Normative data for the Stroop Colour Word Test for a North American population
Sarah A. Morrow, MD, MSc, FRCPC (Neurology)

Background
Selective attention: Ability to focus on what is important by suppressing irrelevant information
- Often affected in MS patients
- Stroop Colour Word Test used to test selective attention
- No up-to-date normative data for an age-appropriate North American MS population
- Stroop thought by some investigators in MS to be a measure of processing speed rather than attention

Objectives
1) To administer Stroop to “normal” healthy controls to determine normal scores
2) To determine if Stroop scores are confounded by processing speed by comparing Stroop performance to scores of Paced Auditory Serial Addition Test (PASAT), and Symbol Digit Modalities Test (SDMT)

Methods
Neuropsychological (NP) Tests administered

Stroop
- 3rd step – interference task
- Ignore written word -- voice colour of ink only
- Reading is an automatic process and difficult to inhibit
- Record correct # of responses in 45 seconds

SDMT
- Valid and reliable measure of processing speed in MS
- Voice number associated with symbol from grid at top of page
- Record correct # of responses in 90 seconds

PASAT
- Measure of processing speed in auditory domain
- Cognitive part of MSFC
- Serial #s heard at 2 or 3s intervals, need to add two consecutive #s

Other Tests
- Beck Depression Index – Fast Screen (BDIFS)
- Fatigue Severity Scale (FSS)
- North American Adult Reading Test (NAART)
- Estimate of baseline intelligence

Statistical Analysis
- Kolmogorov-Smirnov to test normality of data
- Pearson's correlation or one-way ANOVA to examine relationship between cognitive tests
- Z-score = [(X-mean)/SD] X = subject test score m = mean score SD = standard deviation
- If confounder found, regression analysis is used to obtain beta coefficient (b) for Xadj, which is substituted for X
- Xadj = X-b*(subject confounder value – mean confounder value)

Results

SUBJECTS
Recruitment
- Posters in medical clinics and hospital
- Online advertisements
- Social networking sites
Subjects included if
- Age 18-56
- Otherwise healthy
- Vision at least 20/70
- Normal hearing
Medications allowed
- Birth control pill
- Over the counter pain meds (i.e. ibuprofen)
- Thyroid replacement
- For hypertension

Demographics
N=146
Age (years)
Mean ± SD 37.5 ± 10.9
Sex N(%)
Female 100 (68.5)
Male 46 (31.5)
Ethnicity N (%)
Caucasian 131 (89.7)
African Canadian 4 (2.7)
Native Canadian 1 (0.7)
Other 10 (6.9)
Born in Canada? N (%)
Yes 131 (89.7)
No 15 (10.3)
Education (years)
Mean ± SD 14.3 ± 2.1
NAART
Mean ± SD 107.8 ± 7.4
BDIFS
Median (range) 0 (0-8)

Test Mean ± SD KS Confounder? PASAT does not have a normal distribution due to ceiling effect 60 responses
Stroop 45.4 ± 10.5 p=0.98 r=-0.403, p<0.001
SDMT 63.3 ± 9.7 p=0.48 None significant
PASAT 47.6 ± 9.1 p=0.01 None significant
KS = Kolmogorov-Smirnov SD = Standard deviation

Calculating z-score
Step 1: Linear regression
- Age contributed 40.3% of the variance in Stroop scores.
- Mean age = 45.4 years
- Beta coefficient (b) for age = -0.403 (p<0.001).
Step 2: Creating z-score formula
- Unadjusted z-score = [(X-45.4)/10.4]
- Adjusted z-score = [(Xadj-45.4)/10.4]. Xadj = [(X-0.403) (age-37.5)]

STROOP AND PROCESSING SPEED TESTS

<table>
<thead>
<tr>
<th>Test</th>
<th>Mean ± SD</th>
<th>KS</th>
<th>Confounder?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroop</td>
<td>45.4 ± 10.5</td>
<td>p=0.98</td>
<td>r=-0.403, p&lt;0.001</td>
</tr>
<tr>
<td>SDMT</td>
<td>63.3 ± 9.7</td>
<td>p=0.48</td>
<td>None significant</td>
</tr>
<tr>
<td>PASAT</td>
<td>47.6 ± 9.1</td>
<td>p=0.01</td>
<td>None significant</td>
</tr>
</tbody>
</table>

Pearson’s correlation
The Stroop was moderately correlated with both processing speed tests

Comparison in a MS population
- 74 MS patients randomly selected with all three tests and BDIFS ≥ 12
- Classification on NP tests Normal (N): ≥ 1.5
- Abnormal (AN): < 1.5

SDMT N | SDMT AN | PASAT N | PASAT AN
Stroop N 35 21 42 14
Stroop AN 5 13 10 8

Chi-square Analysis
- Abnormal SDMT scores related to abnormal Stroop scores (age adjusted)
  - X² (1, n=74) = 6.61, p=0.01
- Abnormal PASAT scores not related
  - X² (1, n=74) = 2.47, p=0.116

Logistic Regression Analysis
- SDMT accounted for 12.2% of the variation in Stroop scores (R²=0.087)
- PASAT did not significantly contribute to the variance and was not added to the model.

Conclusions
Stroop measures selective attention independently of processing speed. Z-score for Stroop can be calculated using formula above