Cette présentation a été effectuée le 4 décembre 2018 au cours de la journée « La santé cognitive, nouvelle cible de prévention pour la santé publique » dans le cadre des 22es Journées annuelles de santé publique (JASP 2018). L'ensemble des présentations est disponible sur le site Web des JASP à la section Éditions précédentes au : https://www.inspq.qc.ca/jasp.

CENTRE ÉPIC
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LABORATOIRE D'ETUDE DE LA SANTE COGNITIVE DES AINES
COGNITIVE HEALTH AND AGING RESEARCH LAB

Faculté de médecine
Université de Montréal

LES BIENFAITS DE L'ACTIVITÉ PHYSIQUE POUR AMÉLIORER LA COGNITION, PRÉVENIR LA DÉMENCE ET GARDER UN CERVEAU EN SANTÉ

Louis Bherer, M.Ps., Ph.D.
Professeur titulaire, Département de Médecine, Université de Montréal,
Directeur adjoint scientifique, direction de la prévention de l'ICM,
Chercheur, Centres de recherche de l'ICM et de l'IUGM

Centre de recherche iugm
Institut universitaire de gériatrie de Montréal

Université Concordia University
Centre PERFORM Centre

JASP - INSPQ
4 décembre 2018

Aucun conflit d'intérêt

Un mode de vie **sain et actif** peut aider à prévenir le déclin cognitif associé à l'âge

Effets protecteurs de l'exercice

Bherer, Erickson & Liu-Ambrose (2013). *A review of the Effects of Physical Activity and Exercise on Cognitive and Brain Functions in Older Adults.* **Journal of Aging Research**

Annals of Internal Medicine | ARTICLE

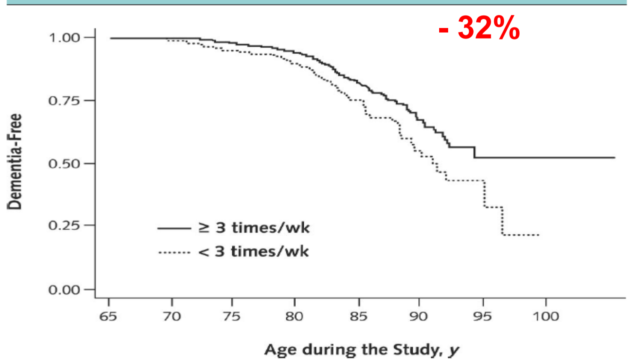
Exercise Is Associated with Reduced Risk for Incident Dementia among Persons 65 Years of Age and Older

Eric B. Larson, MD, MPH; Li Wang, MS; James D. Bowen, MD; Wayne C. McCormick, MD, MPH; Linda Teri, PhD; Paul Crane, MD, MPH; and Walter Kukull, PhD

- 1 740 personnes âgées de 65ans+
- Sans MCI ni démence
- Suivi sur **6,2 ans**

- Activité physique **≥ 3x/semaine**
  → 13/1000 / an
- Activité physique **< 3x/semaine**
  → 20/1000 / an

Figure 1. **Kaplan–Meier survival estimates for the probabilities of being dementia-free.**



Persons who exercised 3 or more times per week were more likely to be dementia-free than those who exercised fewer than 3 times per week.

Original Article | Journal of INTERNAL MEDICINE
doi: 10.1111/j.1365-2796.2010.02281.x

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

F. Sofi[1,2,3], D. Valecchi[1], D. Bacci[1], R. Abbate[2], G. F. Gensini[1], A. Casini[3] & C. Macchi[1]

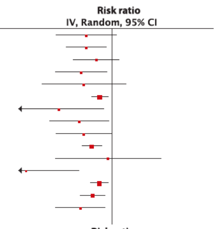
Méta-analyse de 15 études prospectives (12 cohortes) incluant 33 816 individus non-déments (3 210 ont développé des troubles cognitifs durant le suivi de 1 à 12 ans).

L'activité physique prévient de manière systématique et significative le déclin cognitif

-Les **hautement actifs** physiquement montrent **38%** moins de risque de présenter un déclin cognitif

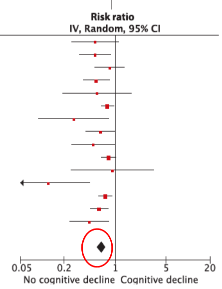
-Les **modérément actifs** ont aussi montré un risque **35%** moins important de déclin cognitif

Study or Subgroup	Weight	Risk ratio IV, Random, 95% CI
Ho *et al.*, (M)	2.7%	0.53 [0.25, 1.12]
Ho *et al.*, (F)	5.8%	0.53 [0.32, 0.87]
Laurin *et al.*, (M)	4.6%	0.68 [0.39, 1.19]
Laurin *et al.*, (F)	3.6%	0.47 [0.25, 0.89]
Schuit *et al.*,	1.4%	0.50 [0.18, 1.41]
Yaffe *et al.*,	20.5%	0.74 [0.60, 0.91]
Pignatti *et al.*,	1.3%	0.27 [0.09, 0.82]
Lytle *et al.*,	2.8%	0.45 [0.22, 0.94]
Flicker *et al.*,	3.2%	0.50 [0.25, 1.00]
Singh–Manoux *et al.*,	16.7%	0.61 [0.48, 0.78]
Sumic *et al.*, (M)	0.9%	0.91 [0.25, 3.36]
Sumic *et al.*, (F)	0.9%	0.12 [0.03, 0.44]
Middleton *et al.*,	19.1%	0.73 [0.59, 0.91]
Niti *et al.*,	12.6%	0.62 [0.46, 0.84]
Etgen *et al.*,	3.9%	0.46 [0.25, 0.85]



Study or Subgroup	Weight	Risk ratio IV, Random, 95% CI
Ho *et al.*, (M)	3.0%	0.53 [0.25, 1.12]
Ho *et al.*, (F)	5.9%	0.53 [0.32, 0.87]
Laurin *et al.*, (M)	6.4%	0.84 [0.53, 1.34]
Laurin *et al.*, (F)	7.6%	0.55 [0.36, 0.83]
Schuit *et al.*,	1.5%	0.56 [0.19, 1.66]
Yaffe *et al.*,	16.0%	0.78 [0.64, 0.96]
Pignatti *et al.*,	1.4%	0.27 [0.09, 0.82]
Lytle *et al.*,	6.4%	0.63 [0.40, 1.00]
Flicker *et al.*,	3.4%	0.50 [0.25, 1.00]
Singh–Manoux *et al.*,	14.8%	0.81 [0.65, 1.01]
Sumic *et al.*, (M)	1.1%	0.91 [0.25, 3.36]
Sumic *et al.*, (F)	1.1%	0.12 [0.03, 0.44]
Middleton *et al.*,	15.2%	0.73 [0.59, 0.91]
Niti *et al.*,	12.1%	0.60 [0.45, 0.80]
Etgen *et al.*,	4.1%	0.44 [0.24, 0.82]
Total (95% CI)	**100.0%**	**0.65 [0.57, 0.75]**

Heterogeneity: $Tau^2 = 0.02$; $\chi^2 = 20.93$, df = 14 ($P = 0.10$); $I^2 = 33\%$
Test for overall effect: $Z = 6.17$ ($P < 0.00001$)



 Journal of Internal Medicine 269; 107–117 113

Association of Muscle Strength With the Risk of Alzheimer Disease and the Rate of Cognitive Decline in Community-Dwelling Older Persons

Arch Neurol. 2009;66(11):1339-1344

Patricia A. Boyle, PhD; Aron S. Buchman, MD; Robert S. Wilson, PhD; Sue E. Leurgans, PhD; David A. Bennett, MD

- **900** aînés en santé suivis sur **3,6 ans**
- **9** groupes musculaires évalués
- Association significative entre la **force musculaire et le risque de déclin cognitif, de MCI et de MA.**
- La relation persiste même après avoir contrôlé pour l'IMC, les facteurs de risque, les maladies vasculaires, ainsi que génétique (ApoE4).

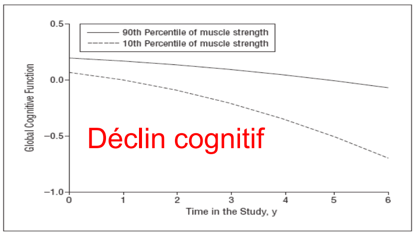


Figure 2. Decline in global cognitive function for participants with low muscle strength vs those with high muscle strength.

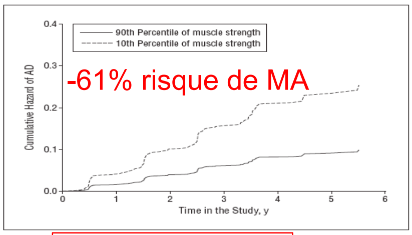


Figure 1. Cumulative hazard of Alzheimer disease (AD) for participants with low muscle strength vs those with high muscle strength.

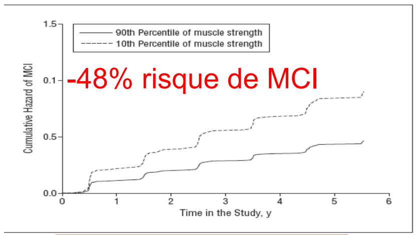
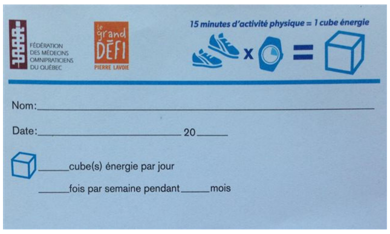


Figure 3. Cumulative hazard of mild cognitive impairment (MCI) for participants with low muscle strength vs those with high muscle strength.

Effets des interventions



L'activité physique c'est bon pour le cœur et le cerveau !

-Quel type d'entraînement (aérobie/résistance) ?
-Durée, fréquence, intensité?
-À quels changements peut-on s'attendre?

FITNESS EFFECTS ON THE COGNITIVE FUNCTION OF OLDER ADULTS: A Meta-Analytic Study

Stanley Colcombe and Arthur F. Kramer

Beckman Institute and Department of Psychology, University of Illinois, Urbana

Table 1. *Results for significant moderating variables*

Moderator variable	Effect size	*SE*	*n*	*p*
Overall				
Control	0.164	0.028	96	*
Exercise	0.478[1]	0.029	101	*
Exercisers				
Training characteristics				
Training type				
Combined	0.59[2]	0.049	49	*
Cardiovascular only	0.41	0.037	52	*
Program duration				
Short (1–3 mo)	0.522[2]	0.067	38	*
Medium (4–6 mo)	0.269	0.047	36	*
Long (6+ mo)	0.674[1,2]	0.048	27	*
Session duration				
Short (15–30 min)	0.176	0.089	11	
Moderate (31–45 min)	0.614[1,3]	0.052	24	*
Long (46–60 min)	0.466[1]	0.041	53	*
Participants' characteristics				
Sex				
High female (>50% female)	0.604[2]	0.036	67	*
High male (≥50% male)	0.150	0.055	27	*
Age				
Young-old (55–65)	0.298	0.044	31	*
Mid-old (66–70)	0.693[1,3]	0.056	37	*
Old-old (71–80)	0.549[1]	0.058	33	*

Note. All listed categorical effects were, as a group, reliably different from zero. A superscript 1, 2, or 3 indicates that the effect size was statistically greater (after Bonferroni correction) than the effect size for the 1st, 2nd, or 3rd item, respectively, listed in that category (e.g., a "1,3" superscript means that the value in that cell was statistically greater than the 1st and 3rd listed items in that category). Asterisks indicate which categories were significantly different from zero.

+ ↑ tailles d'effet observées avec les entraînements combinés (aérobie + résistance), de durée modérée (30-45 min), au long cours (6 mois et +).

+ ↑ bénéfices sur les tâches exécutives ou qui requièrent du contrôle attentionel (ex : inhibition, attention divisée, alternance)

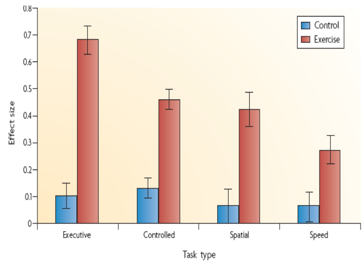


Figure 1 | **Meta-analytic findings of exercise-training effects on cognition in older adults.** The results of a meta-analysis of the effects of fitness training on cognition showed that the benefits of fitness training on four different cognitive tasks were significant. As illustrated in the figure, fitness training has both broad and specific effects. The effects are broad in the sense that individuals in aerobic fitness training groups (represented by the red bars) showed larger fitness training effects across the different categories of cognitive processes illustrated on the x-axis. They are specific in the sense that fitness training effects were larger for some cognitive processes, in particular executive control processes, than for other cognitive processes. Figure reproduced, with permission, from REF. 32 © (2003) Blackwell Publishers.

ICM-01-01-2012-09

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

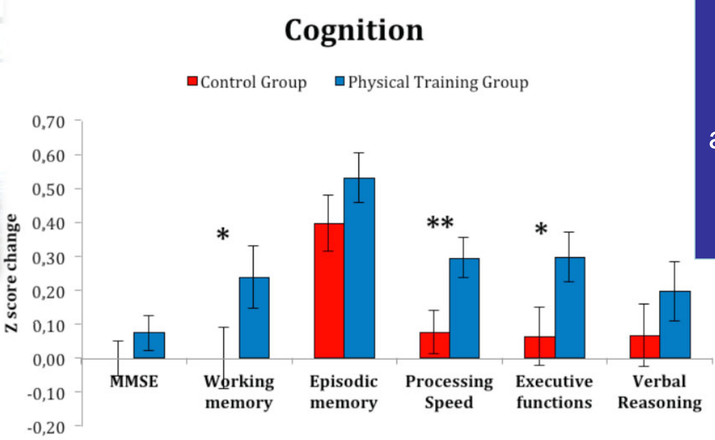
Université de Montréal

Un programme d'entraînement de 3 mois peut faire la différence!

Journal of Gerontology: Psychological Sciences, 2013

Benefits of Physical Exercise Training on Cognition and Quality of Life in Frail Older Adults

Francis Langlois,[1,2] Thien Tuong Minh Vu,[2,3] Kathleen Chassé,[2] Gilles Dupuis,[1,4] Marie-Jeanne Kergoat,[2] and Louis Bherer[1,2]



Amélioration équivalente de la mobilité et la cognition après 3 mois d'exercice chez les patients fragiles et non-fragiles

Pas seulement une question d'aérobie…

Entraîner la force musculaire peut aussi mener à des améliorations de la performance cognitive!

- Amélioration de la **performance mnésique et de l'abstraction verbale** chez 62 aînés vivant dans la communauté (Cassilhas, et al., 2007) après un entraînement en résistance d'intensité modérée à élevée (3x/sem pendant 6 mois).

- Améliorer au **test de Stroop** (fonctions exécutives) dans un échantillon de 155 femmes âgées de 65 à 75 ans (Liu-Ambrose, et al., 2010) après un entraînement progressif de la force (2 sets de 6-8 répétitions) sur 12 mois (1 ou 2 x/sem).

Intervention auprès des patients avec MCI ou démence

ORIGINAL CONTRIBUTION

Arch Neurol. 2010;67(1):71-79

Effects of Aerobic Exercise on Mild Cognitive Impairment

A Controlled Trial

Laura D. Baker, PhD; Laura L. Frank, PhD, MPH; Karen Foster-Schubert, MD; Pattie S. Green, PhD; Charles W. Wilkinson, PhD; Anne McTiernan, MD, PhD; Stephen R. Plymate, MD; Mark A. Fishel, MD; G. Stennis Watson, PhD; Brenna A. Cholerton, PhD; Glen E. Duncan, PhD; Pankaj D. Mehta, PhD; Suzanne Craft, PhD

Entraînement aérobique de 6 mois (essai contrôlé)
N= 33 (17 women) entre 55-85 ans avec MCI de type amnésique

Intervention :
A) **Entraînement aérobique à haute intensité** (75-85% de la fréquence cardiaque (FC) maximale pendant 45-60 min/j, 4 j/sem, sur tapis roulant, bicyclette ou elliptique)
B) **Groupe d'étirements** (inférieur à 50% de la FC maximale)

Malgré des gains comparables en termes de **capacité cardiorespiratoire** et de **réduction de la masse grasse** corporelle, les effets diffèrent entre les hommes et les femmes (mais F plus jeunes et meilleur MMSE)
- **Femmes** : Amélioration de plusieurs mesures des fonctions exécutives
- **Hommes** : Amélioration au Trail B uniquement

ORIGINAL CONTRIBUTION

Arch Neurol. 2010;67(1):71-79

Effects of Aerobic Exercise on Mild Cognitive Impairment

A Controlled Trial

Laura D. Baker, PhD; Laura L. Frank, PhD, MPH; Karen Foster-Schubert, MD; Pattie S. Green, PhD; Charles W. Wilkinson, PhD; Anne McTiernan, MD, PhD; Stephen R. Plymate, MD; Mark A. Fishel, MD; G. Stennis Watson, PhD; Brenna A. Cholerton, PhD; Glen E. Duncan, PhD; Pankaj D. Mehta, PhD; Suzanne Craft, PhD

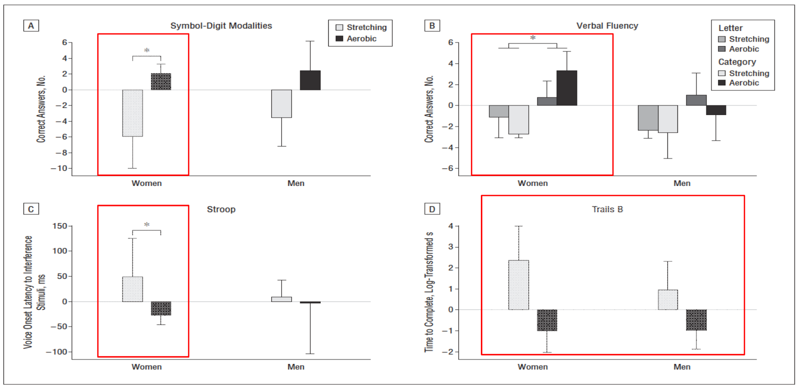


Figure 2. Mean (standard error of the mean) values representing the change from baseline for cognitive measures, expressed as residual scores. A, For the Symbol-Digit Modalities test, the number of correct responses (in 120 seconds) increased for those in the aerobic group relative to the stretching group ($P=.05$); this effect was more pronounced for women ($P=.04$) than men ($P=.33$). B, For the Verbal Fluency test, word generation was increased for those in the aerobic group relative to the stretching group ($P=.04$). For women only, aerobic exercise increased category fluency ($P=.01$). C, For the Stroop test, voice onset latencies to interference stimuli were reduced for women in the aerobic exercise vs stretching group ($P=.02$). D, For the Trails B test, aerobic exercise reduced the time to complete the task ($P=.04$), and this effect was comparable for women ($P=.09$) and men ($P=.05$). *$P<.05$.

Ageing Research Reviews 25 (2016) 13–23

Contents lists available at ScienceDirect

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journal homepage: www.elsevier.com/locate/arr

Review

The effect of physical activity on cognitive function in patients with dementia: A meta-analysis of randomized control trials

C. Groot[a,b,*], A.M. Hooghiemstra[a,c], P.G.H.M. Raijmakers[b], B.N.M. van Berckel[b], P. Scheltens[a], E.J.A. Scherder[c], W.M. van der Flier[a,d], R. Ossenkoppele[a,b]

[a] Department of Neurology and Alzheimer Center, VU University Medical Center, Amsterdam, Th
[b] Department of Radiology and Nuclear Medicine, VU University Medical Center, Amsterdam, Th
[c] Department of Clinical Neuropsychology, VU University, Amsterdam, The Netherlands
[d] Department of Epidemiology and Biostatistics, VU University Medical Center, Amsterdam, The

Bénéfices équivalents observés chez les patients avec MA et chez les patients non-MA

- 18 essais randomisés contrôlés totalisant 802 patients
- **Effet positif global des interventions sur la cognition** (SMD = 0,42)

Study	SMD	CI	N
AD patients			
Cott (2002)	0.05	-0.48-0.58	55
Holthoff (2015)	0.34	-0.38-1.06	30
Kemoun (2010)	0.89	0.15-1.63	31
* Miu (2008)	-0.36	-0.91-0.19	52
Steinberg (2009)	0.26	-0.46-0.98	27
* Venturelli (2011) †	3.00	1.75-4.25	21
Vreugdenhil (2012)	0.75	0.11-1.40	40
Yágüez (2011)	0.11	-0.65-0.87	27
Overall random	0.38	0.09-0.66	210
AD and non-AD dementia patients			
Arcoverde (2014)	0.84	-0.02-1.70	20
Bossers (2015) [1]	0.45	-0.01-0.92	73
Bossers (2015) [2]	0.07	-0.40-0.53	72
* Cheng (2014)	-0.34	-0.80-0.12	74
Christofoletti (2008)	0.06	-0.68-0.80	29
Hokkanen (2008)	0.89	0.13-1.66	29
Winckel v.d. (2004)	1.03	0.18-1.88	25
Overall random	0.47	0.14-0.80	248

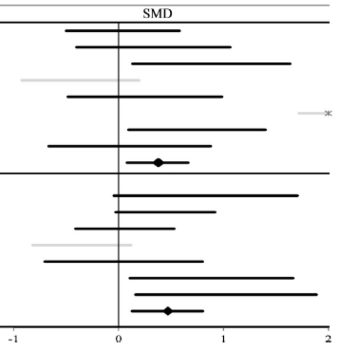

Fig. 4. Dementia type and the association between physical activity and cognition.
SMD >0 favors intervention, SMD <0 favors controls, SMD = standardized mean difference. CI = 95% confidence interval. AD = Alzheimer's disease, [1] = combined intervention group. [2] = aerobic intervention group. * = study removed from the analysis based on funnel plot inspection, † = Figure captures SMDs between −1 and 2.

Importance de la composante aérobie

C. Groot et al. / Ageing Research Reviews 25 (2016) 13–23 19

Study	SMD	CI	N
Combined aerobic and non-aerobic interventions			
Bossers (2015) [1]	0.45	-0.01-0.92	73
Holthoff (2015)	0.34	-0.38-1.06	30
Kwak (2008)	1.03	0.27-1.79	30
* Miu (2008)	-0.36	-0.91-0.19	52
Steinberg (2009)	0.26	-0.46-0.98	27
Vreugdenhil (2012)	0.75	0.11-1.40	40
Winckel v.d. (2004)	1.03	0.18-1.88	25
Overall random	0.59	0.32-0.86	225
Aerobic-only interventions			
Arcoverde (2014)	0.84	-0.02-1.70	20
Bossers (2015) [2]	0.07	-0.40-0.53	72
Cott (2002)	0.05	-0.48-0.58	55
Eggermont (2009b)	0.07	-0.32-0.46	97
Kemoun (2010)	0.89	0.15-1.63	31
Stevens (2006)	0.98	0.38-1.59	45
* Venturelli (2011) †	3.00	1.75-4.25	21
Overall random	0.41	0.05-0.76	320
Non-aerobic interventions			
Cheng (2014)	-0.34	-0.80-0.12	74
Christofoletti (2008)	0.06	-0.68-0.80	29
Eggermont (2009a)	0.04	-0.46-0.53	61
* Hokkanen (2008)	0.89	0.13-1.66	29
Yágüez (2011)	0.11	-0.65-0.87	27
Overall random	-0.10	-0.38-0.19	191

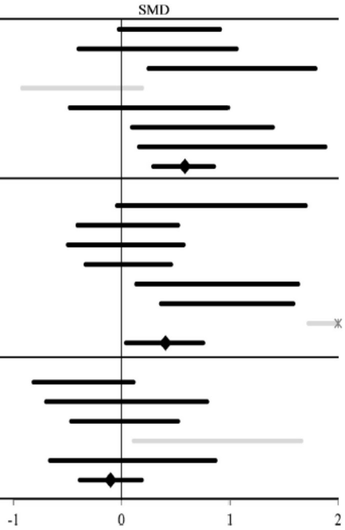

Fig. 5. Intervention type and the association between physical activity and cognition.
SMD >0 favors intervention, SMD <0 favors controls, SMD = standardized mean difference. CI = 95% confidence interval. [1] = combined intervention group. [2] = aerobic intervention group. * = study removed from the analysis based on funnel plot inspection, † = Figure captures SMDs between -1 and 2.

Importance du volume et de la fréquence ?
Pas besoin de 150min/semaine !

Study	SMD	CI	N
High-frequency interventions			
* Cheng (2014)	-0.34	-0.80-0.12	74
Christofoletti (2008)	0.06	-0.68-0.80	29
Cott (2002)	0.05	-0.48-0.58	55
Eggermont (2009a)	0.04	-0.46-0.53	61
Eggermont (2009b)	0.07	-0.32-0.46	97
Kemoun (2010)	0.89	0.15-1.63	31
Vreugdenhil (2012)	0.75	0.11-1.40	40
Winckel v.d. (2004)	1.03	0.18-1.88	25
Overall random	0.33	0.03-0.63	337
Low-frequency interventions			
Arcoverde (2014)	0.84	-0.02-1.70	20
Bossers (2015) [1]	0.45	-0.01-0.92	73
* Bossers (2015) [2]	0.07	-0.40-0.53	72
Hokkanen (2008)	0.89	0.13-1.66	29
Holthoff (2015)	0.34	-0.38-1.06	30
Kwak (2008)	1.03	0.27-1.79	30
* Miu (2008)	-0.36	-0.91-0.19	52
Stevens (2006)	0.98	0.38-1.59	45
* Venturelli (2011) †	3.00	1.75-4.25	21
Yágüez (2011)	0.11	-0.65-0.87	40
Overall random	0.64	0.39-0.89	268

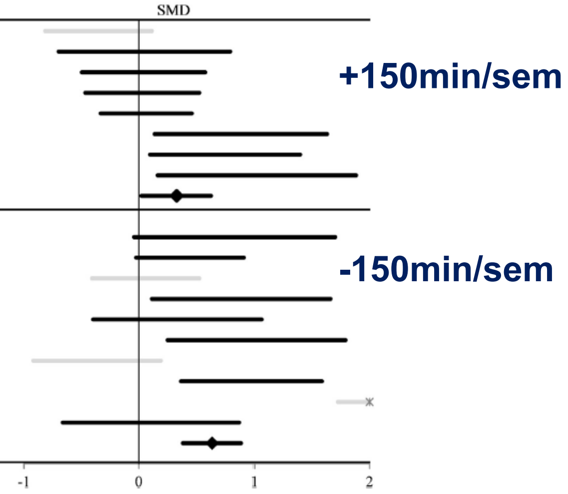

Fig. 6. Intervention frequency and the association between physical activity and cognition.
SMD >0 favors intervention, SMD <0 favors controls, SMD = standardized mean difference. CI = 95% confidence interval. [1] = combined intervention group. [2] = aerobic intervention group. * = study removed from the analysis based on funnel plot inspection, † = Figure captures SMDs between –1 and 2. High-frequency ≥150 min of physical activity per week; Low-frequency <150 min/week.

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Review

The effect of physical activity on cognitive function in patients with dementia: A meta-analysis of randomized control trials

C. Groot[a,b,*], A.M. Hooghiemstra[a,c], P.G.H.M. Raijmakers[b], B.N.M. van Berckel[b], P. Scheltens[a], E.J.A. Scherder[c], W.M. van der Flier[a,d], R. Ossenkoppele[a,b]
[a] Department of Neurology and Alzheimer Center, VU University Medical Center, Amsterdam, The Netherlands
[b] Department of Radiology and Nuclear Medicine, VU University Medical Center, Amsterdam, The Netherlands
[c] Department of Clinical Neuropsychology, VU University, Amsterdam, The Netherlands
[d] Department of Epidemiology and Biostatistics, VU University Medical Center, Amsterdam, The Netherlands

CONCLUSION

- Plusieurs fréquences :
- Mieux multimodal mai
- Exclusion des patients
- Mais….

Brain and Cognition 99 (2015) 68–77
Contents lists available at ScienceDirect
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Enhancing both motor and cognitive functioning in Parkinson's disease: Aerobic exercise as a rehabilitative intervention

C. Duchesne[a,b,c], O. Lungu[a,b,d,e], A. Nadeau[a,b,c], M.E. Robillard[a,b], A. Boré[a,b], F. Bobeuf[a], A.L. Lafontaine[f], F. Gheysen[g], L. Bherer[a,h], J. Doyon[a,b,c,*]

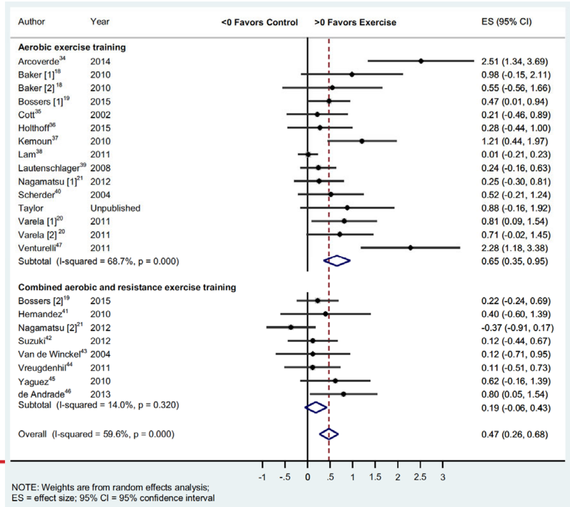
Can Exercise Improve Cognitive Symptoms of Alzheimer's Disease?

Gregory A. Panza, MS,† Beth A. Taylor, PhD,*† Hayley V. MacDonald, PhD,‡ Blair T. Johnson, PhD,§ Amanda L. Zaleski, MS,*† Jill Livingston, MS,¶ Paul D. Thompson, MD,† and Linda S. Pescatello, PhD**

19 études
1145 participants (âge moyen 77 ans)

Patients avec TCL (64%)
À risque de DTA – proche atteint (1%)
Patients avec DTA (34%)

Exercice aérobique: effet modéré sur cognition (d=.65)
Pas d'effet des autres types d'exercise



JAGS, 2018

Université de Montréal

Can Exercise Improve Cognitive Symptoms of Alzheimer's Disease?

Gregory A. Panza, MS,† Beth A. Taylor, PhD,*† Hayley V. MacDonald, PhD,‡ Blair T. Johnson, PhD,§ Amanda L. Zaleski, MS,*† Jill Livingston, MS,¶ Paul D. Thompson, MD,† and Linda S. Pescatello, PhD**

Fréquences et intensités d'entrainement physique semblables aux recommandations de l'OMS

Mais il reste à préciser quelles fonctions cognitives sont + sensibles aux effets de l'entrainement et quelles modalités d'entrainement sont les + appropriées.

Table 1. Summary of Frequency, Intensity, Time, and Type Characteristics of Studies Included in Meta-Analysis and World Health Organization (WHO) Physical Activity Recommendation for Older Adults

Variable	Intervention, Mean ± Standard Deviation	WHO Recommendation for Older Adults (≥65)
Frequency	3.4 ± 1.4 d/wk	≥3 d/wk (aerobic); 2 d/wk (resistance)
Intensity	3.7 ± 0.6 metabolic equivalents (moderate)	Moderate to vigorous
Time	137.05 ± 44.95 min/wk 45.2 ± 17.0 min/session	≥150 min/wk ≥30 min/d if Moderate ≥20 min/d if Vigorous
Type	Primary: Aerobic exercise Adjuvant: Combined aerobic and resistance exercise	Primary: Aerobic exercise Adjuvant 1: Resistance exercise Adjuvant 2: Flexibility exercise Adjuvant 3: Balance exercise

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CENTRE ÉPIC INSTITUT DE CARDIOLOGIE DE MONTRÉAL
INSTITUT DE CARDIOLOGIE DE MONTRÉAL
Université de Montréal

Études d'interventions

Plusieurs études d'imagerie cérébrale et d'électrophysiologie suggèrent que l'exercice physique induit des **changements transitoires et permanents aux niveaux structurel et fonctionnel** dans le cerveau des personnes âgées.

Exercise training increases size of hippocampus and improves memory

Kirk I. Erickson[a], Michelle W. Voss[b,c], Ruchika Shaurya Prakash[d], Chandramallika Basak[e], Amanda Szabo[f], Laura Chaddock[b,c], Jennifer S. Kim[b], Susie Heo[b,c], Heloisa Alves[b,c], Siobhan M. White[f], Thomas R. Wojcicki[f], Emily Mailey[f], Victoria J. Vieira[f], Stephen A. Martin[f], Brandt D. Pence[f], Jeffrey A. Woods[f], Edward McAuley[b,f], and Arthur F. Kramer[b,c,1]

www.pnas.org/cgi/doi/10.1073/pnas.1015950108 PNAS | February 15, 2011 | vol. 108 | no. 7 | 3017–3022

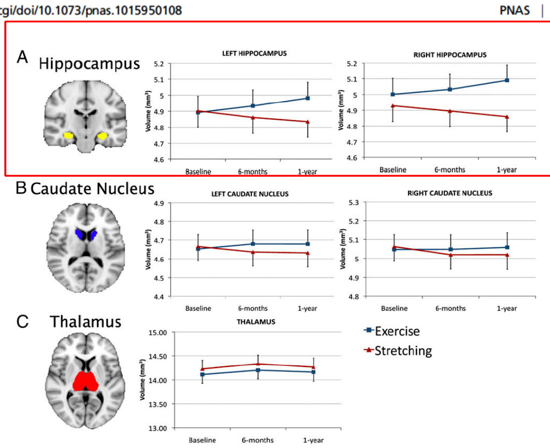


Fig. 1. (*A*) Example of hippocampus segmentation and graphs demonstrating an increase in hippocampus volume for the aerobic exercise group and a decrease in volume for the stretching control group. The Time × Group interaction was significant ($P < 0.001$) for both left and right regions. (*B*) Example of caudate nucleus segmentation and graphs demonstrating the changes in volume for both groups. Although the exercise group showed an attenuation of decline, this did not reach significance (both $P > 0.10$). (*C*) Example of thalamus segmentation and graph demonstrating the change in volume for both groups. None of the changes were significant for the thalamus. Error bars represent SEM.

frontiers in
AGING NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
published: 04 August 2014
doi: 10.3389/fnagi.2014.00170

Not only cardiovascular, but also coordinative exercise increases hippocampal volume in older adults

Claudia Niemann[1], Ben Godde[1,2] and Claudia Voelcker-Rehage[1,2] *

[1] Jacobs Center on Lifelong Learning and Institutional Development, Jacobs University Bremen, Bremen, Germany
[2] AgeAct Research Center, Jacobs University Bremen, Bremen, Germany

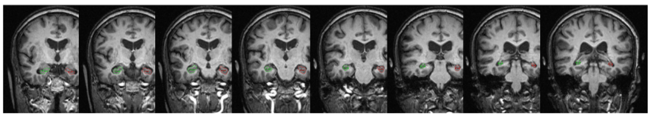


FIGURE 1 | Example images and representative analyses of hippocampal tracing rules from anterior to posterior brain sections. Marked structure on the right-hand side of the pictures represents hippocampal formation of left hemisphere, marked structure on the left-hand side on the pictures represents hippocampal formation of right hemisphere.

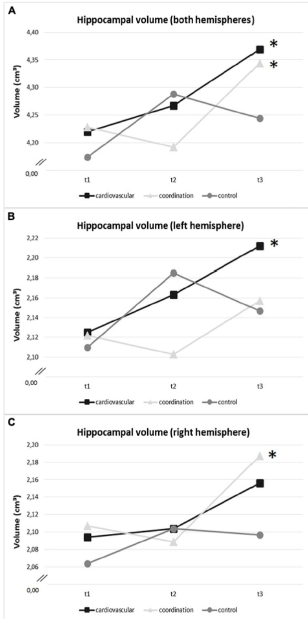


FIGURE 4 | Change in volume of (A) hippocampal volume of both hemispheres, (B) left hippocampus, and (C) right hippocampus (in cm³) within training groups (cardiovascular training, coordination training, control group) over the intervention period (*t1*: baseline, *t2*: after 6 months, *t3*: after 12 months). *Significant change ($p < 0.05$).

Entraînement multi-domaine

A 2 year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial

Tiia Ngandu, Jenni Lehtisalo, Alina Solomon, Esko Levälahti, Satu Ahtiluoto, Riitta Antikainen, Lars Bäckman, Tuomo Hänninen, Antti Jula, Tiina Laatikainen, Jaana Lindström, Francesca Mangialasche, Teemu Paajanen, Satu Pajala, Markku Peltonen, Rainer Rauramaa, Anna Stigsdotter-Neely, Timo Strandberg, Jaakko Tuomilehto, Hilkka Soininen, Miia Kivipelto

Lancet 2015; 385: 2255–63

- Étude randomisée contrôlée à double aveugle
- Inclusion : CAIDE Dementia Risk Score d'au moins 6 points et performances cognitives légèrement inférieures à ce qui est attendu pour l'âge
- 1260 participants de 60-77 ans randomisés dans le **groupe d'intervention** (diète, exercice, entraînement cognitif, gestion des facteurs vasculaires : n = 631) ou dans le **groupe contrôle** (conseils médicaux généraux : n = 629)

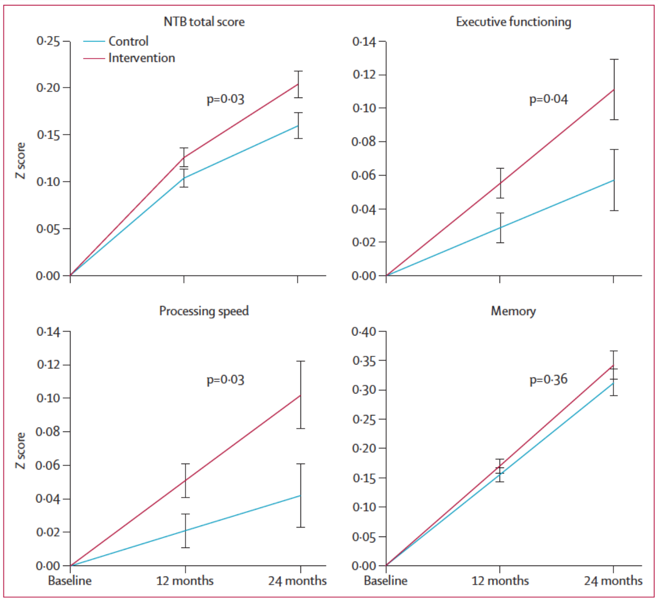


Figure 2: **Change in cognitive performance during the 2 year intervention**
Figure shows estimated mean change in cognitive performance from baseline until 12 and 24 months (higher scores suggest better performance) in the modified intention-to-treat population. Error bars are SEs. Mixed-model repeated-measures analyses were used to assess between-group differences (group × time interaction) in changes from baseline to 24 months based on data from all participants with at least one post-baseline measurement. NTB=neuropsychiatric test battery.

CCNV
Consortium canadien en neurodégénérescence associée au vieillissement

CCNA
Canadian Consortium on Neurodegeneration in Aging

SYNchronizing, Exercises, Remedies in Galt and Cognition (SYNERGIC)

A randomized controlled double blind trial

Équipe 12 – 5 sites au Canada

- **Dr Manuel Montero-Odasso (Team Leader)**, St.Joseph Health Care, Parkwood Hospital, London, Ontario.
- **Dr Louis Bherer (Co-Leader)**, Université de Montréal, Montréal, Québec.
- **Dr Teresa Liu-Ambrose**, University of British Columbia, Vancouver, Colombie britannique.
- **Dr Laura Middleton**, University of Waterloo, Walterloo, Ontario
- **Dr Quincy Almeida**, Wilfrid Laurier University, Waterloo, Ontario

Clinicaltrials.org : NCT02808676

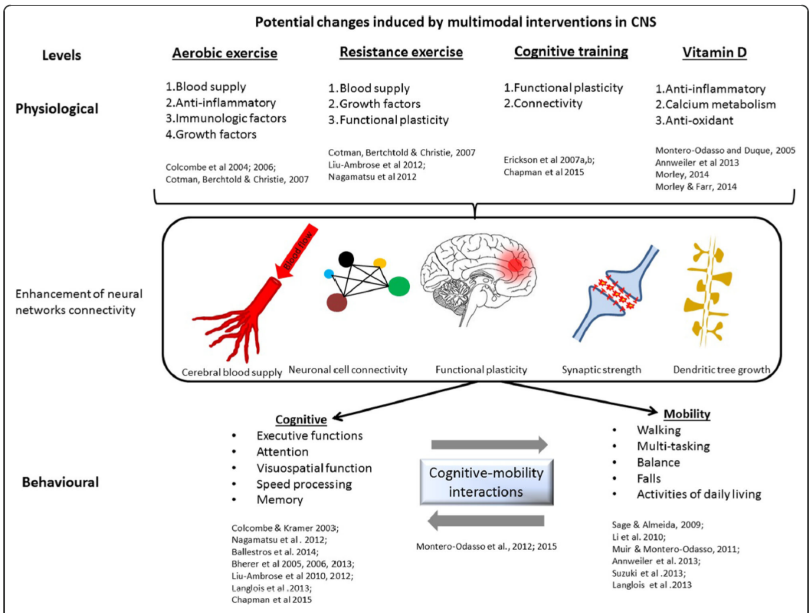


Fig. 3 Conceptual model for individual and synergistic effects of planned interventions in the SYNERGIC Trial

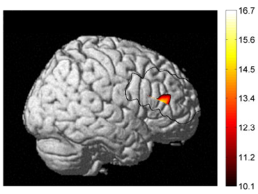
STUDY PROTOCOL — Open Access

SYNERGIC TRIAL (SYNchronizing Exercises, Remedies in Gait and Cognition) a multi-Centre randomized controlled double blind trial to improve gait and cognition in mild cognitive impairment

Manuel Montero-Odasso[1,2,3*], Quincy J. Almeida[4], Amer M. Burhan[5], Richard Camicioli[6], Julien Doyon[7], Sarah Fraser[8], Karen Li[9], Teresa Liu-Ambrose[10], Laura Middleton[11], Susan Muir-Hunter[12], William McIlroy[13], José A. Morais[14], Frederico Pieruccini-Faria[1,3], Kevin Shoemaker[15], Mark Speechley[2], Akshya Vasudev[16], G. Y. Zou[2,17], Nicolas Berryman[18,19], Maxime Lussier[18,20], Leanne Vanderhaeghe[21] and Louis Bherer[9,18,20,22]

Quelques projets en cours

NEUROPEAK



HbO

CCNV Consortium canadien en neurodégénérescence associée au vieillissement

CCNA Canadian Consortium on Neurodegeneration in Aging

Équipe 12 – 5 sites au Canada (Vancouver à London)

IRSC CIHR

2014-2018 (150 aînés, NIRS, Cog, Fit)

2018-2023 (300 Patients FRCV, suivis 1 an)

INSTITUT DE CARDIOLOGIE DE MONTRÉAL

Affilié à Université de Montréal

Conclusions

- L'activité physique régulière semble avoir un effet protecteur contre le déclin cognitif et l'atrophie cérébrale dans les régions sensibles au vieillissement normal et pathologique.
- Dans les études d'interventions, de 3-6-12 mois, les participants aux programmes d'exercice physique montrent des améliorations dans plusieurs domaines cognitifs:
  - Attention
  - Vitesse de traitement de l'information
  - Mémoire visuo-spatiale
  - Mémoire de travail
  - Mémoire épisodique (moins souvent rapporté)

Conclusions

- Importance de l'entraînement en endurance (aérobie) pour la santé cardiovasculaire.
- Effet positif de l'entraînement de la force musculaire (résistance), idéalement entraînement combiné.
- Marche à faible intensité mais régulière (tous les jours) semble avoir un effet protecteur contre l'atrophie cérébrale.
- Les effets bénéfiques pour la cognition sont importants à long terme (plus de 6 mois).
- Effets protecteurs contre la démence pourraient prendre plusieurs années. Il faut plus d'essais cliniques pour confirmer l'efficacité.

Motivation ?

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Faculté de médecine
Université de Montréal

Université Concordia University
Centre PERFORM Centre

Neurosciences/Psychologie/Neuropsychologie

Catherine-Alexandra Grégoire, Ph.D.
Thomas Vincent, Ph.D.
Navin Kaushal, Ph.D.
Antoine Langeard, Ph.D.
Christine Gagnon, Ph.D.
Maxime Lussier, Ph.D.
Laurence Desjardins-Crépeau, Ph.D.
Anne Julien-Rocheleau
Élisabeth Charlebois-Cloutier
Tudor Vrinceanu
Ramzi Houdeib
Francis Comte
Béatrice Bérubé
Kathia Saillant

Kinésiologie

Nicolas Berryman, Ph.D. (U Bishop)
Antony Karelis, Ph.D. (UQAM)
Laurent Bosquet, Ph.D, (U de Poitiers)
Olivier Dupuy, Ph.D., (U de Poitiers)

Médecine

Marie-Jeanne Kergoat, MD, Gériatre (IUGM)
Minh Vu, MD, Gériatre (IUGM et CHUM)
Anil Nigam, MD, Cardiologue (EPIC/ICM)
Martin Juneau, Cardiologue (EPIC)

CRSNG NSERC

Centre de recherche iugm
Institut universitaire de gériatrie de Montréal

IRSC CIHR

Fonds de la recherche en santé Québec

Fondation canadienne pour l'innovation
Canada Foundation for Innovation

Chaire de recherche Mirella et Lino Saputo en Santé Cardiovasculaire et prévention des troubles cognitifs

Canada Research Chairs — Chaires de recherche du Canada

Mécanismes physiologiques

Adv Physiol Educ 39: 55–62, 2015;
doi:10.1152/advan.00101.2014.

Refresher Course

Exercise, cognitive function, and aging

Jill N. Barnes
Department of Anesthesiology, and Department of Physiology and Biomedical Engineerin
Rochester, Minnesota

Submitted 28 July 2014; accepted in final form 6 March 2015

- **Flux sanguin cérébral augmenté à l'exercice modéré-intense**
- **Dysfonction vasculaire (associé à l'âge) diminue avec exercice.**
- **Flux et fonction vasculaire maintenus chez les actifs.**
- **Meilleure hémodynamie**
- **Meilleure réactivité cérébrovasculaire**

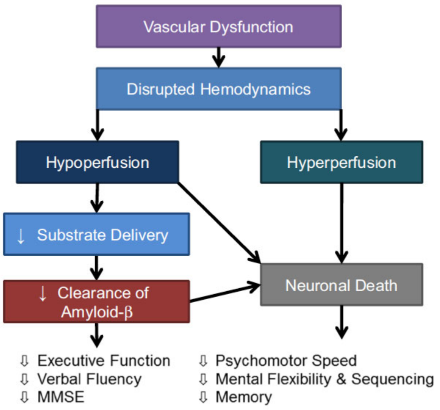


Fig. 2. Modified version of the hypothetical model proposed by de la Torre (15). Cardiovascular disease risk factors, and more specifically vascular dysfunction, disrupt hemodynamics, which may cause either hypoperfusion or hyperperfusion and ultimately affect cognition. MMSE, mini-mental state examination. [This image is modified from de la Torre with permission (15).]

Adv Physiol Educ 39: 55–62, 2015;
doi:10.1152/advan.00101.2014.

Refresher Course

Exercise, cognitive function, and aging

Jill N. Barnes
Department of Anesthesiology, and Department of Physiology and Biomedical Engineering, Mayo Clinic, Rochester, Minnesota

Submitted 28 July 2014; accepted in final form 6 March 2015

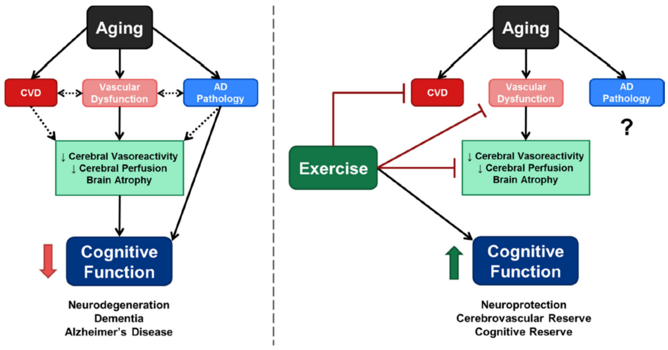
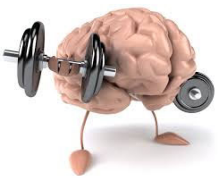


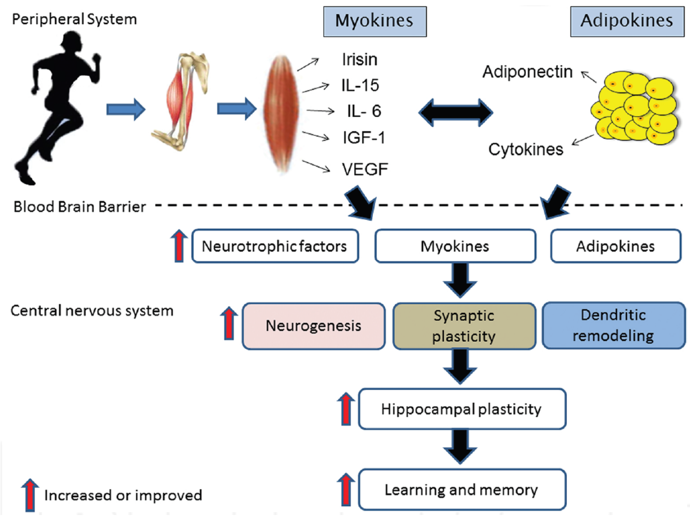
Fig. 5. The potential interactions and ideas of how variables associated with aging may interact to affect cognition and how exercise may inhibit this process. The solid arrows indicate interactions backed by research, and the dotted arrows indicate potential interactions with less research focused on the association. CVD, cerebrovascular disease.

Effets directs de l'activité physique sur les structures et fonctions cérébrales



- **Mécanismes moléculaires** qui pourraient soutenir les effets supramoléculaires :
  - Brain-derived neurotrophic factor (BDNF) (neuroplasticité et protection)
  - Insulin-like growth factor 1 (IGF-1) (neurogenèse et angiogenèse).
  - Neurotransmetteurs (**Lista & Sorrentino**, 2010), sérotonine et dopamine (**Heijnen** et al., 2016).
  - ATTENTION ! Effet d'âge, sexe et génétique (Val66Met sur gène *Bdnf*, voir Erickson et al. 2013, Canivet et al. 2015)

Effets directs de l'activité physique sur les structures et fonctions cérébrales

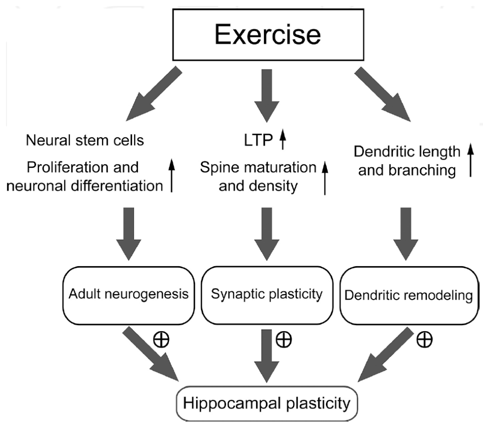


Yau et al. (2016). Potential Biomarkers for Physical Exercise-Induced Brain Health, Role of Biomarkers in Medicine, Prof. Mu Wang (Ed.), InTech, DOI: 10.5772/62458.

Effets directs de l'activité physique sur les structures et fonctions cérébrales

– **Au niveau supramoléculaire** :

- **Angiogenèse, prolifération cellulaire et neurogenèse** dans les hippocampes de rats âgés (van Praag, Shubert, Zhao, & Gage, 2005).
- **Synaptogenèse** (Eadie, Redila, & Christie et al., 2005; Hu et al., 2009).



Yau et al. (2016). Potential Biomarkers for Physical Exercise-Induced Brain Health, Role of Biomarkers in Medicine, Prof. Mu Wang (Ed.), InTech, DOI: 10.5772/62458.

Effets protecteurs de l'exercice

Plusieurs études d'imagerie cérébrale et d'électrophysiologie suggèrent que l'exercice physique induit des **changements transitoires et permanents aux niveaux structurel et fonctionnel** dans le cerveau des personnes âgées.

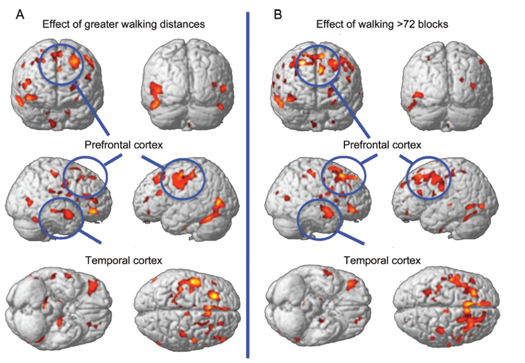
Physical activity predicts gray matter volume in late adulthood

The Cardiovascular Health Study

Conclusion: Greater amounts of walking are associated with greater gray matter volume, which is in turn associated with a reduced risk of cognitive impairment. *Neurology*® 2010;75:1415-1422

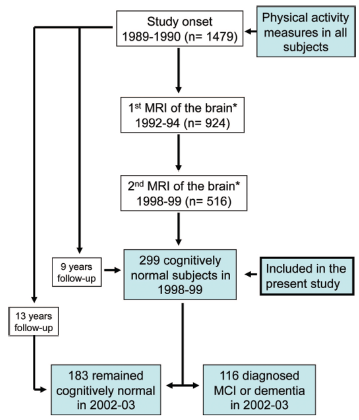
K.I. Erickson, PhD*
C.A. Raji, PhD*
O.L. Lopez, MD
J.T. Becker, PhD
C. Rosano, MD, MPH
A.B. Newman, MD, MPH
H.M. Gach, PhD
P.M. Thompson, PhD
A.J. Ho, BS
L.H. Kuller, MD, DrPh

Figure 2 Brain regions associated with greater walking



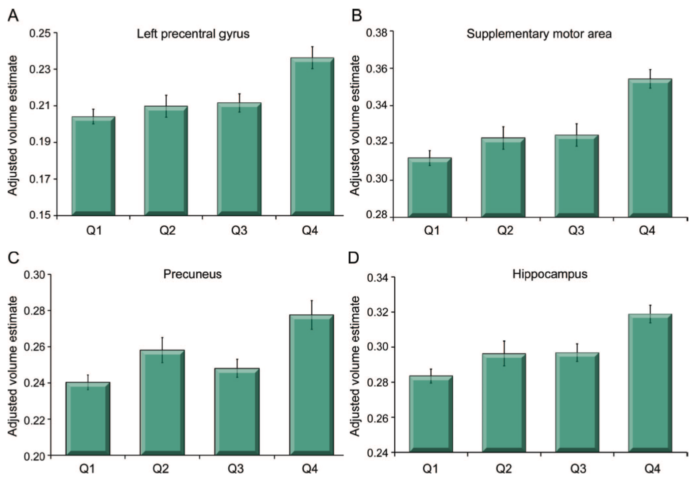
(A) Brain regions showing an association between greater amounts of physical activity (blocks walked) at baseline and greater gray matter volume. Statistical map is thresholded with a false discovery rate of $p = 0.05$ and a minimum cluster threshold of 100 contiguous voxels. (B) Brain regions showing greater volume in the highest quartile (>72 blocks walked in 2 weeks) compared to the bottom 3 quartiles. There were no reliable differences in brain volume among the bottom 3 quartiles.

Figure 1 Subject inclusionary criteria and sample sizes



We demonstrate the longitudinal design beginning in 1989–1990 and ending with the voxel-based morphometry (VBM) analysis on high-resolution MRI data collected in 1998–1999. All participants in this sample were free of dementia and mild cognitive impairment (MCI). Originally, 1,479 individuals had physical activity assessed and 924 had a low-resolution MRI. A total of 516 of these individuals returned 5 years later for a follow-up MRI session. From these individuals, we excluded 61 with dementia, 150 with MCI, and 6 because of missing white matter grades from the first MRI assessment. Our final sample size for the VBM analysis was 299 elderly individuals between 70 and 90 years of age. *Visual rating of white matter lesions, ventricular size, atrophy, and MRI-identified infarcts.

Figure 3 Threshold effects on brain volume



Mean volumes (and SEM) of 4 brain regions (precentral gyrus [A], supplementary motor area [B], precuneus [C], and hippocampus [D]) adjusted for variance due to age, total intracranial volume, gender, body mass index, race, white matter grade, presence of MRI infarcts, and education split into quartiles based on the amount of physical activity (Q1: 0–12 blocks, n = 91; Q2: 13–24 blocks, n = 57; Q3: 25–70 blocks, n = 78; Q4: 72–300 blocks, n = 73). The highest quartile group (Q4) had greater volume in all regions examined compared with the lower 3 quartiles. No significant differences were found among the lower 3 quartiles.

3 key findings:

1-Greater PA predicted greater volumes of frontal, occipital, entorhinal, and hippocampal regions 9 years later.

2-Walking 72 blocks (6-9 miles/wk) was necessary to detect increased gray matter volume (not more).

3-Greater gray matter volume with PA reduced the risk for cognitive impairment 2-fold.