

Hanze University of Applied Sciences Groningen

Healthy Ageing

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IJRG

Move in Age

PARATONIA.ORG
AN INITIATIVE OF IJRG 'MOVE IN AGE'

INTERNATIONAL ASSOCIATION OF PHYSIOTHERAPISTS WORKING WITH OLDER PEOPLE

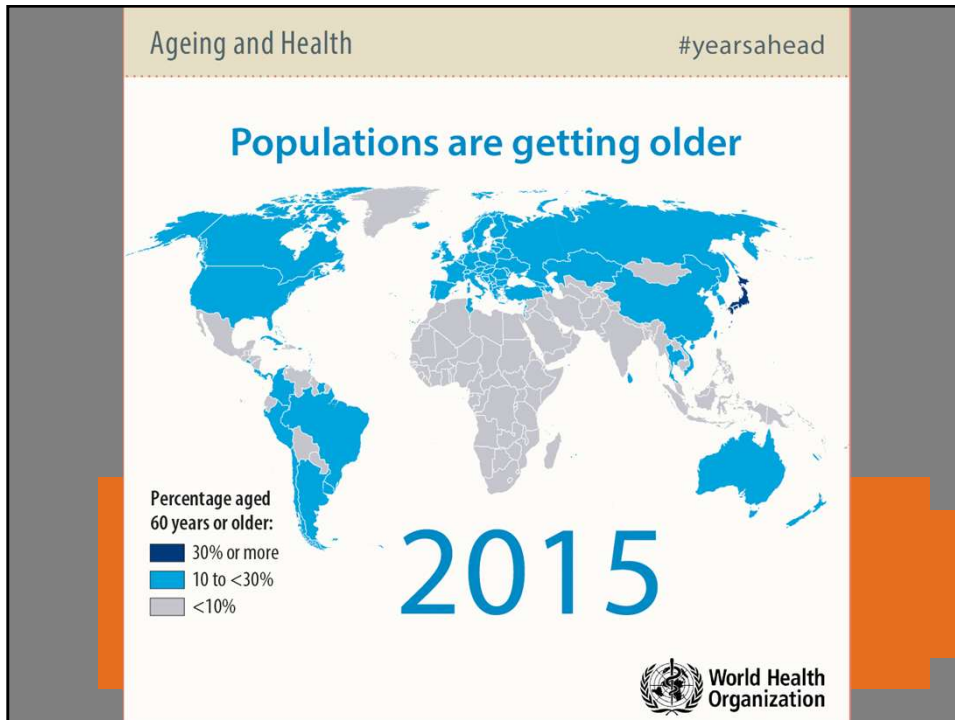
Movement disorders in Dementia (with focus on Paratonia)

Dr. Hans Hobbelen
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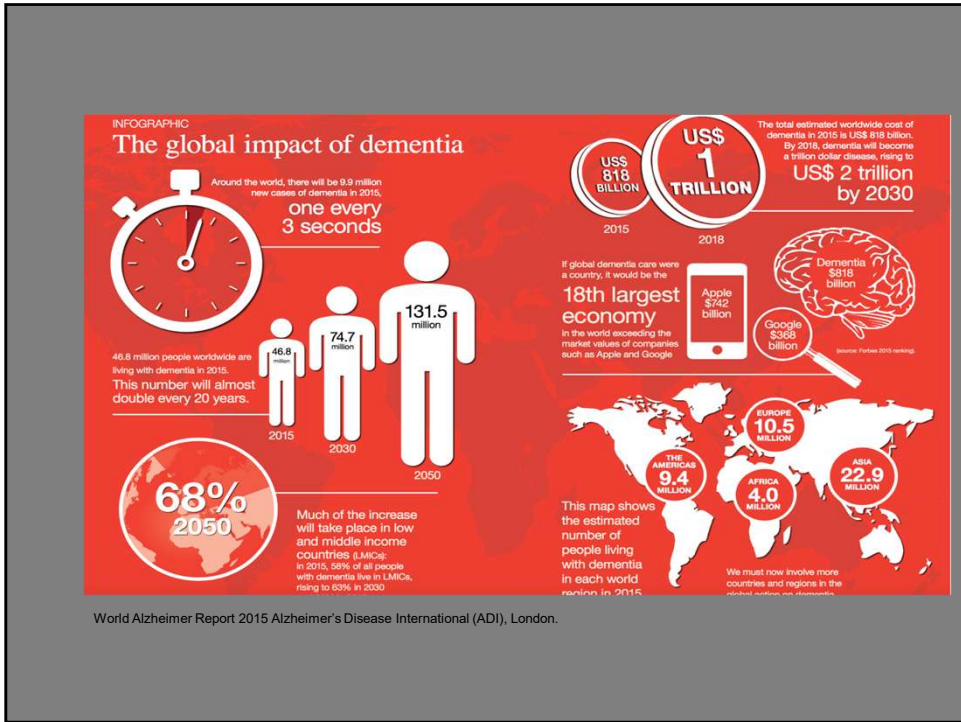
Professor (lector) in Ageing and Allied Health Care
Researchgroup Healthy Ageing Allied Health Care and Nursing
President IPTOP

In nauwe samenwerking met dr. Hans Drenth

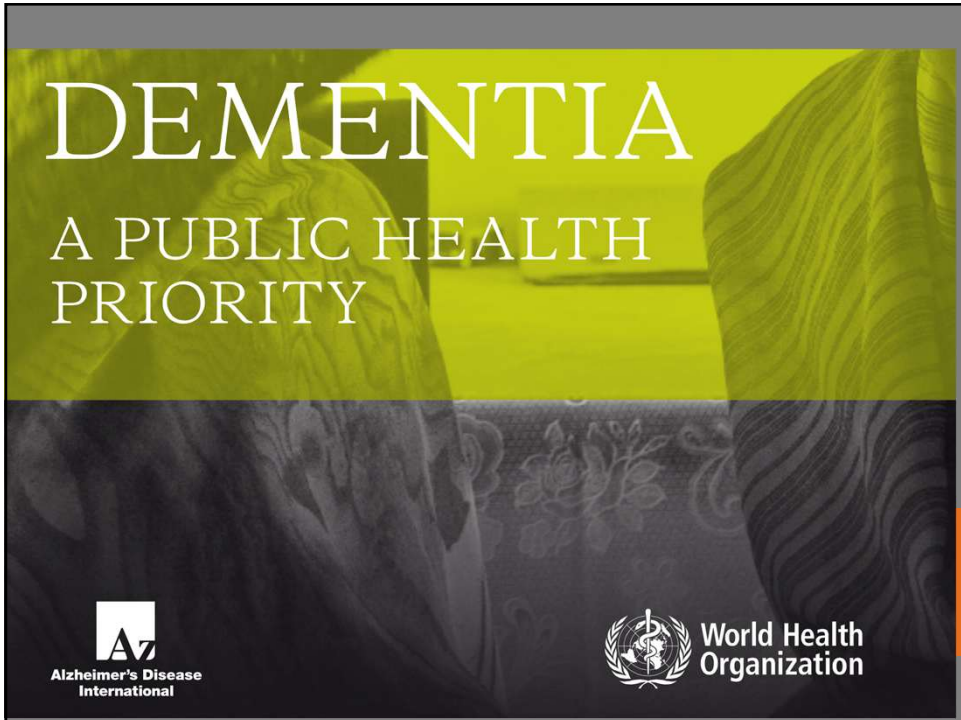
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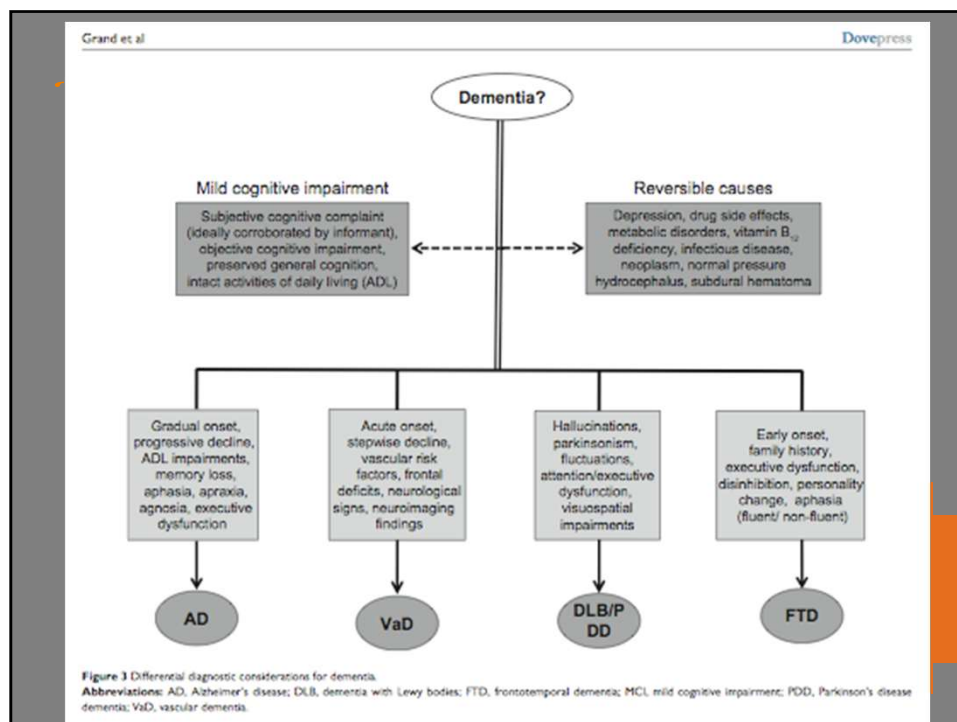
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Dementia:

Major neurocognitive disorder (NCD) ^{DSM V}

- Primarily Cognitive disorder
- (Cognition = The mental process of knowing, including aspects such as awareness, perception, reasoning, and judgment)
- Acquired and represent decline (i.e. not developmental)
- Underlying brain pathology

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Dementia = major neuro cognitive disorder

Cognitive domains

- Complex attention
- Executive functions
- Learning and Memory
- Language
- Movement, feeling of movement and spatial awareness
- Social cognitive functioning



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DEMENTIA

A public health priority

World Health Organization

What are the symptoms?

Difficulties with everyday tasks

Confusion in familiar environments

Difficulty with words and numbers

Memory loss

Changes in mood and behaviour

Who is affected?

Nearly 50 million new cases every year

One every 3 seconds

50 million people worldwide

Set to triple by 2050

Conditions that affect the brain, such as Alzheimer's disease, stroke or head injury

What does it cost?

Majority of people who will develop dementia will be in low- and middle-income countries

US\$818 billion: estimated costs to society in 2015

2015

2030 US\$2 trillion

Families and friends provide most of the care
Carers experience physical, emotional and financial stress

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The impact of cognitive impairment on the physical ageing process

Anne-Marie De Cock¹ · Stany Perkisas^{1,2} · Veronique Verhoeven¹ · Maurits Vandewoude² · Erik Franssen³ · Roy Remmen¹

Received: 4 May 2018 / Accepted: 28 July 2018
© Springer Nature Switzerland AG 2018

Conclusions

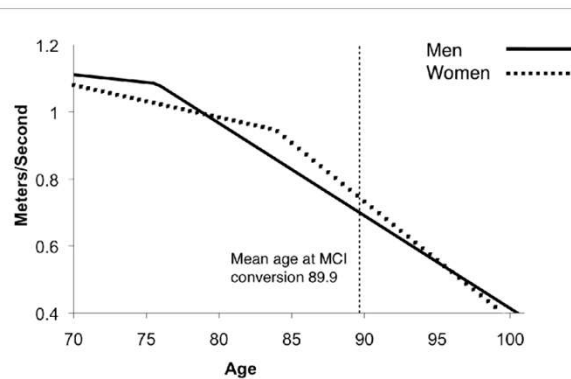
This study suggests that age and cognitive decline are inversely associated with the quality of gait, balance, frailty and skeletal muscle mass. Simultaneous changes in these parameters between dementia severity stages suggest a causal correlation. The relationship between physical status, cognitive impairment and age needs further investigation.

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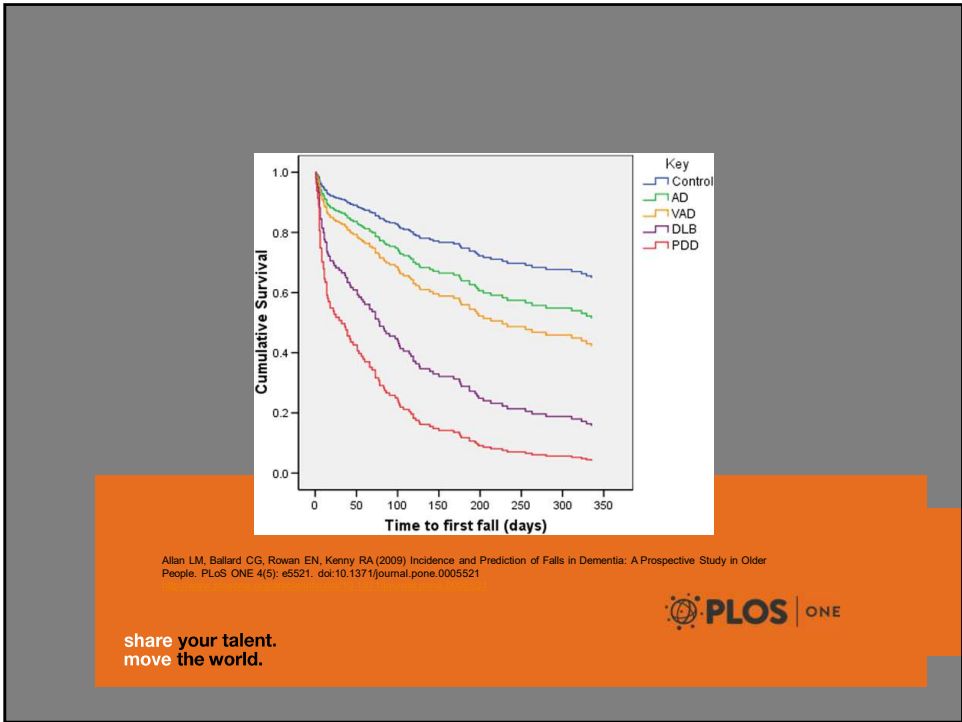
The trajectory of gait speed preceding MCI

Teresa Buracchio, MD^{1,2}, Hiroko Dodge, PhD¹, Diane Howieson, PhD¹, Dara Wasserman, BS¹, and Jeffrey Kaye, MD^{1,2,3}



Conclusions—Motor decline as indexed by gait speed accelerates up to 12 years prior to MCI. Longitudinal changes in motor function may be useful in the early detection of dementia during pre-clinical stages when the utility of disease-modifying therapies would be greatest.

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Trailer: Forgetful not forgotten by Chris Wynn

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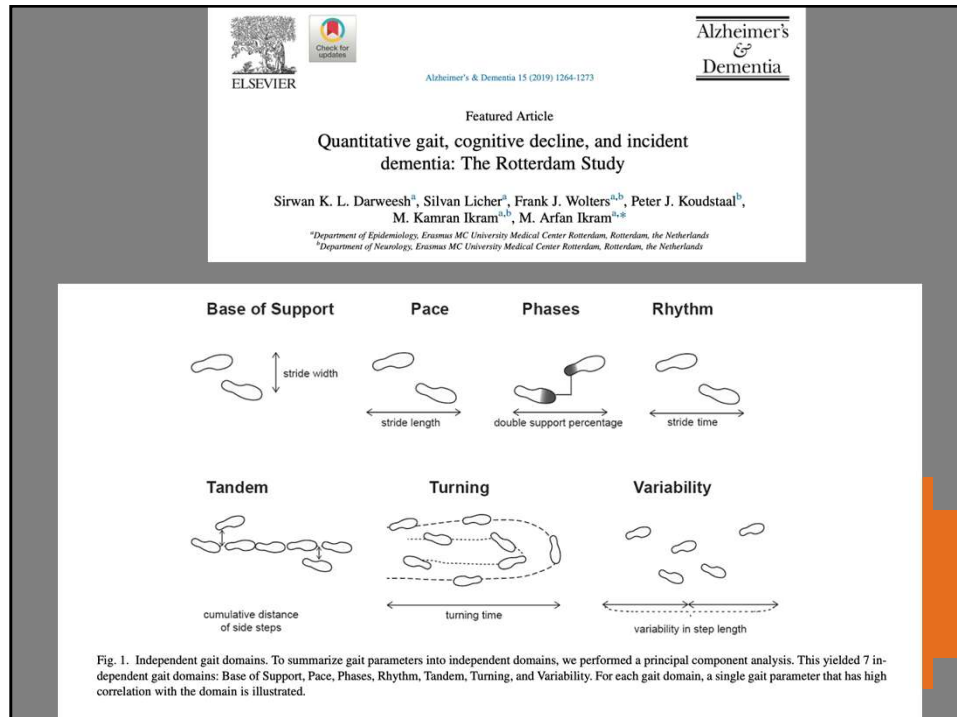
Motor problems in Alzheimer's disease Souren et al

1997

- In early stage clumsiness (apraxia)
- Slowing down of movements
- Apathy or restlessness (aimless walking)
- Walking on forefoot, no armsway and stiff trunk
- Losing the ability to walk, severe paratonia and the development of contractures

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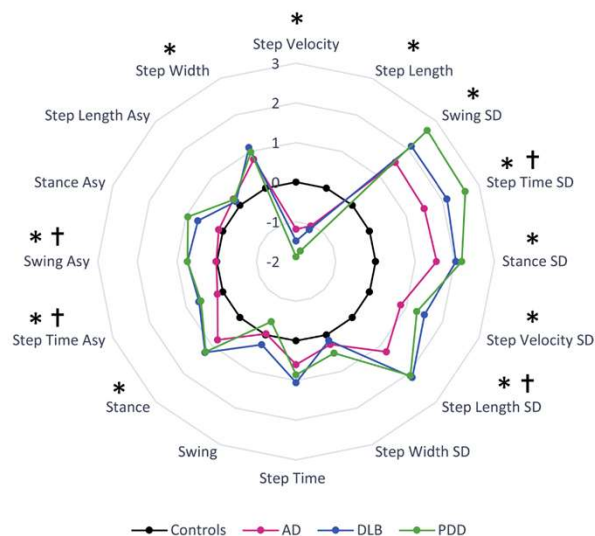


Fig. 1. Radar plots illustrating patterns of gait impairment in disease subtypes. The central black line represents control data, and the lines representing AD, DLB, and PDD demonstrate how many standard deviations from zero (z scores based on control means and standard deviations). Abbreviations: SD, variability; asy, asymmetry; AD, Alzheimer's disease; DLB, dementia with Lewy bodies; PDD, Parkinson's disease dementia; LBD, Lewy body dementia. * = differences between controls and disease groups, † = differences between AD and LBD.

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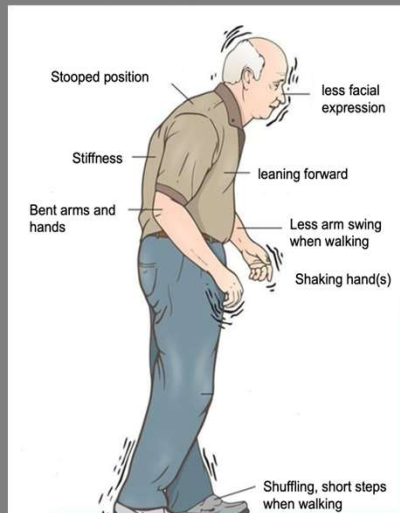
Vascular dementia Scherder 2010

- Motor disorders in diagnostic criteria
- Spasm and hemiparesis
- Walking speed declined
- wider walking base
- Paratonia/rigidity
- Balance (static and dynamic) control disturbed

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Lewy Body dementia



- Bradykinesia
- Parkinsonian rigidity (lead-pipe phenomenon)
- Slowing down
- Small steps in walking
- Stability problems
- Freezing of gait

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Frontotemporal dementia Scherder 2010

- Difficulties in initiating movements
- Core stability disturbed
- Balance disturbed

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Paratonia

- First described by Friedlander (1828) and later by Dupré (1910) :
- “**inability to relax muscles** in the setting of cognitive impairment”
- Kleist (1927) observed **oppositional paratonia**: hypertonic response to passive movement “Gegenhalten”
- Kral (1949) described **facilitory paratonia**: pathologic assistance (actively assisting passive movement or involuntary cooperation).

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Late stage dementia



Photo by José Verheijden



Photo by Bleke van Deun

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* Vahia et al. Am J Geriatr Psychiatry 2007
Hobbelen et al. Int Psychogeriatr 2011

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Paratonia

- Motor function disorder in dementia
- *Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement.*

Journal of Alzheimer's Disease 78 (2020) 1615–1637
DOI 10.3233/JAD-200691
IOS Press

Paratonia in Dementia: A Systematic Review

Hans Drenth^{a,b,*}, Sytse Zuidema^c, Ivan Bautmans^d, Lucio Marinelli^{e,f}, Galit Kleiner^{g,h} and Hans Hobbelen^{a,c}

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Paratonia

- Motor function disorder in dementia
- *Paratonia is a form of hypertonia with an involuntary variable resistance during passive movement.*
- Estimated prevalence of 5-10% in the early/mild stages, 90-100% in later/severe stages*

Journal of Alzheimer's Disease 78 (2020) 1615–1637
DOI 10.3233/JAD-200691
IOS Press

Paratonia in Dementia: A Systematic Review

Hans Drenth^{a,b,*}, Sytse Zuidema^c, Ivan Bautmans^d, Lucio Marinelli^{e,f}, Galit Kleiner^{g,h} and Hans Hobbelen^{a,c}

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* Vahia et al. Am J Geriatr Psychiatry 2007
Hobbelen et al. Int Psychogeriatr 2011

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- **Loss of quality of life**, mobility, severe contractures, and pain
- **Already in early dementia**, paratonia has an impact on functional mobility
- Impact on walking and risk factor for **falls**



Photo by Jan vd Rakt



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Assessment of paratonia and paratonia severity

- PAI
- MAS-P
- Myoton
- EMG

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Paratonia Assessment Instrument (PAI)

Standardized method to clinically identify paratonia and **differentiate it from** other forms of increased muscle tone, such as **parkinsonian rigidity** and **spasticity**



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<https://www.paratonia.org/zorgprofessionals-onderzoekers/paratonia-assessment-instrument-pai/>



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Paratonia severity Modified Ashworth Scale (MAS-P)

Waardenburg et al. 1999 / Drenth et al. 2017

- 0 = no resistance to passive movement
- 0+ = active assistance
- 1 = slight resistance during passive movement
- 2 = more marked resistance to passive movement
- 3 = considerable resistance to passive movement
- 4 = severe resistance, passive movement is impossible

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Myoton



- MAS is the worldwide standard, but
- prone to **subjectivity** and clinical experience is necessary
- Tone, elasticity, stiffness, creep, mechanical stress relaxation
- Validated in CVA, Parkinson
- **Validity and reliability recent in paratonia**

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Gerontology

Regenerative and Technological Section / Original Paper

Gerontology
DOI: 10.1159/000485462

Received: September 5, 2017
Accepted: November 20, 2017
Published online: December 22, 2017

Psychometric Properties of the MyotonPRO in Dementia Patients with Paratonia

Hans Drenth^{a,b} Sytse U. Zuidema^c Wim P. Krijnen^a Ivan Bautmans^d
Cees van der Schans^{a,e,f} Hans Hobbelen^{a,c}

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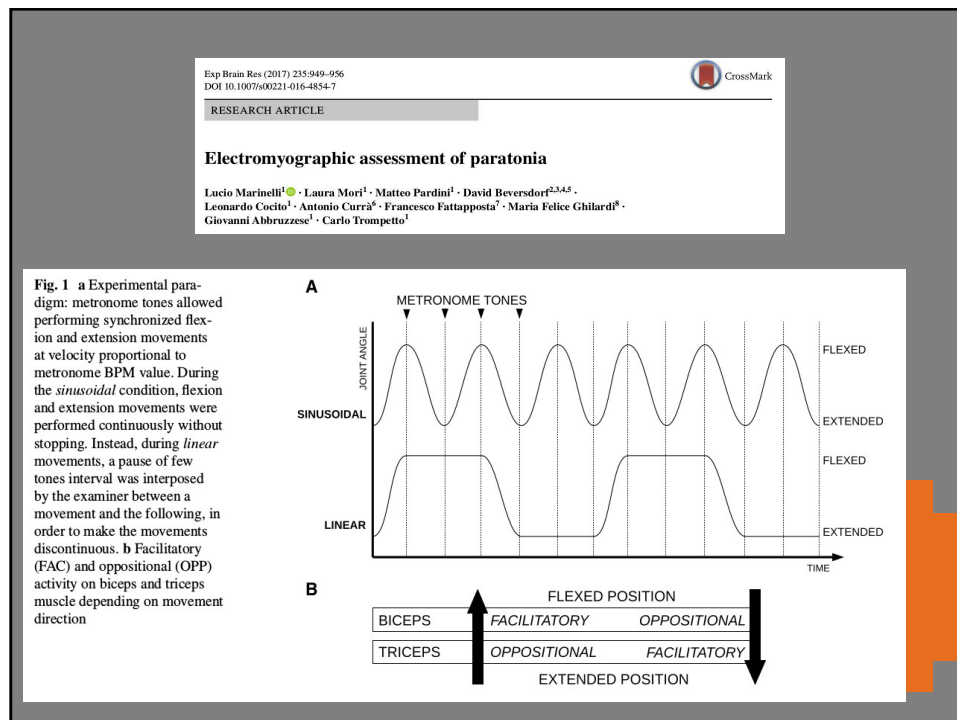
Clinical implications

- Potentially applicable for **cross-sectional** studies between **groups**
- Less suitable to measure intra-individual changes
- Outcomes should be **interpreted with care**, because of the inherent **variability** in movement resistance in paratonia

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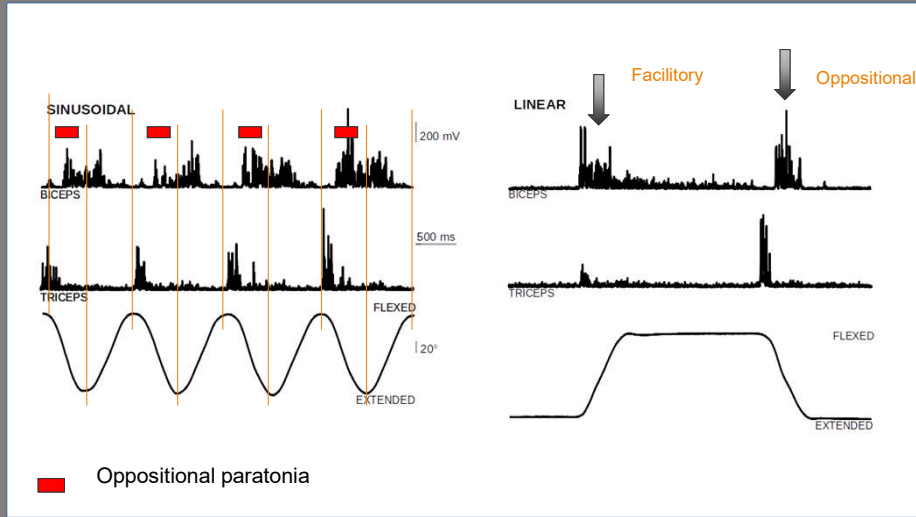
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Paratonic bursts during sinusoidal and linear passive movements while the subject is at rest

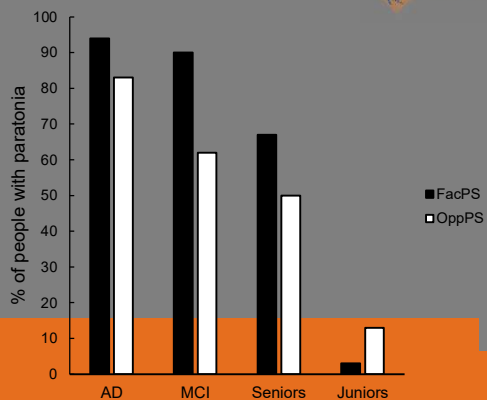


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Prevalence of paratonia

A Mild form of paratonia can be detected in healthy persons

→ Possibly interesting for early detection of AD



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Slide from dr. Menno Veldman
UMCG

Marinelli et al., 2022

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Pathophysiology

- The pathophysiology of paratonia is not well understood
- **CNS-based aetiology** of paratonia seems likely in severe paratonia.
- However, it is likely that peripheral biomechanical changes interfere with or accelerate the severity of paratonia.

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van den Noort, J. C., Bar-On, L., Aertbeliën, E., Bonikowski, M., Braendvik, S. M., Broström, E. W., Buizer, A. I., Burrige, J. H., van Campenhout, A., Dan, B., Fleuren, J. F., Grunt, S., Heinen, F., Horemans, H. L., Jansen, C., Kranzl, A., Krautwurst, B. K., van der Krogt, M., Lerma Lara, S., Lidbeck, C. M., ... Harlaar, J. (2017). European consensus on the concepts and measurement of the pathophysiological neuromuscular responses to passive muscle stretch. *European journal of neurology*, 24(7), 981–e38. <https://doi.org/10.1111/ene.13322>

(c) Final conceptual framework of pathophysiological neuromuscular responses to passive muscle stretch

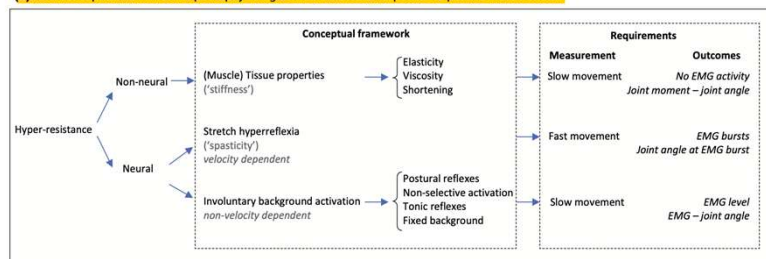


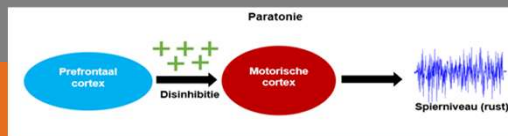
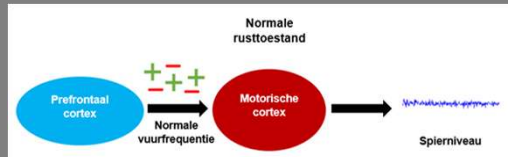
Figure 1 (a) Schematic overview to discuss terminology in concepts of and phenomena around pathophysiological neuromuscular response to passive muscle stretch; (b) alternative terms for hyperstretch reflex and involuntary activation as part of hyper-resistance; (c) final conceptual framework of pathophysiological neuromuscular responses to passive muscle stretch. [Color figure can be viewed at wileyonlinelibrary.com].

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Proposed mechanism Paratonia

Current hypothesis: decreased inhibition from the frontal cortex in AD causes uncontrolled muscle activation



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Marie-Fleur Passchier

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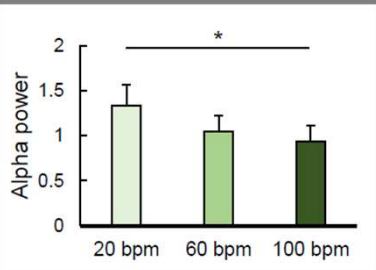


Onderzoek naar paratonia
bij dementie

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First results in healthy young people(n = 12)



Inhibition declines with higher passive movement frequency (*alpha frequencies)

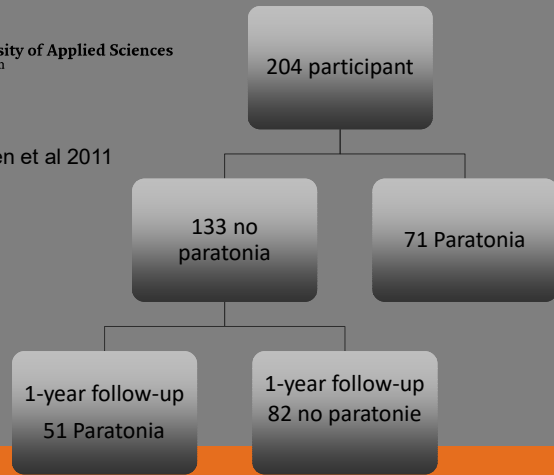
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Dr. Menno Veldman UMCG

- Longitudinal study to investigate factors of influence in developing paratonia

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Hobbelen et al 2011



Results

Hobbelen JS, et al. Prevalence, incidence and risk factors of paratonia in patients with dementia: a one-year

share your talent. move the world. follow-up study. Int Psychogeriatr 2011;23(7):1051-1060.

Prevalence, incidence and risk factors of paratonia in patients with dementia: a one-year follow-up study

Johannes S. M. Hobbelen,^{1,2,3,4,5} Frans E. S. Tan,^{2,6} Frans R. J. Verhey,^{3,8} Raymond T. C. M. Koopmans⁷ and Rob A. de Bie^{2,4}

Table 4 logistic regression with baseline data of those participants with no paratonia at baseline

Variable*	β	SD	Exp (β)	95% CI
Age	.072	.04	1.08	.99-1.16
Gender	-1.0	.58	.37	.12-1.13
MMSE†	-.10	.04	.90	.83-.98
TUG	.64	.69	1.9	.49-7.32
Co-morbidities	-.07	.14	.93	.71-1.21
Diabetes‡	2.37	.81	10.66	2.2-51.7
Stroke-IVA	.81	.47	1.01	.4-2.52
medication	.07	.1	1.08	.89-1.3
Antipsychotics	.28	.71	1.32	.33-5.32
AD +VaD				
AD	-.23	.7	.8	.2-3.2
LBD	-.81	1.2	.45	.04-4.7
VaD	.38	.79	1.5	.31-6.9
other	-.54	1.2	.58	.06-5.7
Intercept	-3.34	3.4	.04	

New insights in the development of paratonia

- Diabetes Mellitus 10.7 times higher risk to develop paratonia
- Hypothesis; Due to nonenzymatic glycation with Advanced Glycation Endproducts (AGE) that causes cross-links in collagen → The PARAGE study

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- Advanced Glycation End-products (AGEs)
- Non-enzymatic condensation of a reducing sugar with proteins (especially collagen tissue)
- AD and DM related to higher level AGEs
- It is hypothesized that in paratonia several central and peripheral pathways take place simultaneously and reinforce or interact with each other

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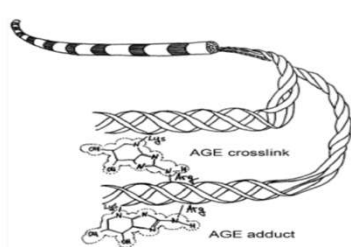
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Experimental Gerontology 45 (2010) 1111–1128
 Contents lists available at ScienceDirect
Experimental Gerontology
 Journal homepage: www.elsevier.com/locate/expgero

The role of inflammaging and advanced glycation end products on paratonia in patients with dementia
 Hans Drenth ^{a,b,c}, Sytse Zuidema ^a, Ivan Bautmans ^d, Hans Hobbelen ^{a,c}

Consequences (accumulation and RAGE activation)
 cross-linking / inflammation

- Thickening of the tissues
- Increase in movement stiffness
- Loss of elasticity
- Disruption of nerve functions

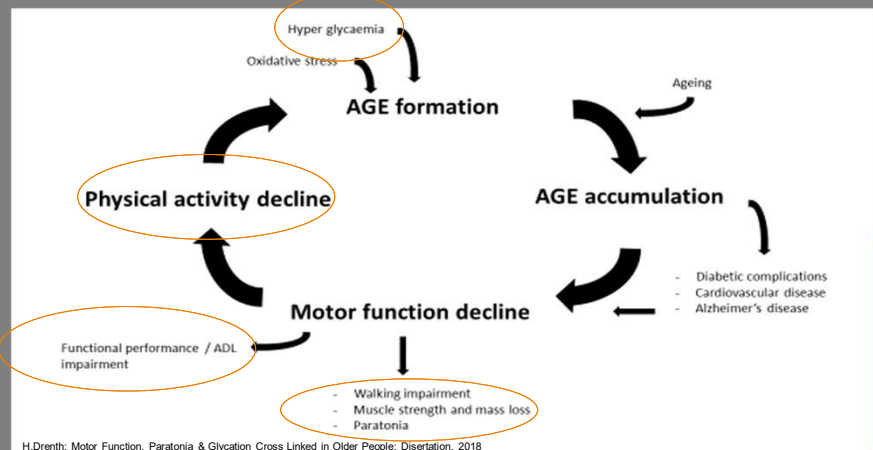


Avery. Scand J Med Sci Sports. 2005
 Monnier. Ann N Y Acad Sci. 2005
 Kjaer. Physiol Rev 2004

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Current insights

High levels of AGEs affect motor skills and can induce Paratonia.



The flowchart illustrates a cycle of decline and accumulation. At the top, 'Hyper glycaemia' and 'Oxidative stress' lead to 'AGE formation'. 'AGE formation' leads to 'AGE accumulation', which is also influenced by 'Ageing'. 'AGE accumulation' leads to 'Motor function decline', which is associated with 'Diabetic complications', 'Cardiovascular disease', and 'Alzheimer's disease'. 'Motor function decline' leads to 'Paratonia', 'Muscle strength and mass loss', and 'Walking impairment'. 'Motor function decline' also leads to 'Functional performance / ADL impairment', which leads to 'Physical activity decline'. 'Physical activity decline' leads back to 'AGE formation', completing the cycle.

H.Drenth; Motor Function, Paratonia & Glycation Cross Linked in Older People; Dissertation, 2018

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Glycation in Parkinson's Disease and Alzheimer's Disease

Hugo Vicente Miranda, PhD,¹ Omar M. A. El-Agnaf, PhD,² and Tiago Fleming Outeiro, PhD^{1,3,4*}

Movement Disorders, Vol. 31, No. 6, 2016

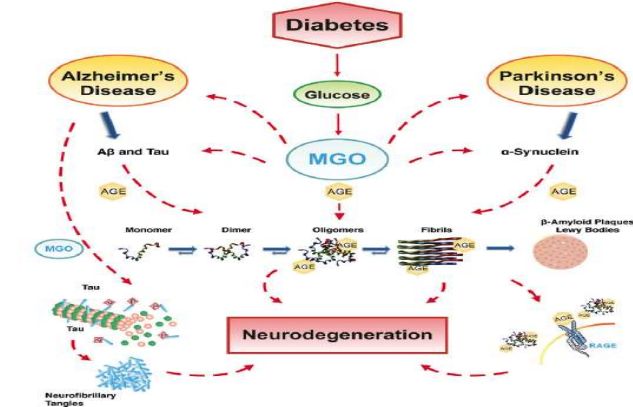


FIG. 2. Diabetes: a common link between AD and PD. Type 2 diabetes is known for being associated with hyperglycemia. An increase in glucose levels directly increases the levels of MGO, a potent glycation agent. MGO plays an important role in both AD and PD, increasing the formation of oligomeric and aggregated toxic forms of α Syn and A β . Moreover, by increasing tau phosphorylation, it drives the formation of tau neurofibrillary tangles. Glycated species activate RAGE, consequently inducing an extensive inflammatory response. Thus, glycation contributes to neurodegeneration in both AD and PD and might constitute the missing link between diabetes and neurodegenerative diseases.

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what is an effective intervention for paratonia

- Passive movement therapy is not beneficial
- Relaxing/rocking movements promising results (van Deun 2018)
- Promising results of Botuline Toxine (Kleiner et al 2014)
- Good stabilising cushions or positioning programs and PDL-concept are not yet investigated.
- Important to analyse the effects with known reliable assessment instruments for individual treatments --> above all it is important to analyse first the problems of the patient.

Journal of Alzheimer's Disease xx (2020) x-xx
DOI 10.3233/JAD-200691
IOS Press

Paratonia in Dementia: A Systematic Review

Hans Drenth^{a,b,*}, Sytse Zuidema^c, Ivan Bautmans^d, Lucio Marinelli^{e,f}, Galit Kleiner^{g,h} and Hans Hobbelen^{a,c}

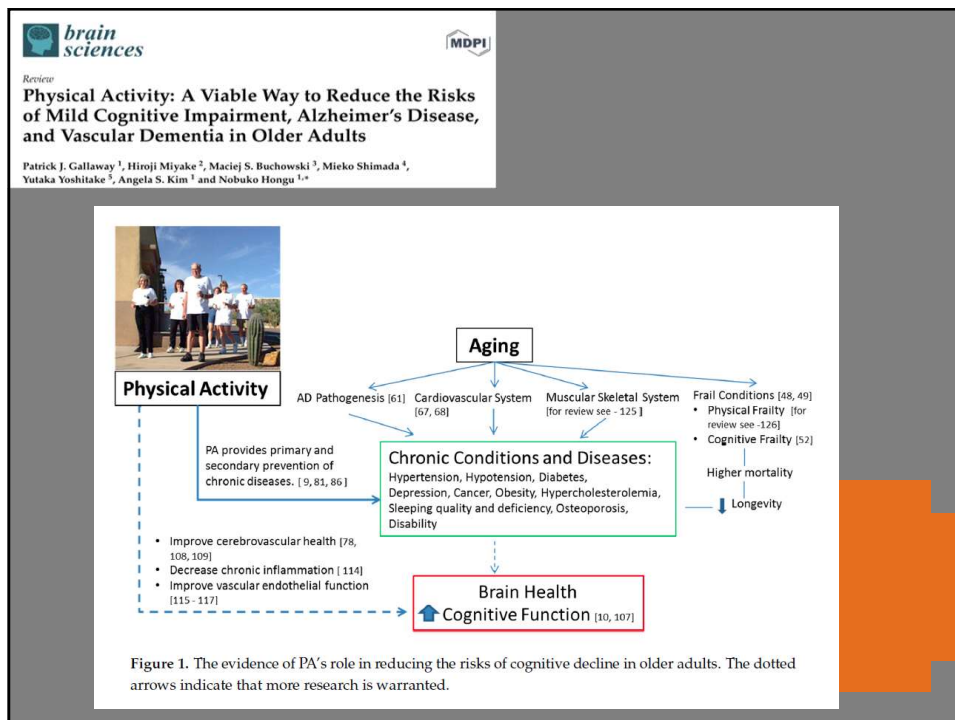
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Focus on prevention Exercise is medicine!!

- Intensive glycemic control (nutrition / physical activity) may be key methods for decreasing AGE formation and potentially prevent paratonia (Drenth et al. 2020)
- To improve physical fitness and control the accumulation of Advanced Glycation End Products
- To preserve cognitive function

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Physical activity and risk of cognitive decline: a meta-analysis of prospective studies

■ F. Sofi^{1,2,3}, D. Valecchi¹, D. Bacci¹, R. Abbate², G. F. Gensini¹, A. Casini³ & C. Macchi¹

subjects who reported performing a high level of activity had a 38% reduced risk of cognitive decline with respect to those who reported being sedentary (HR 0.62, 95% CI 0.54–0.70; $P < 0.00001$)

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小宮 諒

possible effects directly in the brain due to physical activity Rolland 2008, van Praag 2009

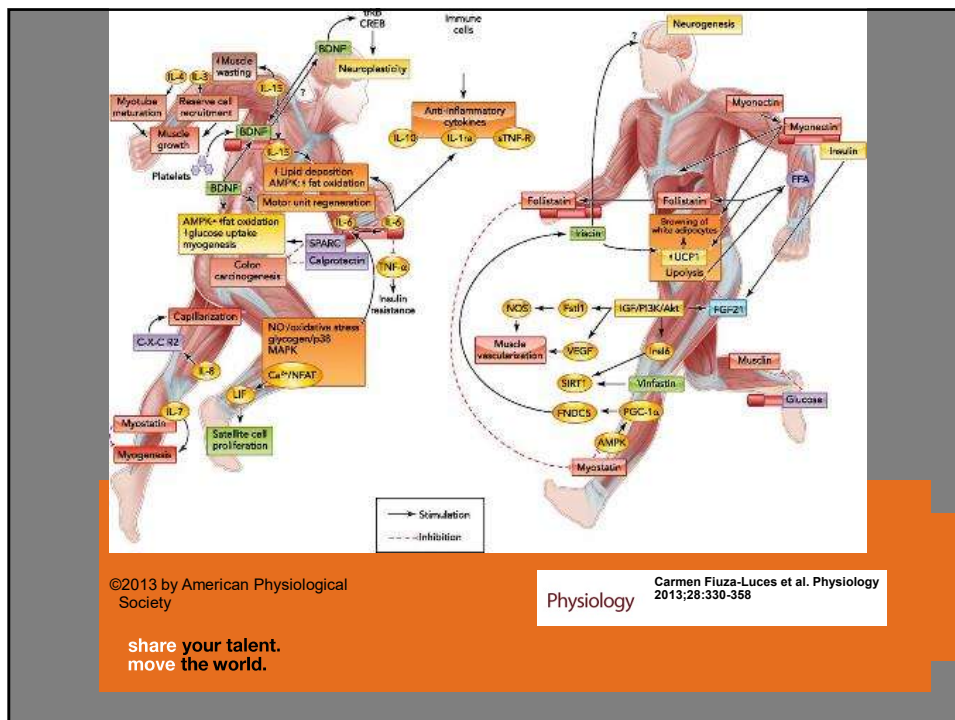
- Positive effect on general health
- improves cytoarchitecture of the brain (neurogenesis, angiogenesis)
- improves electrophysiological capacity (neurotransmitters)
- Increase of brain growth factors (i.e.BDNF)
- decreases amyloid 'burden'
- Positive effect on several enzymes and gene-expression

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Dia 54


小宮 諒1 小宮 諒; 11-10-2019



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Current Geriatrics Reports
<https://doi.org/10.1007/s13670-018-0237-1>

PHYSICAL THERAPY AND REHABILITATION (O. ADDISON, SECTION EDITOR)



Rehabilitation for Individuals with Dementia: Facilitating Success

Julie D. Ries¹

© Springer Science+Business Media, LLC, part of Springer Nature 2018

- Procedural (Implicit) learning
- Errorless learning
- At set times and for a longer period of time
- Sufficient repetition, intensity, challenge and practice at the maximum level of ability → undertreatment is a real risk

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Physiotherapists are pivotal in the care of people living with dementia

Hans Hobbelen^{1,2}, Katherine Lawler^{3,4}, Melanie K. Farlie⁵, Bernadette Kroon⁶, Jan Tessier⁷ and Janet Thomas⁸

¹President of IPTOP, ²Hanze University of Applied Sciences Groningen, The Netherlands, ³School of Allied Health, Human Services and Sport, La Trobe University, Melbourne, Victoria, Australia, ⁴Wicking Dementia Research and Education Centre, College of Health and Medicine, University of Tasmania, Hobart, Tasmania, Australia, ⁵School of Primary and Allied Health Care and Monash Centre for Scholarship in Health Education, Monash University, Melbourne, Victoria, Australia, ⁶University of Southern Maine Lewiston Auburn College, Master of Occupational Therapy program, Lewiston, Maine, US of America, ⁷Governing body ELZ Oostkust vzw, Ulkerke - Blankenberge, Belgium, ⁸NHS Forth and Queen Margaret University, Edinburgh, Scotland

DOI: 10.52057/erj.v4i1.53
ISSN: 2823-989X

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**Alzheimer's Disease
International**

The global voice on dementia

World Alzheimer Report 2025

Reimagining life with dementia –
the power of rehabilitation

“This report aims to illuminate the concept of dementia rehabilitation and, we hope, serve as a resource and roadmap for more individuals to adopt and adapt rehabilitation practices, regardless of their location.”

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Future directions of research



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1) Pathophysiology of paratonia

e.g. can (impaired) sensory and motor signals to and from the sensorimotor areas in the brain be related to the degree of paratonia?

2) Validation and refinement of instruments and techniques to capture and measure the severity of paratonia that can detect changes due to trial interventions

e.g. expanding EMG/EEG research Marinelli et al.

3) Methodologically rigorous clinical trials of therapeutics

e.g. prevention by AGE's reduction or the effect of exercise on severe paratonia or investigate the effect of stabilising cushions

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PARATONIA.ORG
AN INITIATIVE OF IIRG 'MOVE IN AGE'

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Thank you for your attention !
j.s.m.hobbelen@pl.hanze.nl



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