Analysis of Finger Tapping Parameters in People with ADHD

A. Frid, Y. Lavner and I. Rabinowitz

IEEE 27th Convention of Electrical and Electronics Engineers in Israel, Eilat, November 2012
Attention Deficit Hyperactivity Disorder (ADHD)

- Most common childhood psychiatric disorder
- Affecting 4%-12% of 6-12 year-old children
- Up to 65% of cases persist into adolescence
- One of the most common undiagnosed psychiatric disorders in adults
Attention Deficit Hyperactivity Disorder (ADHD)

• Reflected in:
  – Difficulties in timing motor paced tasks
  – Difficulties in attention and impulsiveness

• Recently suggested:
  – Deficit in temporal information processing
  – The attentional-gate model

Frid-Lavner-Rabinovitz (IEEEI 2012)
Spontaneous Motor Tempo (SMT)

• SMT - individual's rate of spontaneous motor functions, such as gait, speech and tapping

• SMT is thought to reflect the pace of an internal attentional timing mechanism, capable of adapting to external temporal events
Detection of the SMT

• Each subject was asked to **tap using his/her index finger of a dominant hand** on a surface, at a regular rate, most comfortable to him/her.

• The tapping duration was **15 sec.**
SMT Analysis System

- **System:**
  - Pressure transducer
  - Data acquisition
  - Signal Processing

- **Analysis**
  - Preprocessing
  - Touch/off detection
  - Statistical Analysis

---

Data Acquisition and Sampling

\[ fs = 1150 \text{ Hz} \]

5-points Median Filtering

Thresholds Setting

Onset and Offset Time Detection

Outliers Removal

Statistical Analysis

\[ \mu_{\text{off}}, \sigma_{\text{off}} \]

\[ P_{\text{cycle}}, C_{\text{off}} \]

\[ \mu_{\text{touch}}, \sigma_{\text{touch}} \]
Finger Tapping Phases

![Finger tapping waveform](image)

- Touch-phase
- Off-phase
- Touch-phase
Closer Look on Tapping Signal

t-off
Experiment and subjects

- Participants: 132 young adults (26.4±5.1 years), 22 were excluded (improper diagnosis or taking methylphenidate (Ritalin))
  
  68 ADHD subjects (26.8±5.8 years)
  41 control subjects (27.8±5.1 years)
## Results

<table>
<thead>
<tr>
<th>Finger tapping parameters</th>
<th>ADHD</th>
<th>Control</th>
<th>$t^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_{touch}$ (t-touch, msec.)</td>
<td>122.3±81.6</td>
<td>120.7±71.5</td>
<td>0.01</td>
</tr>
<tr>
<td>$\sigma_{touch}$ (t-touch std, msec.)</td>
<td>13.0±8.6</td>
<td>10.1±7.3</td>
<td>1.83</td>
</tr>
<tr>
<td>$\mu_{off}$ (t-off average, msec.)</td>
<td>445.0±195.1</td>
<td>439.7±211.4</td>
<td>0.13</td>
</tr>
<tr>
<td>$\sigma_{off}$ (t-off std, msec.)</td>
<td>26.8±14.6</td>
<td>32.6±59.6</td>
<td>0.77</td>
</tr>
<tr>
<td>$\mu_{cycle}$ (whole finger tap cycle, msec.)</td>
<td>567.3±212.4</td>
<td>560.4±230.5</td>
<td>0.16</td>
</tr>
<tr>
<td>$\sigma_p$ (std t-cycle, msec.)</td>
<td>167.5±187.0</td>
<td>172.2±148.4</td>
<td>0.870</td>
</tr>
<tr>
<td>$Cv_{touch}$ (t-touch coeff. of variation)</td>
<td>31.3±14.2</td>
<td>25.4±9.5</td>
<td>*U=942</td>
</tr>
<tr>
<td>$r_{touch}$ t-touch to t-cycle ratio</td>
<td>0.227±0.109</td>
<td>0.234±0.096</td>
<td>0.359</td>
</tr>
</tbody>
</table>

*U=942

Frid-Lavner-Rabinovitz (IEEEI 2012)
Results (cont.)

- t-touch average
- t-off average
- t-cycle (mean rate)
- t-touch coV
- t-off coV
- t-touch to t-cycle ratio
Results (cont.)

• The coefficient of variation of the touch-phase was significantly higher in ADHD subjects compared to control subjects.

• No significant difference was found in: mean rate, rate variability, mean touch phase, mean off-phase or off-phase variability.
Conclusions

• The coefficient of variation of the touch phase was found to be the only parameter that differed between ADHD subjects and controls.

• This parameter was significantly higher in the ADHD group.

• The increased variability in adult ADHD subjects can be interpreted as fluctuations or instability in attention performance, timing performance or both.
Questions for Further Research

• Does the finding also apply to children with ADHD?
• Do other touch phase characteristics such as length of the touch phase differ in children?
• What happens after training?