AQT Cognitive Speed Differentiates Adults with and without ADHD

**Background**

- A **Quick Test of Cognitive Speed (AQT)** – a quantitative timed screening test – investigated potential differentiation of adults with and without ADHD.

- **Objectives:**
  a. Obtain quantitative processing-speed measures of executive functions known to be impaired in ADHD;
  b. Compare pre- and post-medication processing-speed measures to controls;
  c. Evaluate sensitivity and specificity of AQT with ADHD adults.

- **AQT was chosen as it:**
  a. Provides objective, quantitative measures of processing speed (sec.) with rapid naming tasks;
  b. Requires from 3-5 minutes for administration and scoring;
  c. Is a proven candidate for screening for executive-function impairments associated with dementia.

- **AQT features:**
  a. Two single-dimension tests, color (C) and form (F) naming with 40 stimuli each;
  b. One dual-dimension test, color-form combination (CF) naming with 40 stimuli;
  c. C and F measure reaction + retrieval + response times;
  d. CF measures, in addition, ‘switch costs’ and increased demands on attention, working memory, and set shifting;
  e. rCBF and fMRI of normal adults during CF naming show bilateral activation of temporal-parietal and sub-cortical brain regions and hippocampus.

**Methods**

**Participants**

- 30 adults (18 - 43 yr.) referred to a psychiatric center for evaluation of ADHD symptomatology and possible treatment with Methylphenidate.
- 21 met ICD-10 F90.0 (hyperkinetic disturbances) and 9 met F90.9 (hyperkinetic disturbances, unspecified) criteria. None received prescription medication for ADHD at intake.
- 30 age-and sex-matched normal controls, without ADHD symptomatology or other neuro-psychiatric disorders.

**Treatment**

- Treatment concurred with Danish psychiatric practice starting with referral for diagnostic evaluation of possible ADHD based on a psychiatric interview, ICD-10 and ASRS-V1.1 criteria.
- After initial responsiveness to Methylphenidate, dosage was increased and stabilization of ADHD symptoms was determined with each patient's acceptance, shared evaluation and discussion with the psychiatrist.

**Measurements**

- Unmedicated patients completed ASRS-V1.1 at intake and ratings ranged from 22 to 70 points (M = 47.4), indicating likely ADHD (i.e. >20 points).
- AQT C, F, and CF were administered: (a) at intake, without medication, (b) during treatment, and (c) after stabilization of ADHD symptoms with Methylphenidate.

**Results - continued**

- **Two-tailed t-tests, assuming unequal variance, tested significance of overhead (O) differences between ADHD pre- and post-medication (t = 6.80; p < 0.0000, η2 = 0.61) and ADHD post-medication and controls (t = -0.07; p = 0.94).**

- **Figures 2 and 3 show individual naming times for ADHD adults and controls.**

**Figure 1. AQT CF naming times (sec.) for each adult with ADHD without medication (left) and after stabilization of ADHD symptoms with Methylphenidate (right) (n = 30).**

**Figure 2. AQT CF naming times (sec.) for each of 30 adults with ADHD pre- and post-medication with Methylphenidate and 30 normal controls.**

- Sensitivity and specificity evaluated the AQT additive model for differentiating patients with ADHD pre-medication from normal controls (See Table 3). Pass/fail decisions used normative naming-time and overhead criteria for the upper limits of normal performance (+1 SD).
• Overhead, $O = CF - (C + F)$, measured processing efficiency, as norm-referenced in a study with 270 normal adults (ages 18-70 years).
• C, F, CF and O were measured before and after treating adults with ADHD with Methylphenidate and compared to performances by normal controls.
• Psychiatric interviews and AQT were administered concurrently during treatment.
• AQT was administered once to the control group.

Statistical Analysis
One-way ANOVA with post hoc analyses of log-normal measures evaluated C, F and CF differences between (a) ADHD pre- and post-medication, (b) ADHD pre-medication and controls, and (c) ADHD post-medication and controls.

T-tests, assuming unequal variances, compared overhead measures $O = CF - (C + F)$.

Sensitivity and specificity compared individual naming-time measures to criterion-referenced cut-off times (sec.) for normal performance (< +1 SD).

Results
Table 1. Descriptive statistics for AQT naming-times (sec.) for the ADHD group pre- and post-medication and for controls. (No outliers were removed.)

<table>
<thead>
<tr>
<th></th>
<th>Color $M$ (SD)</th>
<th>Form $M$ (SD)</th>
<th>Color-Form $M$ (SD)</th>
<th>Overhead $M$ (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADHD Pre-medication</td>
<td>24.60 (3.98)</td>
<td>30.13 (6.26)</td>
<td>67.93 (10.66)</td>
<td>13.07 (6.92)</td>
</tr>
<tr>
<td>ADHD Post-medication</td>
<td>20.23 (3.14)</td>
<td>22.63 (4.23)</td>
<td>46.07 (7.17)</td>
<td>3.20 (3.92)</td>
</tr>
<tr>
<td>Non-ADHD Controls</td>
<td>20.73 (2.94)</td>
<td>23.53 (3.50)</td>
<td>47.53 (5.82)</td>
<td>3.27 (3.29)</td>
</tr>
</tbody>
</table>

Pre-medication, the F and CF means for the ADHD group were in the slower-than-normal range and overhead (O) in the larger-than-normal range.

Post-medication, ADHD means for C, F, and CF and overhead (O) were in the normal range. (Figure 1 shows changes in CF processing speed).

Control group means were in the normal range.

ANOVA main effects were significant for all ln measures. Effect size was small for C ($\eta^2 = 0.24$) and F ($\eta^2 = 0.33$), and medium for CF ($\eta^2 = 0.59$).

Post-hoc analyses (Tukey HSD) showed significant mean differences between ADHD pre- and post-medication and ADHD pre-medication and controls.

Table 2. One-way ANOVA with post hoc analyses of ln values for AQT measures for 30 adults with ADHD pre- and post-medication and 30 controls.

<table>
<thead>
<tr>
<th></th>
<th>$SS$</th>
<th>$MS$</th>
<th>$F$</th>
<th>$P$</th>
<th>Tukey HSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>2</td>
<td>0.6648</td>
<td>0.3324</td>
<td>13.77</td>
<td>0.0075</td>
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<td></td>
<td>87</td>
<td>2.1005</td>
<td>0.0241</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>1.3749</td>
<td>0.6875</td>
<td>21.21</td>
<td>0.0028</td>
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<td></td>
<td>87</td>
<td>2.8204</td>
<td>0.0324</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF</td>
<td>2</td>
<td>2.7668</td>
<td>1.3834</td>
<td>62.42</td>
<td>0.002</td>
</tr>
<tr>
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<td>87</td>
<td>1.928</td>
<td>0.0222</td>
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<td></td>
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</tbody>
</table>

* Tukey HSD accepted. Abbreviations: C = color; F = form; CF = color-form. Pre = pre-medication; Post = post-medication.

Conclusions
• Findings suggest that the AQT additive model may provide a sensitive quantitative measure for screening for ADHD and monitoring pharmacological treatment effects.
• AQT measurements can indicate when subjects have reached stabilization and normal processing speeds
• AQT single- and dual-dimension processing speed and efficiency were significantly reduced in adults with ADHD before medication, but restored to normal levels after treatment with Methylphenidate.
• A combination of pass/fail for either the AQT dual-dimension or overhead measures or both resulted in high sensitivity (93%) and specificity (100%).
• Findings are preliminary, as data were collected in an outpatient psychiatric practice, without external funding, and procedures were limited by requirements to follow Danish psychiatric practice in a social-medicine environment.

References