



Unité de réadaptation et de médecine physique
Université catholique de Louvain
Cliniques universitaires St-Luc



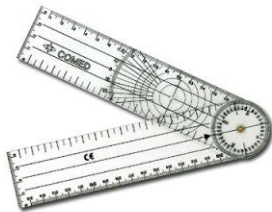
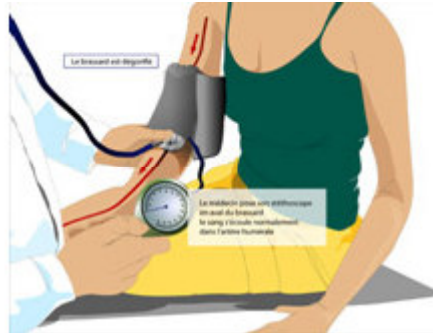
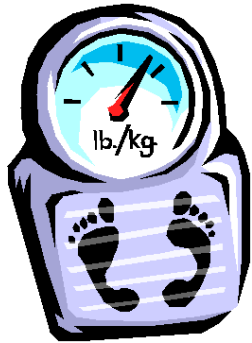
Application of the Rasch model: the **ACTIVLIM** questionnaire

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Institut de Myologie 4 mai 2010

Evaluation in rehabilitation

observable variables



Latent variables

- Anxiety
- Pain
- Manual ability
- Functional Independence
- Quality of life

Evaluation in medicine

Latent variables

How difficult are the following activities?

	Impossible 0	Very difficult 1	Difficult 2	Easy 3
Washing one's face				
Standing up from a chair				
Walking on a level ground				
Walking upstairs				

Evaluation in medicine

Latent variables

How difficult are the following activities?

	Impossible 0	Very difficult 1	Difficult 2	Easy 3
Washing one's face			V	
Standing up from a chair		V		
Walking on a level ground		V		
Walking upstairs	V			

Questionnaire :

Total score

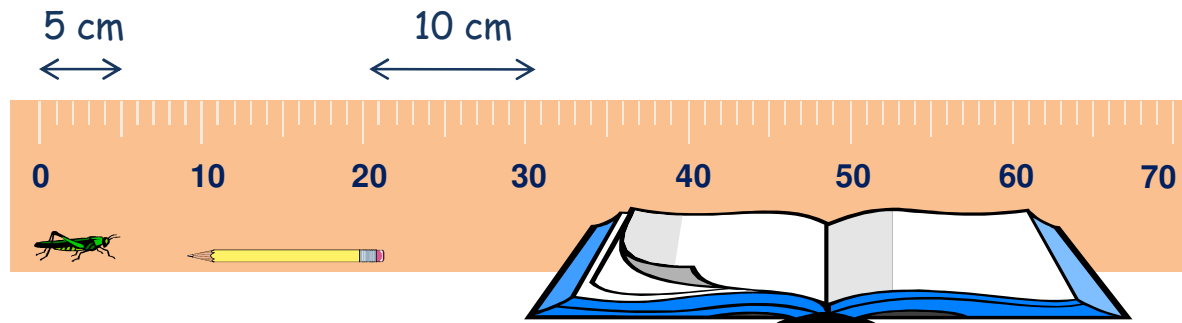
4/12

Ordinal scale

Linear scales

Linearity

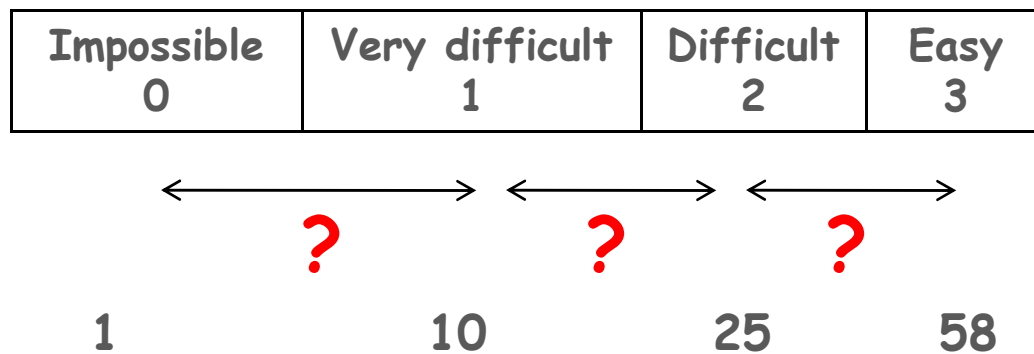
A scale is linear when it has a constant measurement unit so that the distance between each graduation of the scale are equal



Ordinal scales

Linearity ?

Within an item:



Same distance ?

Between items:

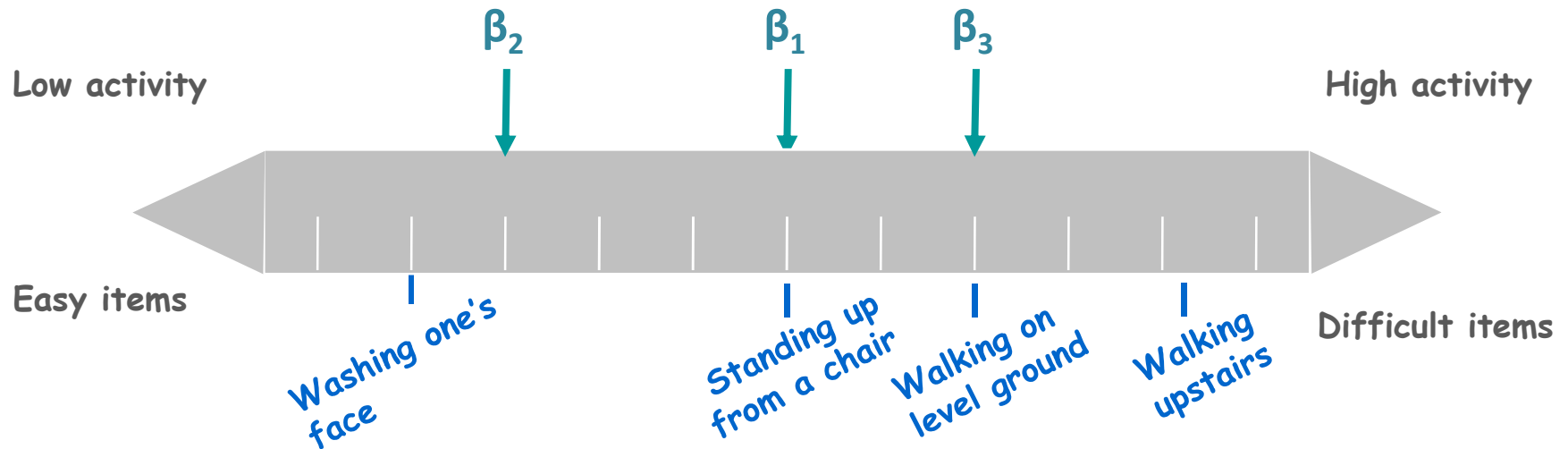
obtaining the same score at different item do not necessarily represent an identical amount of the variable

Standing up from a chair scored 2

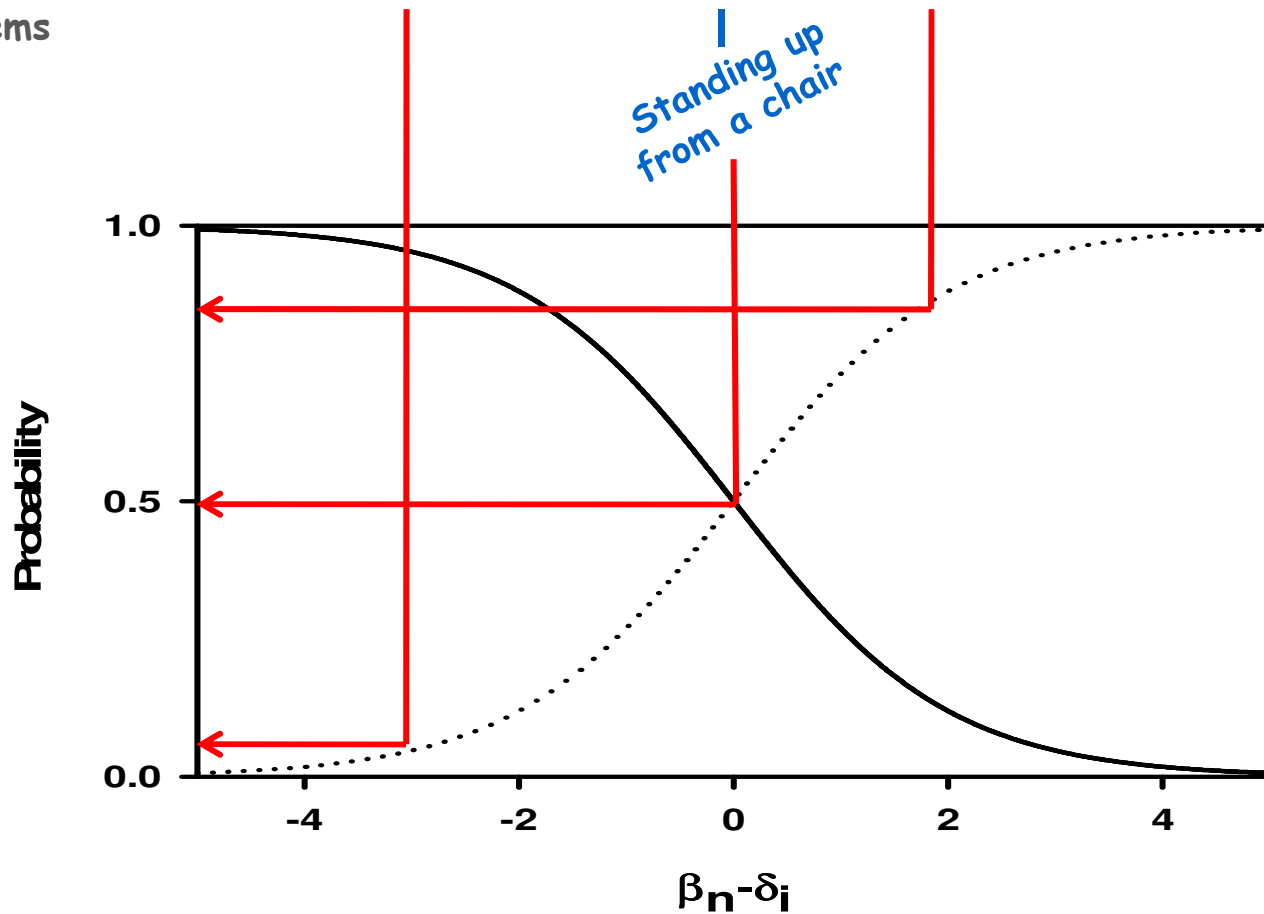
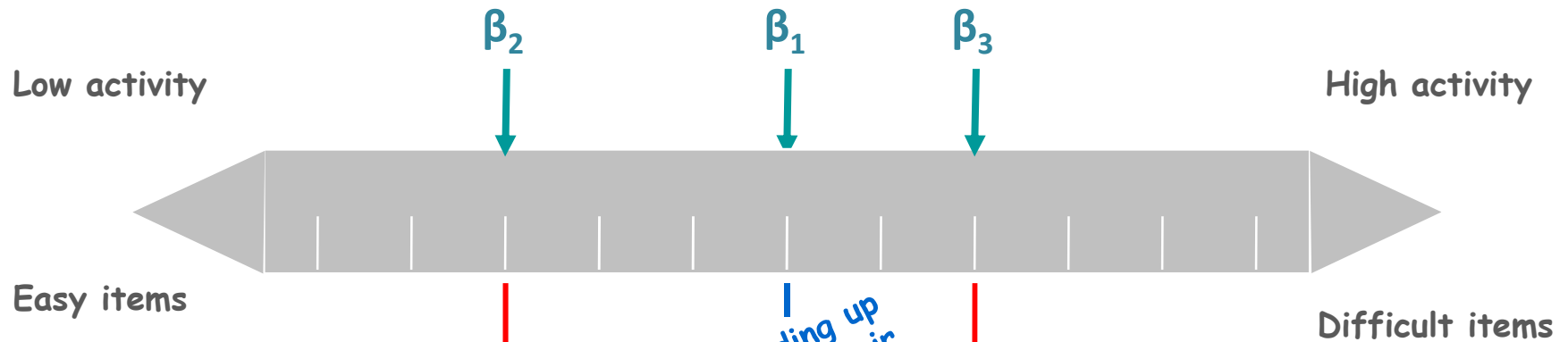
Walking upstairs scored 2

Same weight ?

Rasch model

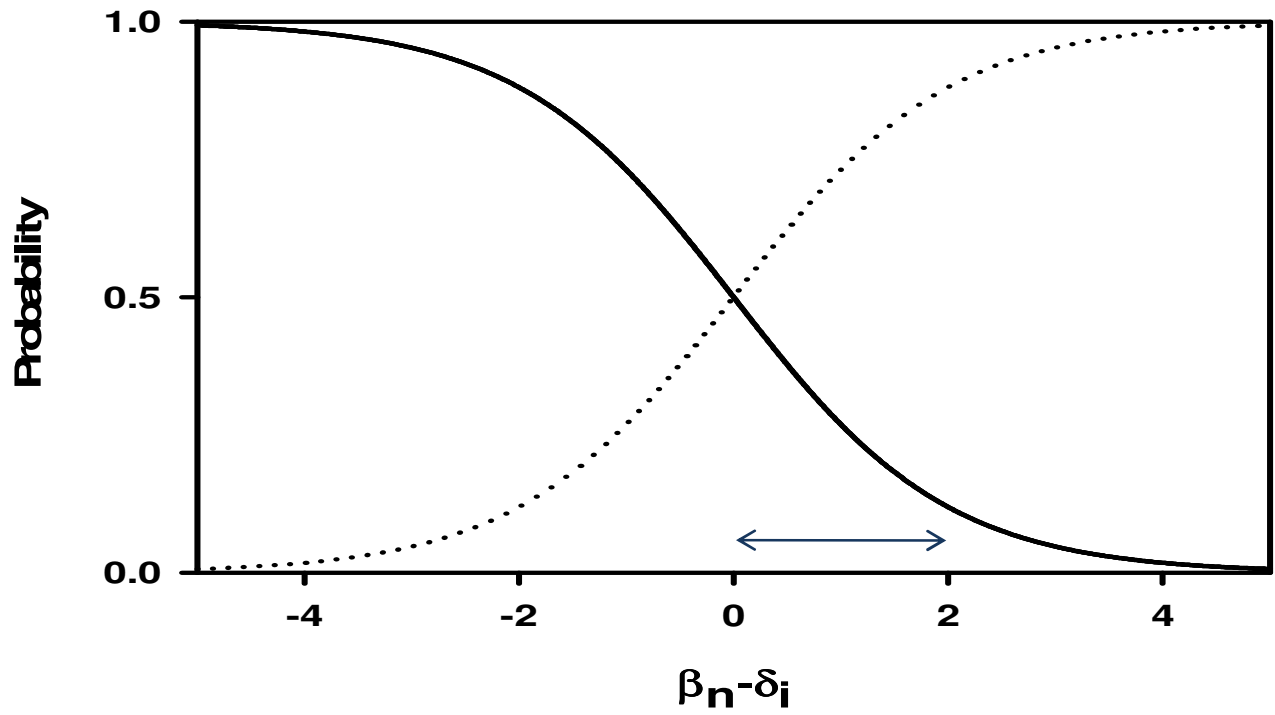
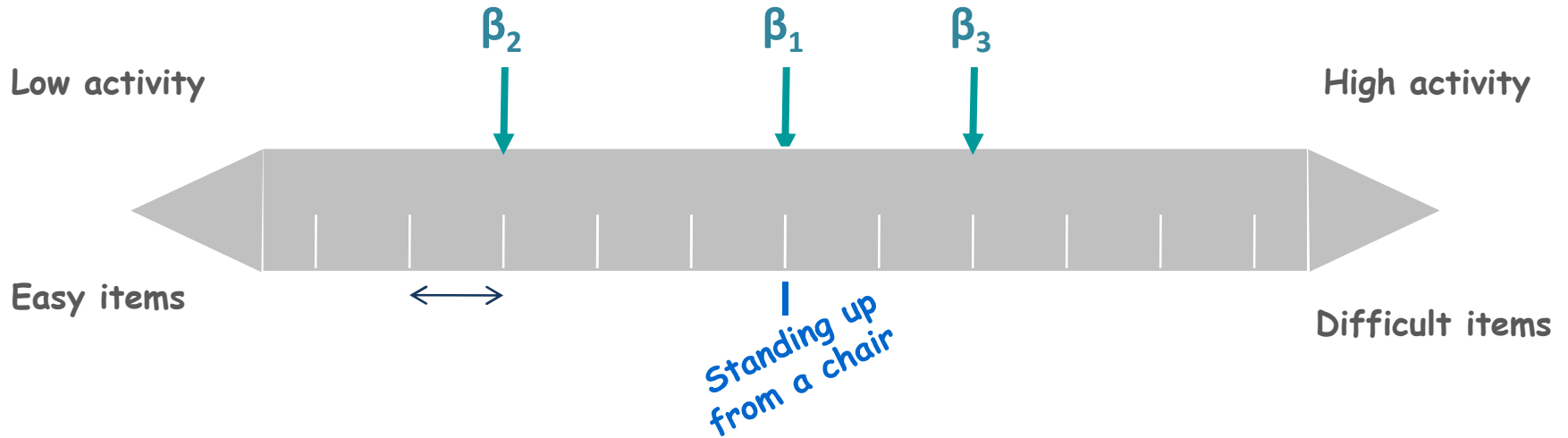


Rasch model



$$p_{ni1} = \frac{e^{\beta_n - \delta_i}}{1 + e^{\beta_n - \delta_i}}$$

Rasch model



measure unit:
logits

Rasch model

1. Transforms ordinal score into linear measures
2. Verifies **unidimensionality** of the scale. A scale is unidimensional when the measure relates only one attribute of the person, unbiased by other qualities either of the patient or the instrument itself.

	Washing one's face	Standing up from a chair	Walking upstairs	Speaking english	Score total
Patient A	1	1	1	0	3
Patient B	1	1	0	1	3
Patient C	0	0	0	1	1
Patient D	1	0	0	0	1

Application of the Rasch model

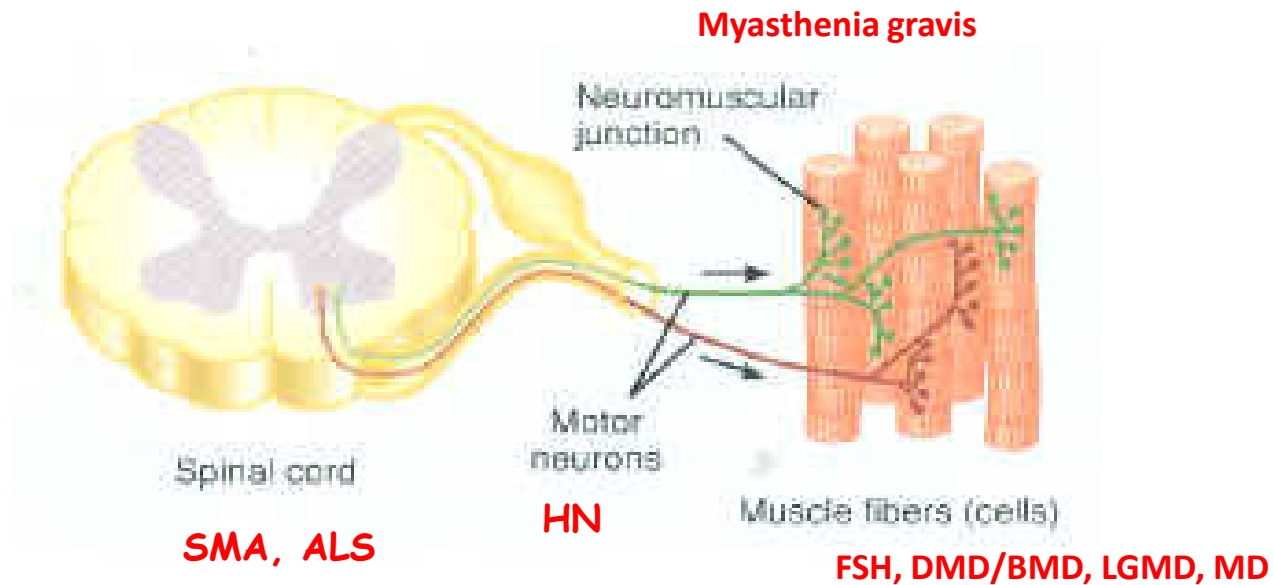
ACTIVLIM: A Rasch-built measure of activity limitations in children and adults with neuromuscular disorders

www.rehab-scales.org

Vandervelde et al, Neuromusc Disord 2007

Neuromuscular diseases

Neuromuscular diseases (NMD) are hereditary or acquired disorders caused by an abnormality of any component of the motor unit



Both adults and children can be affected by NMD

Variable identification

For the NM patients, the most important problems are

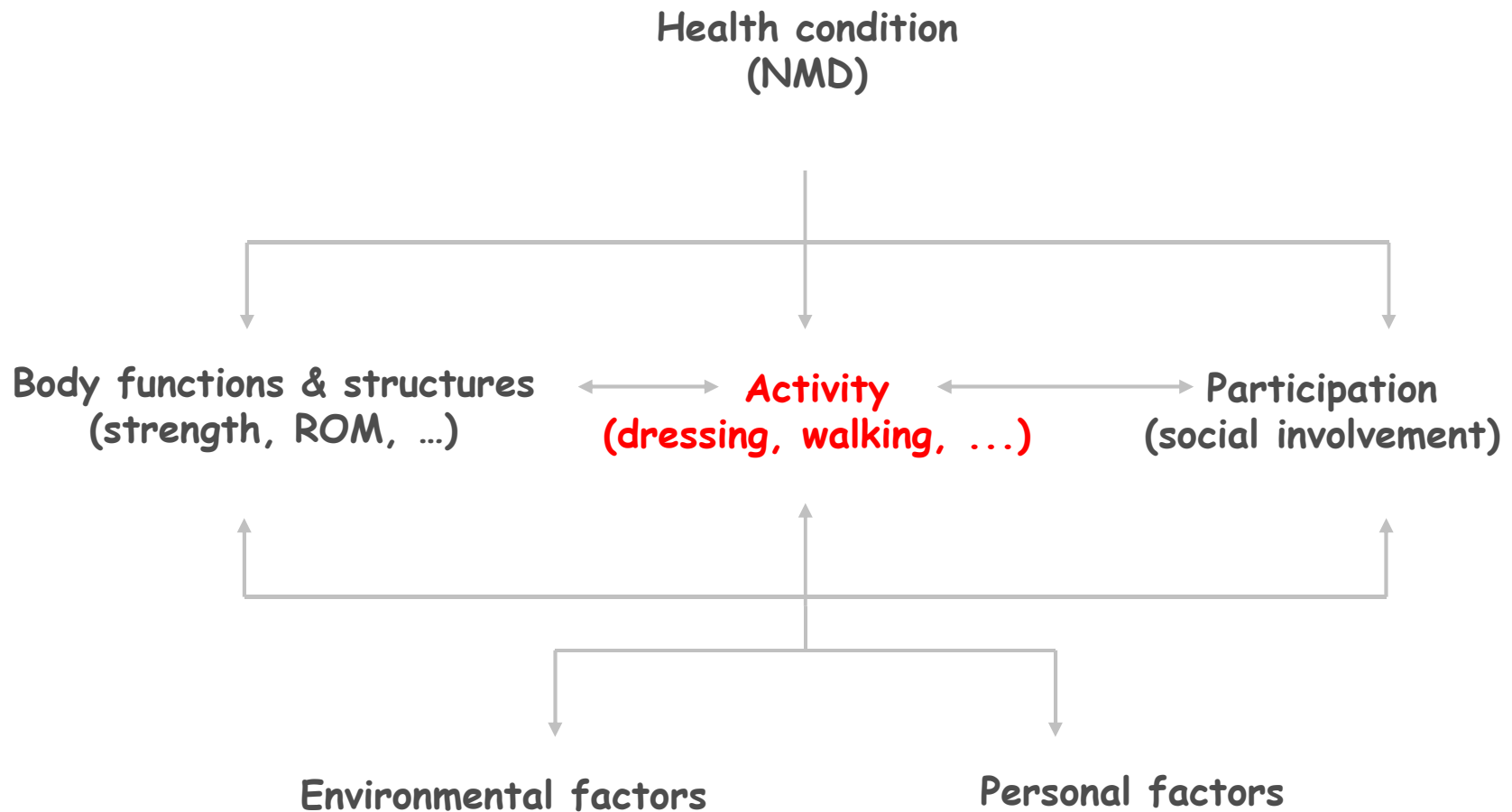
(Mc Donald, Am J Phys Med Rehabil, 2002) :

- Muscle weakness and atrophy
- Fatigue
- Problems in Activities of Daily Living (ADL)
- Inability to exercise

→ Identified variable = **activity limitations**

WHO-ICF

International Classification of Functioning, Disability and Health



Objective

To build a **common measure of activity** in both adults and children with NMD in order to follow patients' evolution across time

To Create a new scale that respects Linearity and Unidimensionality

Sample

		245 adults	124 children
Age		16 - 80 y	6 - 16 y
Gender	Girls	44 %	32 %
	Boys	56 %	68 %
Language	Dutch speakers	42 %	64 %
	French speakers	58 %	36 %
Diagnosis	DMD/BMD, LGMD	15 %	38 %
	HN	16 %	28 %
	MD	17 %	
	ALS	9.5 %	
	FSHD	5 %	
	SMA	5.5 %	11 %
	Others (PPS, CMD, CM, ...)	32 %	23 %

Methods

Questionnaire

126 items including daily activities for children and/or for adults



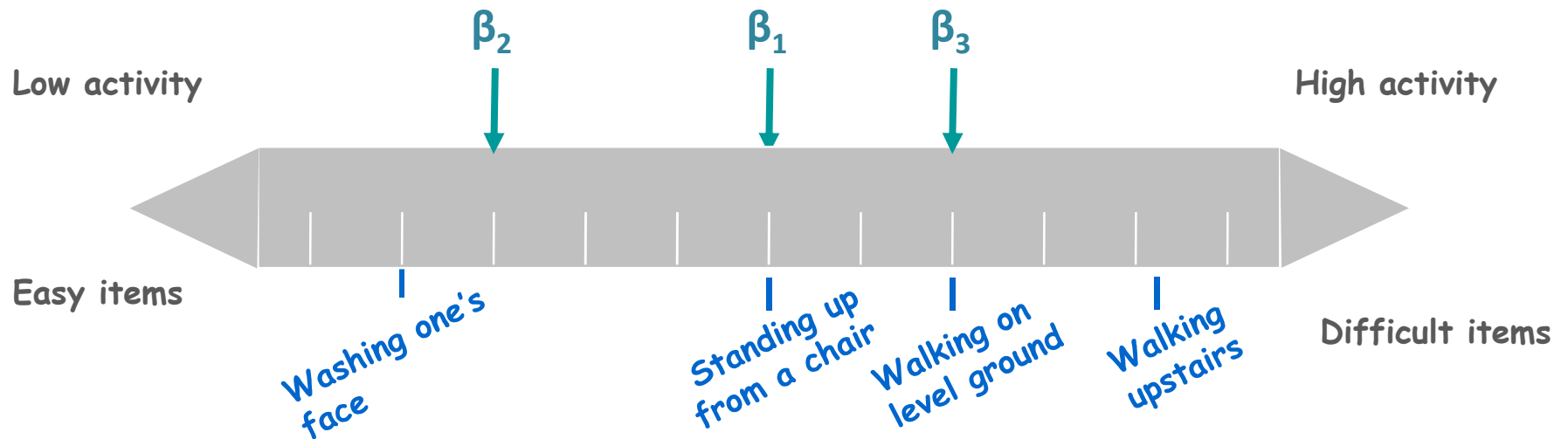
Impossible	/	Difficult	/	Easy	/	?
0	/	1	/	2	/	?

Reproducibility was tested by a second evaluation after 24 ± 9 days

Methods

Data analysis: Rasch model

- psychometrically correct method used to build a rating scale from well-established criteria



Logiciel : RUMM

Methods

Calibration

To avoid that adults responses have a decisive influence in scale calibration, adult sample was divided into 2 stratified samples.

Calibration: 123 adults + 124 children (sample 1)

Validation: 122 adults + 124 children (sample 2)

Item selection

1. **Ordered rating scale**

2. Rating scale model

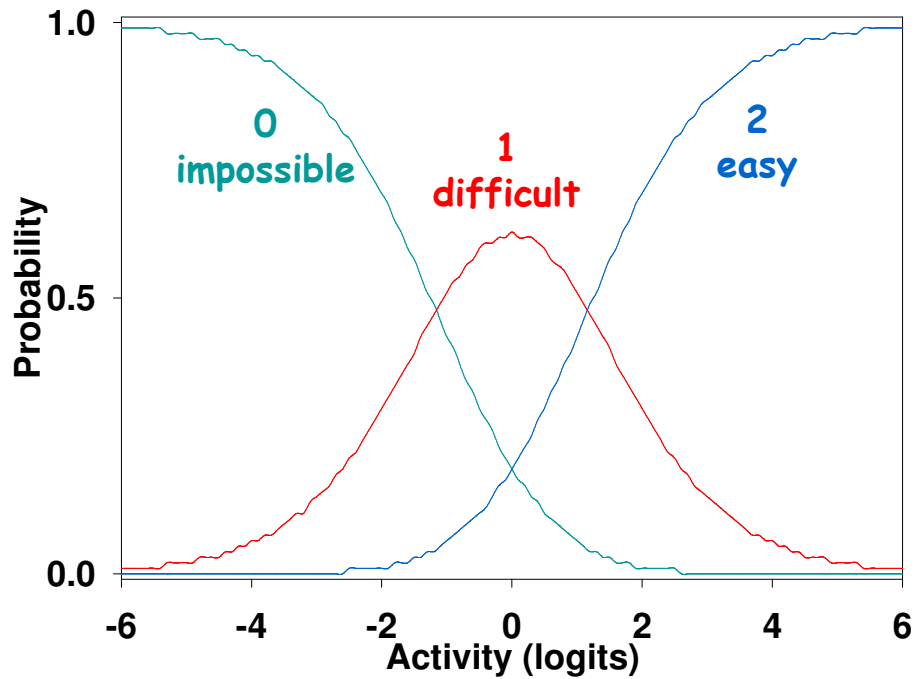
3. Unidimensionality

4. Invariance

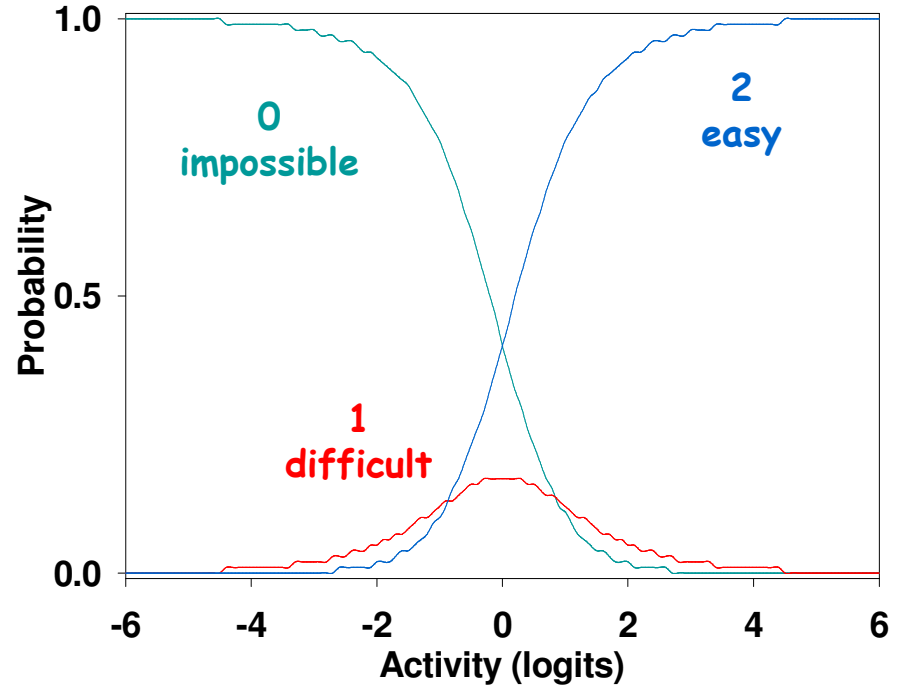
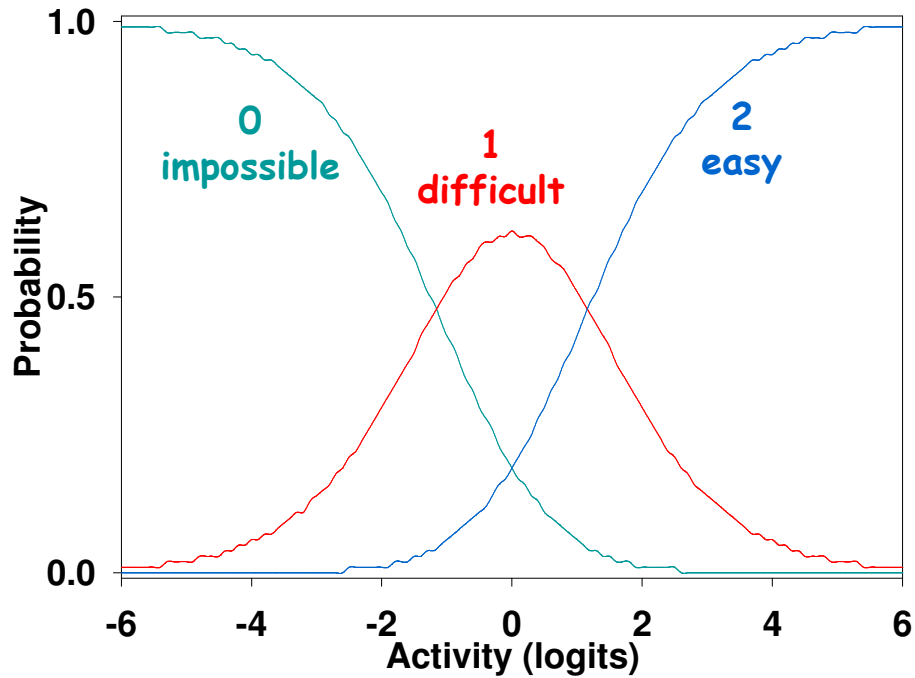
5. Redundancy

An ordered rating scale

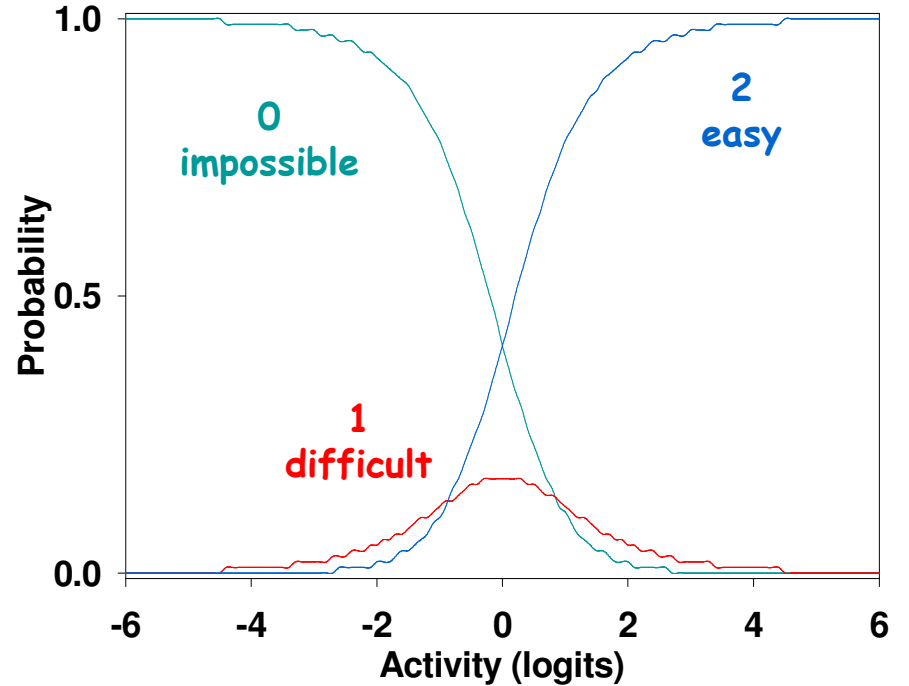
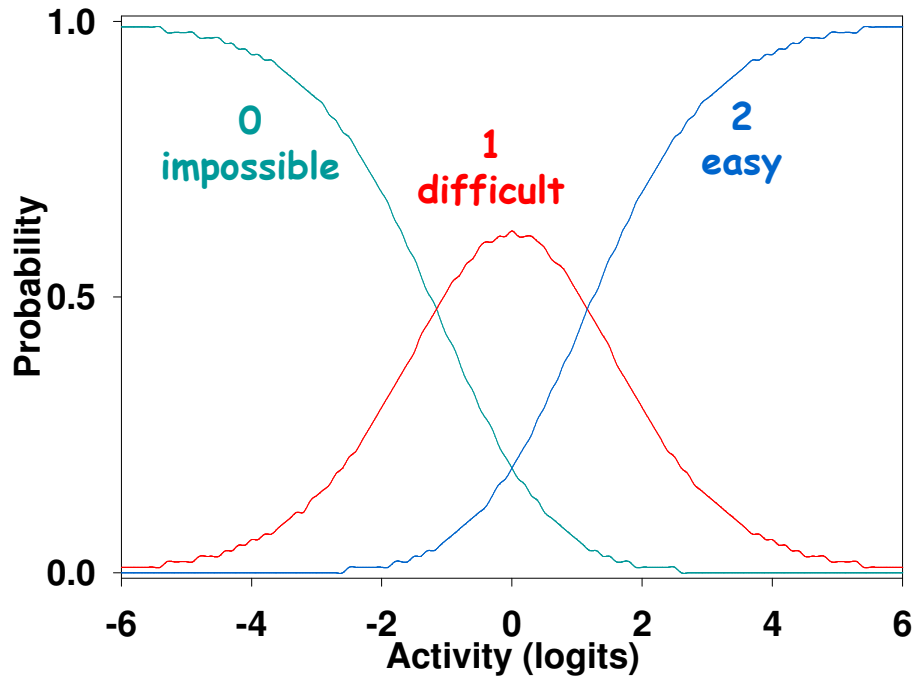
Impossible	/	Difficult	/	Easy	/	?
0	/	1	/	2	/	?



An ordered rating scale



An ordered rating scale



- 7 items

Item selection

1. Ordered rating scale

2. Rating scale model

3. Unidimensionality

4. Invariance

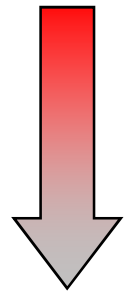
5. Redundancy

Rating scale model

Partial Credit

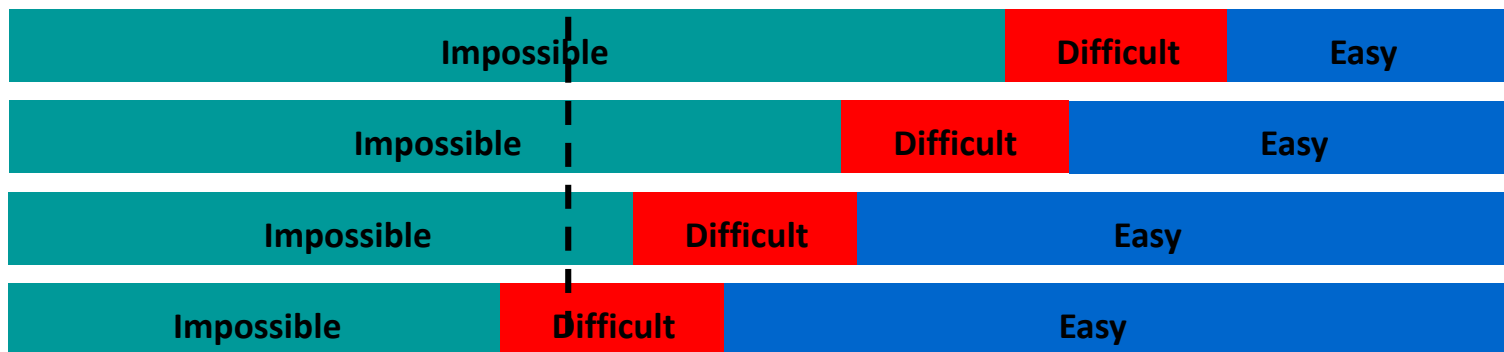


More difficult



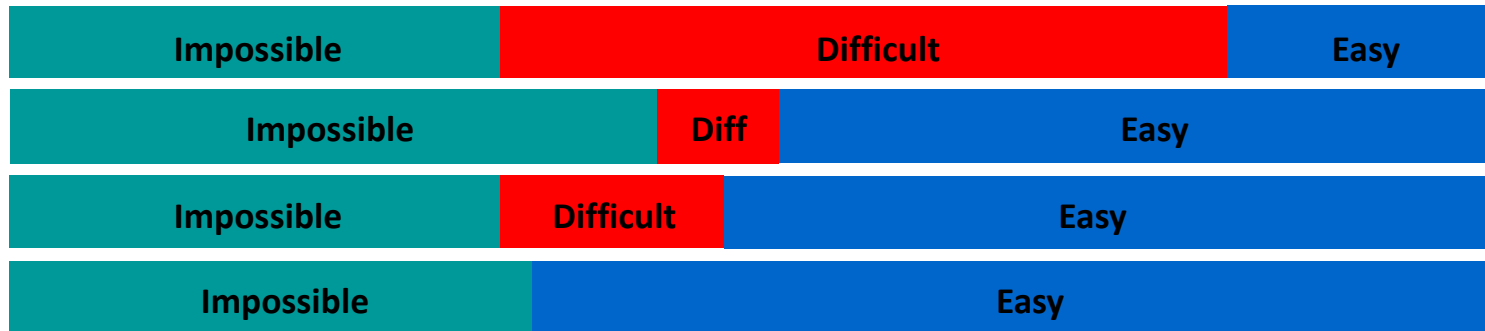
Less difficult

Rating scale



Rating scale model

Partial Credit

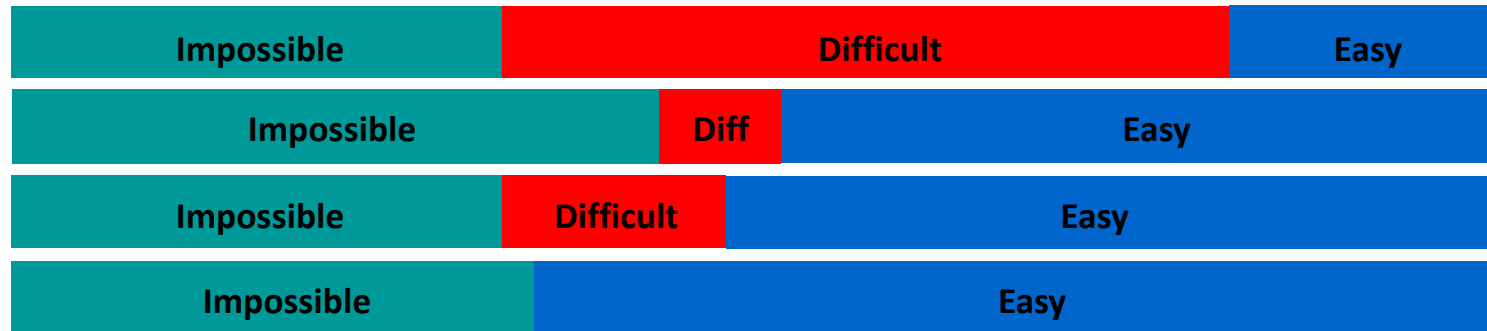


Mean spread difficult ± 2 SD

- 14 items

Rating scale model

Partial Credit



Mean spread difficult ± 2 SD

- 14 items

Discrimination adults vs children: t-test ($p = 0.86$)

→ A single rating scale model for both adults and children

Item selection

1. Ordered rating scale

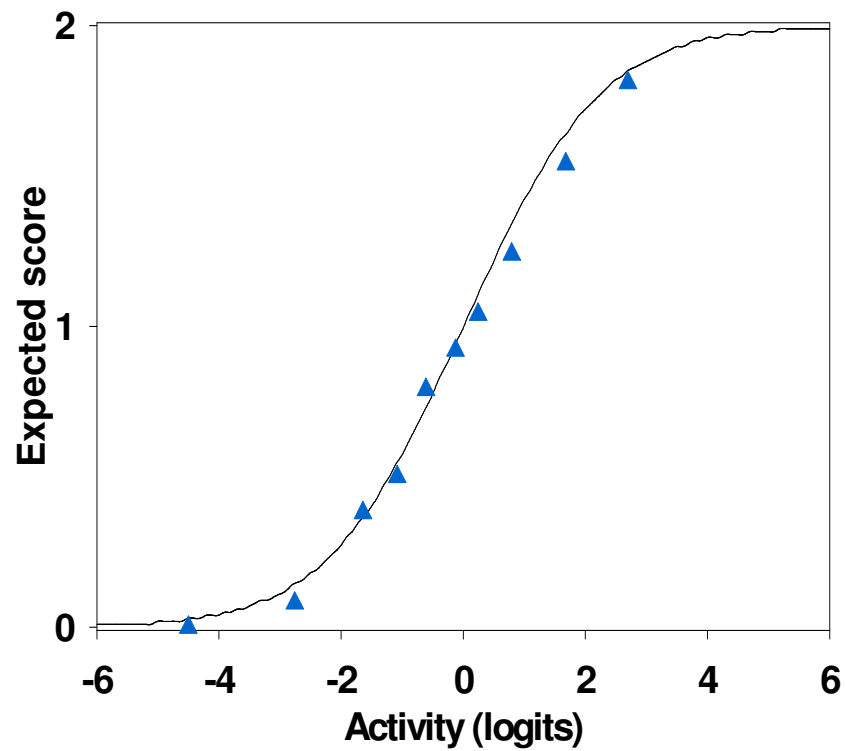
2. Rating scale model

3. Unidimensionality

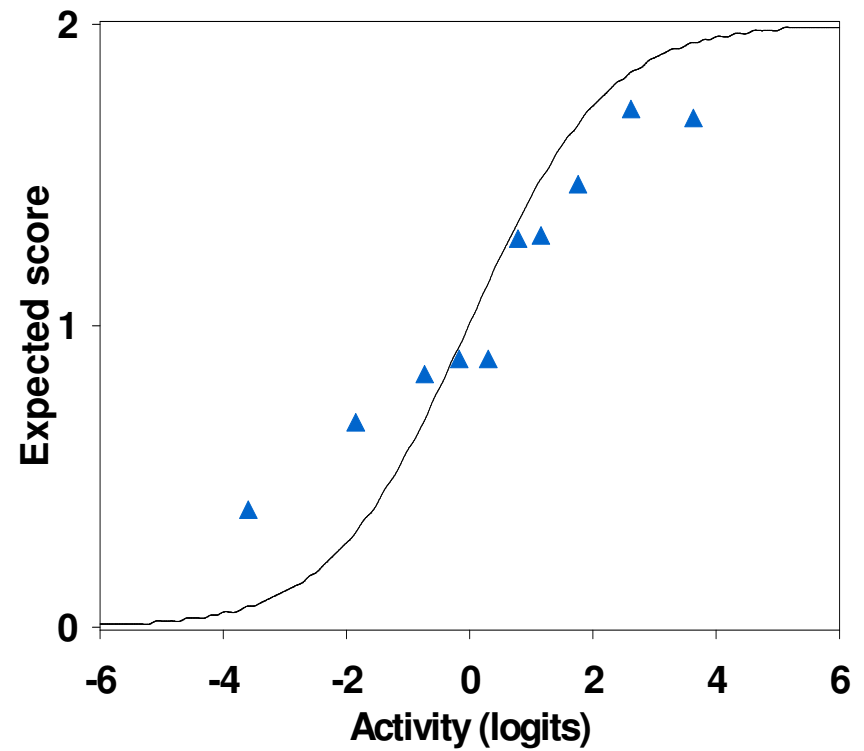
4. Invariance

5. Redundancy

Unidimensionality

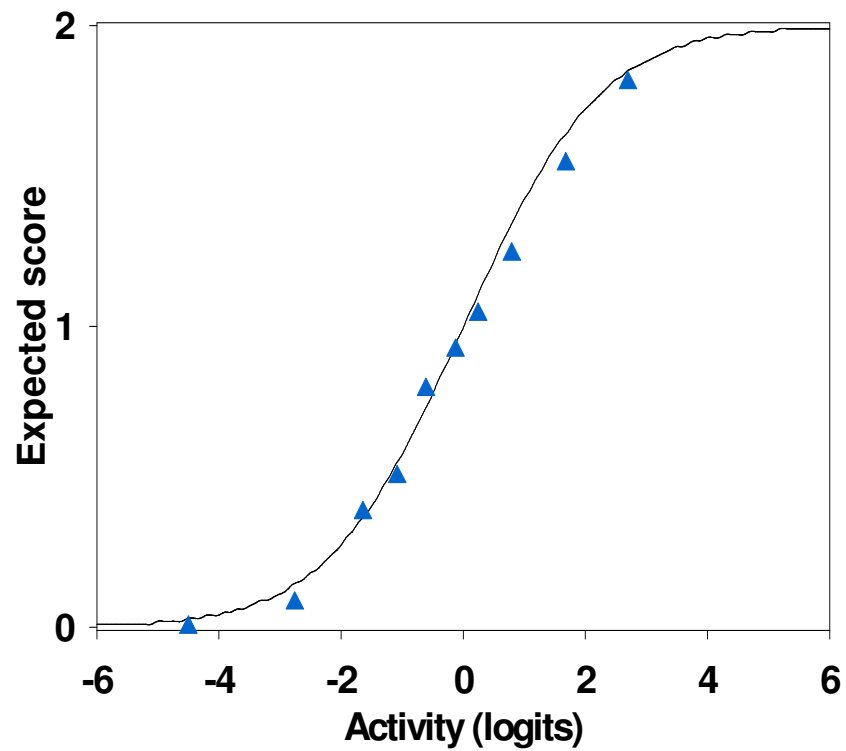


Example: Walking upstairs

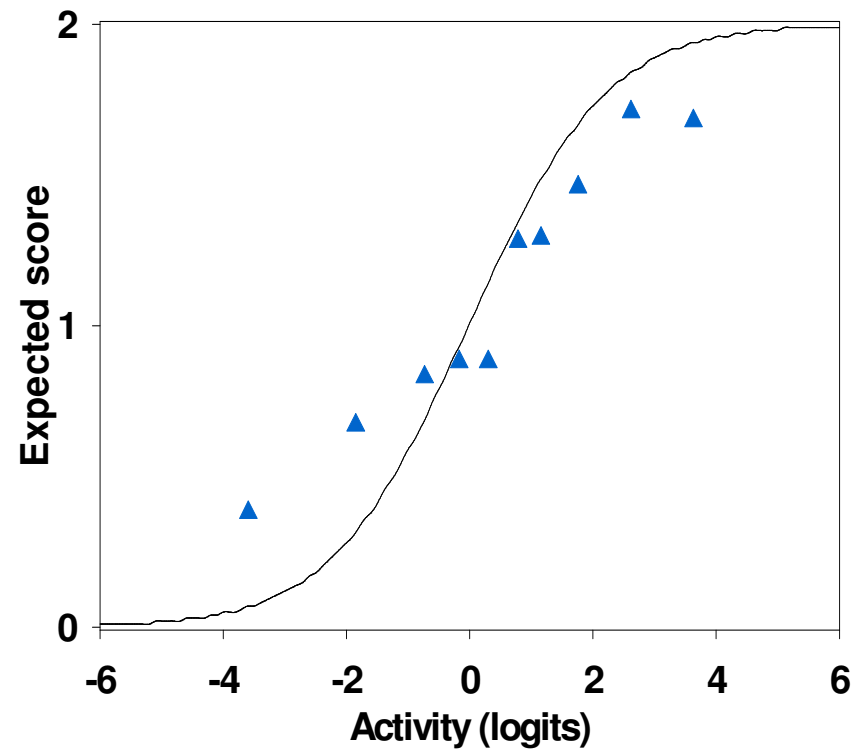


Example: Unscrewing a bottle cap

Unidimensionality



Example: Walking upstairs



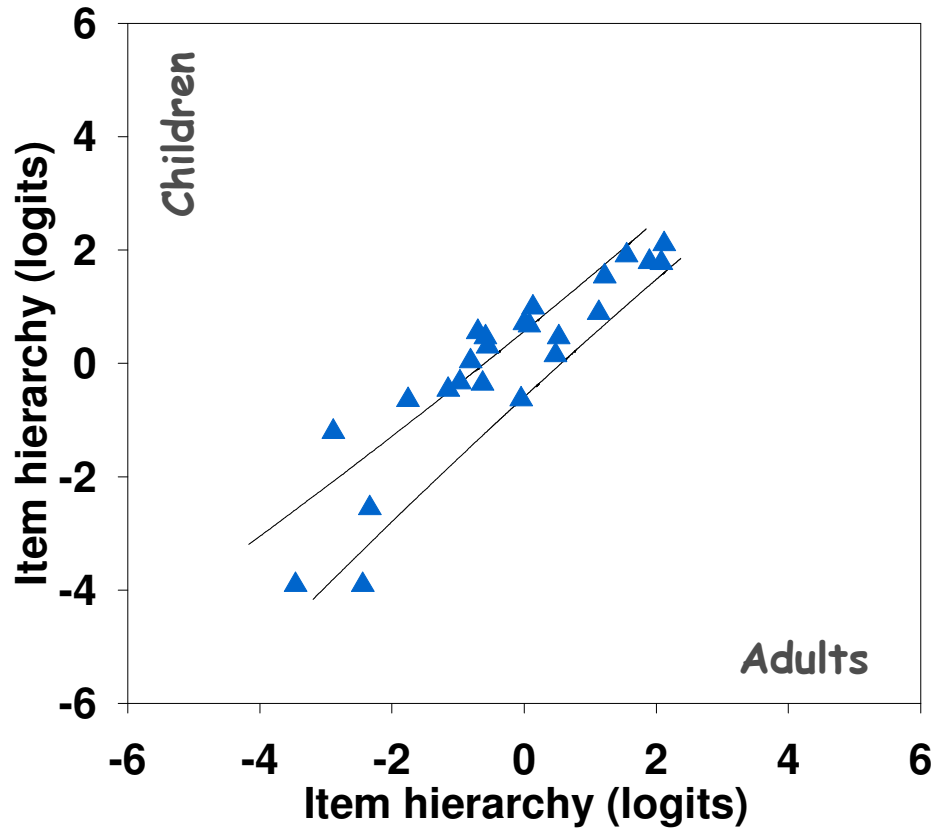
Example: Unscrewing a bottle cap

- 49 items

Item selection

1. Ordered rating scale
2. Rating scale model
3. Unidimensionality
- 4. Invariance**
5. Redundancy

Invariance



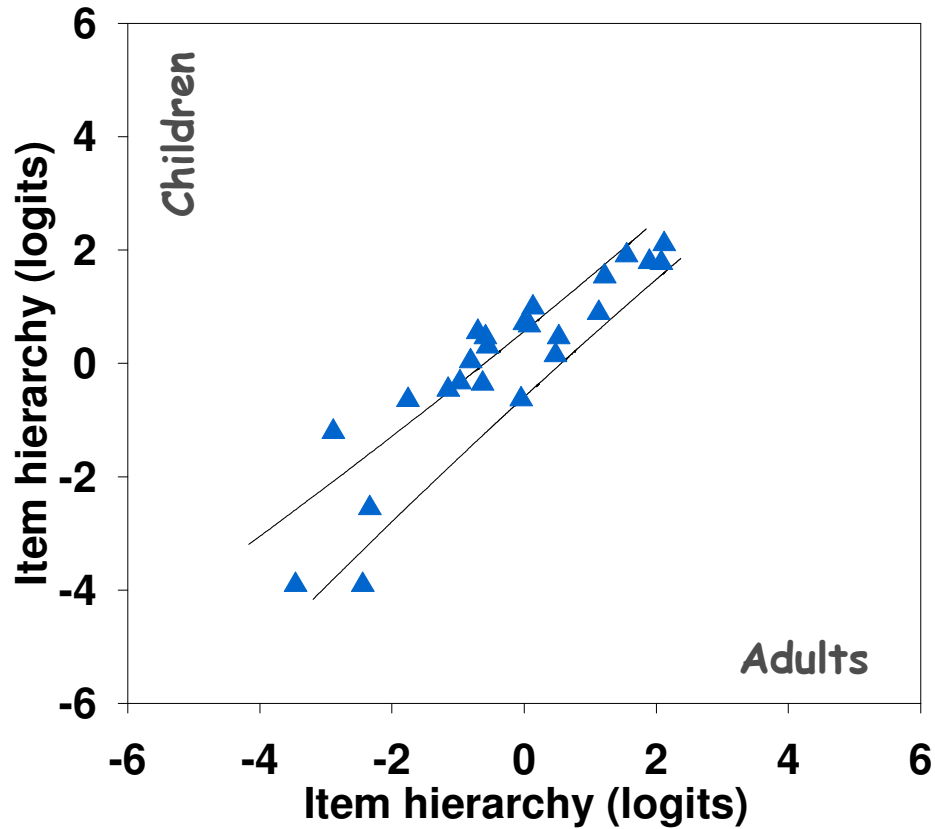
Category (child-adults)

Language (French sp-Dutch sp)

Gender (man-woman)

Diagnosis (proximal-distal)

Invariance



Category (child-adults)

- 9 items

Language (French sp-Dutch sp)

- 4 items

Gender (man-woman)

- 2 items

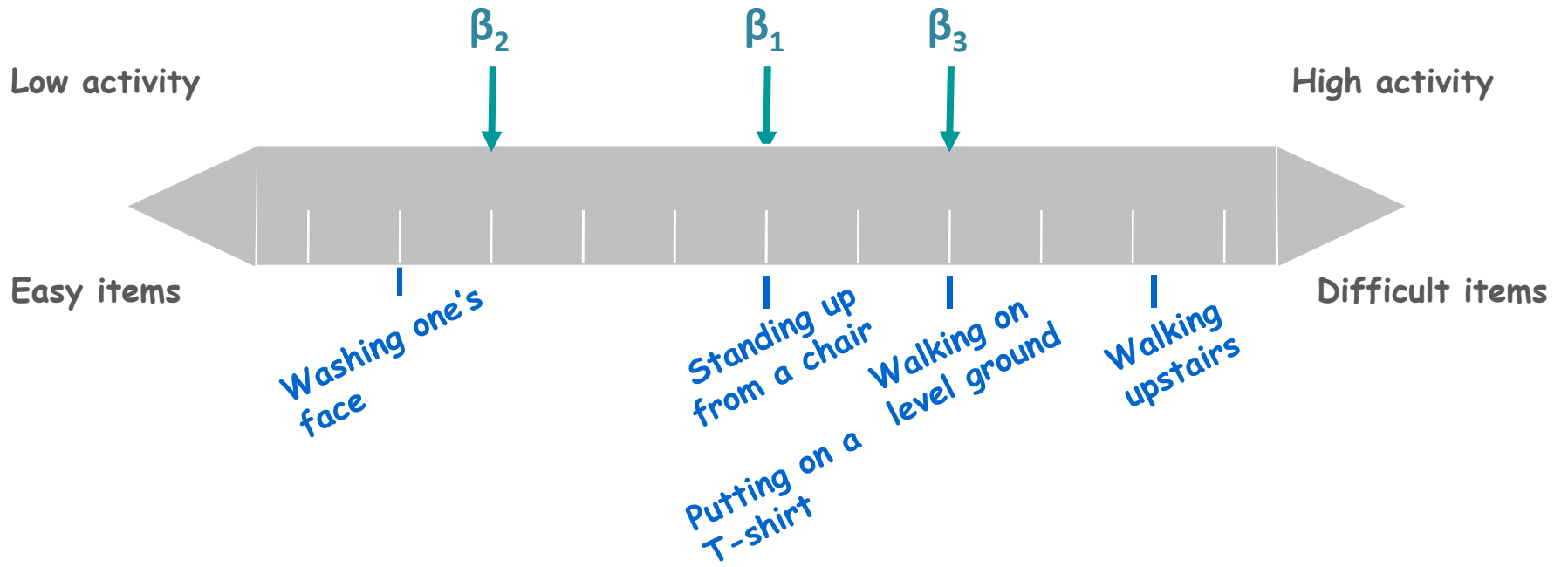
Diagnosis (proximal-distal)

- 7 items

Item selection

1. Ordered rating scale
2. Rating scale model
3. Unidimensionality
4. Invariance
5. Redundancy

Redundancy



- 12 items

Results

Data analysis: Rasch model

126 items



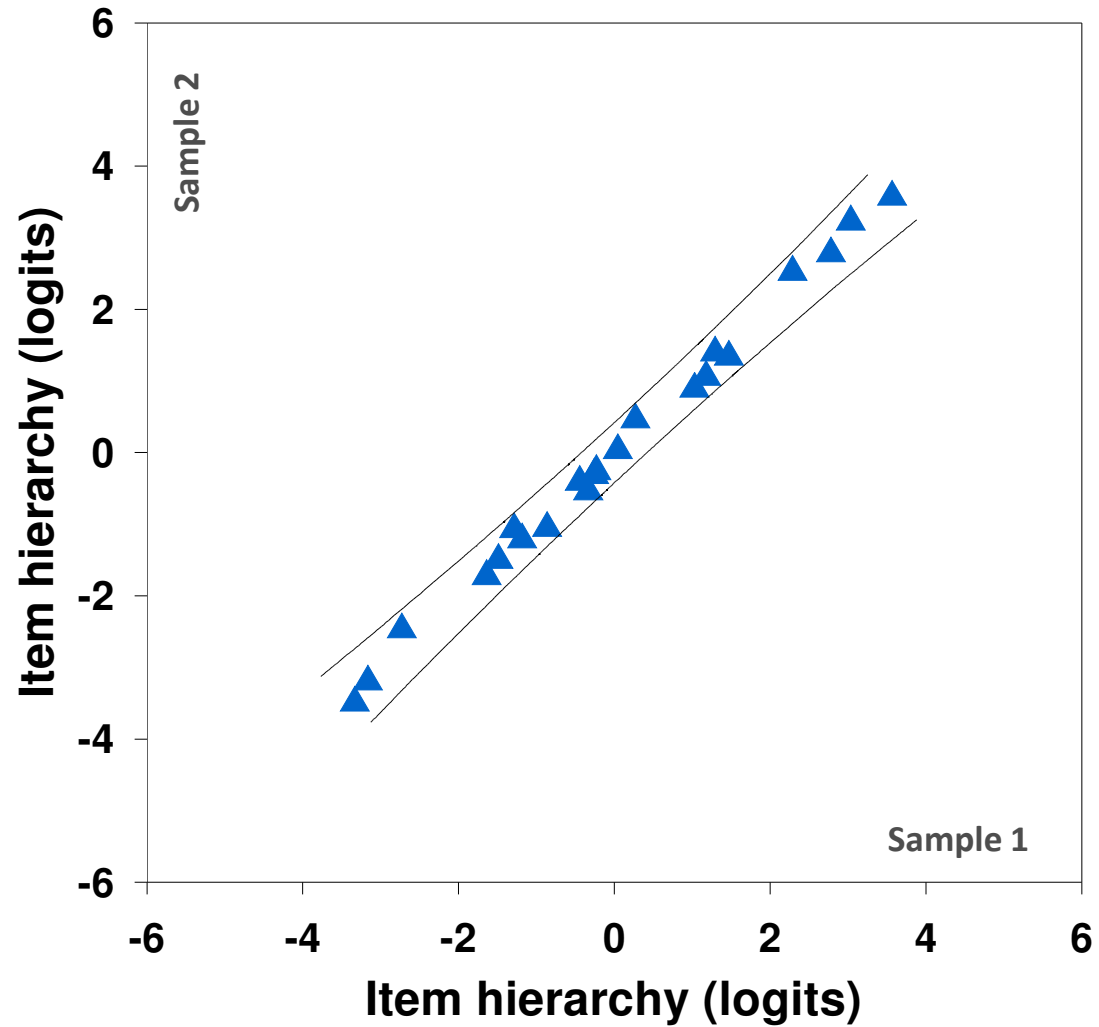
22 items

The 22 items define a **single** variable on a **linear** scale.

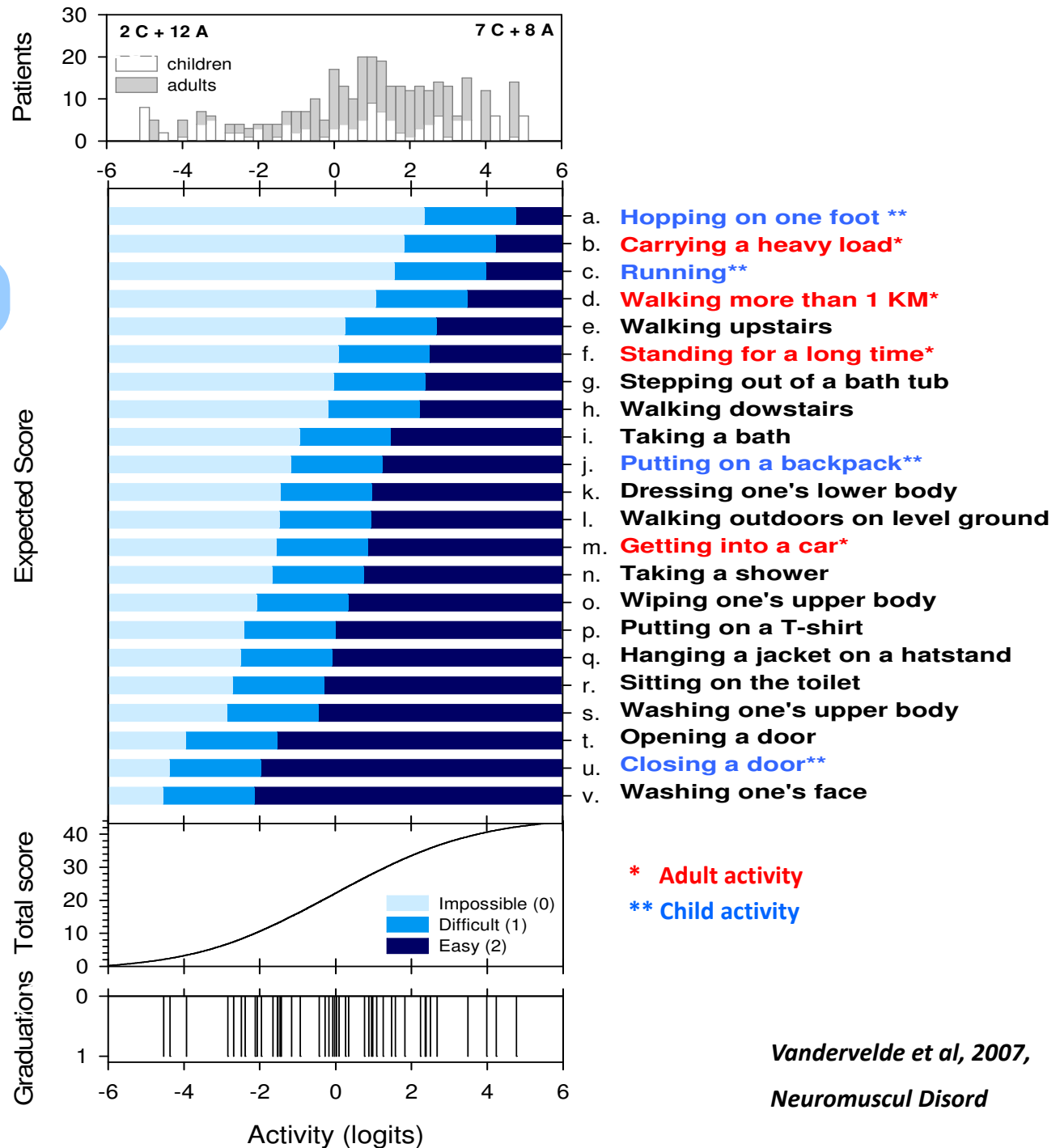
Validation: sample-1 vs sample-2

123 adults + 124
children (sample 1)

122 adults + 124
children (sample 2)



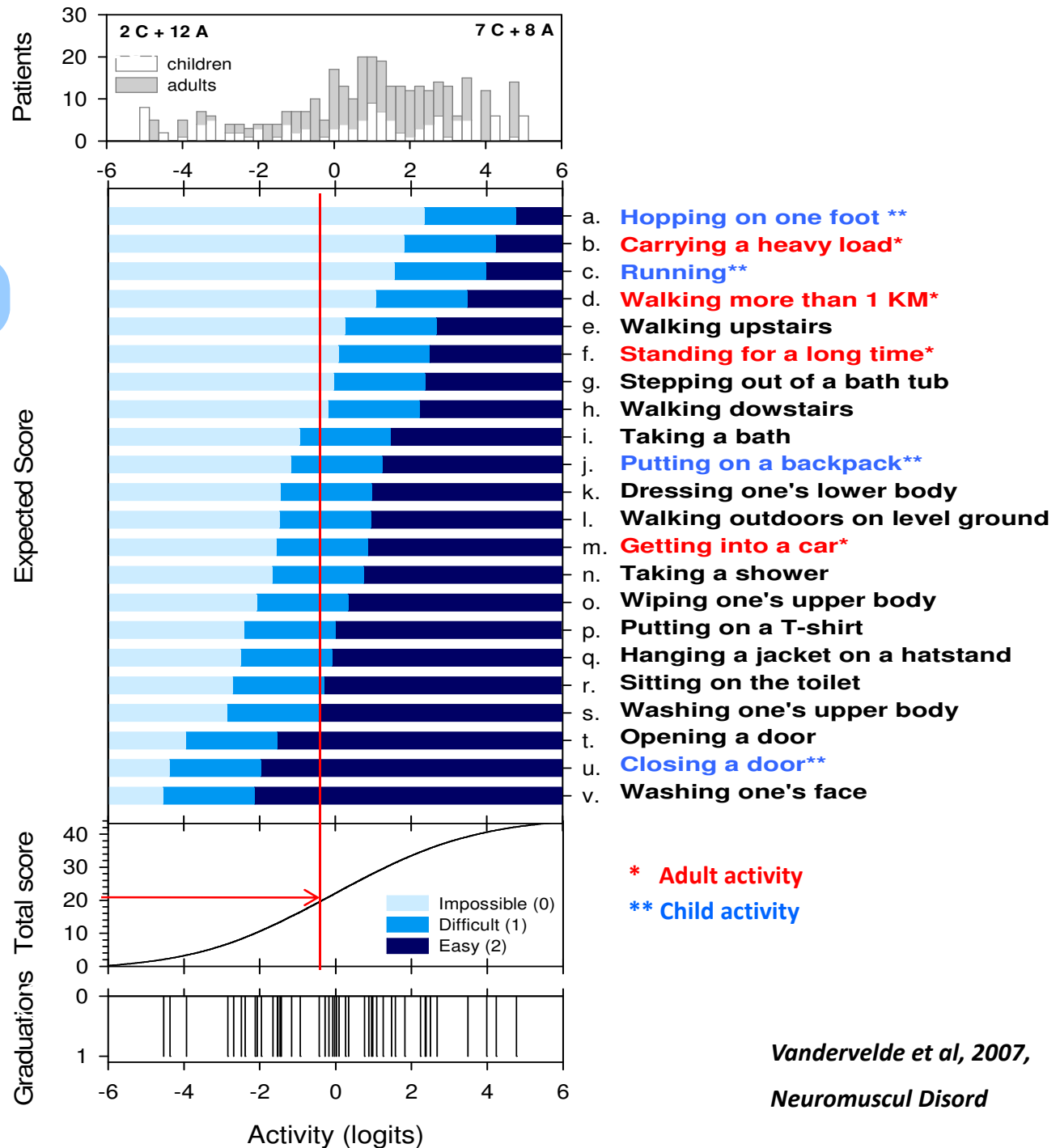
ACTIVLIM



Reliability : 0.96

Vandervelde et al, 2007,
Neuromuscul Disord

ACTIVLIM



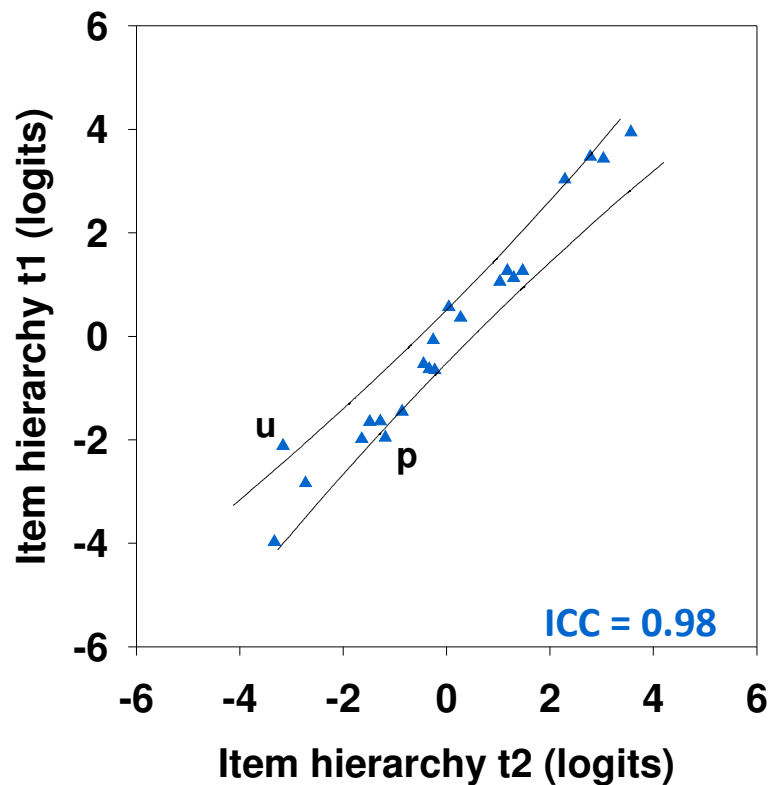
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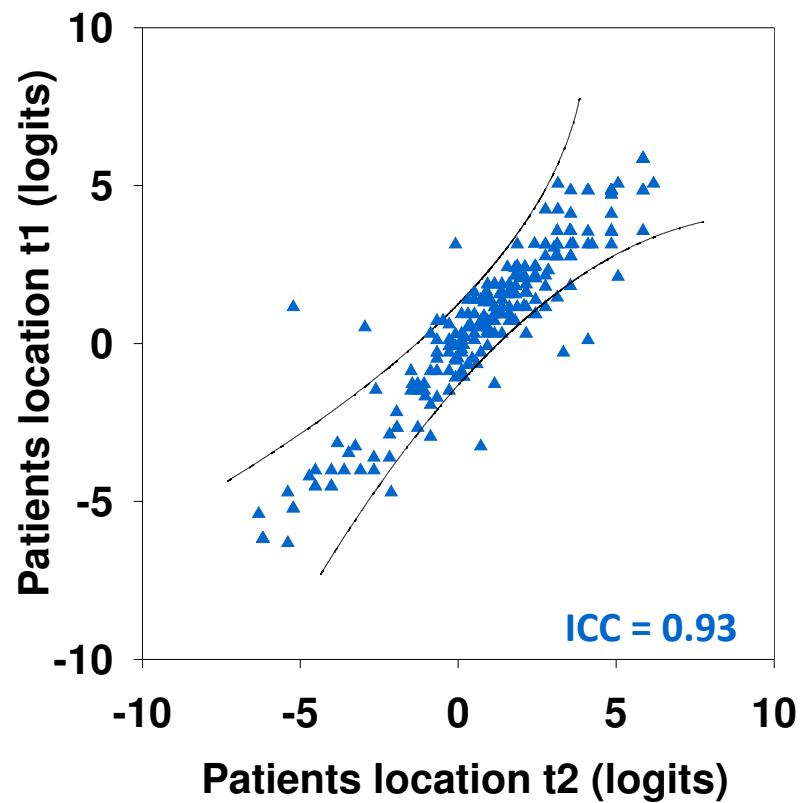
Reproducibility

Delay 24 ± 9 days

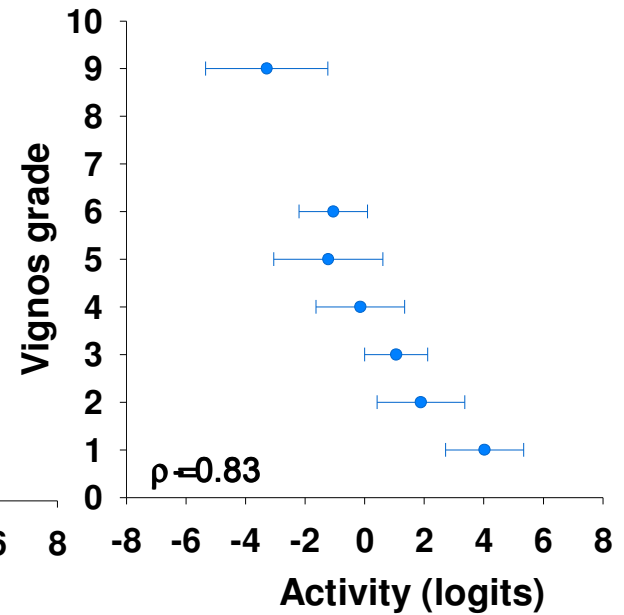
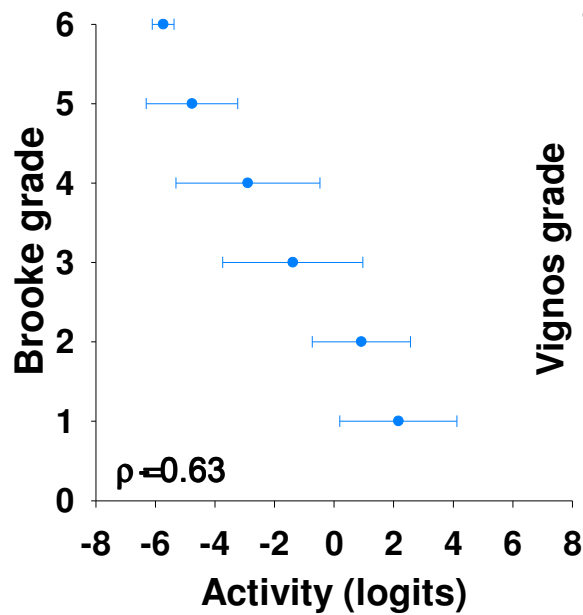
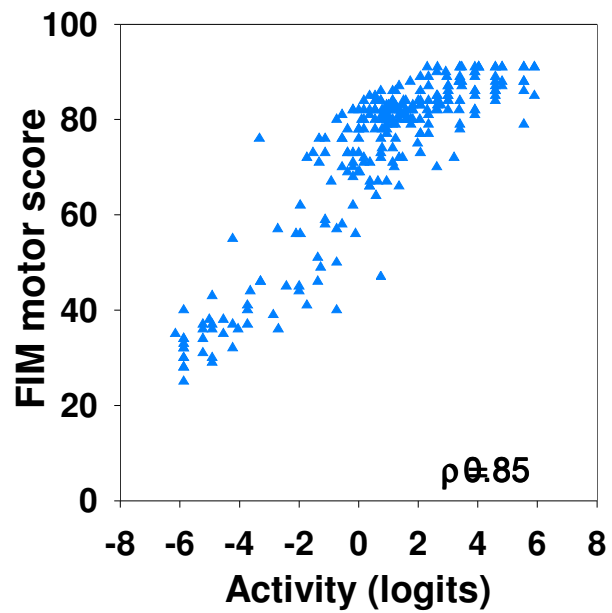
Item hierarchy



Patients' measures



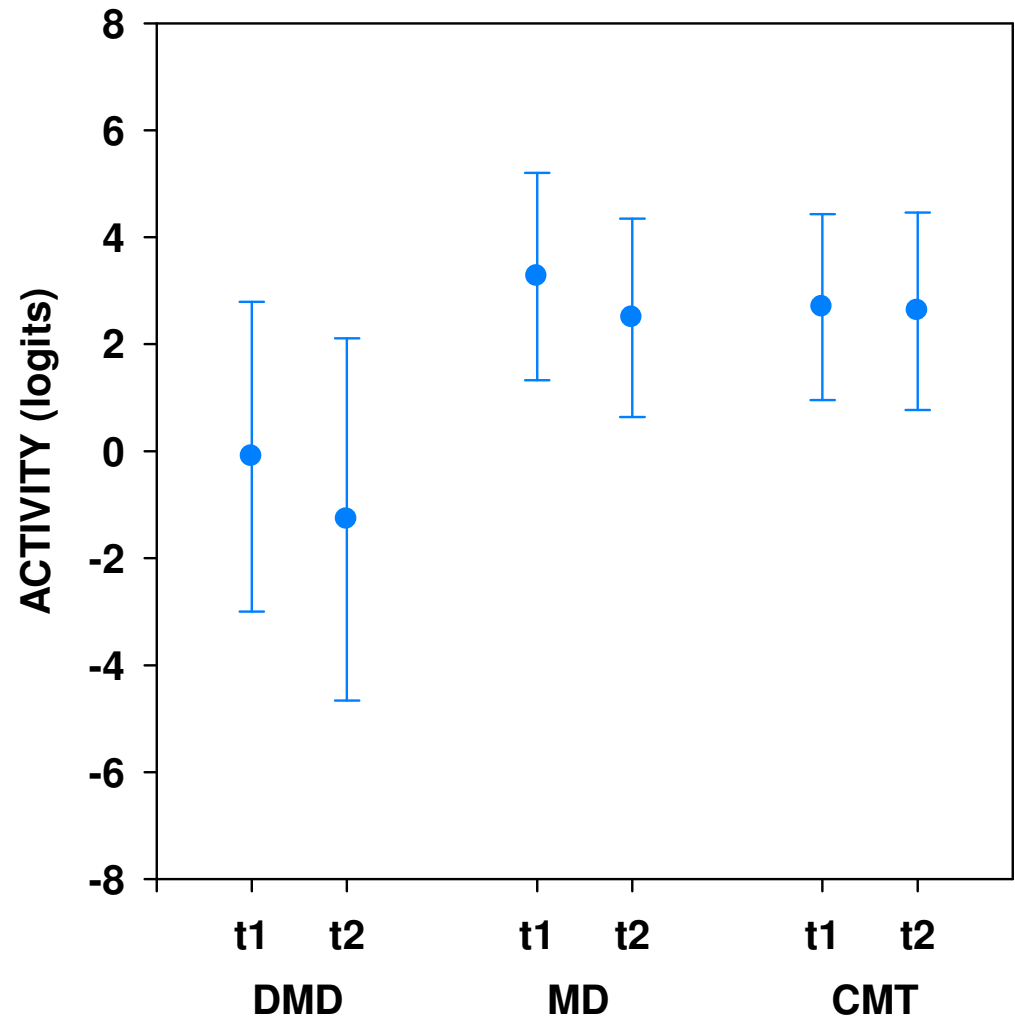
Construct validity



Sensitivity to change

Delay 21 ± 4 months

	DMD	MD	CMT
n	27	17	20
Mean change	1.18	0.77	0.08
	logits	logits	logits
Paired t-test	$p < 0.001$	$p = 0.01$	$p = 0.71$
Effect Size	0.41	0.4	0.04
Standardized Response Mean	0.81	0.68	0.08



Conclusions

This questionnaire is the first functional scale designed specifically to measure activity limitations in adults and children with NMD.

Good psychometric qualities : reliable, valid, reproducible, linear and unidimensional

It is easy and rapid to administer, cost-effective.

www.rehab-scales.org

+

admin as mass

[admin log out](#)

▼ **Welcome**

■ ICF

■ Rasch Model

- ▶ ABILHAND
- ▶ ABILHAND-Kids
- ▶ ACTIVLIM
- ▶ ABILOCO
- ▶ ABILOCO-Kids
- ▶ SATISPART-Stroke
- ▶ Situational Pain Scale (SPS)

Evaluation scales in rehabilitation

- ▶ [Welcome to rehab-scales.org](#)
- ▶ [Our evaluation scales](#)
- ▶ [Our scales per pathology](#)

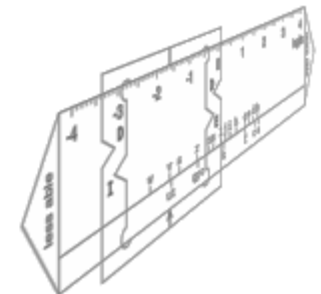
Welcome to rehab-scales.org

This site presents a set of evaluation scales specifically designed to be used in rehabilitation.



Each scale defined below was developed in [Unité de réadaptation et de médecine physique, Université catholique de Louvain](#), using the [Rasch measurement model](#). This model provides a method to convert the raw scores obtained from a questionnaire into a linear measure located on a unidimensional scale.

The place of these scales in the health process can be determined using the [International Classification of Functioning, Disability and Health](#) proposed by the World Health Organization (WHO, 2001).



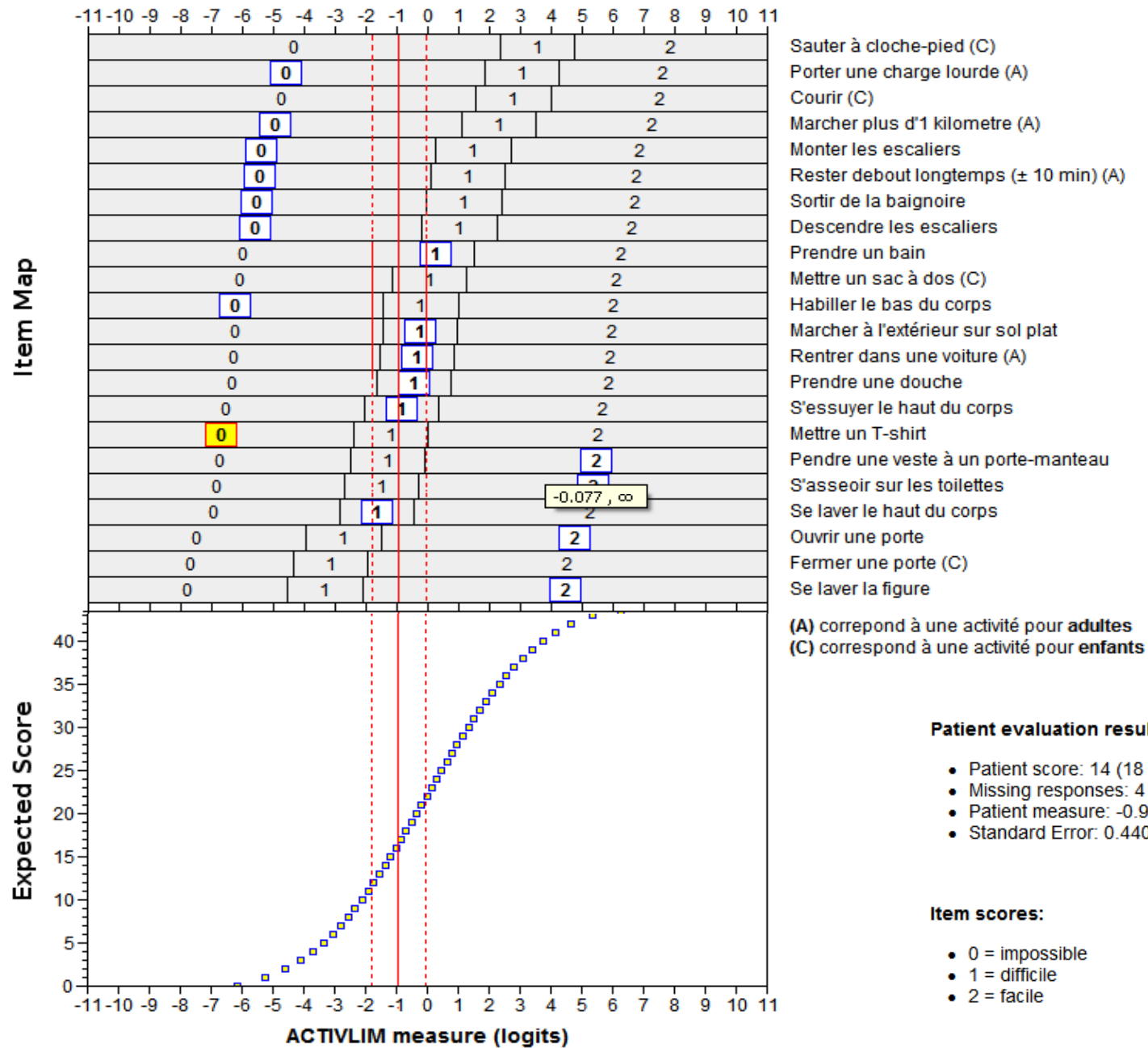
ACTIVLIM specific to children and adults with neuromuscular disorders

Language Order

www.rehab-scales.org

English - Order 1					
1.	Putting on a T-shirt	<input type="radio"/> impossible	<input type="radio"/> difficult	<input checked="" type="radio"/> easy	<input type="radio"/> ?
2.	Washing one's upper body	<input type="radio"/> impossible	<input checked="" type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
3.	Dressing one's lower body	<input type="radio"/> impossible	<input type="radio"/> difficult	<input checked="" type="radio"/> easy	<input type="radio"/> ?
4.	Taking a shower	<input type="radio"/> impossible	<input checked="" type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
5.	Sitting on the toilet	<input type="radio"/> impossible	<input checked="" type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
6.	Taking a bath	<input type="radio"/> impossible	<input checked="" type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
7.	Walking downstairs	<input checked="" type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
8.	Stepping out of a bath tub	<input checked="" type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
9.	Opening a door	<input type="radio"/> impossible	<input type="radio"/> difficult	<input checked="" type="radio"/> easy	<input type="radio"/> ?
10.	Walking outdoors on level ground	<input type="radio"/> impossible	<input checked="" type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
11.	Washing one's face	<input type="radio"/> impossible	<input type="radio"/> difficult	<input checked="" type="radio"/> easy	<input type="radio"/> ?
12.	Hanging up a jacket on a hatstand	<input type="radio"/> impossible	<input type="radio"/> difficult	<input checked="" type="radio"/> easy	<input type="radio"/> ?
13.	Wiping one's upper body	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
14.	Walking upstairs	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
In the case of an adult evaluation (age 16-80) , please answer to the following questions. In the case of a child evaluation (age 6-15), please mark the following questions with the "?".					
15.	Carrying a heavy load (A)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
16.	Getting into a car (A)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
17.	Standing for a long time (\pm 10 min) (A)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
18.	Walking more than 1 kilometre (A)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
In the case of a child evaluation (age 6-15), please answer to the following questions. In the case of an adult evaluation (age 16-80), please mark the following questions with the "?".					
19.	Closing a door (C)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
20.	Hopping on one foot (C)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
21.	Putting on a backpack (C)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?
22.	Running (C)	<input type="radio"/> impossible	<input type="radio"/> difficult	<input type="radio"/> easy	<input type="radio"/> ?

ACTIVLIM evaluation report - rehab-scales.org



Collaborators

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Thanks to

Medical and paramedical teams of neuromuscular centers

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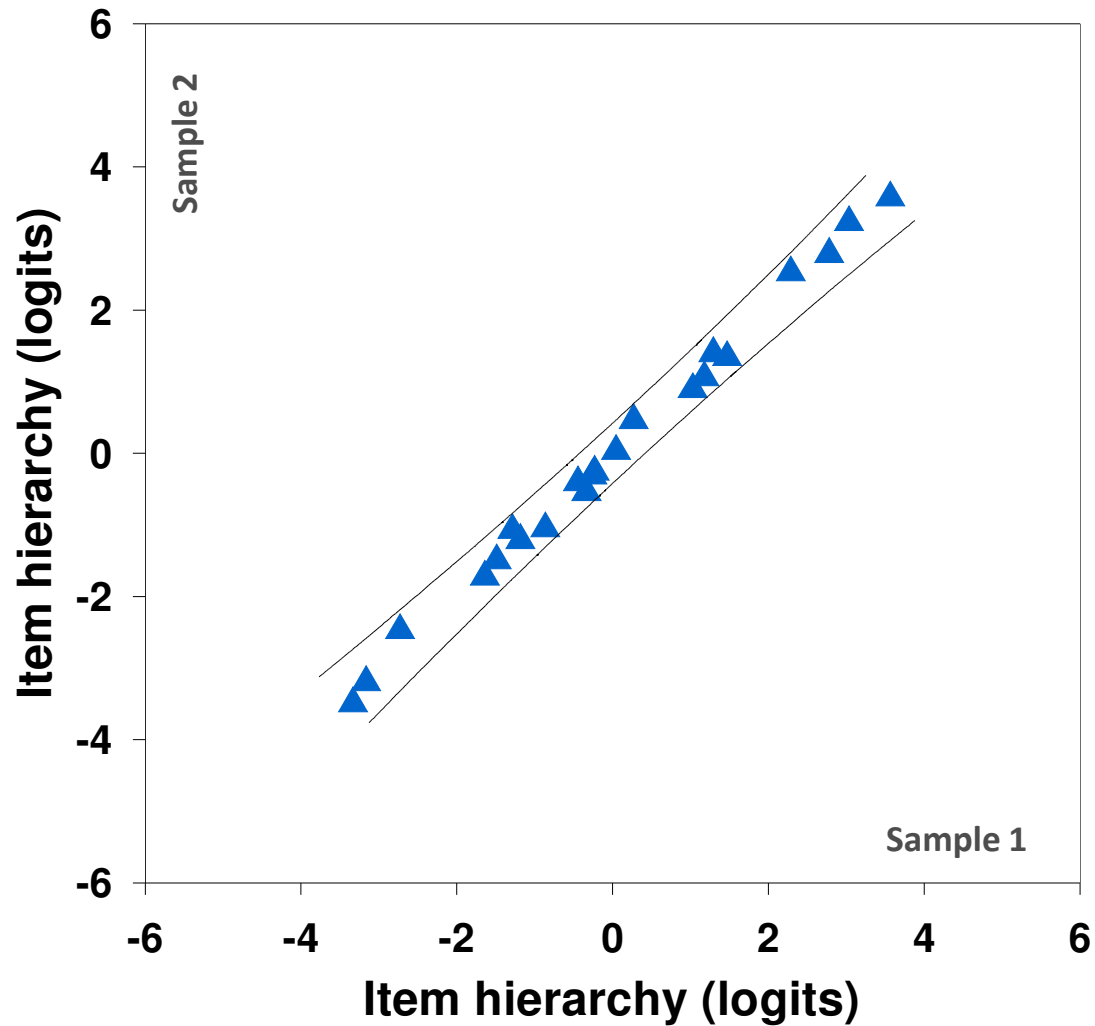
Variable identification

For the NM patients, the most important problems are
(*Mc Donald, Am J Phys Med Rehabil, 2002*) :

- Muscle weakness and atrophy
- Fatigue
- Problems in Activities of Daily Living (ADL)
- Inability to exercise

→ Identified variable = **activity limitations**

Validation: Sample-1 vs sample-2



Evaluation in medicine

Lantent variables : questionnaires

How difficult are the following activities?

• Washing one's hands

Impossible Very difficult Difficult Easy

• Inserting a key in a keyhole

Impossible Very difficult Difficult Easy

• Buttoning up a shirt

Impossible Very difficult Difficult Easy

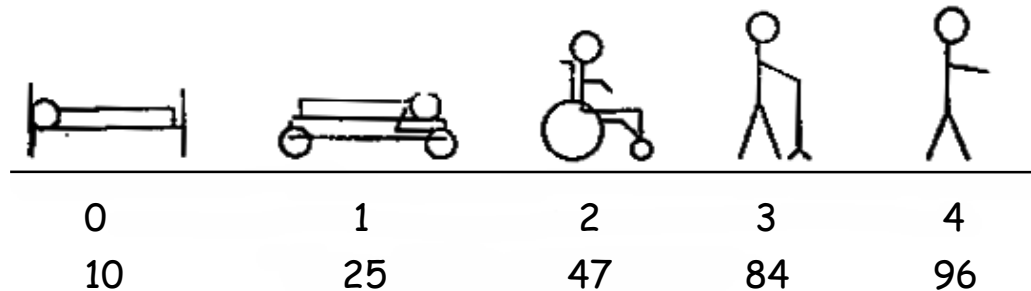
Les différents type d'échelles

Evaluer = assigner des nombres

Echelle ordinale

Les nombres assignés correspondent à un classement hiérarchique de la propriété étudiée.

Exemple: Echelle de mobilité (Merbitz et coll, 1989). **La plupart des échelles de réadaptation sont de nature ordinale**



- **Caractéristiques:** ordre de grandeur $1 < 2$
pas d'opération mathématique $2 \neq 2 \times$ plus de mobilité que 1,
la distance qui sépare deux graduations n'est pas connue
→ **Utilisation de tests statistiques non-paramétriques**

Les différents type d'échelles

Evaluer = assigner des nombres

Echelle d'intervalles

= une échelle ordinale possédant une unité de mesure constante, les intervalles entre deux graduations sont comparables

Exemple: numérotation des années, échelles de température

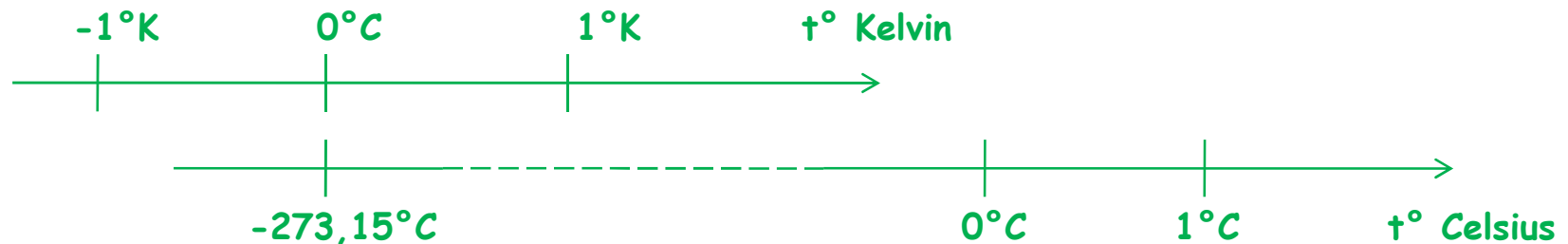


Les différents type d'échelles

Evaluer = assigner des nombres

Echelle d'intervalles

Caractéristiques: pas de zéro absolu ($0^{\circ}\text{C} \neq$ absence de température), la place du zéro dépend de l'unité de mesure



→ opérations mathématiques sur les différences entre les valeurs de l'échelle (diff entre 15°C et 30°C = $3\times$ la diff entre 25°C et 30°C) mais pas sur les valeurs en elles-mêmes ($15^{\circ}\text{C} \neq$ de la $\frac{1}{2}$ de 30°C)

→ utilisation de tests statistiques paramétriques si les valeurs sont distribuées normalement

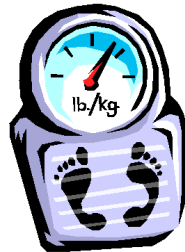
Les différents type d'échelles

Evaluer = assigner des nombres

Echelle proportionnelle

= échelle d'intervalle avec un zéro absolu

- Exemple: 1. Mesure de la force musculaire avec un dynamomètre
(0 Newton = absence de force)
2. Echelle de masse



Caractéristiques: Toutes opérations mathématiques ($40 \text{ kg} = 2 \times 20 \text{ kg}$)

→ Utilisation de tests statistiques paramétriques si les valeurs sont distribuées normalement