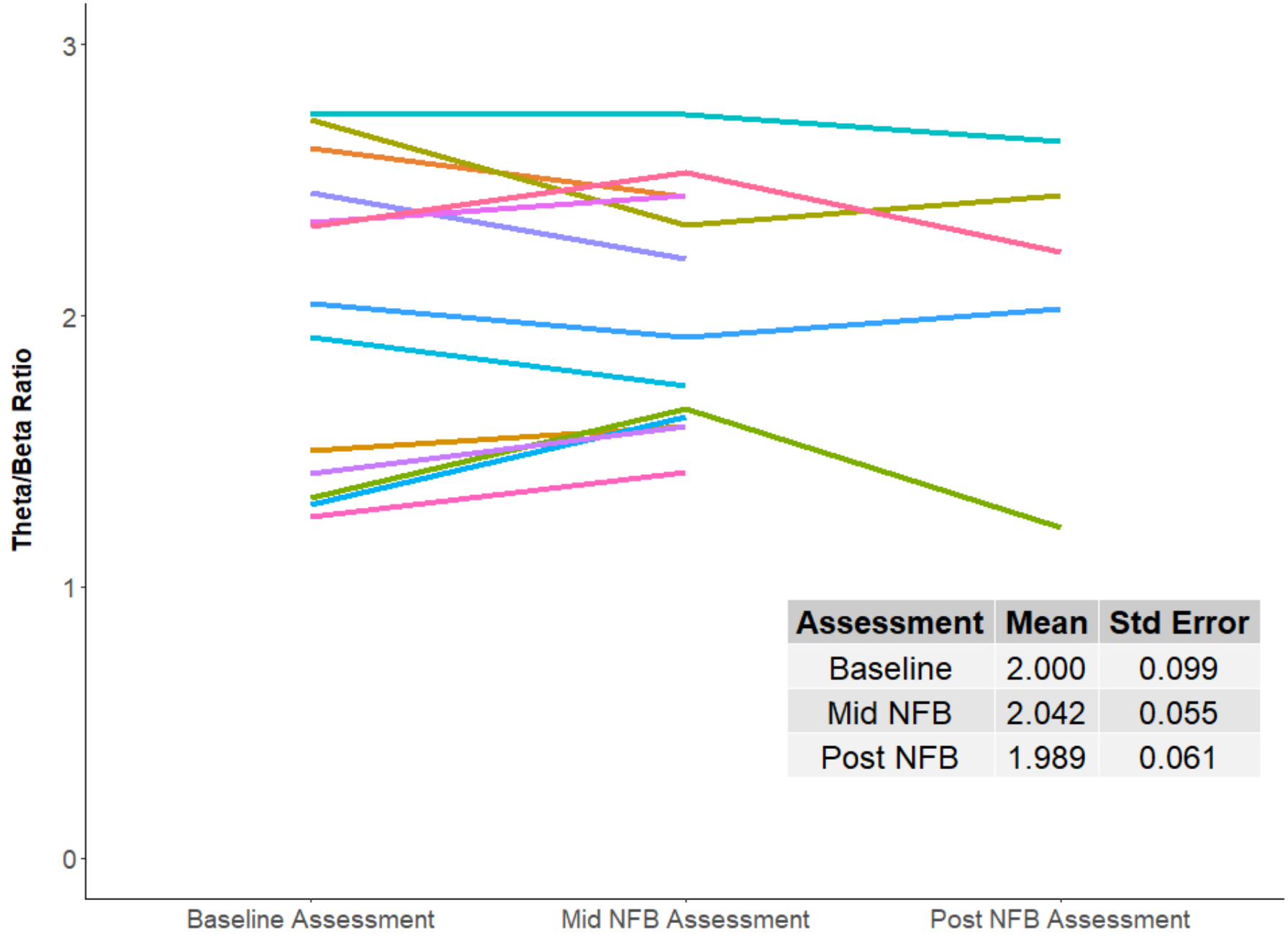
OVERACTIVE BRAIN OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	73.300	8.524
Mid NFB	84.812	9.714
Post NFB	69.567	10.389

Attention becomes more focused as HRV moves toward balanced state.

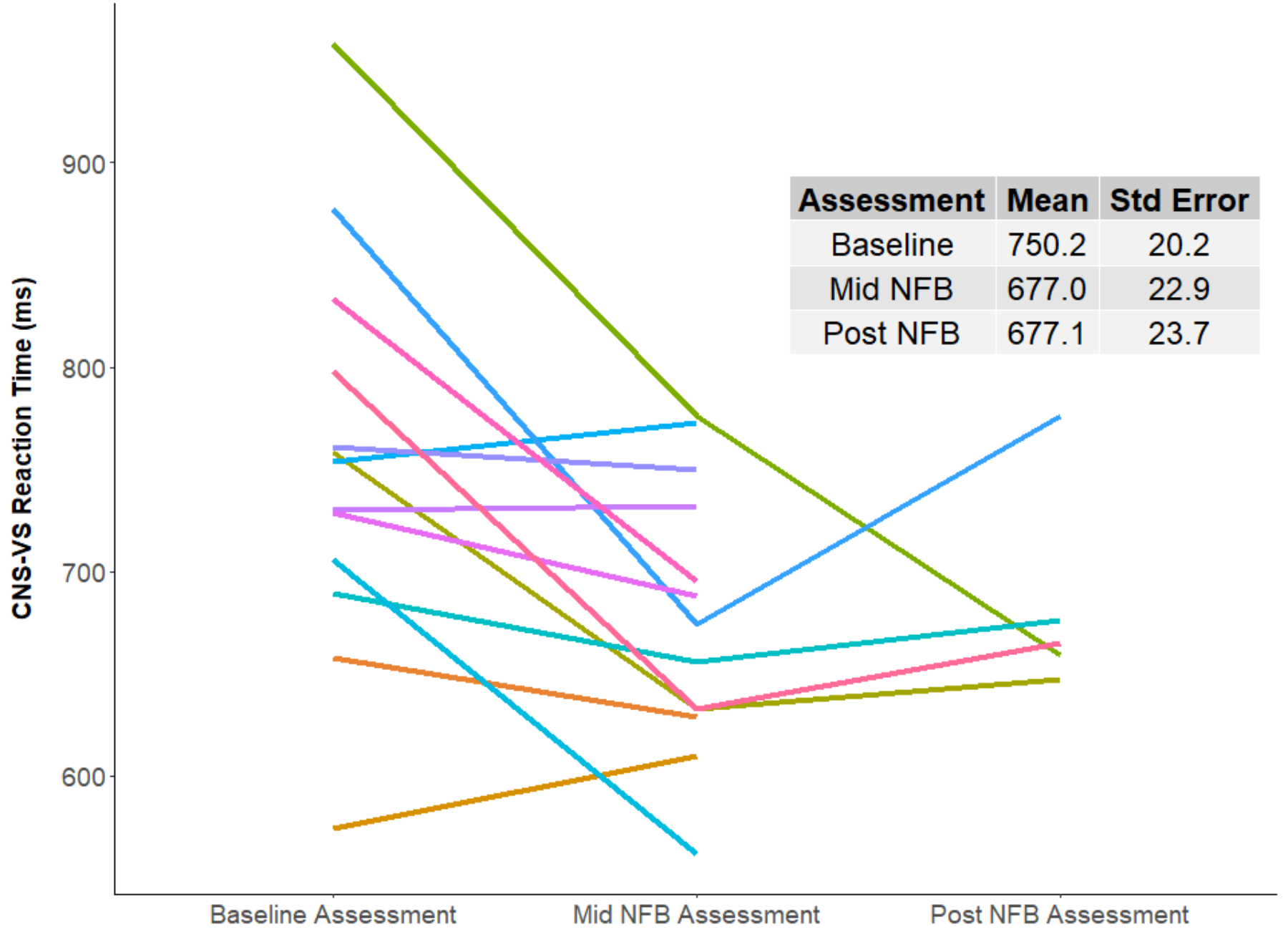
OVERACTIVE BRAIN OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	2.000	0.099
Mid NFB	2.042	0.055
Post NFB	1.989	0.061

Attention becomes more focused as HRV moves toward balanced state.

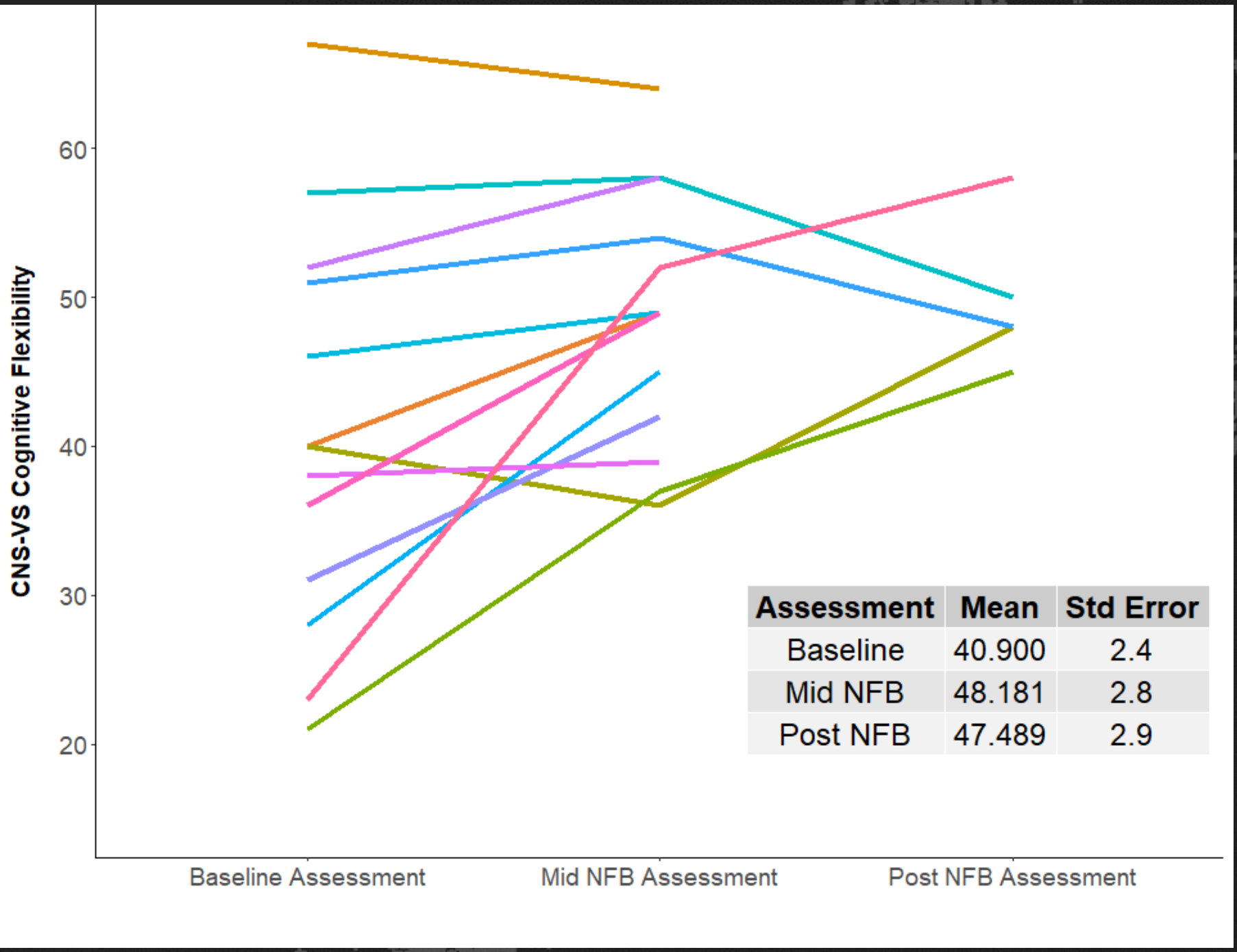
OVERACTIVE BRAIN OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	750.2	20.2
Mid NFB	677.0	22.9
Post NFB	677.1	23.7

- Reaction time and processing performance improves with greater mental clarity and agility.
- Accuracy improved:
  - Omission = improved by an average of 2.2 responses
  - Commission = improved by an average of 1.25 response

OVERACTIVE BRAIN OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	40.900	2.4
Mid NFB	48.181	2.8
Post NFB	47.489	2.9

Reaction time and processing performance improves with greater mental clarity and agility.

STRESS OUTCOME TRACK

STRESS weakens neural circuitry impairing cognitive performance.

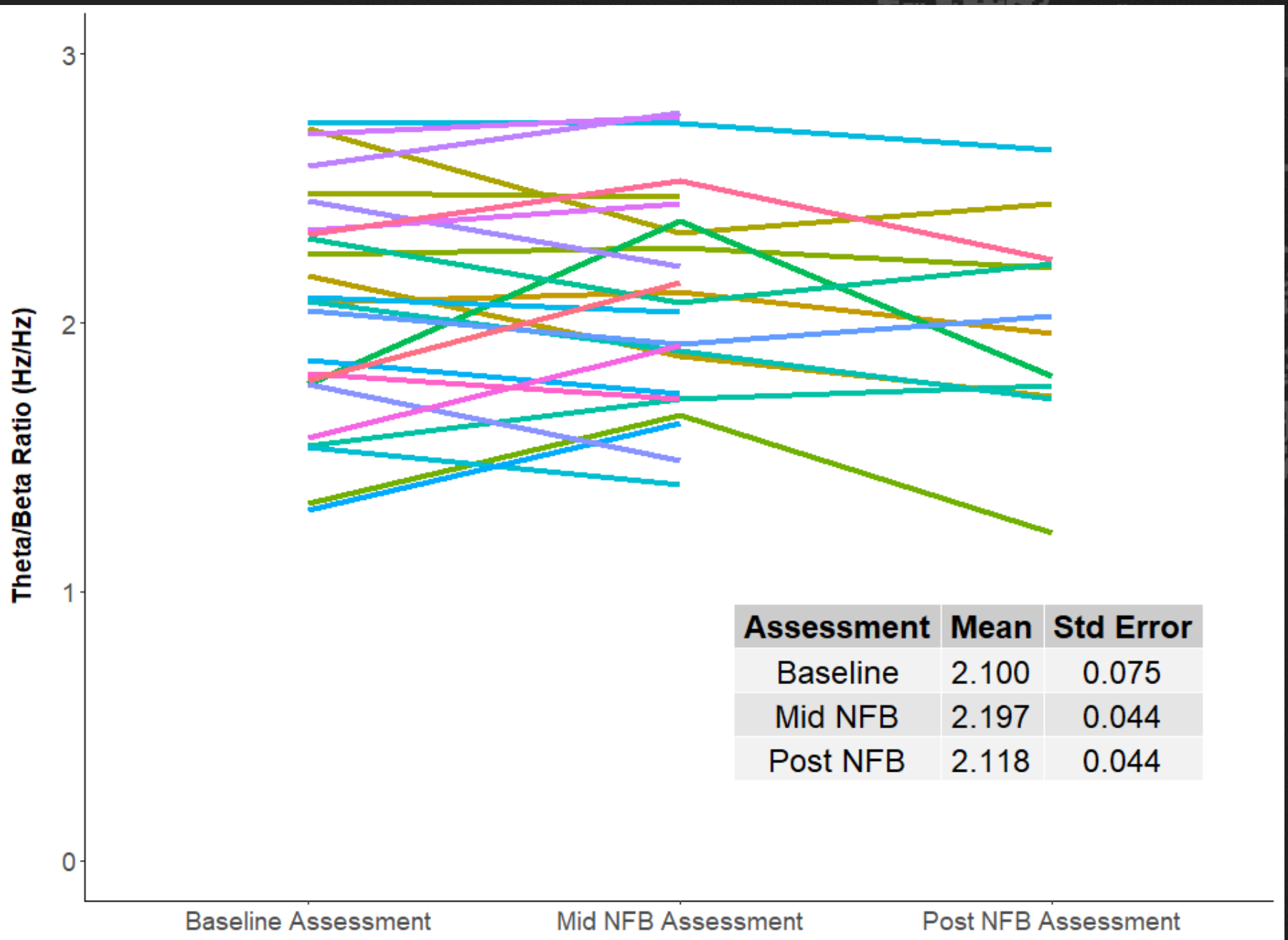
Impact of Chronic Fatigue/Sleep Impairment – *slow Reaction time and Executive Function/Cognitive Flexibility percentiles (28^{th}, 42^{nd}, 45^{th} percentiles, respectively)*

Slight sympathetic and parasympathetic predominance of autonomic nervous system regulation– *Bimodal HRV frequency spectrums*

Broad Situational awareness – *Theta/beta brainwave ratios (2.2 ± .53)*

Brain Function Index within range **–** *Mean peak alpha frequency (10.0 ± 0.67Hz)*

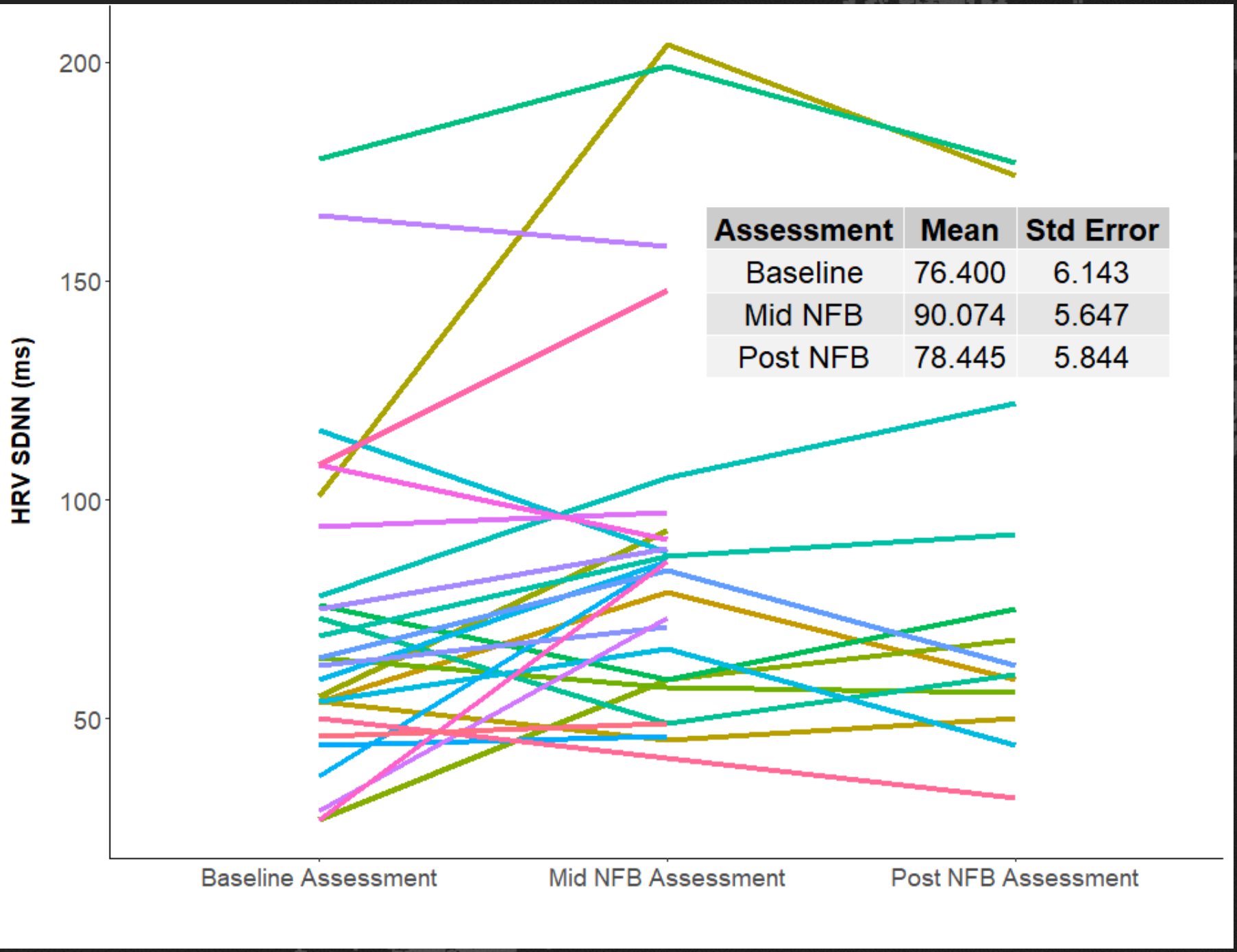
- Theta/Beta ratio trends towards a more focused state to off-set the damaging physiological effects of fatigue (measured by SDNN).
- Peak Alpha Frequency improves, promoting resiliency in the face of adversity.



Assessment	Mean	Std Error
Baseline	2.100	0.075
Mid NFB	2.197	0.044
Post NFB	2.118	0.044

STRESS OUTCOME TRACK

- At midpoint: As SDNN stabilizes, Theta/Beta ratio trends towards broader situational awareness.
- At post-NFB: Theta/Beta ratio trends towards a more focused state to off-set the damaging physiological effects of fatigue (measured by SDNN).

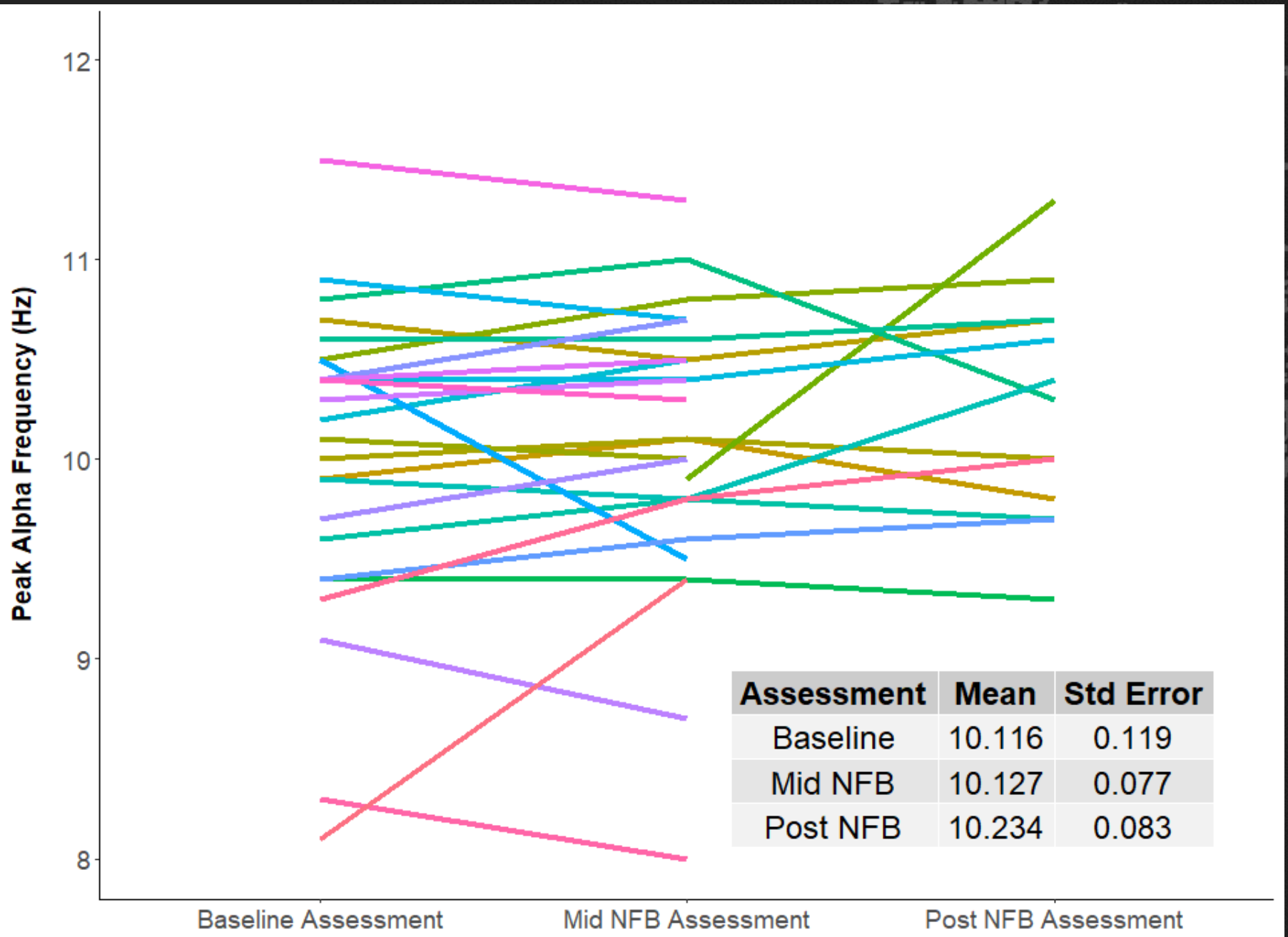


Assessment	Mean	Std Error
Baseline	76.400	6.143
Mid NFB	90.074	5.647
Post NFB	78.445	5.844

STRESS OUTCOME TRACK

Theta/Beta ratio trends towards a more focused state to off-set the damaging physiological effects of fatigue (measured by SDNN).

STRESS OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	10.116	0.119
Mid NFB	10.127	0.077
Post NFB	10.234	0.083

Peak Alpha Frequency improves, promoting resiliency in the face of adversity.

ATTENTION OUTCOME TRACK

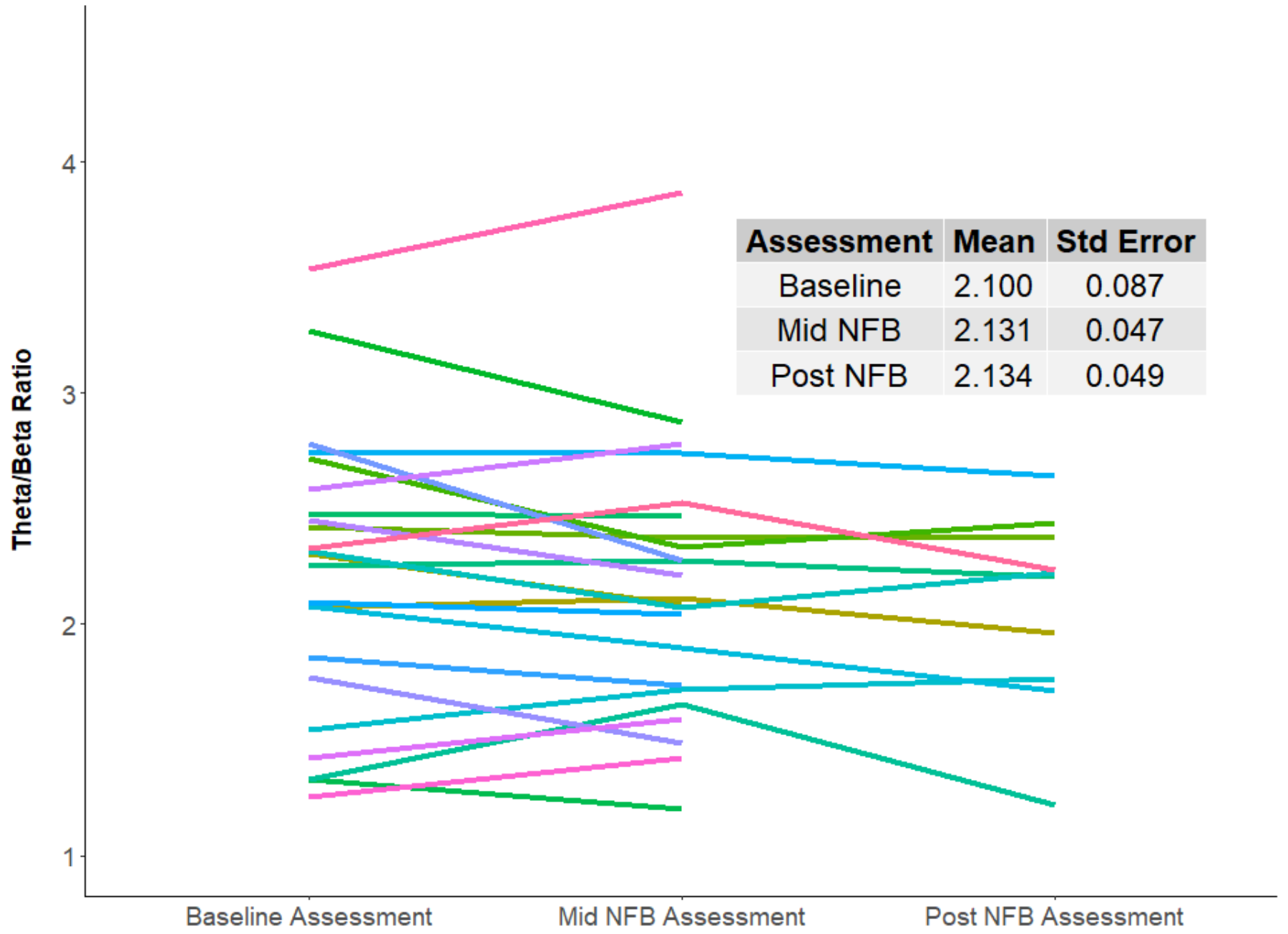
ATTENTION is the cognitive-behavioral process of selectively focusing on a discrete aspect of information while ignoring irrelevant information.

Impact of Chronic Fatigue/Sleep Impairment – *slow Reaction time and Executive Function/Cognitive Flexibility percentiles (28^{th}, 42^{nd}, 45^{th} percentiles, respectively)*

Broad Situational awareness – *Theta/beta brainwave ratios (2.2 ± .53)*

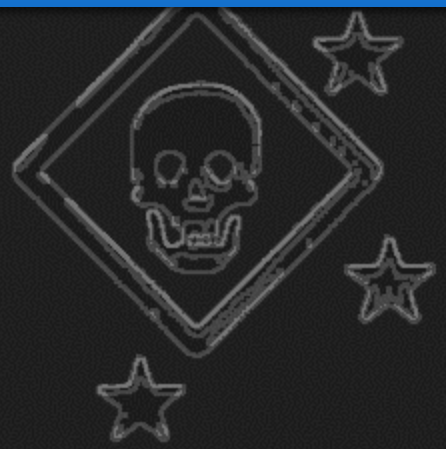
- Most participants converge towards ideal attention balance of 2.1 for their Theta/Beta ratio which maximizes their attentional style.
- Evoke Task components demonstrates sustained attention with stronger response consistency.
- Cognitive Flexibility highlights increased ability to shift attention.

ATTENTION OUTCOME TRACK

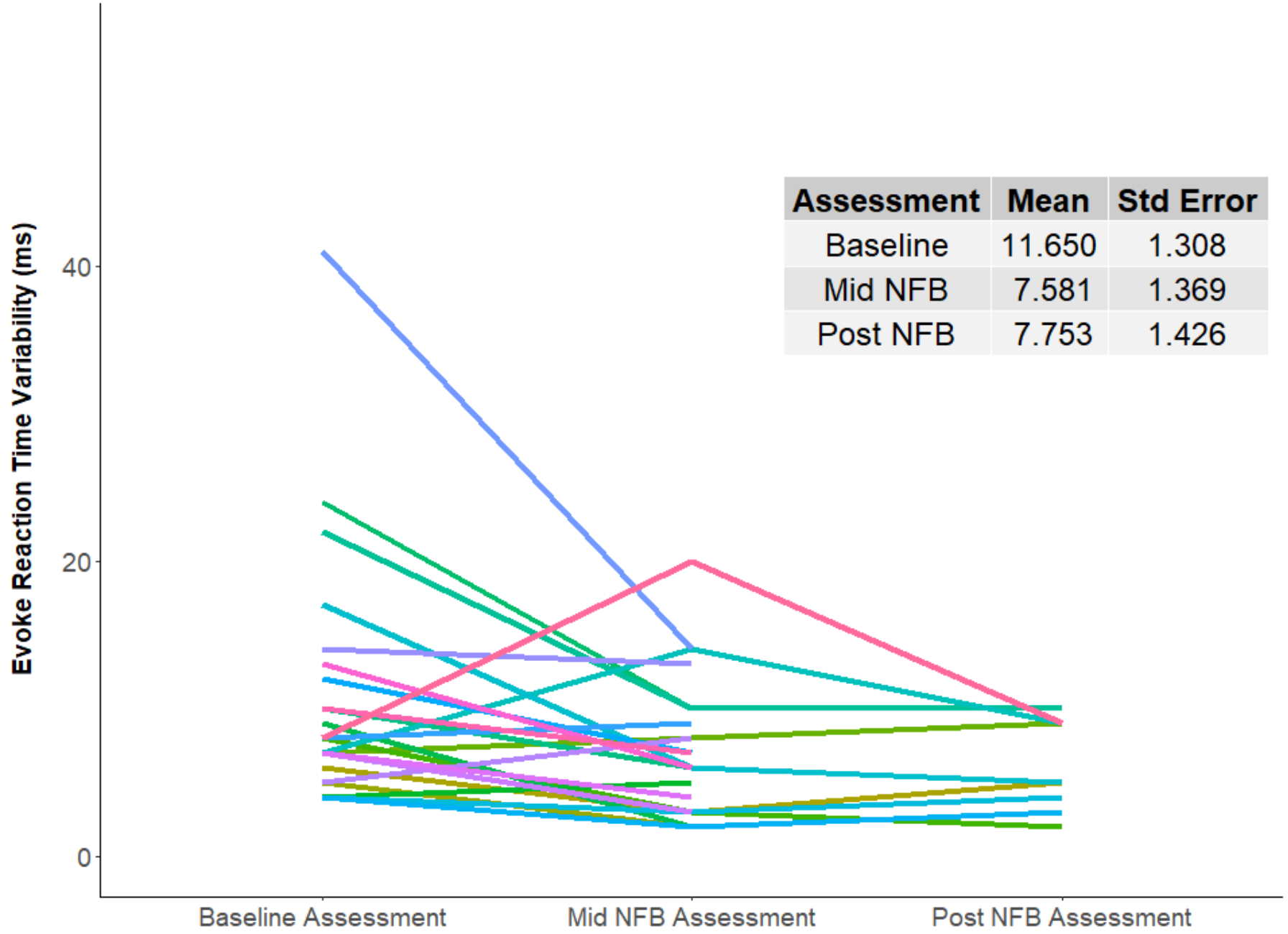


Assessment	Mean	Std Error
Baseline	2.100	0.087
Mid NFB	2.131	0.047
Post NFB	2.134	0.049

Most participants converge towards ideal attention balance of 2.1 for their Theta/Beta ratio which maximizes their attentional style.



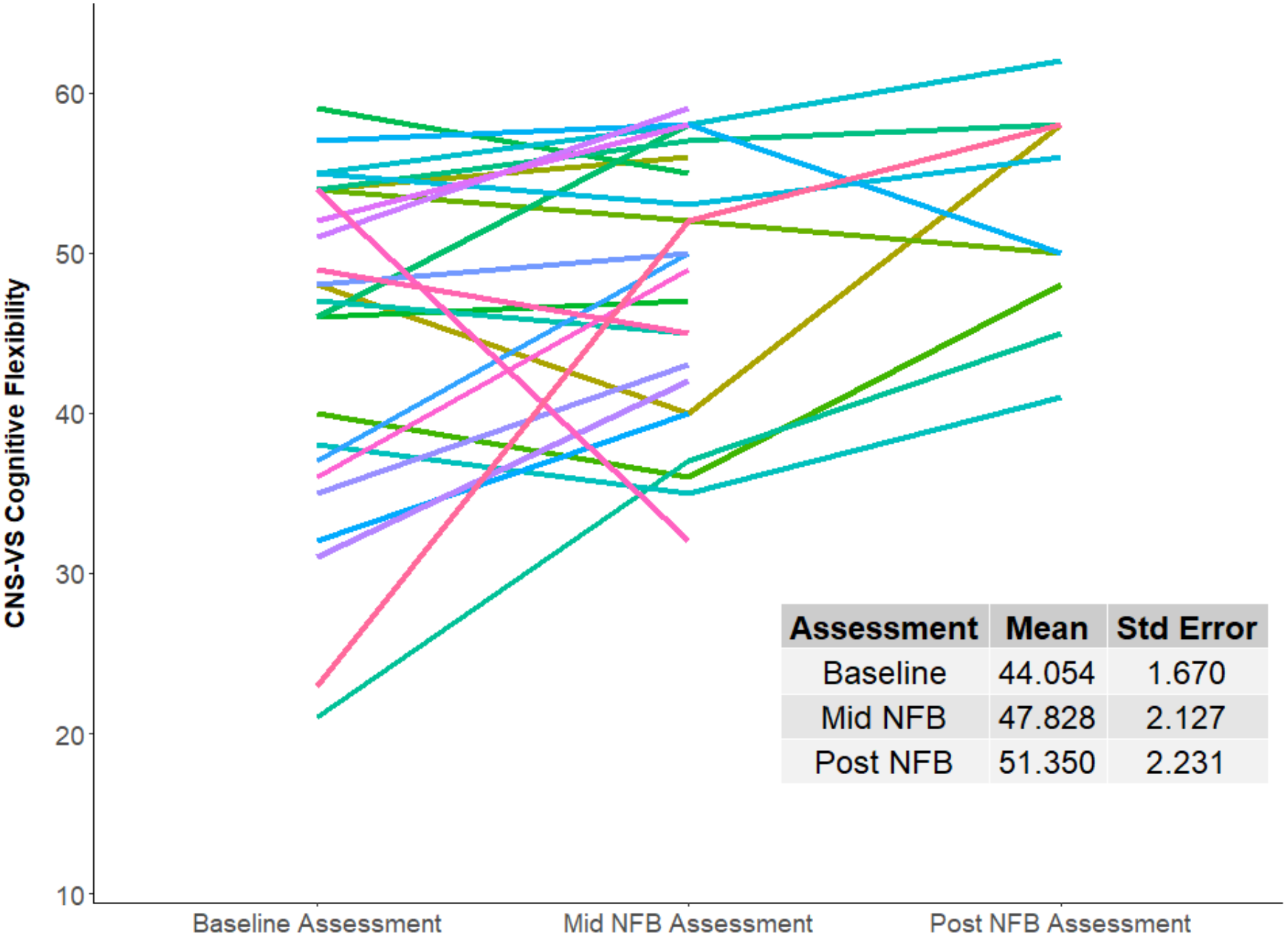
ATTENTION OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	11.650	1.308
Mid NFB	7.581	1.369
Post NFB	7.753	1.426

Evoke Task components demonstrates sustained attention with stronger response consistency.

ATTENTION OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	44.054	1.670
Mid NFB	47.828	2.127
Post NFB	51.350	2.231

Cognitive Flexibility highlights increased ability to shift attention.

MEMORY & PROCESSING OUTCOME TRACK

INFORMATION PROCESSING are the sensory and cognitive processes that determine how and when information is received and appropriately stored.

Impact of Chronic Fatigue/Sleep Impairment – *slow Reaction time and Executive Function/Cognitive Flexibility percentiles (28^{th}, 42^{nd}, 45^{th} percentiles, respectively)*

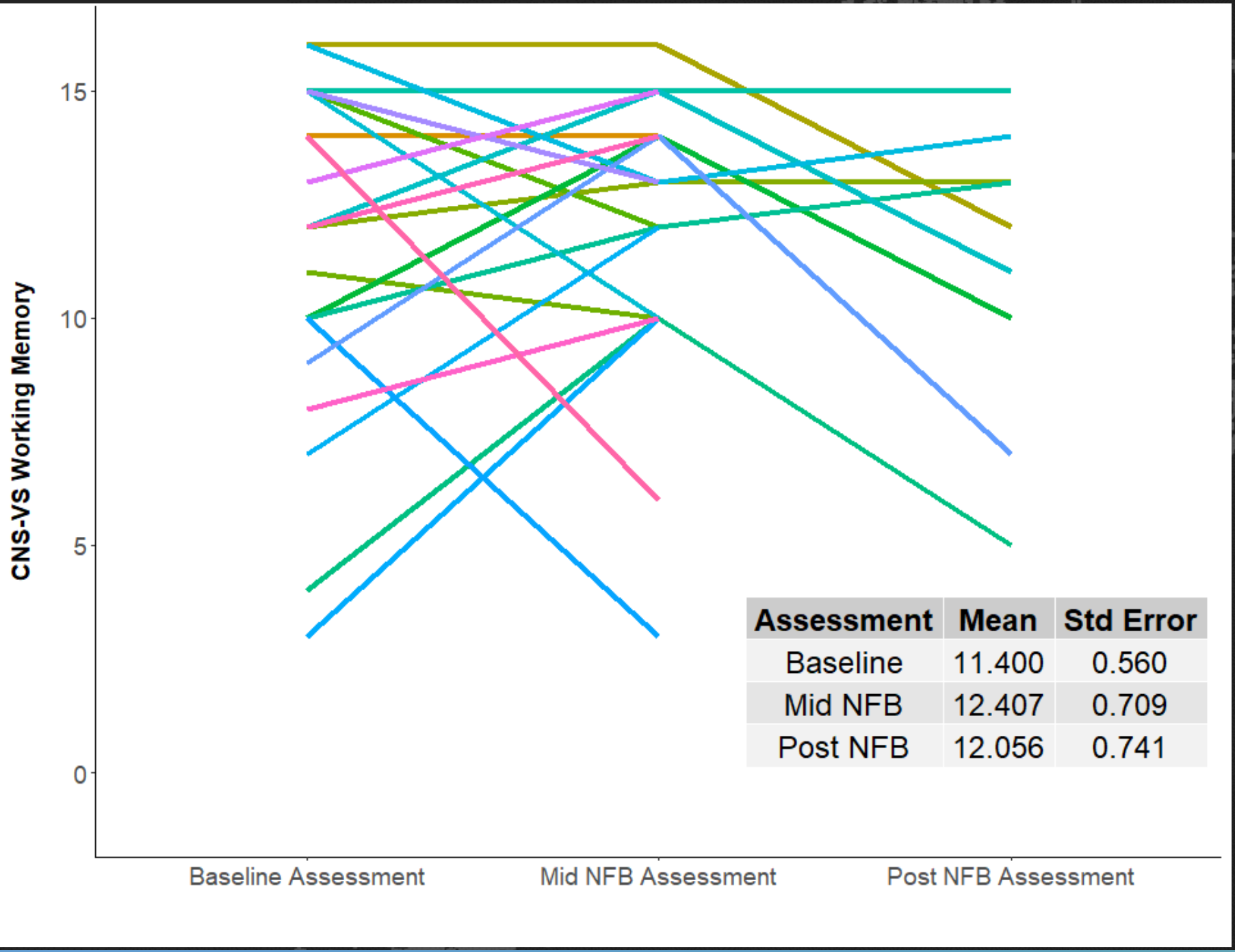
Broad Situational awareness – *Theta/beta brainwave ratios (2.2 ± .53)*

Brain Function Index within range – *Mean peak alpha frequency (10.0 ± 0.67Hz)*

Potential indicators of TBI/Concussion – *ERP300b latency (517.5 ± 65.4 ms)*

- Improvements in performance with CNSVS Working Memory sub-tests, especially those with greatest deficit (common complaint).
- Peak Alpha Frequency demonstrates the capability to manage larger bits of information more efficiently.
- ERP 300b shows how quickly neural networks are detecting stimuli and transferring information.

MEMORY & PROCESSING OUTCOME TRACK

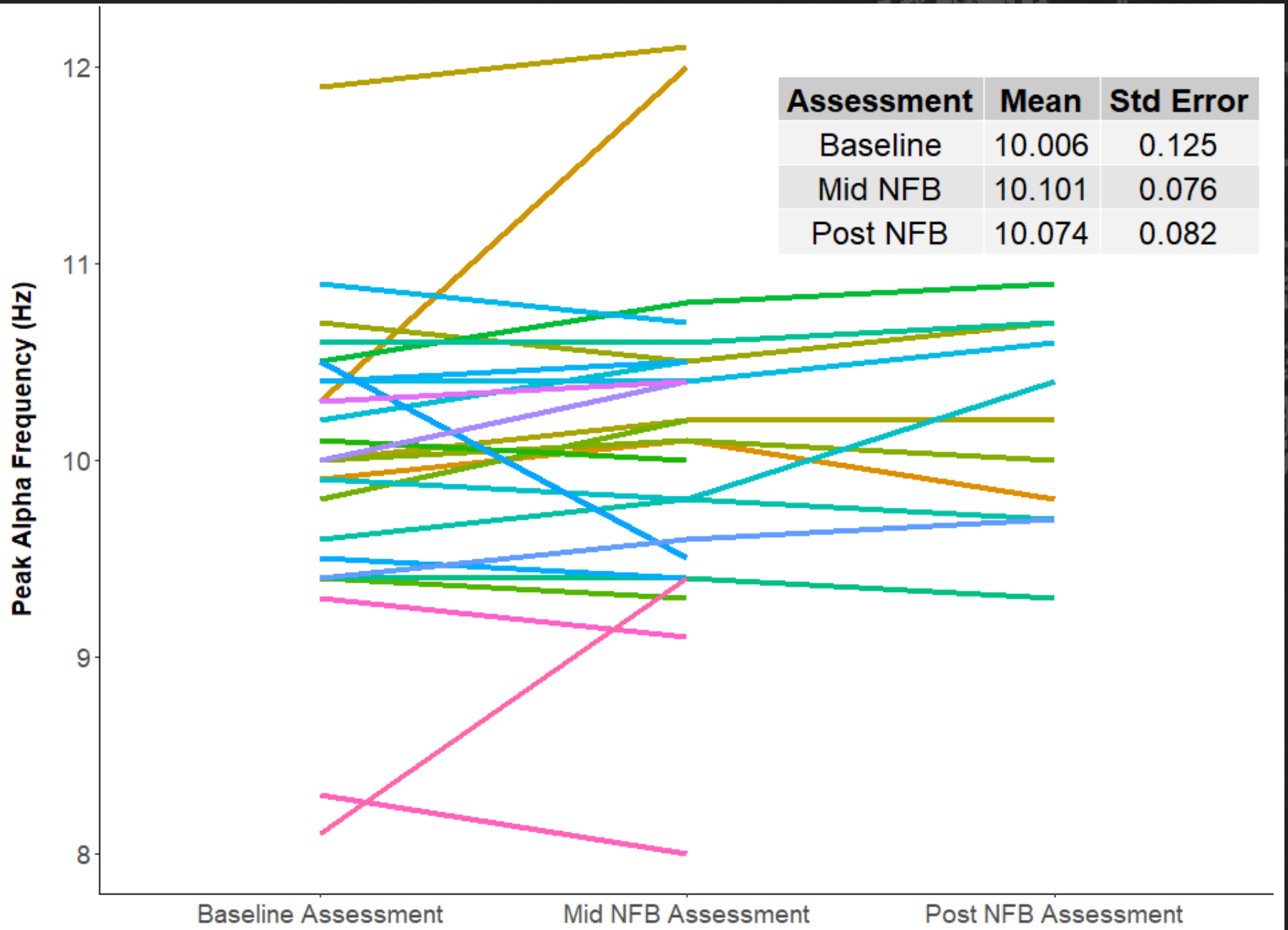


Assessment	Mean	Std Error
Baseline	11.400	0.560
Mid NFB	12.407	0.709
Post NFB	12.056	0.741

Improvements in performance with CNSVS Working Memory sub-tests, especially those with greatest deficit (common complaint).

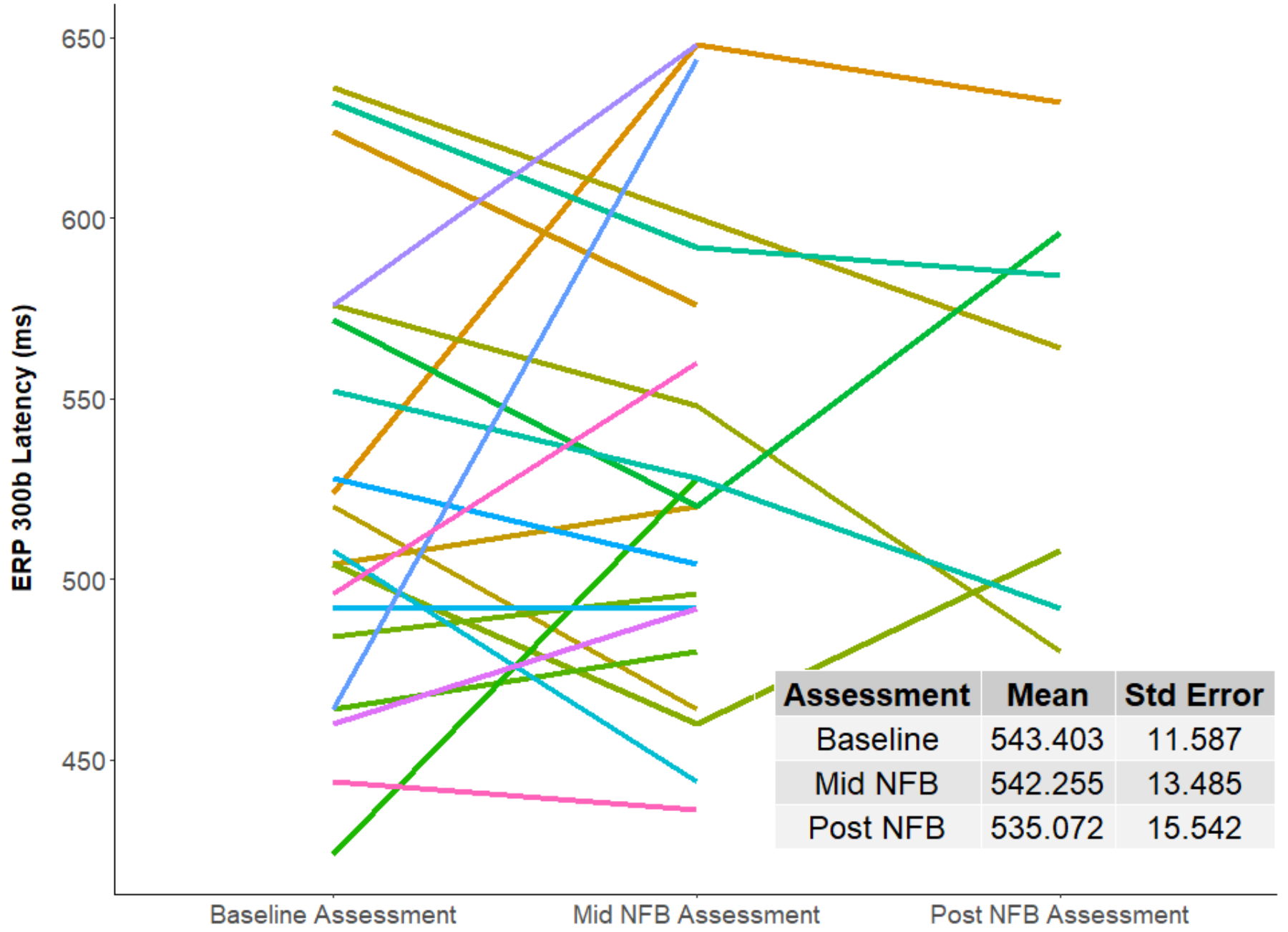
MEMORY & PROCESSING OUTCOME TRACK

Assessment	Mean	Std Error
Baseline	10.006	0.125
Mid NFB	10.101	0.076
Post NFB	10.074	0.082



Peak Alpha Frequency demonstrates the capability to manage larger bits of information more efficiently.

MEMORY & PROCESSING OUTCOME TRACK



Assessment	Mean	Std Error
Baseline	543.403	11.587
Mid NFB	542.255	13.485
Post NFB	535.072	15.542

ERP 300b shows how quickly neural networks are detecting stimuli and transferring information

NEXT STEPS…

- Address Data challenges as Sample size increases
- Analyze type of NFB Intervention to determine Best Practices
- Pair Blast Exposure with SABRES Data
- Pair use of other services with SABRES Data to determine Impacts of Holistic service utilization
- Pilot Study utilizing Mobile NFB devices

CONCLUSION

- Multiple metrics targeting performance outcomes and brain physiology enable a **unique understanding of brain health and performance**
- Metrics validate and **tell the story** of positive shifts and/or cognitive deficits
- Neurocognitive assessment data can be paired with qEEG analyses to detect potential changes in function and **lead to earlier delivery of interventions**
- **NFB is a promising tool** to affect improvements in neurocognitive performance of warfighters
- NFB improves performance on various computer-based neurocognitive assessments, however **more work is needed** to demonstrate the effects of NFB training on operational tasks such as close quarters battle.

QUESTIONS OR FOLLOW-UP…

Amy E Bair, PhD

Amy.E.Bair.ctr@socom.mil

Catherine P Starnes, PhD

Catherine.P.Starnes.ctr@socom.mil

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