Heart Rate and Heart Rate Variability as a Measure of Physiologic Response During Language and Cognitive Tasks in Typically Developing Children

Katherine J. Bangert, M.A., CCC-SLP, Lizabeth H. Finestack, Ph.D., CCC-SLP, & John D. Hoch, Ph.D.
University of Minnesota
Department of Speech-Language-Hearing Sciences; Department of Educational Psychology, University of Minnesota

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; Patrinqu 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 compared to baseline.

Research Questions

1. Do mean HR and/or HRV vary across language, cognitive, and/or metalinguistic tasks when compared to baseline?

2. If differences exist, is there a significant relationship between task performance and HRV in typically developing children?

Participant Characteristics

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

<table>
<thead>
<tr>
<th>Participants (n = 10)</th>
<th>Mean</th>
<th>SD</th>
<th>min-max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>6.1</td>
<td>.67</td>
<td>5.6-9.0</td>
</tr>
<tr>
<td>Nonverbal IQ</td>
<td>102.58</td>
<td>16.74</td>
<td>83-133</td>
</tr>
<tr>
<td>CELF Recalling Sentences*</td>
<td>12</td>
<td>2.39</td>
<td>8-15</td>
</tr>
<tr>
<td>Sex (M/F)</td>
<td>5/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education*</td>
<td></td>
<td></td>
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<tr>
<td>Some College</td>
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<td></td>
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<tr>
<td>Bachelor Degree</td>
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<tr>
<td>Graduate/Professional</td>
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</tr>
</tbody>
</table>

*Based on Kaufman Brief Intelligence Test - 2 (KBIT-2) Matrices subtest, standard score, mean = 100 SD = 15; **Clinical Evaluation of Language Fundamentals-4 (CELF-4) Recalling Sentences scaled score, mean= 10, SD = 1.5*. One participant did not provide demographic information.

HRV Measurement

- Researchers used the Polar® wristband 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.

Results

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

- Baseline vs. KBIT
  - Mean Difference: 15.56
  - V = 11
  - p = .11

- Baseline vs. Meta probe
  - Mean Difference: -24.45
  - V = 6
  - p = .03

- Baseline vs. Recalling Sentences
  - Mean: -12.89
  - V = -6
  - p = .01

2. Non-parametric correlation analyses: Spearman’s rho

<table>
<thead>
<tr>
<th>Task</th>
<th>Mean RR (all)</th>
<th>Mean R-R @ BL</th>
<th>Mean HF FFT (all)</th>
<th>Mean HF FFT @ BL</th>
</tr>
</thead>
<tbody>
<tr>
<td>KBIT</td>
<td>0.55</td>
<td>-0.28</td>
<td>-0.16</td>
<td>-0.03</td>
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<tr>
<td>Meta</td>
<td>0.50</td>
<td>-0.44</td>
<td>-0.09</td>
<td>-0.08</td>
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<tr>
<td>RS</td>
<td>0.48</td>
<td>-0.43</td>
<td>-0.60</td>
<td>-0.39</td>
</tr>
</tbody>
</table>

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


Acknowledgments

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