GERIATRIC ASSESSMENT IN OT: Psychometrics Of Computer Adaptive Cognitive Assessment

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BACKGROUND OF PROBLEM IN ASSESSMENT...

- Detail neuropsychological assessment
  - Need special training & equipment
  - Time consuming, especially for elderly
    - (Heyn, Tang, Nakamura & Schwartz, 2007)

- Not considering for
  - Item difficulties and
  - Test takers’ ability
Mathematics Examination

1. $8 \times 3 = 24$  
   By Primary 4 student
2. $9 / 3 = 3$
3. $5 \times 6 = 30$
   By K3 student
4. $5 + 7 = 12$

Total Mark = 100
Easy items may provide meaningless information
- extending the time
- exhausting the test taker
Cognitive status itself is not uni-dimensional

- Not a quick reference for decision making
- E.g. Profile score of NCSE
Solution:

Rasch model - a member of Item response theory (IRT)

- Georg Rasch (1961)
- Applied Poisson distribution as a measurement model
- \( \ln(P/1-P) = \text{Person ability - item difficult} \)
- Pull test items into a unidimensional continue linear scale
OTHER PROBLEMS...

- Standardization of administration procedures
- Requirement of specific equipment to conduct the test
- Culture relevance and limited degree of ecological validity
- Learning effect, ceiling and floor effect
Advantages

- assist in recording and scoring examinee responses
- enhance the standardization of admin. procedures
- stop test at right time
- stimulus capacity can be controlled
- random alternative forms
- Efficient by adaptive testing method
Disadvantages

- individual discomfort with computers and consequent awkwardness when dealing with computer
- not take into consideration human-computer interactions
- stimuli through either visual or auditory modalities
  - not allow for the collection of spontaneous verbal responses and eliminate the ability to test verbal functioning
OUR PROPOSED SOLUTION!

Computerized Cognitive Assessment System
WHAT IS CAT?

- is a method of TEST administration procedures by using of COMPUTER
- test items that could ADAPTS to (MATCH with) the examinee's ability level

This type of test namely **Computer Adaptive Testing**
KEY FEATURES OF CCAS

A computerized assessment system which
- considers both test item difficulty and test-taker’s ability
  - presents test items to test takers and will meet their abilities or just a bit challenging to them
- equips with rich multimedia and simulation of real situations
- ensures the accurate administration and scoring system
- provide a linear scaling score for cognitive abilities
SPECIAL FEATURES OF THE CCAS

- Computer Adaptive Testing (CAT)

- Based on item response theory in development (Racsh Model) by
  - pulling all different cognitive aspects into the same linear scale (unidimensional)
  - providing an overall score for cognitive functions
STRUCTURAL FRAMEWORK OF CCAS

1. Cognitive Item Bank stored in Computer
2. Easy
   - Randomly Draw
   - More Difficult

 Patients with Stroke

3. Human Computer Interaction

4. Cognitive Assessment Item in Computer
   - Cognitive Ability

5. Yes
   - Unidimensionalized cognitive items

6. No
   - Item Difficult Stable
   - Correct Response
<table>
<thead>
<tr>
<th>Items Number</th>
<th>Cognitive Aspects</th>
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<tbody>
<tr>
<td>1-3</td>
<td>Working Memory</td>
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<tr>
<td>4-10</td>
<td>Orientation to time</td>
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<td>11-20</td>
<td>Semantic memory</td>
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<tr>
<td>21-27</td>
<td>Calculation</td>
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<tr>
<td>28-30</td>
<td>Visual Recognition</td>
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<tr>
<td>31-40</td>
<td>Abstract Thinking</td>
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<td>41-46</td>
<td>Visual Interference</td>
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<td>47-51</td>
<td>Attention Span</td>
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<td>52-53, 55, 59-62</td>
<td>Executive Function</td>
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<td>Visual Inattention</td>
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<td>56-57</td>
<td>Similarity Categorization</td>
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<td>58</td>
<td>Sequence</td>
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<td>63-65</td>
<td>Memory</td>
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</table>
The objective of this study was to

- Investigate the psychometric properties of the CCAS
**Sampling Criteria**

- **Inclusion Criteria**
  - Age 60 or above
  - Suffered from CVA and confirmed by CT scan
  - Both Hemorrhagic and infraction stroke
  - Medically stable
  - Can follow verbal instruction

- **Exclusion Criteria**
  - Suffered from transient ischaemic attack (TIA)
  - Premorbid diagnosis of vascular dementia or Alzheimer’s disease
  - Uncooperative and unable to follow instructions
  - Visual or hearing impaired
METHODOLOGY

- All data were collected in **sub-acute ward**, **rehabilitation ward** and **geriatric day hospital** of rehabilitation hospitals in HK
  - Subjects in **Sub-acute ward** usually post stroke within **2 weeks**
  - Subjects in **rehabilitation ward** usually post stroke **2 to 8 weeks**
  - Subjects in **day hospital** is post stroke **8 weeks or more**
**DATA COLLECTION PROCEDURE**

- Sign consent form
- Demographic data were collected
- Assessed by MMSE, NCSE, CCAS
- Re-assessed by CCAS within 7 days
RESULTS
<table>
<thead>
<tr>
<th>Item</th>
<th>Measures</th>
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RASCH ANALYSIS

- Analysis by WINSTEPS
  - Person abilities and items difficulty
  - INFIT and OUTFIT mean square
    - 0.5 to 1.5
  - Principle Component Analysis of residual
    - Variance by measure > 60% is good
    - Variance by 1st contrast <3 or < 5% is good

(Linacre, 2006)
RESULT - PHASE II
MNSQ INFIT PLOT OF CCAS ITEMS
RESULT - PHASE II
MNSQ OUTFIT PLOT OF CCAS ITEMS
RESULT - PCA OF RESIDUAL

TABLE 23.2 ICAS

<table>
<thead>
<tr>
<th>TABLE OF STANDARDIZED RESIDUAL variance (in Eigenvalue units)</th>
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<tbody>
<tr>
<td>Empirical</td>
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<tr>
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<tr>
<td>Total variance in observations=</td>
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<tr>
<td>Variance explained by measures=</td>
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<tr>
<td>Unexplained variance (total)=</td>
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<td>Unexplained variance in 1st contrast=</td>
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-4 -3 -2 -1 0 1 2 3 4 5

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</tr>
</tbody>
</table>

COUNT: 2 4 1 2 4 5 1 5473122 12321 2 1 1 1 1
RESULT - VARIABILITY OF CCAS ITEMS

(t = 1.997, p > 0.05; corr = 0.843)

item measure for high MMSE

item measure for low MMSE

R² = 0.7102

(t = 1.997, p > 0.05; corr = 0.843)
## Result

- **Current validity with MMSE and NCSE**

<table>
<thead>
<tr>
<th></th>
<th>CCAS</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE–CV *</td>
<td>0.760</td>
<td>0.000</td>
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<tr>
<td>NCSE–CV</td>
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<td></td>
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<tr>
<td>Orientation*</td>
<td>0.688</td>
<td>0.000</td>
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<tr>
<td>Attention#</td>
<td>0.353</td>
<td>0.055</td>
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<tr>
<td>Comprehension**</td>
<td>0.727</td>
<td>0.000</td>
</tr>
<tr>
<td>Repetition*</td>
<td>0.595</td>
<td>0.001</td>
</tr>
<tr>
<td>Naming*</td>
<td>0.534</td>
<td>0.002</td>
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<tr>
<td>Construction*</td>
<td>0.636</td>
<td>0.000</td>
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<tr>
<td>Memory**</td>
<td>0.530</td>
<td>0.003</td>
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<tr>
<td>Calculation*</td>
<td>0.786</td>
<td>0.000</td>
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<tr>
<td>Similarity*</td>
<td>0.521</td>
<td>0.003</td>
</tr>
<tr>
<td>Judgment*</td>
<td>0.709</td>
<td>0.000</td>
</tr>
<tr>
<td>NCSE–CV Overall (by Rasch analysis)**</td>
<td>0.876</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*p < 0.05; **p < 0.01;
Area under the curve is 0.909, p < 0.001
## Cutoff score and corresponding sensitivity and specificity of the ICAS

<table>
<thead>
<tr>
<th>CCAS score (logits)</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
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</thead>
<tbody>
<tr>
<td>0.8</td>
<td>100</td>
<td>52</td>
</tr>
<tr>
<td>1.47</td>
<td>92.7</td>
<td>56</td>
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<tr>
<td>2.07</td>
<td>87.8</td>
<td>68</td>
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<tr>
<td>2.35</td>
<td>85.4</td>
<td>72</td>
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<tr>
<td>2.79</td>
<td>82.9</td>
<td>88</td>
</tr>
<tr>
<td>2.94</td>
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<td>3.02</td>
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<td>96</td>
</tr>
<tr>
<td>4.54</td>
<td>24.4</td>
<td>100</td>
</tr>
</tbody>
</table>
RESULT - SCREENING ABILITY

- Cut off point at 3.02
- Sensitivity with 80.5%
- Specificity with 96%
  - False positive rate at 4%
- Area under the curve = 0.909, p<0.001
TEST-RETEST RELIABILITY

- Cronbach’s $\alpha = 0.878$, $p < 0.001$ ($n = 66$)

- Correlation test-retest = 0.789, $p < 0.001$ ($n = 66$)
RESULT - A SUMMARY

- Psychometrics of CCAS
- Concurrent validity with MMSE at 0.79; with NCSE ranged from 0.353 to 0.876
- Cut off point at 3.02 with sensitivity at 80.5% and Specificity at 96%
- Internal consistency by Cronbach’s $\alpha = 0.878$
- Test - Retest reliability at 0.789
Sample Size

- Totally have 110 subject, compare total admission stroke case 26,167 in 2008, only 0.4%
- Although power analysis shown that the statistically significance founding was not due to chance
- Not large enough to generalize the result to whole stroke population
- Result refer to stroke survivors with age 60 or above, no information on young stroke survivors
- Further studies on young stroke survivors is needed
CONCLUSION

- Developed and validate the CCAS
  - can now provide an interactive testing environment
  - Can be a quick and informative cognitive assessment for elderly
  - simulates the real life environment during testing
  - having a linear scale that precise monitoring of the progress of stroke patients’ cognitive functions
  - serve as an important outcome indicator for rehabilitation programmes
CONCLUSION

- The study provide preliminary evidence of CCAS to serve as clinical tool
- CCAS is an valid and reliable alternative of cognitive assessment for stroke survivors
- It is not the end but just the beginning of further studies to improve the CCAS
NEXT STEPS

- **Internal**
  - Conduct multi-center study by using ICAS
  - Investigate the application of ICAS in young stroke survivors
  - Investigate the effect of education and depression on the performance in ICAS for stroke survivors

- **External**
  - Investigate the delivery of CCAS through internet
  - Potential for translate the CCAS into other language version
~Q&A~

~Thank you~
REFERENCE