Centre de recherche iugm
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Université de Montréal

Cognitive training in MCI and SCI: Impact on cognition, strategy use and virtual reality measures of real-life cognition

Sylvie Belleville, PhD

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Professor, Dept. Psychology, Université de Montréal
Scientific director, Research Center, Institut universitaire de gériatrie de Montréal
Director, Consortium for the early Identification of Alzheimer's disease-Québec (CIMA-Q)

Cognitive training in MCI

- **Cognitive training** might modify the brain to create a form of late-life reserve.

- It might **reduce the burden of cognitive impairment** in daily life by providing strategy to better perform cognitively demanding activities.

- **MCI = an ideal target for cognitive training**

  They are concerned and impaired, able to learn and apply new strategies, the potential benefit is tremendous.

Cognitive training in MCI

What is its efficacy to improve cognition?

Based on trials with **solid designs**

- *randomisation, active control condition, large groups, prior identification of the primary outcome.*

What is its durability?

Do these transfer in real-life (every day impact)?

Different types of training

(Willis et Belleville, 2016)

- **Therapist-based strategy training :** teaching of new/more efficient ways to complete tasks (e.g.: *ACTIVE*, *MÉMO)*

- **Computerized training**: **Serious videogames** experimental (e.g.: Neuropeak; priority training) or **commercial plateforms** (e.g: Brain HQ, Happy Neuron), **casual videogames** (e.g. Super Mario 64; Crazy taxi)

- **Community-based activities** : **Volunteering** or **intergenerational activities** (e.g.: Experience corps), **new cognitively stimulating leisures** – music, second language, digital photography (e.g.: Synapse; Engage)

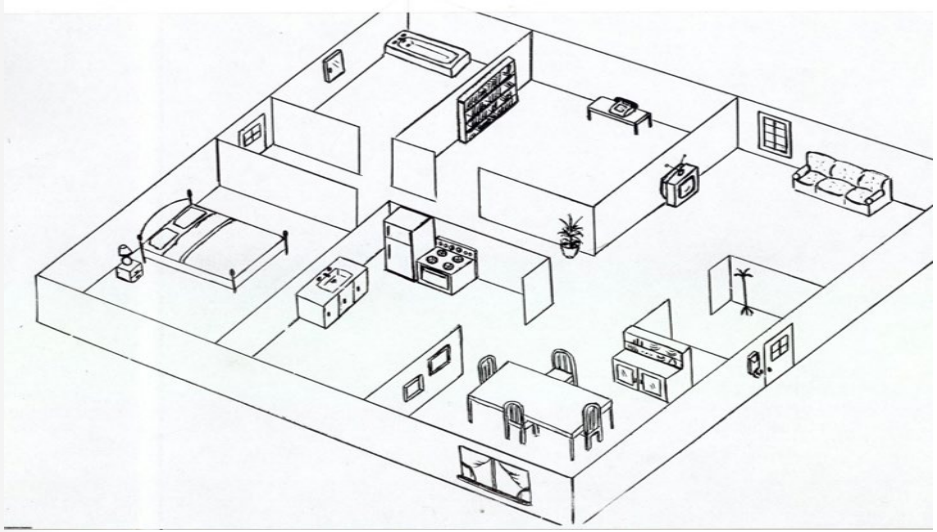
The MEMO program

- Focuses on **memory** : main complaint, main deficit.
- Provides a **range** of **strategies** known to increase elaborate encoding + relying on preserved capacities (semantic, visual imagery).
- Includes **dual-tasking training**, a deficit present in MCI which might reduce their ability to memorize in real-life distracting conditions.
- **Therapist-based small group** format (4-5 people/group)
  allows individual guidance, social contact, healthy emulation
- Designed to promote **self-efficacy** : positive information on aging, modeling, gradual difficulty level
- Exercices to favour **use of strategy in everyday life** ; homeworks ,real-life examples, instructions on when to use and not use the strategies.

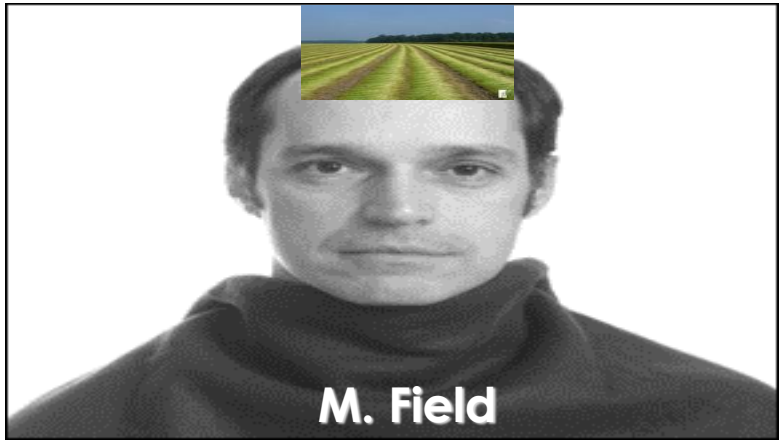
Gilbert, Fontaine & Belleville (2007) MEMO : A memory training program for older adults

Memory strategies

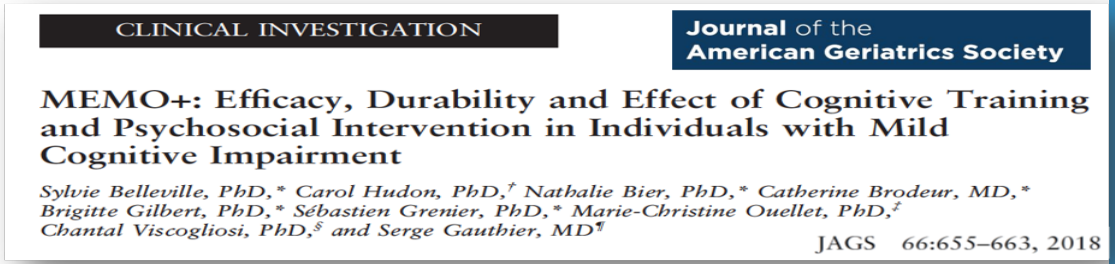
Method of loci



Face name association



MEMO+


CLINICAL INVESTIGATION

Journal of the American Geriatrics Society

MEMO+: Efficacy, Durability and Effect of Cognitive Training and Psychosocial Intervention in Individuals with Mild Cognitive Impairment

Sylvie Belleville, PhD, Carol Hudon, PhD,† Nathalie Bier, PhD,* Catherine Brodeur, MD,* Brigitte Gilbert, PhD,* Sébastien Grenier, PhD,* Marie-Christine Ouellet, PhD,‡ Chantal Viscogliosi, PhD,§ and Serge Gauthier, MD¶*

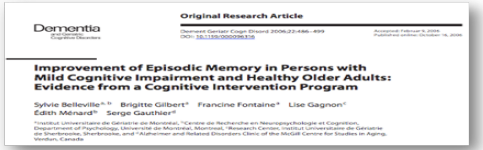
JAGS 66:655–663, 2018

- A 6-month single-blind randomized controlled trial with 145 persons with MCI

- 16 hours of training (8 weekly sessions)

- Cognitive training; Active control (psychosocial); Wait-list

- Post; post 3 month and post 6 month


Dementia

Original Research Article

Improvement of Episodic Memory in Persons with Mild Cognitive Impairment and Healthy Older Adults: Evidence from a Cognitive Intervention Program

Sylvie Belleville[a, b] Brigitte Gilbert[a] Francine Fontaine[a] Lise Gagnon[c] Édith Ménard[b] Serge Gauthier[d]

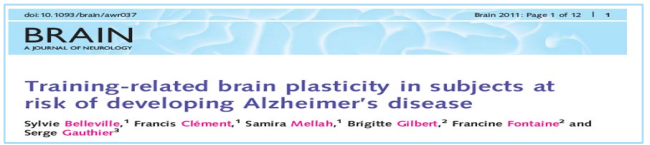
Pilot study


PROTOCOL-ONLY PAPER

Measuring the impact of cognitive and psychosocial interventions in persons with mild cognitive impairment with a randomized single-blind controlled trial: rationale and design of the MEMO+ study

Nathalie Bier,[1,2] Sébastien Grenier,[1,10] Catherine Brodeur,[3,4] Serge Gauthier,[4,5] Brigitte Gilbert,[1] Carol Hudon,[6,7] Émilie Lepage,[1] Marie-Christine Ouellet,[7,8] Chantal Viscogliosi[9] and Sylvie Belleville[1,10]

Design paper


BRAIN

A JOURNAL OF NEUROLOGY

Training-related brain plasticity in subjects at risk of developing Alzheimer's disease

Sylvie Belleville,[1] Francis Clément,[1] Samira Mellah,[1] Brigitte Gilbert,[2] Francine Fontaine[2] and Serge Gauthier[3]

Effect on the brain

MEMO: a strategy-based memory training program

Structured teaching and training on memory strategies

- Interactive imagery (1 session)
- Method of Loci (1 session)
- Face-name association (1 session)
- Text hierarchization (1 session)
- Semantic organization (1 session)

} Imagery based

} Semantic elaboration

Pre-training

- Mental imagery and attention control (3 sessions)

Self-efficacy and transfer to real life

- Psycho-education
- Gradual increase of difficulty level
- Modeling and group exercises
- Homework + when to use vs not use the strategy

Gilbert, Fontaine & Belleville (2007) MEMO : A memory training program for older adults

Active control: Psychosocial intervention

Based on the cognitivo-behavioral approach.

Designed to improve general well-being, prevent psychological distress and increase social networking.

- Psychoeducation
- Solution focused training
- Cognitive restructuring
- Diaphragmatic breathing
- Behavioral activation
- Anger management
- Problem-solving skill training

Ouellette, Grenier & Ducharme (2010)

8 weekly sessions; booster session after 3-month up

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Measure of efficacy

Composites for **immediate** and **delayed memory**

Effect on psychological outcomes

Depressive (GDS) and Anxiety symptoms (GAS); well-being

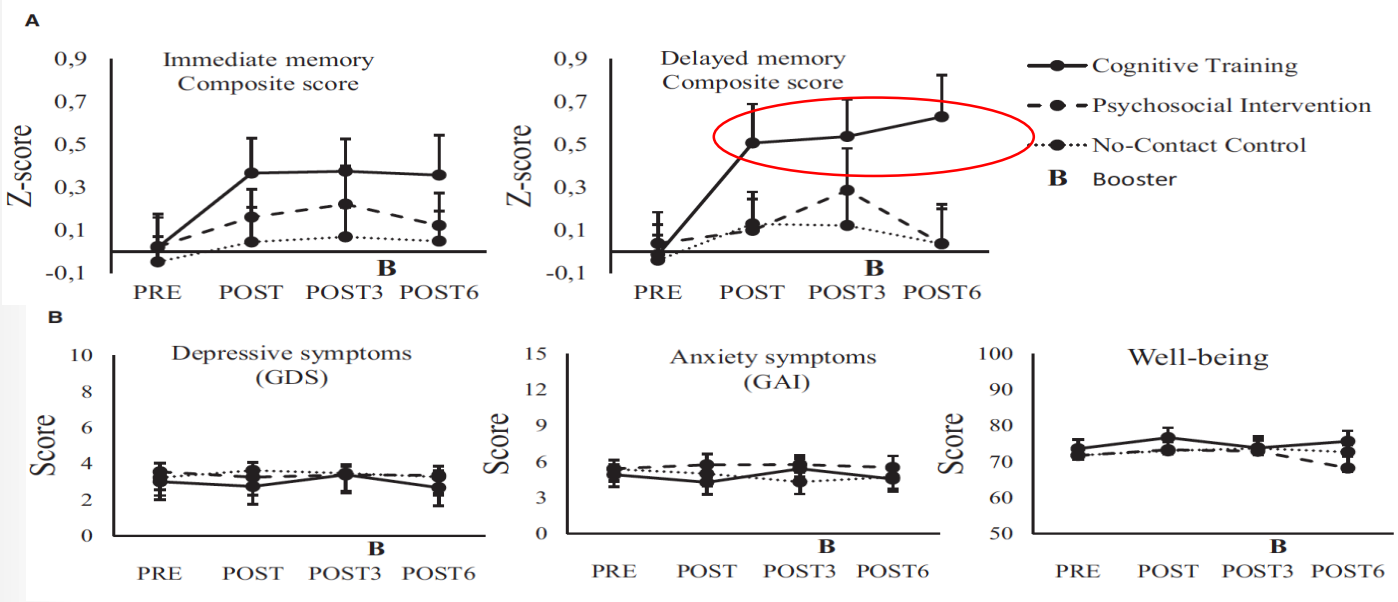
Questionnaires for transfer in everyday life

Use of strategy in real life (MMQ)

Self-reported memory in daily life (QAM)

Complex activities of daily living (ADL-PI)

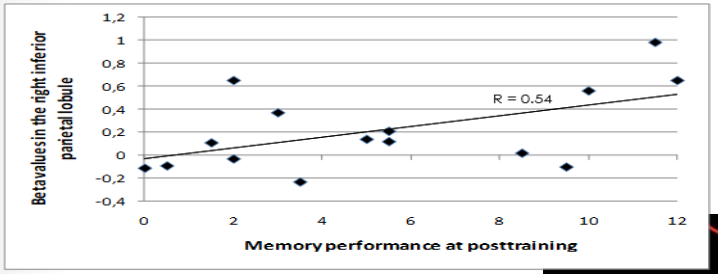
Efficacy, durability and specificity



Modified ITT analyses; Mixed linear model adjusted for sex, educations and age;
Group x Time interaction; $P<0.01$, for delayed memory composite

Mean Age: 72.3 yrs; Mean Education: 14.6 yrs; 53.4% women

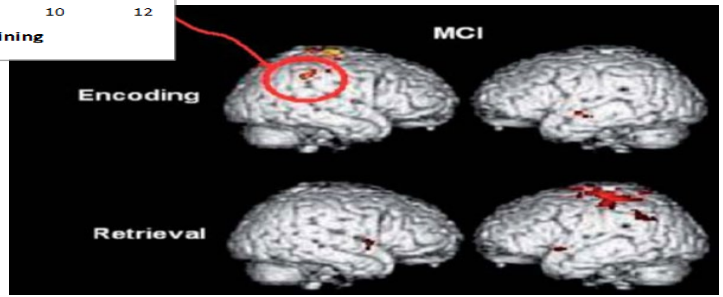
Increased brain activation in regions related to the learned strategies



doi:10.1093/brain/awr037 Brain 2011: Page 1 of 12 | 1
BRAIN
A JOURNAL OF NEUROLOGY

Training-related brain plasticity in subjects at risk of developing Alzheimer's disease

Sylvie Belleville,[1] Francis Clément,[1] Samira Mellah,[1] Brigitte Gilbert,[2] Francine Fontaine[2] and Serge Gauthier[3]

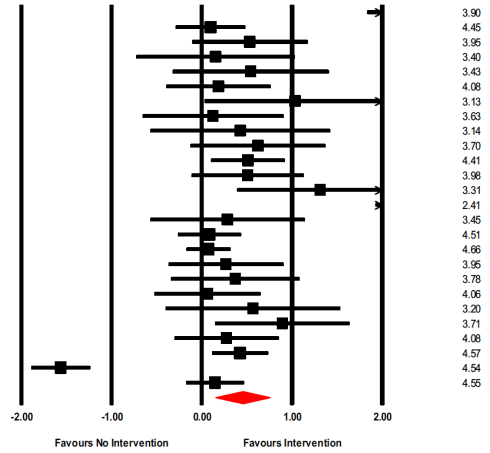


Post-Pre activation

Strategy based cognitive training improves cognition in persons with MCI and the effect is durable

Effect on all outcome measures

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Relative weight
Balietti et al. (2016)	Combined	2.495	0.335	0.112	1.839	3.151	7.452	0.000	3.90
Barban et al. (2016)	Combined	0.097	0.195	0.038	-0.285	0.478	0.497	0.619	4.45
Barnes et al. (2009)	Combined	0.533	0.323	0.104	-0.101	1.166	1.648	0.099	3.95
Buschert et al. (2011)	Combined	0.154	0.445	0.198	-0.719	1.027	0.345	0.730	3.40
Carretti et al. (2013)	Combined	0.542	0.439	0.193	-0.318	1.402	1.235	0.217	3.43
Fiatarone Singh et al. (2014)	Combined	0.184	0.292	0.085	-0.388	0.756	0.631	0.528	4.08
Finn & McDonald (2011)	Combined	1.033	0.507	0.257	0.039	2.027	2.037	0.042	3.13
Finn & McDonald (2015)	Combined	0.125	0.396	0.157	-0.650	0.901	0.316	0.752	3.63
Forster et al. (2011)	Combined	0.427	0.505	0.255	-0.564	1.417	0.844	0.399	3.14
Gagnon et al. (2012)	Combined	0.623	0.378	0.143	-0.118	1.364	1.649	0.099	3.70
Giuli et al. (2016)	Combined	0.511	0.206	0.042	0.108	0.915	2.485	0.013	4.41
Greenaway et al. (2012)	Combined	0.508	0.315	0.099	-0.109	1.126	1.613	0.107	3.98
Hampstead et al. (2012)	Memory - Visual - Percent Change	1.312	0.466	0.217	0.399	2.225	2.817	0.005	3.31
Herrera et al. (2012)	Combined	3.293	0.694	0.481	1.934	4.652	4.748	0.000	2.41
Jean et al. 2010a	Combined	0.285	0.434	0.188	-0.565	1.136	0.657	0.511	3.45
Jeong et al. (2016)	Combined	0.084	0.176	0.031	-0.261	0.428	0.476	0.634	4.51
Lam et al. (2015)	Combined	0.074	0.120	0.014	-0.162	0.310	0.614	0.539	4.66
Mowszowski et al. (2014)	Combined	0.268	0.322	0.104	-0.364	0.900	0.832	0.406	3.95
Olchik et al. (2013)	Combined	0.371	0.360	0.130	-0.334	1.077	1.031	0.302	3.78
Polito et al. (2015)	Combined	0.063	0.296	0.088	-0.517	0.644	0.213	0.831	4.06
Rapp et al. (2002)	Combined	0.566	0.491	0.241	-0.396	1.528	1.154	0.249	3.20
Rojas et al. (2013)	Combined	0.894	0.376	0.142	0.156	1.631	2.375	0.018	3.71
Schmitter-Edgecombe et al. (2014)	Combined	0.275	0.291	0.085	-0.296	0.846	0.943	0.346	4.08
Tsolaki et al. (2011)	Combined	0.424	0.154	0.024	0.122	0.727	2.748	0.006	4.57
Valdes et al. (2012)	Speed - SOPT	-1.565	0.164	0.027	-1.887	-1.243	-9.528	0.000	4.54
Vidovich et al. (2015)	Combined	0.146	0.161	0.026	-0.169	0.461	0.910	0.363	4.55
		0.454	0.152	0.023	0.156	0.753	2.983	0.003	



Neuropsychol Rev (2017) 27:440–484
https://doi.org/10.1007/s11065-017-9363-3

REVIEW

The Efficacy of Cognitive Intervention in Mild Cognitive Impairment (MCI): a Meta-Analysis of Outcomes on Neuropsychological Measures

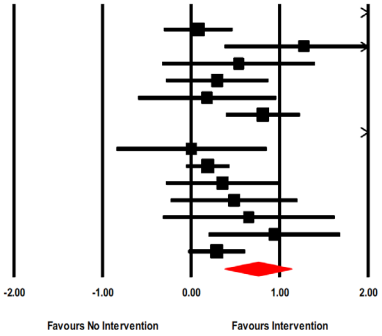
Dale S. Sherman[1,2] · Justin Mauser[3] · Miriam Nuno[4] · Dean Sherzai[5]

26 studies (887 MCI received intervention) Significant moderate effects

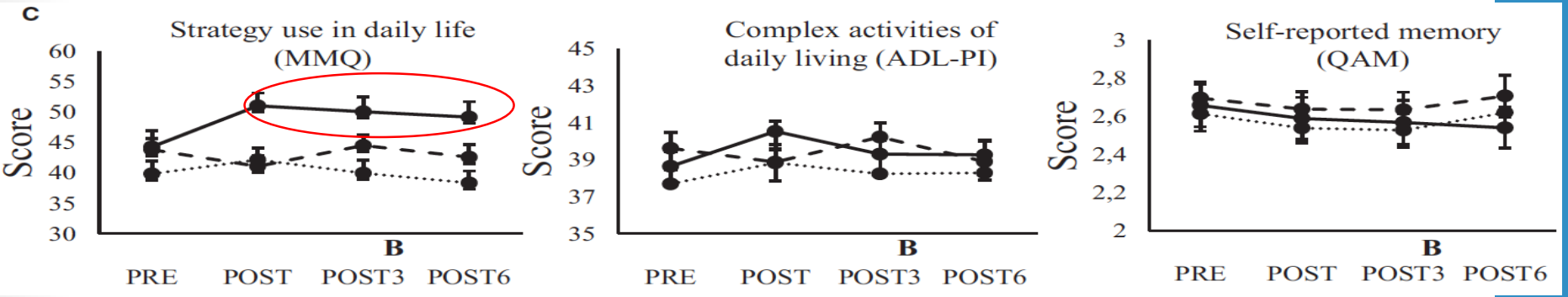
Meta-regression: memory-focused interventions were the most effective

Effect on memory measures

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	Relative weight
Balietti et al. (2016)	Combined	2.824	0.336	0.113	2.165	3.483	8.399	0.000	6.87
Barban et al. (2016)	Memory - Verbal - RAVLT (Delay)	0.083	0.195	0.038	-0.299	0.464	0.425	0.671	8.00
Buschert et al. (2011)	Memory - Story Delay (RBANS)	1.276	0.455	0.207	0.385	2.167	2.806	0.005	5.85
Carretti et al. (2013)	Memory - List Delay	0.538	0.437	0.191	-0.318	1.394	1.232	0.218	6.00
Fiatarone Singh et al. (2014)	Memory - Verbal - LM II (Delay)	0.296	0.292	0.085	-0.276	0.868	1.014	0.310	7.25
Finn & McDonald (2015)	Memory - Verbal - VPA-II	0.182	0.395	0.156	-0.592	0.956	0.461	0.645	6.36
Giuli et al. (2016)	Memory - Verbal - Word Pairs	0.812	0.210	0.044	0.401	1.223	3.873	0.000	7.89
Herrera et al. (2012)	Combined	4.644	0.811	0.658	3.053	6.234	5.723	0.000	3.40
Jean et al. (2010)	Memory - CVLT-II Long Delay	0.005	0.430	0.185	-0.839	0.849	0.012	0.991	6.05
Lam et al. (2015)	Memory - List Learning (Delayed Recall)	0.190	0.120	0.015	-0.046	0.426	1.577	0.115	8.42
Mowszowski et al. (2014)	Memory - Verbal - RAVLT (Delay)	0.356	0.323	0.104	-0.276	0.989	1.105	0.269	6.99
Olchik et al. (2013)	Memory - Verbal - RAVLT (Delay)	0.487	0.362	0.131	-0.221	1.196	1.347	0.178	6.65
Rapp et al. (2002)	Combined	0.654	0.491	0.241	-0.309	1.617	1.331	0.183	5.54
Rojas et al. (2013)	Memory - List Delay	0.944	0.376	0.141	0.208	1.680	2.513	0.012	6.53
Vidovich et al. (2015)	Memory - CVLT-II Long Delay	0.291	0.161	0.026	-0.024	0.606	1.811	0.070	8.21
		0.758	0.192	0.037	0.382	1.133	3.956	0.000	



Effect on transfer ? They more often use strategies … but do not show improvement on self-reported complex activities



Modified ITT analysis with mixed linear model adjusted for sex, age and education; Group x Time interaction; P<0.01 for strategy use (MMQ)

Neuropsychol Rev (2016) 26:225–251
DOI 10.1007/s11065-016-9330-4

REVIEW

Everyday Impact of Cognitive Interventions in Mild Cognitive Impairment: a Systematic Review and Meta-Analysis

M. J. Chandler[1] · A. C. Parks[1] · M. Marsiske[2] · L. J. Rotblatt[2] · G. E. Smith[2]

Meta-analysis of therapist-based interventions :

Moderate transfer on metacognitive abilities (perception of cognitive function) but no impact on mood or self-reported activities of daily living *(Chandler, Parks, Mariske, Rotblatt & Smith, 2016)*

Lack of transfer was raised as a major drawback for cognitive training *(Simon et al, 2016)*

Self-reported questionnaires are influenced by judgement, expectancy, mood and the cognitive ability to estimate change.

Virtual reality (VR) to reflect real-life cognition

A technology creating a **phenomenal intangible experience** that reproduces real world/physical reality

More accessible, easier to use and to develop

Can be used to design a diversity of multisensorial environments and scenarios

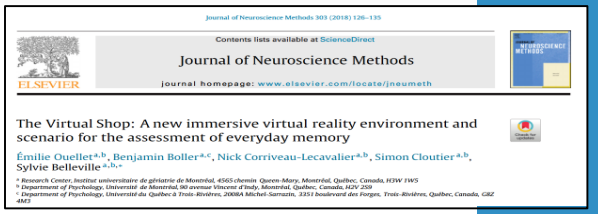
- Reproduces the complexity characterizing everyday life with excellent visual quality.
- Tested in safe environment and conditions.
- Provides objective measurement.
- Can be validated and normed.

Real and virtual appartement

Corriveau-Lecavalier, Ouellet & Belleville, 2017; Ouellet, Boller, Corriveau-Lecavalier, Cloutier & Belleville, 2018; Bier &Belleville, 2017, Boujut & Belleville, in preparation

Set of validation studies in older adults

- Appropriate construct (e.g: sensitive to age)
- Ecological validity
- High sense of presence and motivation
- Few cybersickness symptoms


Journal of Neuroscience Methods 303 (2018) 126–135

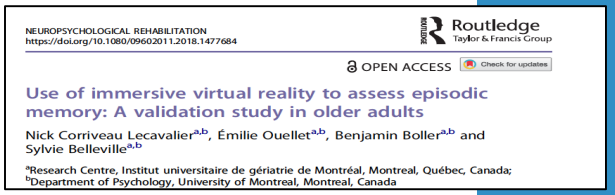
Contents lists available at ScienceDirect

Journal of Neuroscience Methods

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

The Virtual Shop: A new immersive virtual reality environment and scenario for the assessment of everyday memory

Émilie Ouellet[a,b], Benjamin Boller[a,c], Nick Corriveau-Lecavalier[a,b], Simon Cloutier[a,b], Sylvie Belleville[a,b,*]


NEUROPSYCHOLOGICAL REHABILITATION
https://doi.org/10.1080/09602011.2018.1477684

Routledge Taylor & Francis Group

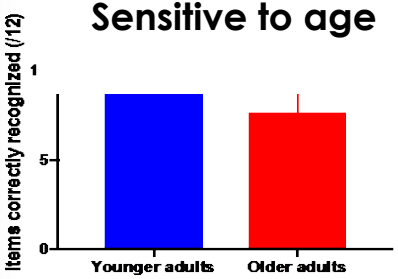
OPEN ACCESS Check for updates

Use of immersive virtual reality to assess episodic memory: A validation study in older adults

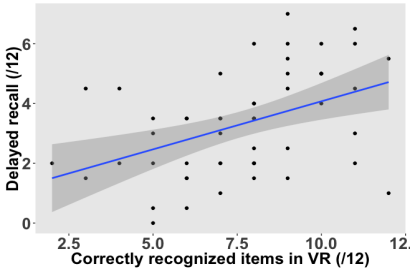
Nick Corriveau Lecavalier[a,b], Émilie Ouellet[a,b], Benjamin Boller[a,b] and Sylvie Belleville[a,b]

[a]Research Centre, Institut universitaire de gériatrie de Montréal, Montreal, Québec, Canada; [b]Department of Psychology, University of Montreal, Montreal, Canada

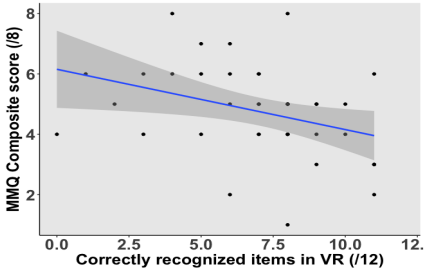
Virtual memory is Sensitive to age



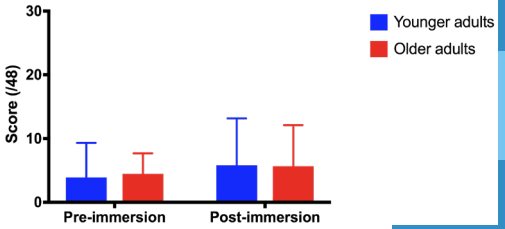
Correlates with traditional measures



Correlates with memory complaint



Few cybersickness symptoms



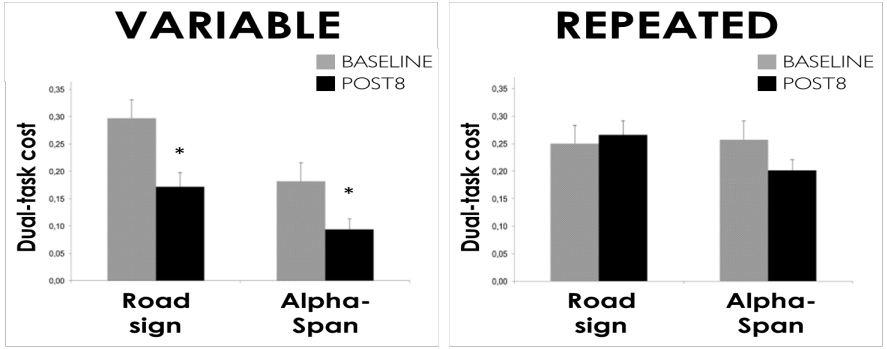
The loci study: **Train and measure transfer** with virtual reality

Transfer to a virtual car ride attention

(but no transfer on self-reported questionnaire)

VARIABLE PRIORITY TRAINING

Vary attentional priority between two concurrent tasks



Computerized Attentional Training and Transfer With Virtual Reality: Effect of Age and Training Type

Neuropsychology

Bianca Bier, Émilie Ouellet, and Sylvie Belleville
Institut universitaire de gériatrie de Montréal, Montreal, Canada, and University of Montreal

Conclusion

- Cognitive training has a **beneficial** effect on the cognition of persons with MCI and the effect appears **durable** for at least a few months (ACTIVE : 10 year durability in healthy older adults; *Rebock et al, 2014*)

- Persons with MCI **report using strategies in real life** but demonstrating **transfer** remains challenging, an issue that might be addressed with the help of new technologies.

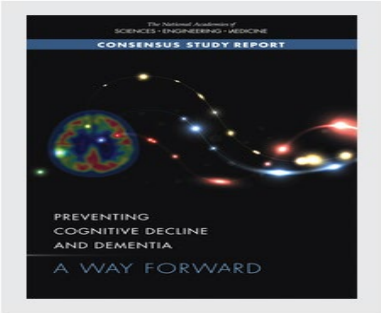
- Clinicians **should advise** their patients about the **potential** of cognitive training and offer information as to how to access these programs in their community.

Conclusion

A Consensus Study Report of

The National Academies of

SCIENCES · ENGINEERING · MEDICINE



Recommendation 1: Communicating with the Public
When communicating with the public about what is currently known, the National Institutes of Health, the Centers for Disease Control and Prevention, and other interested organizations should make clear that positive effects of the following classes of interventions are supported by encouraging although inconclusive evidence:

- *cognitive training*—a broad set of interventions, such as those aimed at enhancing reasoning, memory, and speed of processing—to delay or slow age-related cognitive decline
- *blood pressure management for people with hypertension* to prevent, delay, or slow clinical Alzheimer's-type dementia
- *increased physical activity* to delay or slow age-related cognitive decline

Suggested citation: National Academies of Sciences, Engineering, and Medicine. 2017. *Preventing cognitive decline and dementia: A way forward*. Washington, DC: The National Academies Press. doi: https://doi.org/10.17226/24782.

Other issues

- What is the active ingredient, the optimal dose?
- Assess the impact on dementia and reserve
  - longer follow-up, large groups, surrogate biomarkers, neuroimaging
- Combined approaches are increasingly used
  - Brain stimulation (Benjamin Hampstead), physical activity, nutrition, community-based approach
- One size fit all? Probably not. We need to know the responders and measure the effect in less well represented groups (but:
  - less education, various SES and cultural background but…

Estudos de Psicologia

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Cognitive interventions to improve memory in healthy older adults: the use of Canadian (MEMO) and Brazilian (*Stimullus*) approaches

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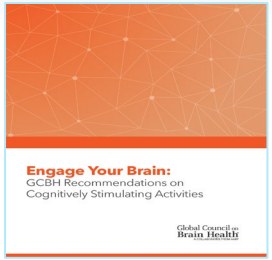
Thank you for your attention and take care of your brain health



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