Construct and predictive validity of the Comprehensive Neurodiagnostic Checklist 10/20 (CNC)

- BSc. N. A. H. Helgers, University of Leiden,
- M.Ed. T. S. Brownback, Brownback, Mason and Associates
- Drs. D. Mulder, Neurofeedback Institute Netherlands
- Drs. W. A. Fonteijn, Neurofeedback Institute Netherlands
Introduction CNC

• Web-based neurodiagnostic questionnaire
• 300 items related to 42 neuropathologies
• Calculates the likelihood of the presence of each neuropathology
• Demonstrates which 10-20 system placement is associated with each neuropathology
• Guides clinical interpretation of the QEEG
• Facilitates best electrode placements for z-score training
The Comprehensive Neurodiagnostic Checklist to the 1020 Power Neuropathology Percentages 10-20 System format (Cortex)

Executive Cognitive Dysfunction _79_
ADD Distractibility _90_

Depression _91_
Inability to Feel Positive Emotions _85_
LD--Language\Speaking _64_
LD--Language\Writing _80_

Impulse Control _70_
Inability to Feel Negative Emotion _76_
Elevated Anger, Rage, Fear _70_
Dissociative Identity Disorder _67_

Hyper\Hypoactivity Disorder _73 / 97_
Motor Dysfunction--Fine and Gross _84 / 50_

All scales are derived from Manual 3 of the Brownback, Mason and Associates Neurofeedback System (BMANS)
The Comprehensive Neurodiagnostic Checklist to the 1020 Power Neuropathology Percentages 10-20 System format (Cortex)

**Learning Disabilities**

- Language/Listening: 43
- Language/Listening, Perception: 50
- Language/Listening, Comprehension: 94
- Sound/Voice, Perception: 56
- Sound/Voice, Comprehension: 63
- Comprehending Social Cues Dysfunction: 65
- Mathematics: 74
- Spatial/Facial, Perception: 46
- Spatial/Facial, Comprehension: 62

All scales are derived from Manual 3 of the Brownback, Mason and Associates Neurofeedback System (BMANS)
The Comprehensive Neurodiagnostic Checklist to the 1020 Power Neuropathology Percentages 10-20 System format (Limbic System-Deeper Structures)

- Obsessive Compulsive Disorder: 62/94
- Oppositional Defiant Disorder: 75
- Addiction: 93

Memory Dysfunction--Auditory, Language\Listening: 68

Emotional Disorder, Social: 94

Memory Dysfunction--Auditory, Sound\Voice: 35

Emotional Disorder, Primary: 82

All scales are derived from Manual 3 of the Brownback, Mason and Associates Neurofeedback System (BMANS)
Generalized Anxiety Disorder 98
Sleep Disorder 85/100

All scales are derived from Manual 3 of the Brownback, Mason and Associates Neurofeedback System (BMANS)
Dysfunctional Microvoltages, Peak Frequencies, Asymmetries and Coherences Associated with 10-20 System Placements for the Diagnosis of Attention Deficit Disorder

Microvoltage Excess and Microvoltages Deficit (Dysfunctional Patterns are Reference Database Driven)
Study design and aim

• Evaluation of construct and predictive validity of the CNC
  • clinical observational design, syndrome analysis on the sampled clients with the CNC, factor analysis
  • clinical observational design, construct validity of CNC compared with SCL and CBCL
  • pre-experimental design, one group pretest-posttest study design, predictive validity CNC compared with SCL after neurofeedback treatment
Developmental sample

• 1733 clients of Neurofeedback Institute Netherlands
• Male female ratio 2 : 1
• age 6 – 80
• inclusion clients with one or more guided psychosomatic complaints and or clinical diagnosis
Validation sample

- 429 adults, clients of Neurofeedback Institute Netherlands
  - Male female ratio 1 : 1
  - age 18 - 80

- 586 children
  - Male female ratio 4 : 1
  - age 6 – 18

- inclusion clients with one or more guide question and or clinical diagnosis
Procedure

- Clients were invited for Intake at 14 locations of NIN in the Netherlands
- Clients received a link by email to complete the CNC, intake session at NIN, completing SCL and CBCL is filled in by the parents at home
- pretreatment and premeasurement
- neurofeedback treatment ± 25 sessions
- postmeasurement
Figure 1: Systematic overview of the research design of this study, in which P = population, S1 = developmental sample, S2 = validation sample, M1, 2, 3 en 4 = measurement 1, 2, 3 en 4 and “NF treatment” means neurofeedback treatment.
Symptom Checklist (SCL-90)

- Self report inventory to identify psychopathological symptoms
- 90 items
- Dutch version: 9 primary symptoms Anxiety, Agoraphobia, Somatic Complaints, Insufficiency, Sensitivity, Hostility, Sleep, Other and Total Psychoneuroticism Score
- Research shows a reliable and valid inventory (Carlozzi, 2008)
Child Behavior Checklist (CBCL)

- Parent filled inventory
- Behavioural and emotional problems
- 120 items
- Factor analysis: 8 syndromes (Achenbach, 2001)
- Anxious/depressed, Withdrawn/depressed, Somatic complaints, Social problems, Thought problems, Attention problems, Rule-breaking behaviour, Aggressive behaviour, Other problems
Statistical analysis

- Factor analysis, component loads and own value of items on all categories of CNC
  - Cronbach’s alpha is used to optimize CNC
- Multimethod-matrix and pearson moment correlation to analyse construct and predictive validity
  - subscales of CNC compared with subscales of SCL and subscales of CBCL
  - total sum scores
  - multivariate data analysis
Results

- Reliability of CNC
- Construct validity CNC compared with SCL
- Construct validity CNC compared with CBCL
- Predictive validity CNC compared with SCL
Results

• Reliability of CNC
  – n= 1733
  – Cronbach’s alpha: 0.982
  – High reliability

• Principal component analysis
  – 49 components based on ‘eigen-value’ > 1
    (expected 47)
Factor analysis and testing construct bias

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy. 0.963

Bartlett's Test of Sphericity

Approx. Chi-Square 421477.848
df 42486

Sig. 0.000

score above 0.9 is good and indicates that the factor analysis is reliable.
Intern consistency CNC

cronbach's α

category

ADD Distractibility Inattention 0.876
Addiction 0.72
Amotivational 0.868
Asperger syndrome 0.895
Comprehending Social Cues Dysfunction 0.837
Depression 0.856
Dissociative Identity Disorder 0.84
Elevated Anger, Rage, Fear 0.797
Emotional Disorder, Primary 0.76
Emotional Disorder, Social 0.826
Executive Cognitive Dysfunction 0.857
Generalized Anxiety Disorder 0.741
HyperHypoactivity Disorder 0.826
Impulse Control 0.826
Inability to Feel Negative Emotion 0.805
Inability to Feel Positive Emotion 0.51
<table>
<thead>
<tr>
<th>Category</th>
<th>Cronbach's α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Disability--LanguageListening, Comprehension</td>
<td>0.822</td>
</tr>
<tr>
<td>Learning Disability--LanguageReading</td>
<td>0.66</td>
</tr>
<tr>
<td>Learning Disability--LanguageReading, Comprehension</td>
<td>0.773</td>
</tr>
<tr>
<td>Learning Disability--LanguageReading, Perception</td>
<td>0.803</td>
</tr>
<tr>
<td>Learning Disability--LanguageSpeaking</td>
<td>0.801</td>
</tr>
<tr>
<td>Learning Disability--LanguageSpelling, Perception</td>
<td>0.939</td>
</tr>
<tr>
<td>Learning Disability--LanguageWriting</td>
<td>0.931</td>
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<tr>
<td>Learning Disability--Mathematics</td>
<td>0.889</td>
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<tr>
<td>Learning Disability--Somatosensory, Perception</td>
<td>0.583</td>
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<tr>
<td>Learning Disability--SoundVoice (intonation, prosody)</td>
<td>0.898</td>
</tr>
<tr>
<td>Learning Disability--SpatialFacial</td>
<td>0.768</td>
</tr>
<tr>
<td>Learning Disability--SpatialFacial, Perception</td>
<td>0.859</td>
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<tr>
<td>Memory Dysfunction--Visual, LanguageReading</td>
<td>0.833</td>
</tr>
<tr>
<td>Memory Dysfunction--Visual, SpatialFacial</td>
<td>0.803</td>
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<tr>
<td>Motor Dysfunction--Fine and Gross</td>
<td>0.864</td>
</tr>
<tr>
<td>Neurosensory Integration Disorder</td>
<td>0.746</td>
</tr>
<tr>
<td>Obsessive Compulsive Disorder</td>
<td>0.831</td>
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<tr>
<td>Oppositional Defiant Disorder</td>
<td>0.73</td>
</tr>
<tr>
<td>Sleep Disorder (HypoHypersomnia)</td>
<td>0.78</td>
</tr>
</tbody>
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### Construct validity CNC compared with SCL-90

<table>
<thead>
<tr>
<th>CNC</th>
<th>SCL-90</th>
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<tbody>
<tr>
<td></td>
<td>Anxiety</td>
</tr>
<tr>
<td>ADD Distractibility Inattention</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>,631**</td>
</tr>
<tr>
<td>Emotional Disorder, Social</td>
<td></td>
</tr>
<tr>
<td>Executive Cognitive Dysfunction</td>
<td></td>
</tr>
<tr>
<td>Generalized Anxiety Disorder</td>
<td>,586**</td>
</tr>
<tr>
<td>Hypoactivity Disorder</td>
<td></td>
</tr>
<tr>
<td>Impulse Control</td>
<td></td>
</tr>
<tr>
<td>Inability to Feel Positive Emotion</td>
<td>,410**</td>
</tr>
<tr>
<td>Obsessive Compulsive Disorder: Compulsions</td>
<td></td>
</tr>
<tr>
<td>Oppositional Defiant Disorder</td>
<td></td>
</tr>
<tr>
<td>Sleep Disorder: Hyposomnia</td>
<td></td>
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</tbody>
</table>
Construct validity CNC compared with CBCL

<table>
<thead>
<tr>
<th>CNC</th>
<th>CBCL</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Anxious/ depressed</td>
</tr>
<tr>
<td>ADD Distractibility Inattention</td>
<td></td>
</tr>
<tr>
<td>Amotivational</td>
<td></td>
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<tr>
<td>Asperger Syndrome</td>
<td></td>
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<tr>
<td>Depression</td>
<td></td>
</tr>
<tr>
<td>Elevated Anger, Rage, Fear</td>
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<tr>
<td>Emotional Disorder, Social</td>
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<tr>
<td>Executive Cognitive Dysfunction</td>
<td></td>
</tr>
<tr>
<td>Generalized Anxiety Disorder</td>
<td></td>
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<tr>
<td>Hypoactivity Disorder</td>
<td></td>
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<tr>
<td>Impulse Control</td>
<td></td>
</tr>
<tr>
<td>Motor Dysfunction: Gross</td>
<td></td>
</tr>
<tr>
<td>Obsessive Compulsive Disorder: Obsessions</td>
<td></td>
</tr>
<tr>
<td>Oppositional Defiant Disorder</td>
<td></td>
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</tbody>
</table>

Notes: *, ** indicates statistical significance.
Predictive validity CNC compared with SCL n=197

<table>
<thead>
<tr>
<th></th>
<th>SCL-90</th>
<th>total score</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTC</td>
<td>0.484**</td>
<td></td>
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**Note:** The value 0.484** indicates a statistically significant correlation.
Discussion

• Factor analysis extracts 49 components, 47 expected components, 1 general and 1 still to detect
• Reliable instrument with good internal consistency
• Medium to large correlations, which means a good construct validity of the CNC compared with SCL and CBCL
• Large correlation on total scores which means a good predictive validity of CNC compared with SCL
• Further research:
  – On predictive validity on subcategories of CTC is recommended
  – Testing construct bias
Conclusion

• CNC is a useful neurodiagnostic instrument in the neurofeedback practice
• CNC is useful to evaluate treatment outcome
Acknowledgments

• Rado Ionel
• Bernice Tonino
• Bernadet Klaassens
• Ger Loots
• 1793 clients of NIN
• 33 Neurofeedback therapists of NIN
Questions?