

## Fysiotherapie en Wetenschap: In memoriam Prof. dr. Robert Wagenaar

Prof. Gert Kwakkel  
Chair Neurorehabilitation,  
Amsterdam University Medical Center,  
The Netherlands;  
& Northwestern University, Chicago USA  
([G.Kwakkel@amsterdamumc.nl](mailto:G.Kwakkel@amsterdamumc.nl))



visionary  
non-linear predictable dynamics  
strategic responsive honest  
methodology friend science  
pioneer movement  
reliable

rehabilitation  
Robert  
students  
scientist  
clinical  
science  
research  
devoted  
mentorship  
University  
practice  
write  
published  
PhD  
outcomes  
started  
homework  
disease  
colleague  
friend  
field  
patterns  
questions  
trainees  
literature  
approaches  
community  
Boston  
mentorship  
University

Daniel White & Douglas Katz  
(2013)



➤ **1986:** Coordinator Research Department Physical Therapy VU Medical Centre, Amsterdam.

➤ **December 1990:** Robert received his PhD in human movement science from Vrije University in Amsterdam, the Netherlands.

➤ **1991-1998:** Coordinator research & co-promotor of PhDs working at the Dept Rehabilitation Medicine of the VUmc.



• **2001:** Boston University as chairman and associate professor of the Department of Physical Therapy and Athletic Training.

• **2003:** Tenured for professorship and he became a full professor in 2005.

• **2005-2012:** Director of the Center for Neurorehabilitation and the Doctor of Science in the rehabilitation sciences program at the Boston University.



• **2012:** Professor of clinical health sciences and head of the Rehabilitation, Nursing Science and Sport division at the University Medical Center of Utrecht.

Prof. dr. Eline Lindeman & Prof. dr. Hans Arentzen



Prof. Dr. Peter Beek



Prof. Dr. Richard van Emmerik



Prof. Dr. Rik Gosselink



Dr. Erwin van Wegen



Dr. Hanneke van der Lee



Prof. Dr. Roberto Perez



Dr. Daniel White



Dr. Terry Ellis

Memorial lecture:

## Understanding dynamics of motor recovery after stroke.

Prof. Gert Kwakkel  
Chair Neurorehabilitation

VU University Medical Center, Amsterdam

([g.kwakkel@vumc.nl](mailto:g.kwakkel@vumc.nl))



San Diego Nov 7-8<sup>th</sup> 2013



ACRM  
A HENK VAN DER KAMM FOUNDATION  
Improving lives through interdisciplinary rehabilitation research

ASNR  
American Society of Neurorehabilitation

ACRM Archives of Physical Medicine and Rehabilitation  
 Prof Daniel White  
 University of Delaware | UDel  
 Department of Physical Therapy

In Memoriam: A Tribute to Robert C. Wagenaar, PhD

Prof Douglas Katz  
 Boston University | BU  
 Department of Neurology

Physical Therapy  
 Journal of the American Physical Therapy Association

PTJ

Original Article  
 The impact of walking speed on interlimb coordination in individuals with Parkinson's disease

N=76  
 Citaties 5.576  
 H=34

'Een hartinfarct in de hersenen: Verschijnselen en epidemiologie'

Tijdschrift: [Neuropraxis > Uitgave 1/1997](#)

Auteur: Robert Wagenaar

20 jaar Neuropraxis: 'Een hartinfarct in de hersenen'

Tijdschrift: [Neuropraxis > Uitgave 6/2017](#)

Auteur: Gert Kwakkel

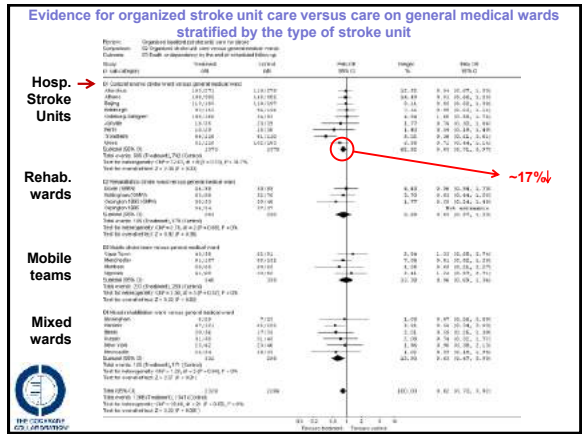
Revalidatie van de motoriek: 20 jaar later

RW: "Het multidisciplinair behandelen op stroke units heeft een belangrijk klinisch voordeel (wat de opzet van gespecialiseerde afdelingen binnen ziekenhuizen legitimeert)."

Nu: Georganiseerde CVA-zorg op een gespecialiseerde afdeling blijkt volgens meta-analyse de kans op overlijden, dan wel ADL-afhankelijkheid, met 15 tot 20% omlaag te brengen in vergelijking met opname in niet-gespecialiseerde ziekenhuizen [13, 21].

BETTER ↑

Interdisciplinary  
 Multidisciplinary  
 Disciplinary



1982 1986 1994 1998 2001 2012

Functional Recovery After Stroke

Onderzoek

- Methodologie
- Bewegingswetenschappen
- Functionele prognose

Onderwijs

1982 1987 1994 1998 2001 2012

Quasi-Experimentation: Critical Appraisal for Public Health

Nonparametric Statistics: For the Behavioral Sciences

Single-Case Research Designs: Methods for Clinical and Applied Settings

Principles of Brains: Functioning in Health and Disease

1979 1988 1982 1996

THE ECOLOGICAL APPROACH TO NEURAL PERCEPTION

James Jerome Gibson

$$\tau = k \cdot (A/A)$$

### Systematic Reviews

- Kwakkel G, van Peppen R, Wagenaar RC, Wood-Dauphinee S, Richards C, Ashburn A, Miller K, Lincoln N, Partridge C, Welkwood I, Langhorne P. Effects of augmented exercise therapy time after stroke: a meta-analysis. *Stroke*. 2004 Nov;35(11):2529-39.
- de Goede CJ, Keus SH, Kwakkel G, Wagenaar RC. The effects of physical therapy in Parkinson's disease: a research synthesis. *Arch Phys Med Rehabil*. 2001 Apr;82(4):509-15. PubMed PMID: 11295012.
- van der Lee JH, Snels IA, Beckerman H, Lankhorst GJ, Wagenaar RC, Bouter LM. Exercise therapy for arm function in stroke patients: a systematic review of randomized controlled trials. *Clin Rehabil*. 2001 Feb;15(1):20-31.
- Selles RW, Bussmann JB, Wagenaar RC, Stam HJ. Effects of prosthetic mass and mass distribution on kinematics and energetics of prosthetic gait: a systematic review. *Arch Phys Med Rehabil*. 1999 Dec;80(12):1593-9.
- Cambach W, Wagenaar RC, Koelman TW, van Keimpema AR, Kemper HC. The long-term effects of pulmonary rehabilitation in patients with asthma and chronic obstructive pulmonary disease: a research synthesis. *Arch Phys Med Rehabil*. 1999 Jan;80(1):103-11.
- Kwakkel G, Wagenaar RC, Koelman TW, Lankhorst GJ, Koetsier JC. Effects of intensity of rehabilitation after stroke: A research synthesis. *Stroke*. 1997 Aug;28(8):1550-6. PubMed PMID: 9259747.

1982 1987 1998

Simpliciteits index

Observatiedagen

Pyromaan bracht mensen in getrouwen

Alan E. Kazdin

Single-Case Research Designs

EFFECTS OF NEUROLOGICAL APPROACHES: NDT VERSUS BRUNNSTROM

1982 1987 1998

K.D.T. versus Brunnstrom

COMFORTABLE WALKING SPEED (m/s)

STRIDE LENGTH (m)

ASSESSMENTS

Wagenaar et al, The functional recovery of stroke: a comparison between neuro-developmental treatment and the Brunnstrom method. *Scand J Rehabil Med*. 1990;22(1):1-8.

### 'Steps to follow?'

Steps to Follow

Wagenaar et al, The functional recovery of stroke: a comparison between neuro-developmental treatment and the Brunnstrom method. *Scand J Rehabil Med*. 1990;22(1):1-8.



**Intensity**  $n=467$  trials (N = 25.373) **Task & (context) specificity**

**How to augment neurorehabilitation?**

Skilled Nursing?    Telerehabilitation services at home?    Robotics?    CCT?

*Veerbeek et al, PLoS One. 2014 Feb 4;9(2):e87987.*

1982    1987    1994    1998    2001    2012

1982    1987    1994    1998    2001    2012

**Onderzoek**

- Methodologie
- Bewegingswetenschappen
- Functionele prognose

**Onderwijs**

ELSEVIER    Human Movement Science 13 (1994) 441-471

**Dynamics of pathological gait**

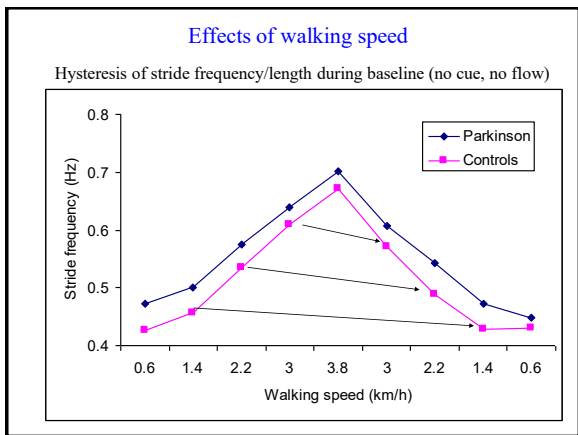
Robert C. Wagenaar \*, Richard E.A. van Emmerik

*Department of Physical Therapy, VU Hospital, De Boelelaan 1117, 1081 HV Amsterdam, The Netherlands*

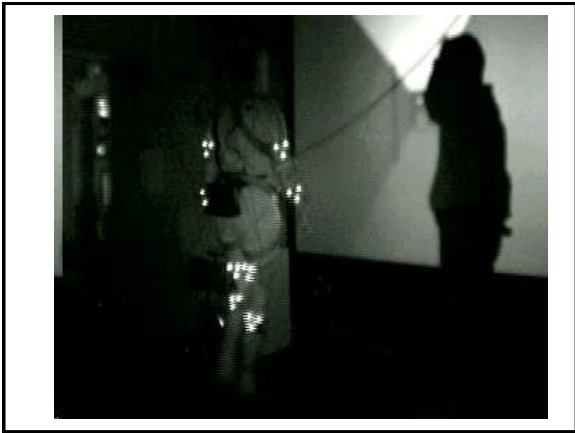
**Dynamical system theory**

- “Order parameter”
- “Control parameter”

HEALTH MOVEMENT SCIENCES



0.5 m/s



### Efficacy of a Physical Therapy Program in Patients With Parkinson's Disease: A Randomized Controlled Trial

Terry Ellis, MSPT, Coes J. de Goede, MSPT, Robert G. Feldman, MD, Erik C. Wolters, MD, Gert Kwakkel, PhD, Robert C. Wagenaar, PhD

ABSTRACT: Ellis T, de Goede CJ, Feldman RG, Wolters EC, Kwakkel G, Wagenaar RC. Efficacy of a physical therapy program in patients with Parkinson's disease: a randomized controlled trial. Arch Phys Med Rehabil. 2005;86:626-32.

© 2005 by American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation

CONTROL PD

DA CELLS WITH NEUROMELANIN

CONTROL PD

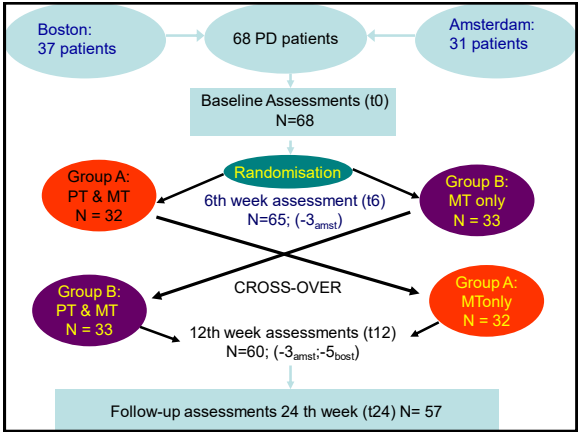
[<sup>123</sup>I]β-CIT SPECT

Gezond

Patiënt met PD

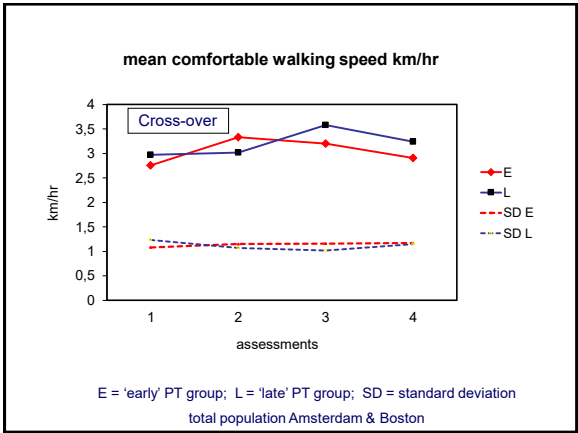
[<sup>123</sup>I]β-CIT SPECT

Winogrodzka A, Wagenaar RC, Bergmans P, Vellinga A, Booij J, van Royen EA, van Emmerik RE, Stoof JC, Wolters EC. Rigidity decreases resting tremor intensity in Parkinson's disease: A [<sup>123</sup>I]beta-CIT SPECT study in early, nonmedicated patients. Mov Disord. 2001 Nov;16(6):1033-40



### Efficacy of a Physical Therapy Program in Patients With Parkinson's Disease: A Randomized Controlled Trial

Ellis D et al. Arch of Phys Med Rehab 2005;86:626-32



Neurospass (1997) 1:32-36  
DOI 10.1017/S091059061

**ARTIKELN**


**Een hartinfarct in de hersenen**  
Revalidatie van de motoriek na een CVA

Robert Wagenaar · Gert Kwakkel


- Een aantal studies vanuit het perspectief van de niet lineaire dynamica heeft bijvoorbeeld aangetoond dat loopsnelheid een belangrijke onafhankelijke (stuur)parameter is bij de bestudering van het gezonde gaan en het hemiplegische gaan (zie ook Wagenaar & van Emmerik, 1994).



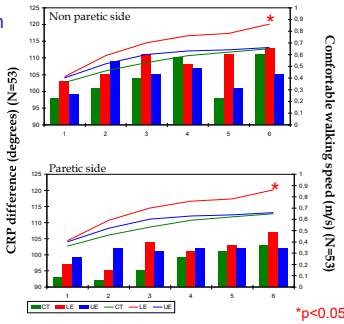
1982 1987 1998 2002 2012



**Behavioral compensation strategies**

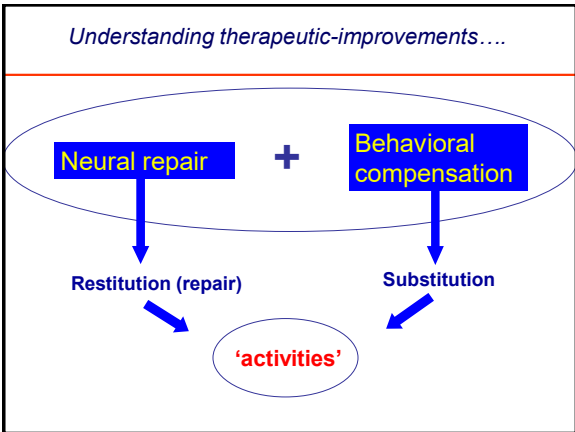


*Kwakkel & Wagenaar, Phys. Ther. 2002;82:432-448*

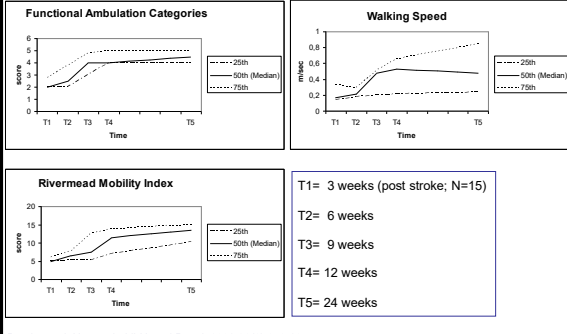


Conformable walking speed (m/s) (N=53)

\*p < 0.05



**Behavioral compensation strategies lower limb (N=15)**



Functional Ambulation Categories

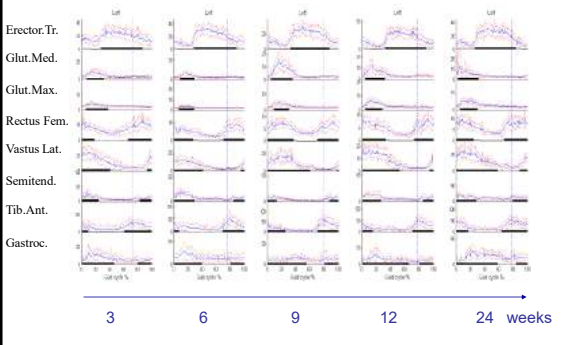
Walking Speed

Rivermead Mobility Index

T1= 3 weeks (post stroke; N=15)  
T2= 6 weeks  
T3= 9 weeks  
T4= 12 weeks  
T5= 24 weeks

*Buurke et al. Neurorehabil Neural Repair 2008;22(6):676-83*

**Smooth rectified EMG-recordings of paretic leg post stroke (N=15)**



Erector.Tr.  
Glut.Med.  
Glut.Max.  
Rectus Fem.  
Vastus Lat.  
Semitend.  
Tib.Ant.  
Gastroc.

3 6 9 12 24 weeks

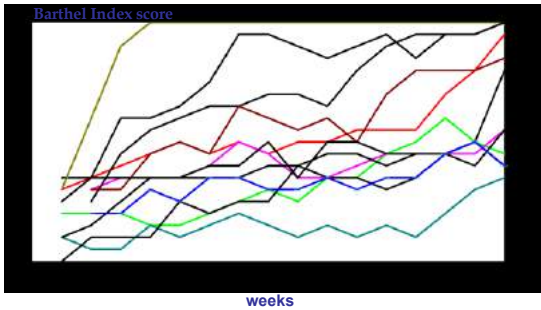
*Buurke et al. Neurorehabil Neural Repair 2008;22(6):676-83*

1982 1987 1994 1998 2001 2012

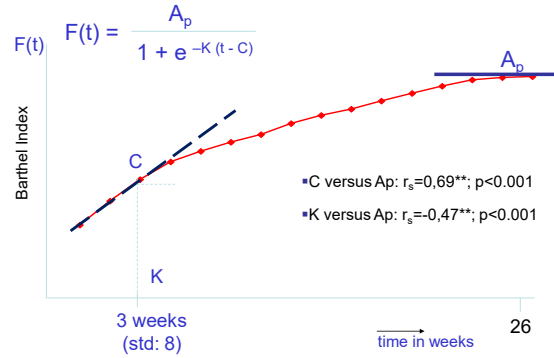


- Onderzoek
  - Methodologie
  - Bewegingswetenschappen
  - Functionele prognose
- Onderwijs

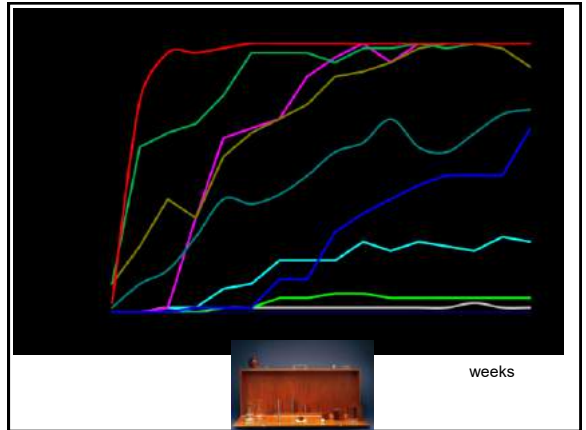
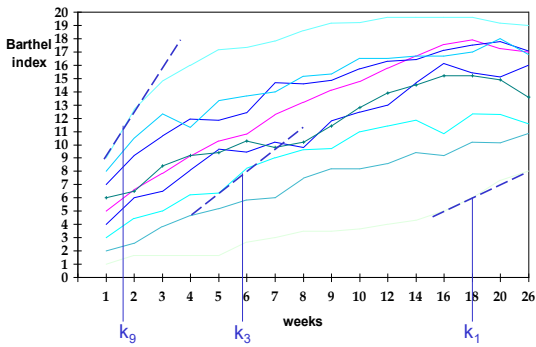
Recovery profiles of 10 randomly selected stroke patients with a first-ever MCA stroke



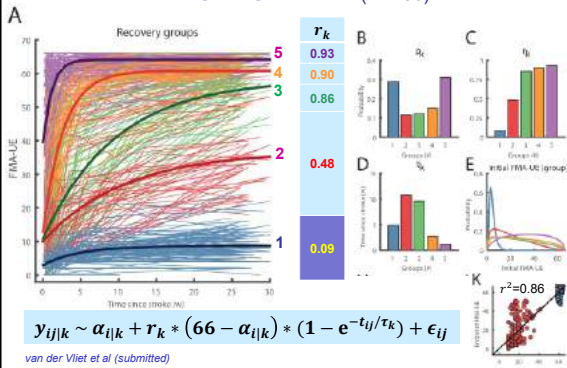
Individual curve fitting (N=89)



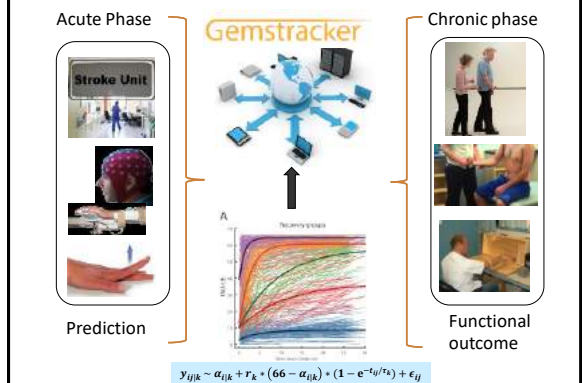
Effects of initial BI on moment of most fast recovery (N=102)



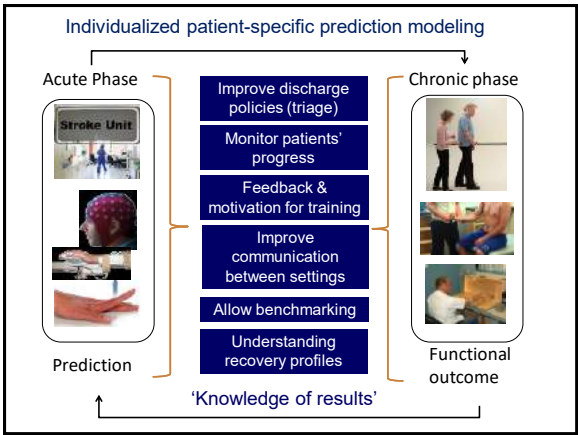
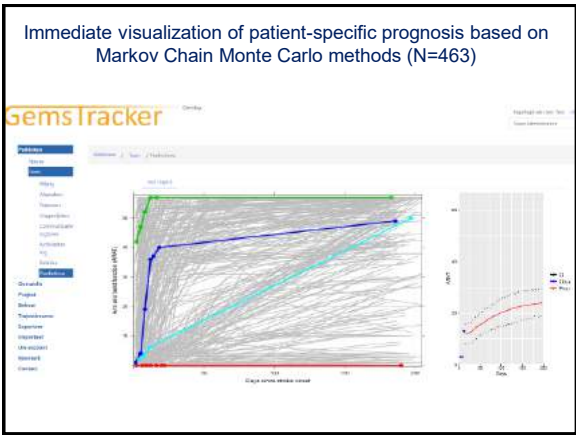
Applying MCMC (mixture) methods on the EXPLICIT, EPOS and 4D-EEG FM-UE datasets (N=456)



WEB-BASED ICT-SOLUTIONS FOR PATIENT-SPECIFIC PREDICTIONS







### PROFITS

A clinical infrastructure for assessment of **determinants & modulators** of neurological and functional recovery after stroke

Serial measurements at *fixed* moments post stroke!

**THE '4D-EEG' BRAIN VAN**

1982 1987 1994 1998 2001 2012

- Onderzoek
  - Methodologie
  - Bewegingswetenschappen
  - Functionele prognostiek
- Onderwijs

Apprenticeships



Onderzoek	Onderwijs	Bezoek	Home Search Contact Ticket sales	Koninklijk Kabinet van Schilderijen
-----------	-----------	--------	---	---

*"Uitzicht op  
inzicht"*

Prof. Dr. Gert Kwakkel  
[G.Kwakkel@amsterdamumc.nl](mailto:G.Kwakkel@amsterdamumc.nl)

<https://www.mauritshuis.nl/en/>

Mauritshuis



Collaboration & Co-creation

		
Peter Paul Rubens (1577-1640)	Antwerp in the golden age	Jan Bruegel the Elder (1568 – 1625)

Bedankt voor uw aandacht!

