

Introduction

- The ability to adapt heart rate via parasympathetic intervention in response to attentive demands is often positively associated with cognitive function, including better processing speed, working memory, learning, and receptive language skills.
- Heart Rate Variability (beat-to-beat variation – HRV) may be a sensitive measure of parasympathetic influence on the heart (Christensen & Wright, 2014; Thayer & Lane, 2009).
- Evidence suggests greater HRV in response to social stimuli is associated with better receptive language ability in children with autism spectrum disorder (Watson et al., 2010; Patriquin et al., 2013), although the relationships are inconsistent across studies.
- The current study is an exploratory investigation to examine if differences in HRV can be detected across cognitive and language tasks within TD children when compared to baseline.

Research Questions

- Do mean HR and/or HRV vary across language, cognitive, and/or metalinguistic tasks when compared to baseline?
- If differences exist, is there a significant relationship between task performance and HR and/or HRV in typically developing children?

Participant Characteristics

- Participants included 10, 5- through 6-year-old typically developing children.

Participants (n = 10)			
	Mean	SD	min-max
Age	6.1	.67	5.1-6.9
Nonverbal IQ ^a	102.56	16.74	83-133
CELF Recalling Sentences ^b	12	2.39	8-15
Sex (M:F) ^c	5:4		
Education ^c			
Some College	1		
Bachelor Degree	3		
Graduate/Professional	5		

^aBased on Kaufman Brief Intelligence Test-2 (KBIT-2) Matrices subtest; standard score, mean = 100 SD = 15; ^bClinical Evaluation of Language Fundamentals (CELF-IV) Recalling Sentences scaled score, mean = 10, SD = 1.5 ^cOne participant did not provide demographic information.

HRV Measurement

- Researchers used the Polar[®] waistband heart rate monitor to collect HRV data.
- This device uses electrodes to measure continuous heart rate.
- Data extracted included R-R interval (time between heart beats in ms—heart rate) and high frequency spectral density (HF FFT—measure of HRV) using Kubios[®] software.

Method

- At the 2016 Minnesota State Fair, children completed the following assessments in random order:
 - Matrices subtest of the Kaufman Brief Intelligence Test, 2nd Edition (KBIT-2, Kaufman & Kaufman, 2004)
 - Recalling Sentences (RS) subtest of the Clinical Evaluation of Language Fundamentals (CELF-4, Semel, E. M., Wiig, E. H., & Secord, W., 2006)
 - Metalinguistic awareness probe
- Metalinguistic probe (Meta probe; right) comprised tasks used by other researchers to evaluate vocabulary and morphology metalinguistic skills.
- Participants also completed ~3 minute baseline activity during which they played a simple game on an iPad and casually conversed with the examiner prior to assessments.
- Of the 200 children who participated, we collected HRV data on 10, 5- to 6- year-old children with the Polar[®] HR monitor.



Task 1: Word Manipulation

- My friend and I are making up a new language. Could this be a gok? Yes it could. What is this?*
- Can you eat a gok?
- Do goks have wheels?



Task 2: Word Swap

- Suppose that everyone in the world agreed that from now on we will call the sun the moon and the moon will be called the sun. All we are going to do is change the names.*
- What would this be? (moon)
- What will the sky look like when you see this? (blue)



Task 3: Wug Task

- I am going to show you some pictures and say some sentences. Sometimes a word will be missing. I want you to tell me the missing word.*
- This is a wug.
- Now there is another one. There are two of them. There are two _____.



Task 4: Grammatical Judgment

- Wobba is a creature from outer space. Sometimes she says things the wrong way. Sometimes she says things that are silly. You need to tell her when she says a sentence the wrong way.*
- Apples grow on noses.
- I have two pencil.

Results

- Baseline vs. Task Comparisons Heart Rate Analyses: Wilcoxon Signed Rank Tests: Mean R-R intervals (ms)

Baseline vs. KBIT

n = 10

- Mean Difference: 15.56
- V = 11
- p = .11

Baseline vs. Meta probe

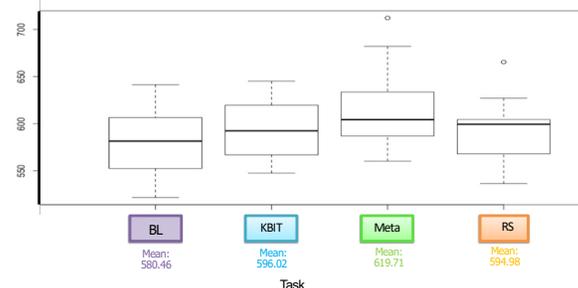
n = 10

- Mean Difference: -24.45
- V = 6
- p = .03*

Baseline vs. Recalling Sentences

n = 10

- Mean: -12.89
- V = -6
- p = .01*



- Baseline vs. Task Comparisons HRV Analyses: Wilcoxon Sign Ranked Tests: Mean High Frequency Activity (HF FFT)

Baseline vs. KBIT

n = 10

- Mean Difference: .01
- V = -31
- p = 0.77

Baseline vs. Meta probe

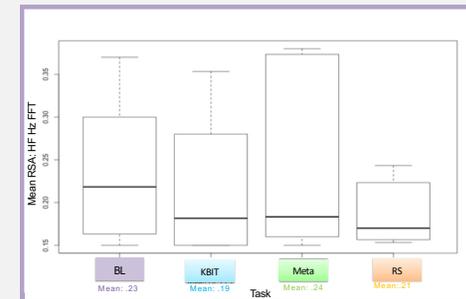
n = 10

- Mean Difference: .02
- V = 25.5
- p = 0.87

Baseline vs. Recalling Sentences

n = 10

- Mean Difference: .05
- V = 39
- p = 0.27



- Non-parametric correlation analyses: Spearman's rho

	Mean RR (all)	Mean R-R @ BL	Mean Hz FFT (all)	Mean Hz FFT @ BL
KBIT	.55	.28	-.16	-.03
Meta	.50	.44	-.09	-.08
RS	.48	.43	-.60	-.39

p: all ps > 0

Conclusions

- The language-based tasks potentially had longer periods between heart beats (slower HR), perhaps reflecting an adaptive response to the task.
- However, measures of HRV (HF FFT) did not reveal significant differences in variability across tasks.
- Measures of HR and HRV not closely associated with task performance based on correlational analyses in our sample.

Limitations and Future Directions

- The sample size of 10 with missing data for two participants on task performance limits our findings, as well as the novel/unfamiliar environment of the state fair.
- Future studies should examine more precise measures of language and cognition.

Key References

- Christensen, S. C., & Wright, H. H. (2014). Quantifying the effort individuals with aphasia invest in working memory tasks through heart rate variability. *American Journal of Speech-Language Pathology*.
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