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Development of a computerized adaptive testing for assessing balance function in stroke patients



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Contents

- Why we need to develop a Balance CAT (Computerized Adaptive Testing)?
- Why a CAT is efficient & valid?
- How the Balance CAT was developed
- Results and Implications

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The importance of balance function

- A key component to perform ADL
- An indicator of severity
- An indicator of prognosis

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The importance of measuring balance function

- Assist clinicians in
 - Client management
 - Clinical reasoning
 - Making prognosis
 - Intervention
 - Outcome measurement

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The most commonly used balance scale in research

- The Berg Balance Scale (BBS), 1989
- Berg K, *et al.* Measuring balance in the elderly: Preliminary development of an instrument. *Physiother Can.* 1989;41:304-311.

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Scoring: 0, 1, 2, 3, 4

Item	Description
1.	Sitting to standing
2.	Standing unsupported
3.	Sitting unsupported
4.	Standing to sitting
5.	Transfers
6.	Standing with eyes closed
7.	Standing with feet together
8.	Reaching forward with outstretched arm
9.	Retrieving object from floor
10.	Turning to look behind
11.	Turning 360 degrees
12.	Placing alternate foot on stool
13.	Standing with one foot in front
14.	Standing on one foot

6 6

We have studied the BBS for years

1. Liaw LJ, Hsieh CL, Lo SK, Chen HM, Lee S, Lin JH. The relative and absolute reliability of two balance performance measures in chronic stroke patients. *Disabil Rehabil* 2008;30:656-61.
2. Chien CW, Hu MH, Tang PF, Sheu CF, Hsieh CL. A comparison of psychometric properties of the smart balance master system and the postural assessment scale for stroke in people who have had mild stroke. *Arch Phys Med Rehabil* 2007;88:374-80.
3. Wang CY, Hsieh CL, Olson SL, Wang CH, Sheu CF, Liang CC. Psychometric properties of the BBS in a community-dwelling elderly resident population in Taiwan. *J Formos Med Assoc* 2006;105:992-1000.
4. Chou CY, Chien CW, Hsueh IP, Sheu CF, Wang CH, Hsieh CL. Developing a short form of the BBS for people with stroke. *Phys Ther* 2006;86:195-204.
5. Wang CH, Hsueh IP, Sheu CF, Yao G, Hsieh CL. Psychometric properties of 2 simplified 3-level balance scales used for patients with stroke. *Phys Ther* 2004;84:430-8.
6. Mao HF, Hsueh IP, Tang PF, Sheu CF, Hsieh CL. Analysis and comparison of the psychometric properties of three balance measures for stroke patients. *Stroke* 2002;33:1022-7.

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The BBS NOT often used in clinical settings

- Time-consuming
 - Places burden on patients and clinicians
- Complicated
 - Scoring criteria vary from item to item

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Flaws of balance scales

- Time-consuming
 - Complicated design
 - Redundancy
- Impractical
 - Irrelevant items for extreme patients
- Floor/ceiling effects
 - Imprecise for extreme patients
- Difficult to interpret the score

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Recent advances of assessment theories/techniques

Item Response Theory (IRT)

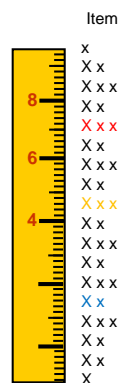


Computerized Adaptive Testing (CAT)

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- Computer-based testing
- Adaptive testing
 - Mainly tested on items with difficulty nearby clients' ability

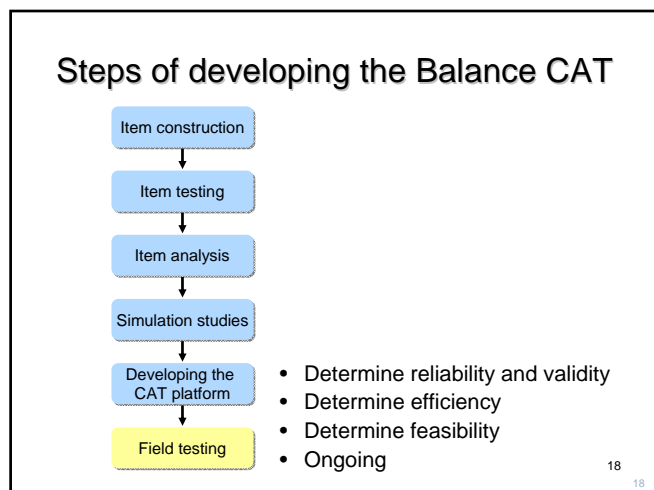
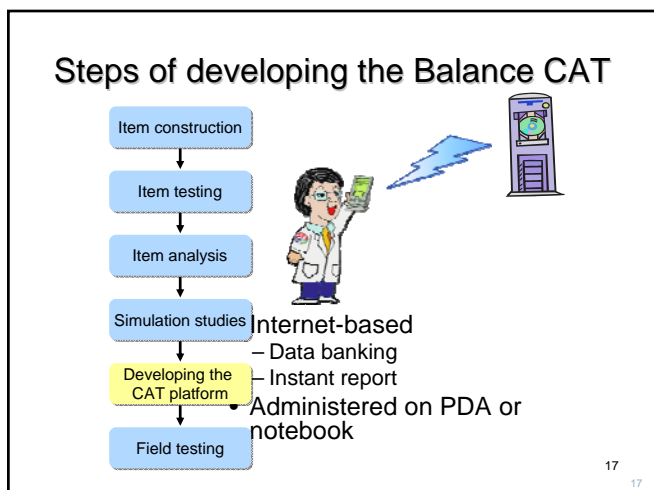
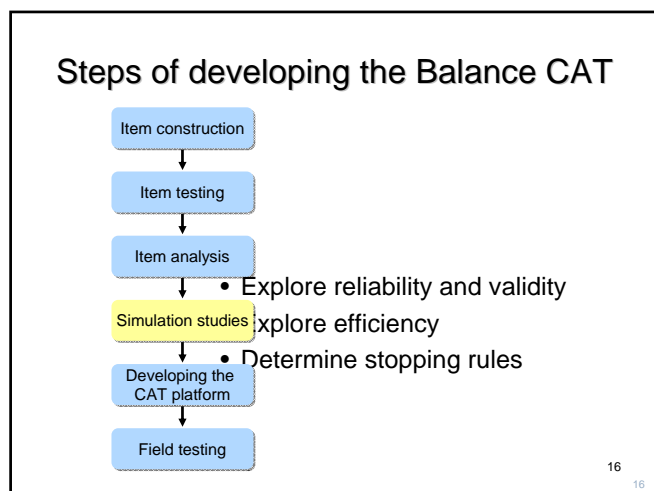
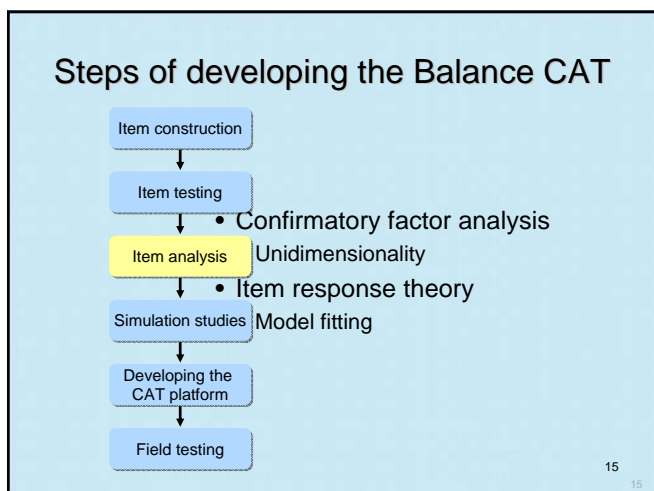
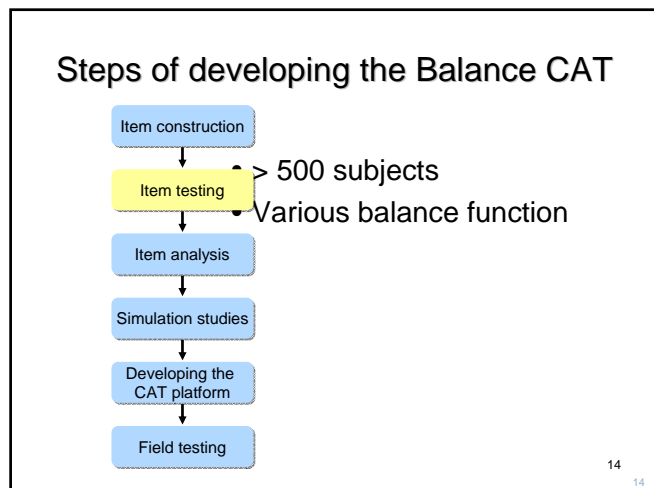
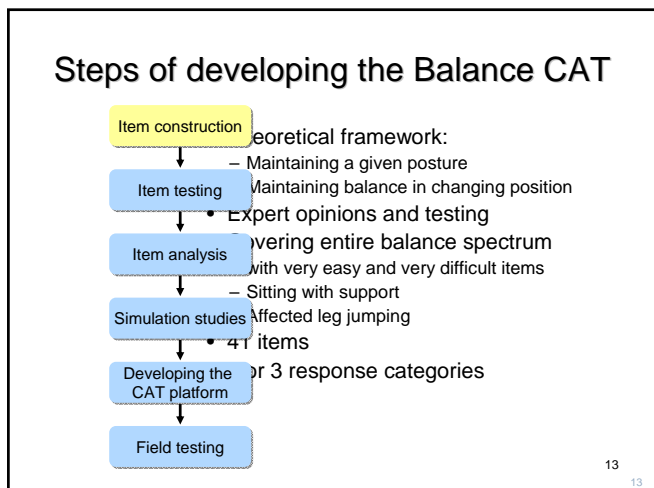


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The Advantages of CAT

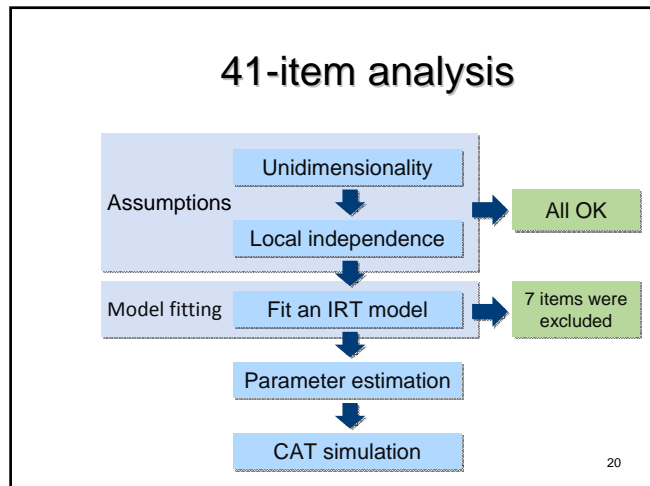
- Provides a precise score for a client with the minimal number of items
 - Precise, valid, and efficient
 - Minimizes floor and ceiling effects
- Provides instant reports to clinicians to speed up decision making
- Data banking/sharing

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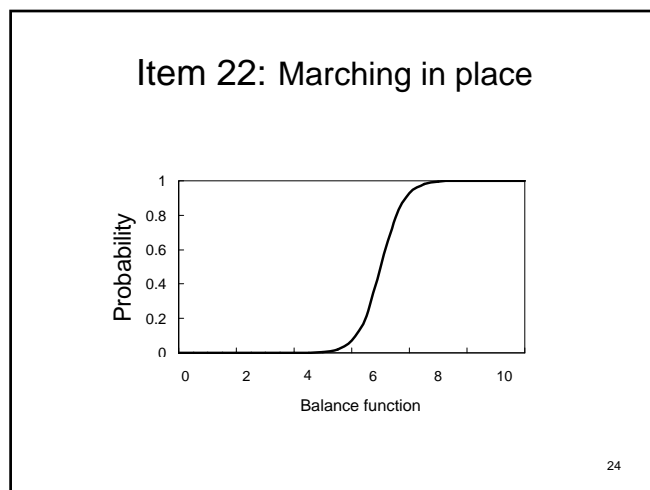
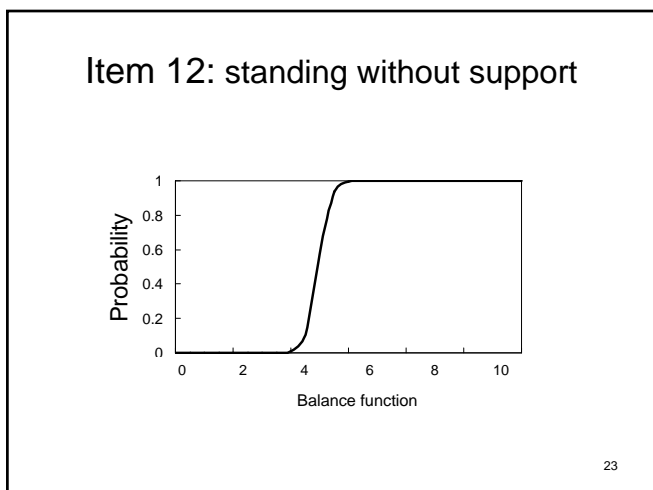
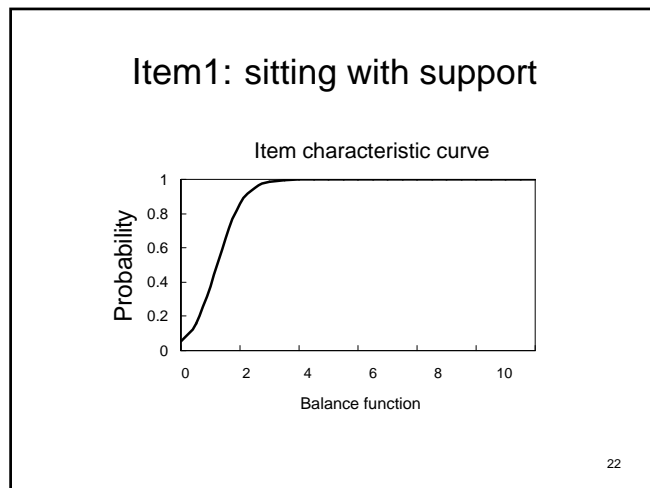


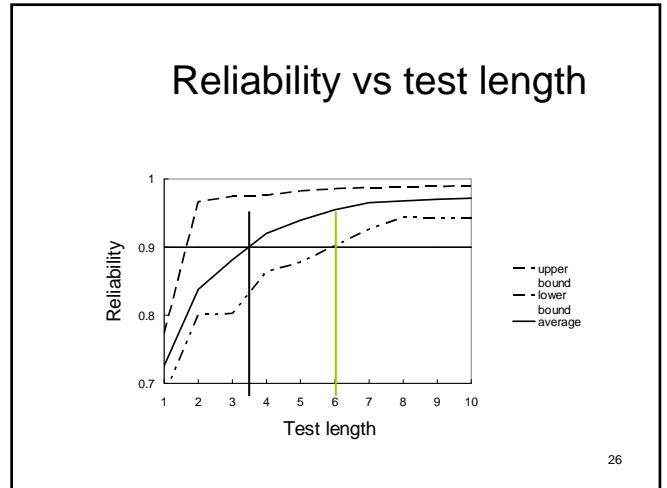
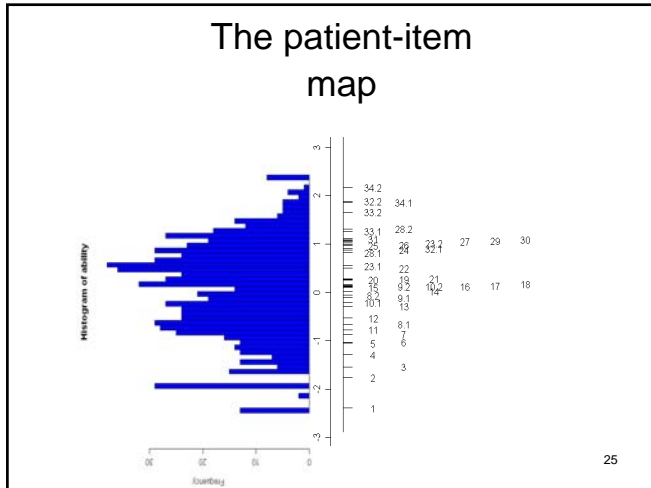
Sample characteristics (N=763)

Characteristic	% or mean (SD)
Age (y) (mean (SD))	61.9 (12.0)
Diagnosis	
Hemorrhage	25%
Infarction	75%
Sex (male/female)	64/36%
Side of hemiplegia (r/l/b)	46/50/4%
Months after stroke at evaluation	6.8 (14.2)



- ### 34 items (2-3 levels) of the item bank
- Sitting with/without support
 - Reaching for a pen*
 - Sitting to standing
 - Sitting to supine
 - Supine to sitting
 - Tapping alternate feet
 - Standing to squatting
 - Squatting to standing
 - Marching in place
 - Jumping vertically with both legs
 - Standing on tiptoe
 - Standing on the unaffected leg
 - Standing on the affected leg
 - Hopping on the unaffected foot
 - Hopping on the affected foot
 - Standing with/without support*
 - Picking up a pen on the floor*
 - Standing heel to toe*
 - Maintaining a stride posture
 - Maintaining a squatting position
 - Turning the body to the affected side
 - Standing with feet together*





Proposed stopping rules for the Balance CAT

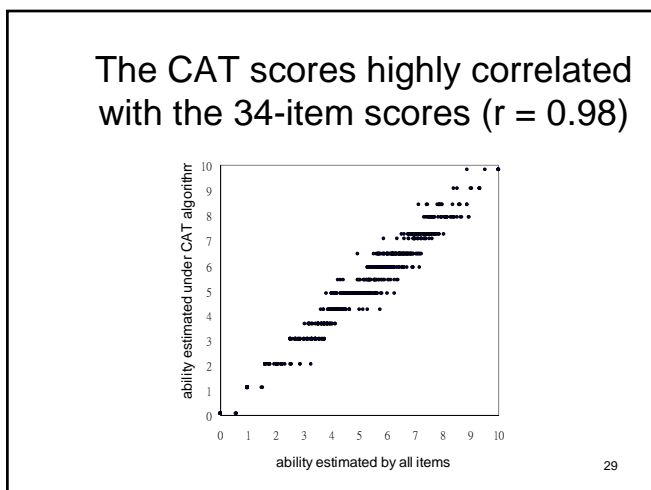
- Reliability > 0.90
- ≤ 6 items

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The Balance CAT is efficient

About 4 items
> 0.9 reliability

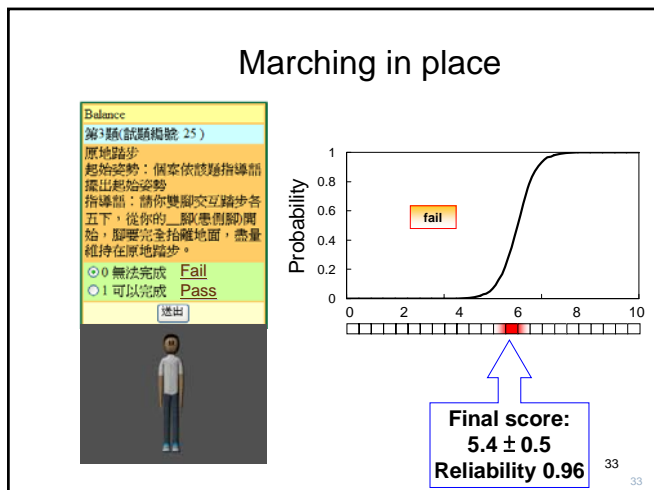
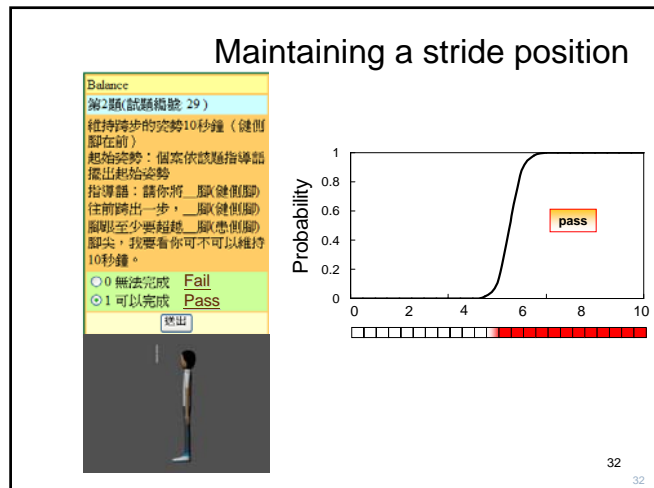
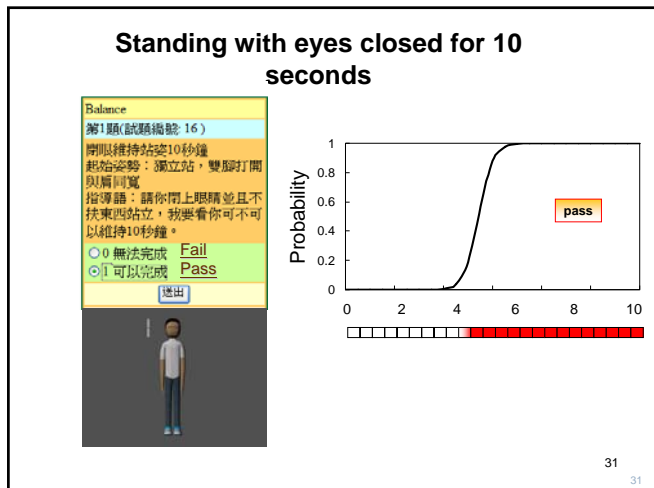
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Real testing using PDA or Notebook

<http://140.112.116.44/cat/>

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- ### Summary: The promising CAT
- Appears efficient, reliable, and easy for interpretation
 - Speeds up clinical reasoning, decision making, and outcome measurement
 - A new generation of measurement tools
 - Benefits patients, clinicians, and researchers
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Questions & Comments

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Results

Balance score	5.39
95% CI upper bound	6.34
95% CI lower bound	4.44
Reliability	0.96

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