"The Importance of Bilingualism for Cognitive Aging and Development of Dementia" MCI conference-Public Forum, Miami Beach, January, 2018

Dr. Howard Chertkow and Dr. Natalie Phillips,
Professor of Psychology, Concordia University

Professor of Neurology, McGill;
Director,
nfield Centre for Research in Aging
y Davis I Gill University
Montreal, Quebec

Hôpital général juif
Jewish General Hospital

McGill

What's good about bilingualism?

Judith Kroll (2012)

- More people in the world are bilingual than unilingual!
- Research shows that both languages in a bilingual's brain are active even if just using one language.
- A life of resolving cross-language competition may make you a "mental juggler"…so builds Cognitive Reserve
- Advantages for children in attention and other cognitive functions as they mature.

Montréal, Québec, Canada

a richly multi-lingual city

"homogeneous" group of non-immigrant bilinguals

language mixing is common.

55% of the population are Francophones, many bilingual
35% of the population are Anglophones, ¾ of them having learned French from age 8
10% of the population are allophones / immigrants,

Recent suggested protective factors for AD

(based on animal or population studies, not RCT's)

Rheumatoid arthritis

Use of NSAIDs

Nutrition:anti-oxidants (fruit juice) , red wine

Nutrition-flavenoids - blueberries

low homocysteine, (high folate, B6, B12 intake)

Mediterannean diet (low fat)

Cold water fish diet (omega fatty acids)

Use of Estrogen since menopause

More exercise (Larson, Ann. Int Med., 2006)

Education

Mental stimulation, professional (complex) work

Leisure activities

Bilingualism

There are two ways that bilingualism could prevent dementia:

1. Increase Brain reserve capacity prenatal to childhood

- Genetic protective factors, early nutrition, etc. affect synapse count, brain size, etc. These increase “brain reserve capacity”.
  - When synapses are depleted beyond a critical threshhold, symptoms occur.

2. Build Cognitive reserve

•Environmental factors: education, stimulating environment, occupation -affect active cognitive reserve.

•Greater flexibility and efficiency increase tolerance for brain disease, affect critical threshhold for symptoms to occur

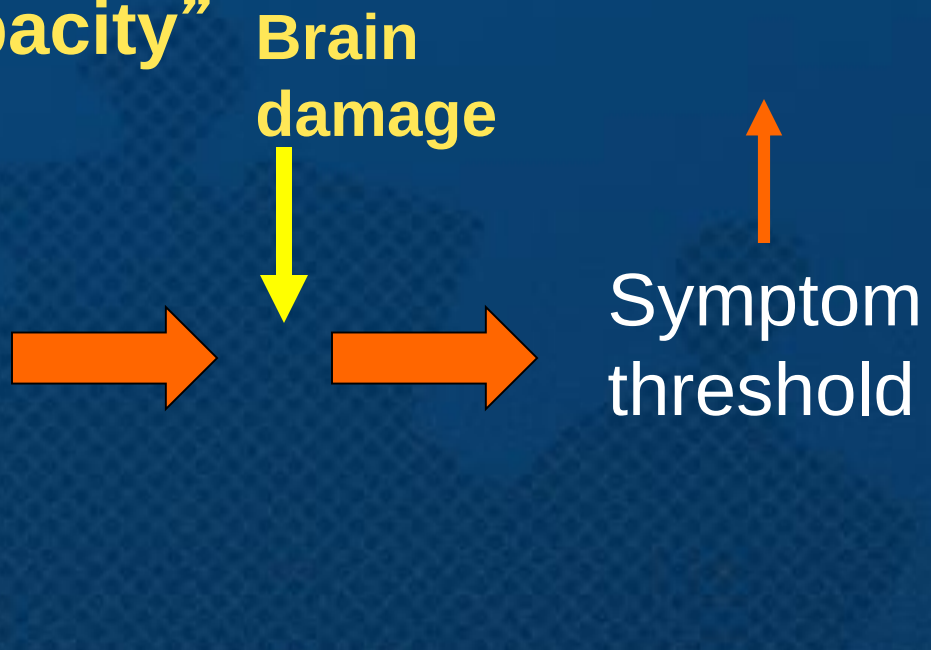
•

Stern, J “What is cognitive reserve? Theory and research application of the reserve concept” Int Neuropschol,2002;8(3):448-460]; Bartres-Faz and Arenaza-Urquijo, 2011

Evidence for brain reserve capacity-building the hardware of the brain

“Brain reserve capacity”

- Brain size
- Head circumference
- Neuronal count
- Synaptic count
- Cortical thickness
- Dendritic branching



- pre-natal > post-natal > lifetime

Evidence for Cognitive reserve "proxies" and acquired factors-all these delay onset of dementia or are associated with less dementia

- socioeconomic status
- income
- occupation
- education/literacy
- I.Q.
- Executive cognitive functions
- leisure activities
- Bilingualism (?)

Valenzeula & Sachdev, 2006

Animal evidence- richer environment builds brains

Rats raised in enriched environment had thicker cerebral cortices, and performed better on cognitive tests. [Markhan et al, Neuron Glia Biol, 2004;1:351-63]

- Increase in hippocampus, ERC, BG.
- Neurons, synapses, dendritic arborization.

Adult marmoset monkeys- similar changes in dendrites, synapse growth. [Kozorovitsky et al, PNAS,2005;102:`7478-82]

Evidence for cognitive reserve in dementia:

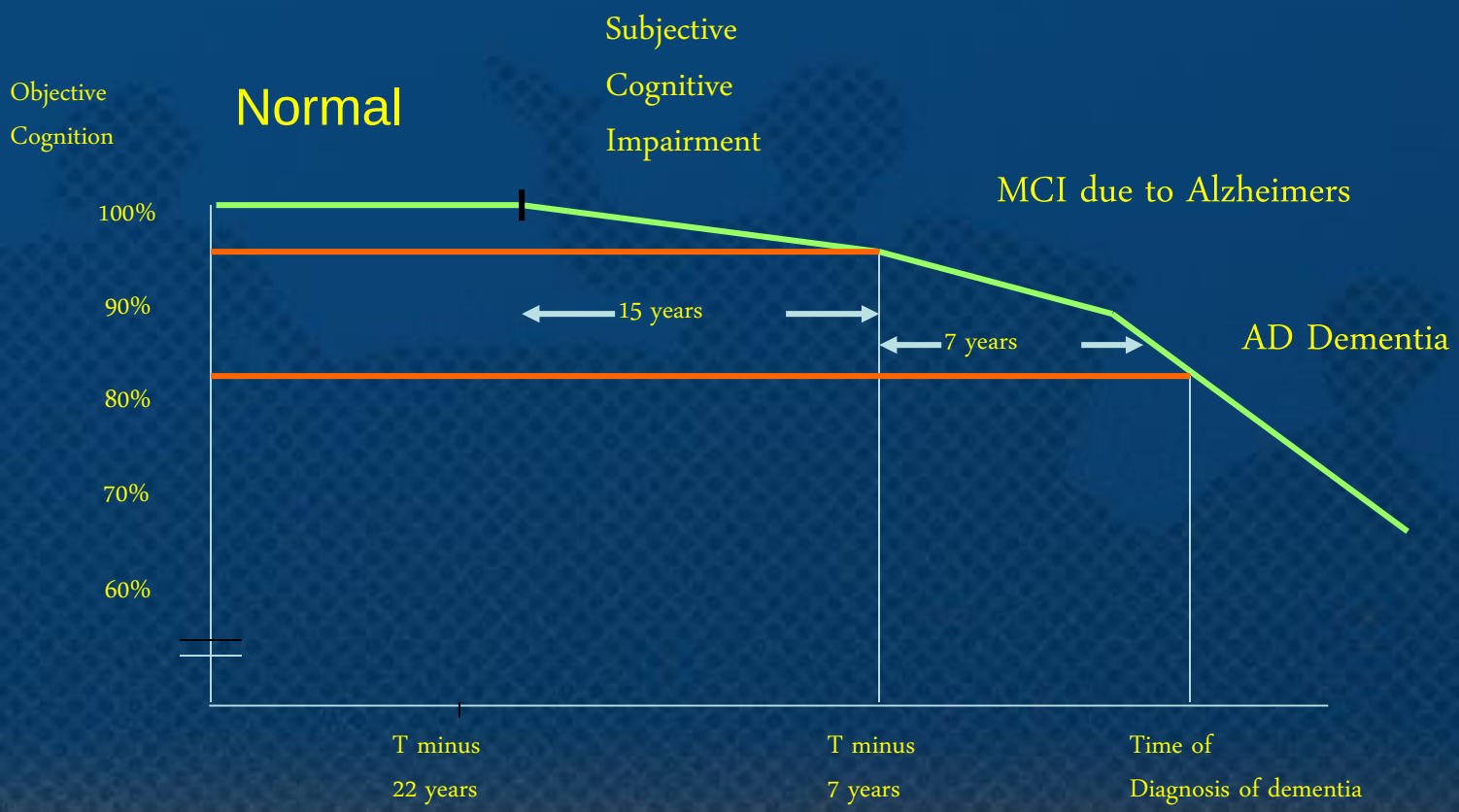
[Stern et al,Neurology,1999;53: 1942-57]

- If you have two groups of Alzheimer Disease subjects matched for dementia severity,
- …..with high (e.g., multilingual) and low (unilingual) CR patient groups,
- …..then the AD subjects with high CR will have a higher pathology burden = more disease needed to get to the same level of memory loss..
- This will be reflected in brain imaging evidence that they have “more disease”. Either greater atrophy (shrinkage on CT,MRI), or lower cortical thickness (MRI) or other measures.

“Neuroanatomical evidence of multilingualism’s contribution to brain reserve and cognitive reserve in patients with mild cognitive impairment and Alzheimer Disease” (Duncan, Chertkow, Phiillips 2017)

HYPOTHESIS:

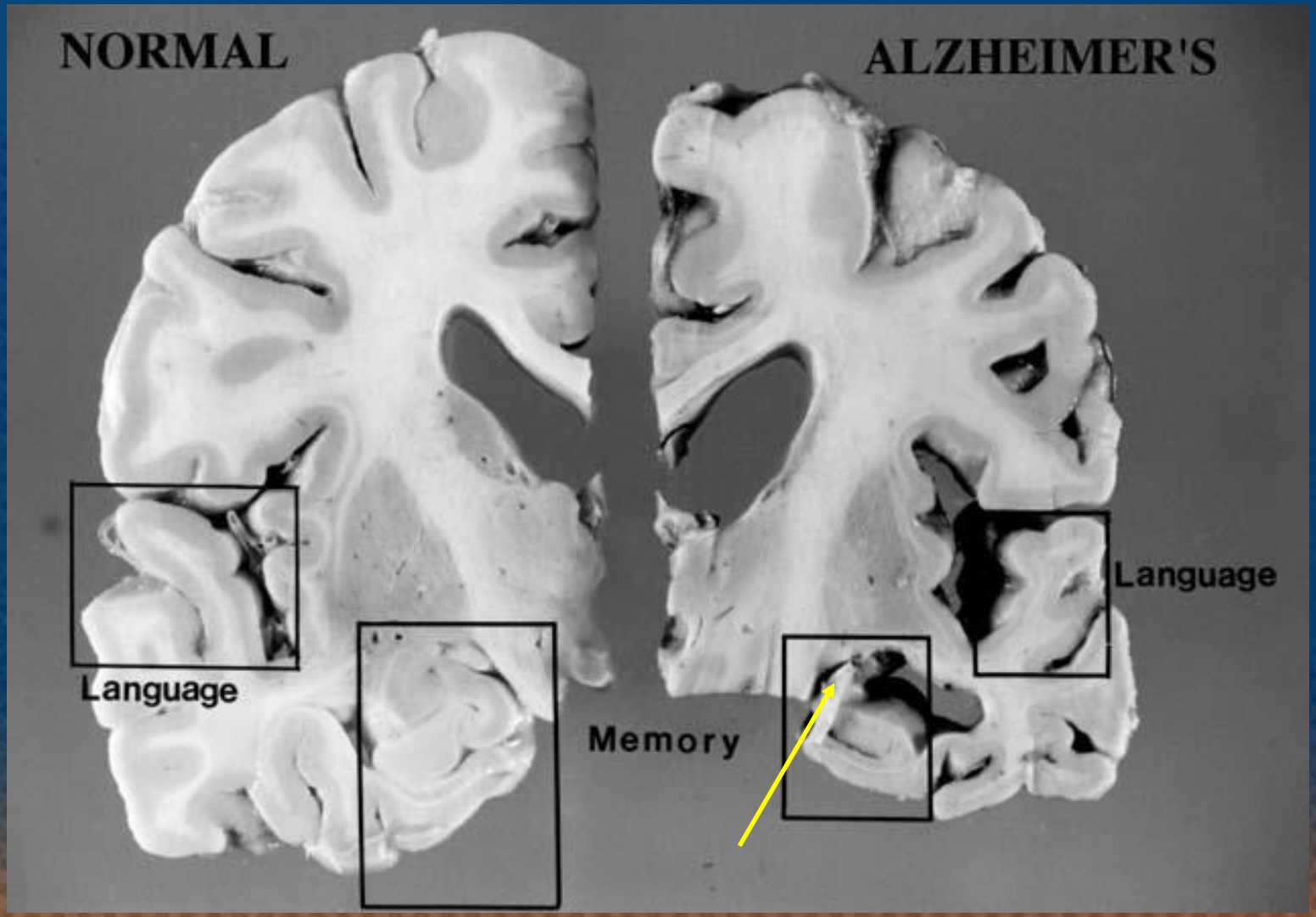
1. Brain reserve might show thicker cortices in all multilingual subjects in language areas.
2. Cognitive reserve might show greater atrophy in matched AD multilinguals vs. monoliguals in regions susceptible to pathology.



When does AD begin?

B. Reisberg, IPA meeting, 2009

Atrophy in Alzheimer's disease



Atrophy of the brain in AD: Medial temporal lobes are affected first and most severely

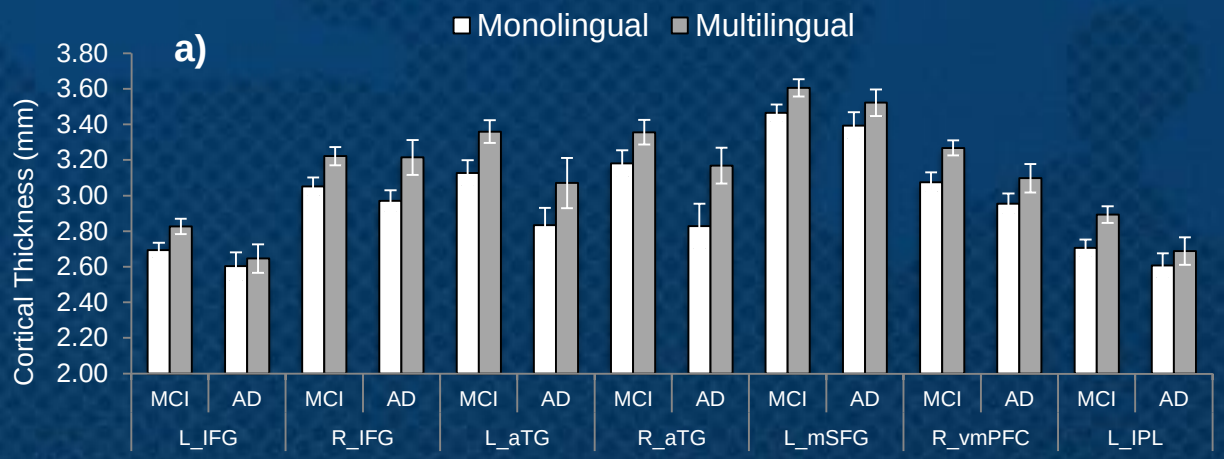
Figure from: 8 : http://pathology.ouhsc.edu/DeptLabs/diagnostic_center_for_alzheimer.htm

//

Methods

- Looked at individuals with Alzheimer Disease, and other individuals very mildly impaired (Mild Cognitive Impairment)
- Subjects were matched within the AD & MCI groups based on age,education,symptom severity.
- Research protocol MRI scans . Cortical thickness measures were derived.
- Regions of interest (ROI's) were selected to reflect areas involved in cognitive control (frontal areas, insula), memory (hippocampus & parahippocampal gyri) and language (temporal areas) .
- .

Both AD and MCI Bilinguals and Multilinguals have thicker cortices in many language regions:

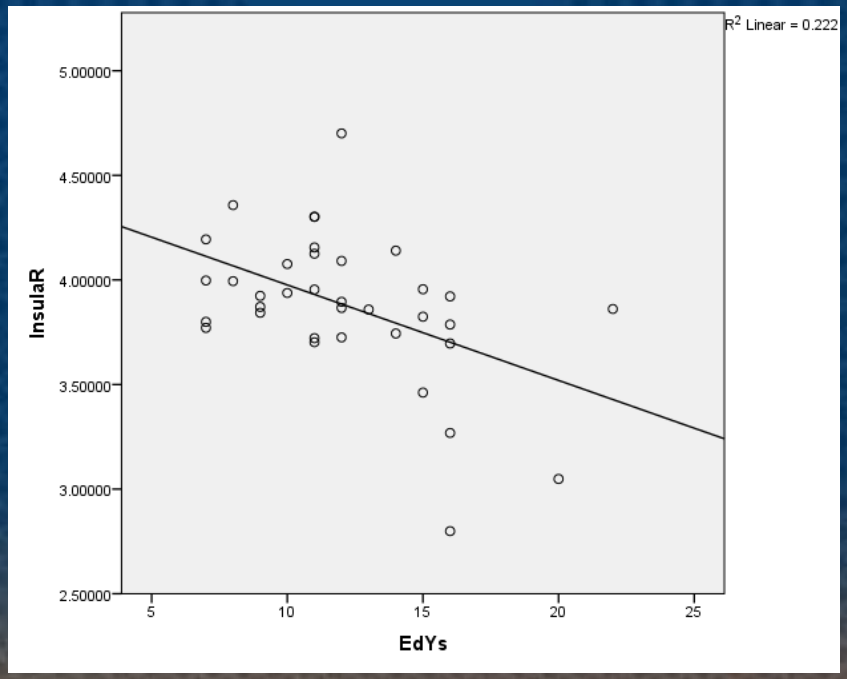


Effect seen in : left and right inferior frontal (and other frontal regions), right anterior middle temporal, left inferior parietal.

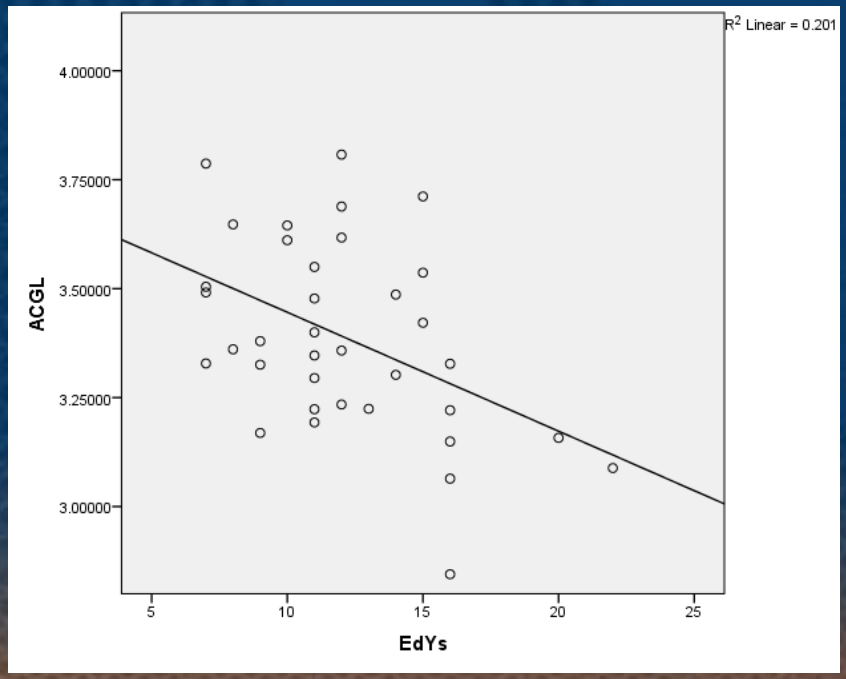
Results support a CR for education in some areas

AD group: Education effects found:Cortical Thickness was found to be negatively correlated to education in two ROI's:

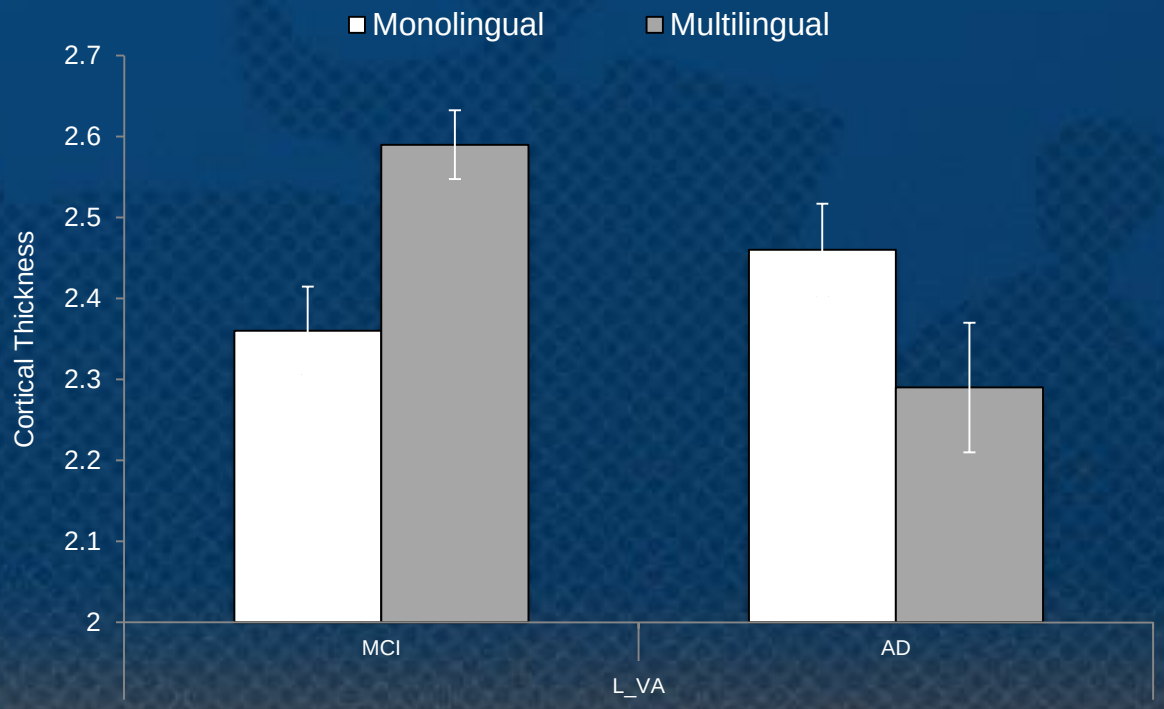
Right Insula (ß=-0.47, p=0.004)



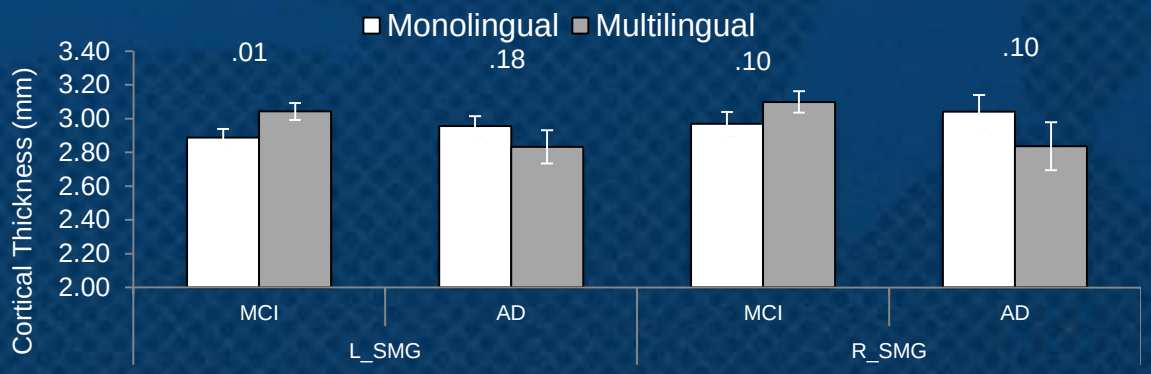
Left Anterior Cingulate (ß=-0.45, p=0.006)



Interaction: Bilinguals and Multilinguals AD have thinner cortices in visual association regions:



Interaction between Language Group and Patient Group



In the Supramarginal gyrus, MCI's show greater Ct for bilinguals (BR), and AD show greater atrophy for multilinguals (CR)

“Neuroanatomical evidence of multilingualism’s contribution to brain reserve and cognitive reserve in patients with mild cognitive impairment and Alzheimer Disease” (Duncan, Chertkow, Phiillips 2017)

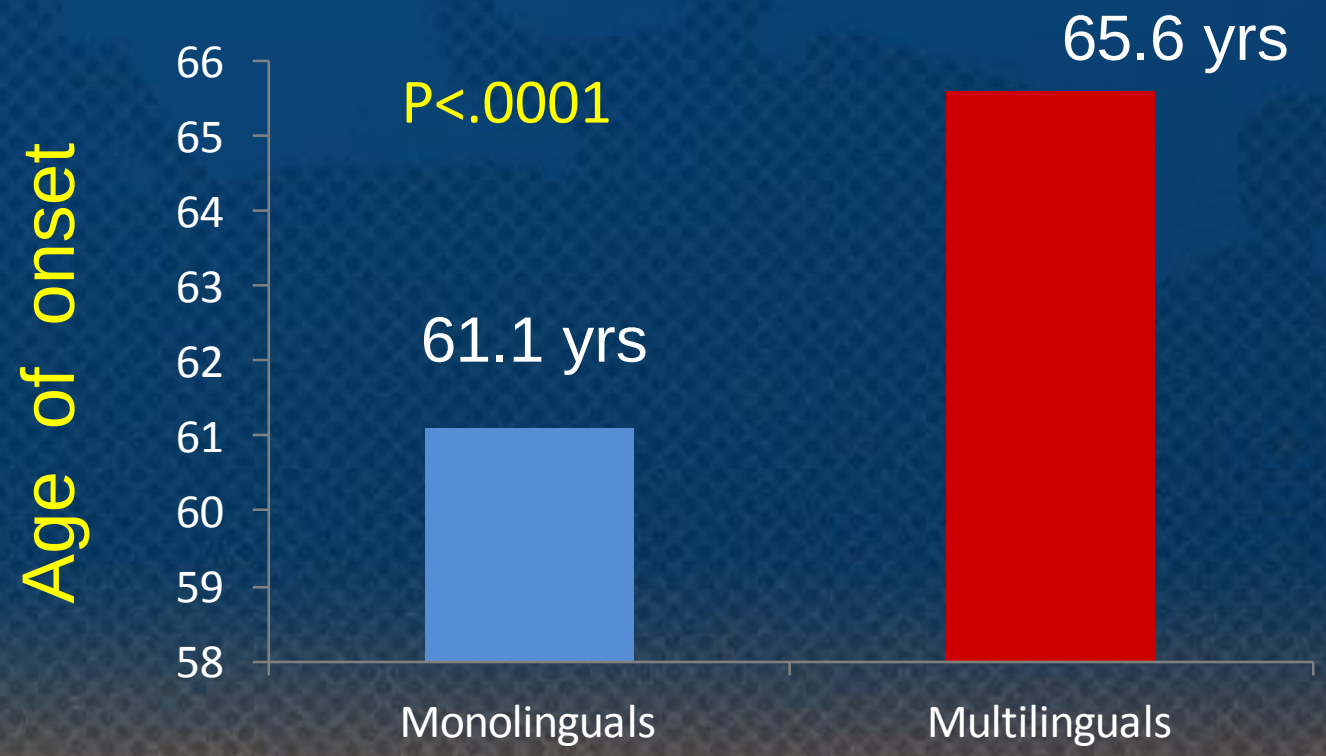
HYPOTHESIS:

1. Brain reserve might show thicker cortices/tissue density in all multilingual subjects in language areas. YES!
2. Cognitive reserve might show greater atrophy in matched AD bilinguals vs. monoliguals in regions susceptible to pathology. YES!

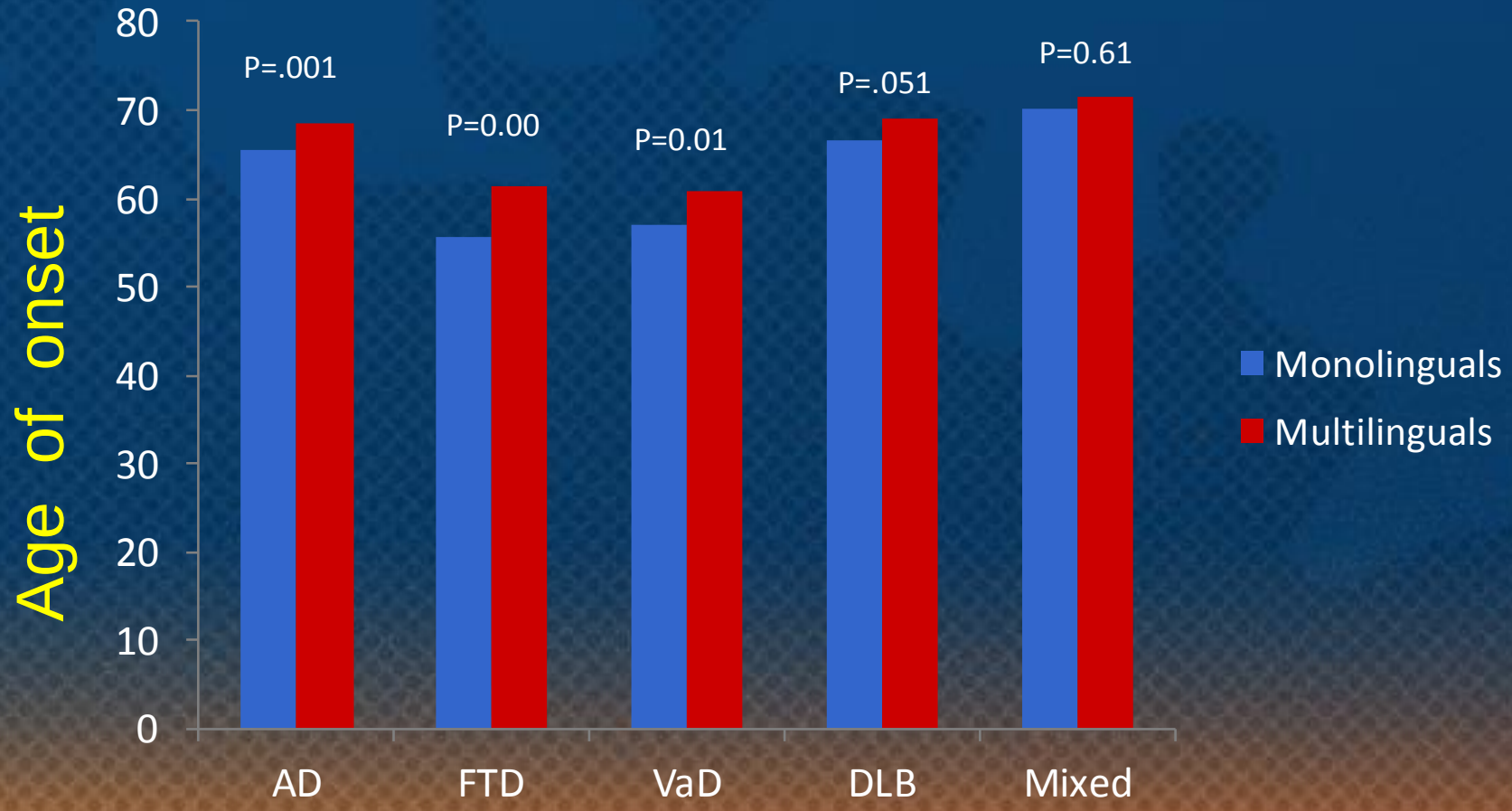
Multilingualism and Age of onset of Dementia Study from a Memory Clinic in Hyderabad

Suvarna Alladi, Hyderabad, India

Multilingualism and age of onset of dementia



Multilingualism and Dementia Subtypes



Montreal/McGill University study of Bilingualism, multilingualism and dementia

Chertkow, H., Whitehead, V., Phillips, N., Wolfson, C., Atherton, J., & Bergman, H. (2010). Multilingualism (but not always bilingualism) delays the onset of Alzheimer's disease - evidence from a bilingual community. *Alzheimer's Disease & Associated Disorder, 24,* 118–125.

Age of AD dementia diagnosis organized according to number of languages spoken.

Number of Languages spoken	n	Age at Diagnosis	Years of Education	MMSE score at diagnosis
1	379	76.7 (7.8)	10.9 (3.5)	23.1 (3.9)
2	168	76.7 (7.8)	10.7 (3.7)	22.8 (4.3)
3	67	78.6 (6.0)	11.3 (4.2)	23.1 (4.3)
$\geq$ 4	18	80.8 (5.5)	9.1 (3.6)	23.6 (2.7)

But if you break down the population in terms of ethnicity (Anglophones, Francophones, Immigrants), you see that the effect of multiple languages only shows up in certain of the groups!

RESULTS – ORIGINS SUBGROUPS

Age of Diagnosis of Alzheimer's disease organized according to number of languages spoken within Native Canadians whose mother tongue in English (Native English), Native Canadians whose mother tongue is French (Native French), and immigrants to Canada (Immigrants).

Number of Languages spoken	Native English	Native French	Immigrants
1	78.0 (7.0)	72.7 (9.1)	71.4 (8.1)
[n]	[289]	[66]	[23]
2	77.9 (7.5)	75.9 (6.5)	76.5 (8.2)
[n]	[62]	[24]	[81]
3	79.8 (5.6)	79.5 (2.5)	77.8 (6.4)
[n]	[24]	[4]	[39]
≥ 4	80.7 (3.2)	-	80.9 (5.9)
[n]	[3]	-	[15]

unilingual anglophones seem protected!

Analysis shows it is not due to income

ELSEVIER

Neuropsychologia 45 (2007) 459–464

NEUROPSYCHOLOGIA

www.elsevier.com/locate/neuropsychologia

Note

Bilingualism as a protection against the onset of symptoms of dementia

Ellen Bialystok[a,b,*], Fergus I.M. Craik[b,c], Morris Freedman[b,d,e]

[a] *Department of Psychology, York University, 4700 Keele Street, Toronto, Ontario, Canada M3J 1P3*
[b] *Rotman Research Institute at Baycrest, Canada*
[c] *Department of Psychology, University of Toronto, Canada*
[d] *Division of Neurology, Baycrest, Canada*
[e] *Department of Medicine, Division of Neurology, Mt. Sinai Hospital, University Health Network, and University of Toronto, Canada*

Received 19 June 2006; received in revised form 23 October 2006; accepted 24 October 2006

Abstract

This study examined the effect of lifelong bilingualism on maintaining cognitive functioning and delaying the onset of symptoms of dementia in old age. The sample was selected from the records of 228 patients referred to a Memory Clinic with cognitive complaints. The final sample consisted of 184 patients diagnosed with dementia, 51% of whom were bilingual. The bilinguals showed symptoms of dementia 4 years later than monolinguals, all other measures being equivalent. Additionally, the rate of decline in Mini-Mental State Examination (MMSE) scores over the 4 years subsequent to the diagnosis was the same for a subset of patients in the two groups, suggesting a shift in onset age with no change in rate of progression.

Keywords: Bilingualism; Cognitive reserve; Dementia

Bialystok et al. (2007)-Toronto Canada
Bilinguals' age of onset
of symptoms 4.1 years later than unilinguals.

Bilingualism → brain plasticity → does it increase *cognitive* reserve ?

Does bilingualism offer a protective effect against dementia?

positive evidence:

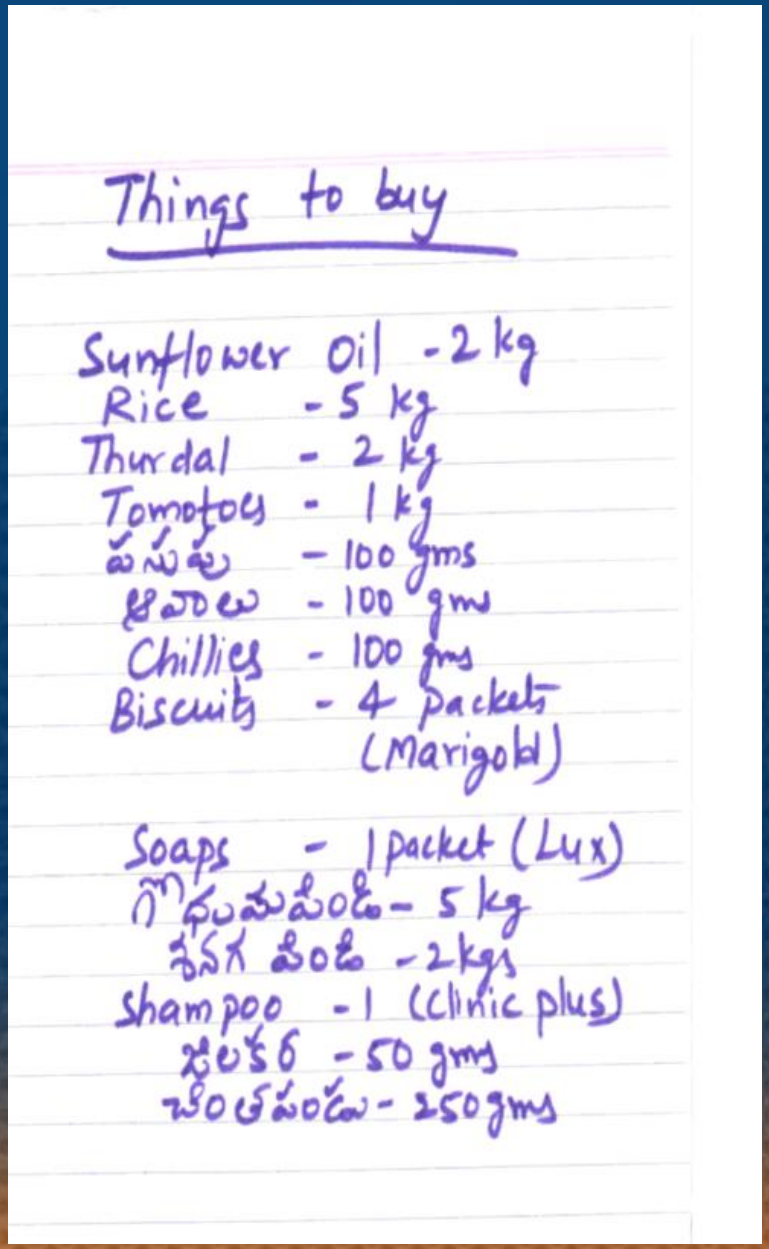
- Bialystok, Craik, & Freedman (2007): delay of 4.1 years in onset of dementia symptoms
- Alladi et al. (2013)

mixed evidence, results dependent on:

- immigrant status; nature of the L1/L2 relationship
  - e.g., Chertkow, Whitehead, Phillips, Wolfson, Atherton, & Bergman, 2010
- education level (Gollan et al., 2011)

negative evidence:

- Brewster et al. (2014); Crane et al., (2009); Sanders, Hall, Katz, & Lipton (2012); Yeung, St. John, Menec, & Tyas (2014)



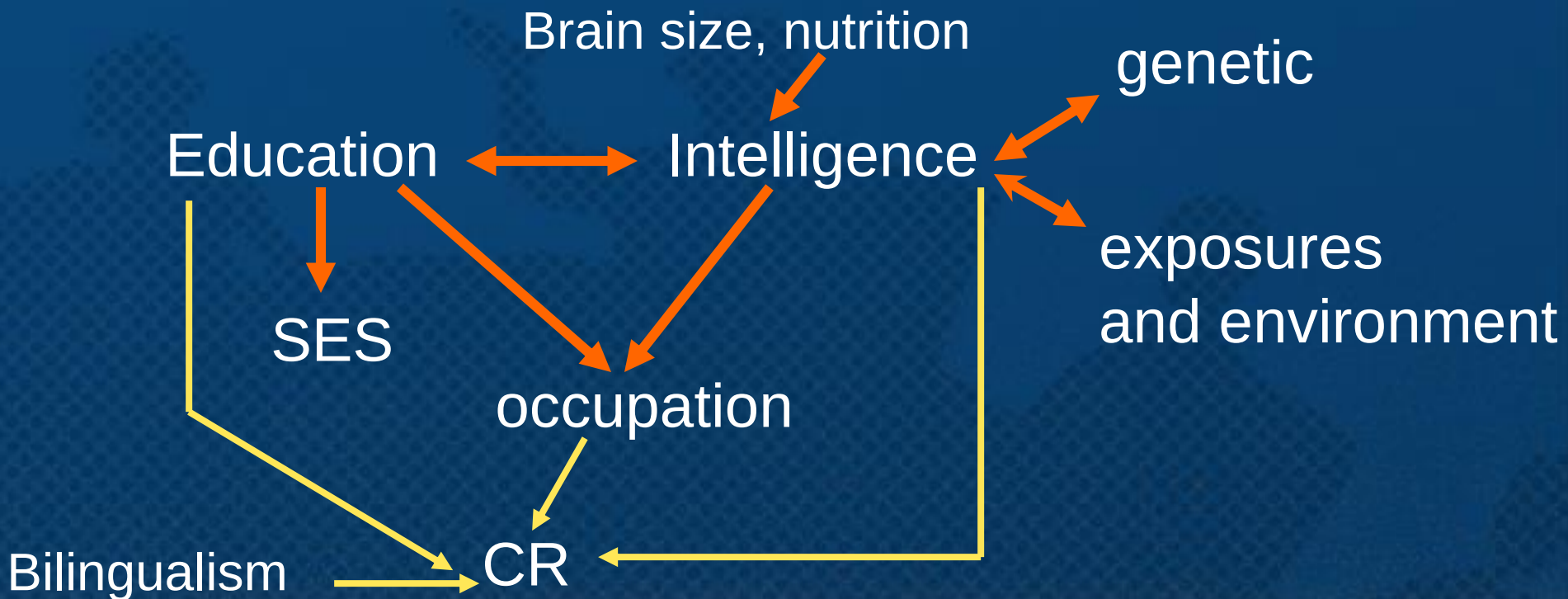
Difference between Montreal and Hyderabad?: Day to day use of normative multilingualism in India

Difference between Montreal and Toronto? - unknown

Conclusions

- Results in the MCI/ Prodromal AD subgroup : There is evidence for bilingualism building brain reserve –cortical thickness differences in language regions of brain.
- Multilingual and sometimes bilingual AD subjects have 4 years later disease onset = cognitive reserve effect
- All studies have found CR brain volumes results for bilingualism/multilingualism (greater atrophy at the same level of dementia severity in multilinguals).
- Overall, the hypothesis of bilingualism contributing to cognitive reserve was partially supported.
- Results in the MCI group (more education, bilingualism = greater cortical thickness) are suggestive of education and bilingualism both contributing to brain reserve and building thicker cortices.

Conclusion from studies- CR is complex, contains Nature and Nurture factors



Cognitive reserve in each individual appears to be a complex phenomenon. Learning languages is ONE piece of the puzzle, ONE aspect of an individual's life which may be protective. It may play a bigger role in one cultural setting than another!

Funding Support for Dr. Chertkow

Canadian Institutes for Health Research
Alzheimer's Society of Canada
Weston Foundation

Bloomfield Centre for Research in Aging
Lady Davis Institute
McGill University
Montreal Canada