THE UNIVERSITY OF HONG KONG

Multilingualism and the Brain

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HKU February 2018

THE UNIVERSITY OF MELBOURNE

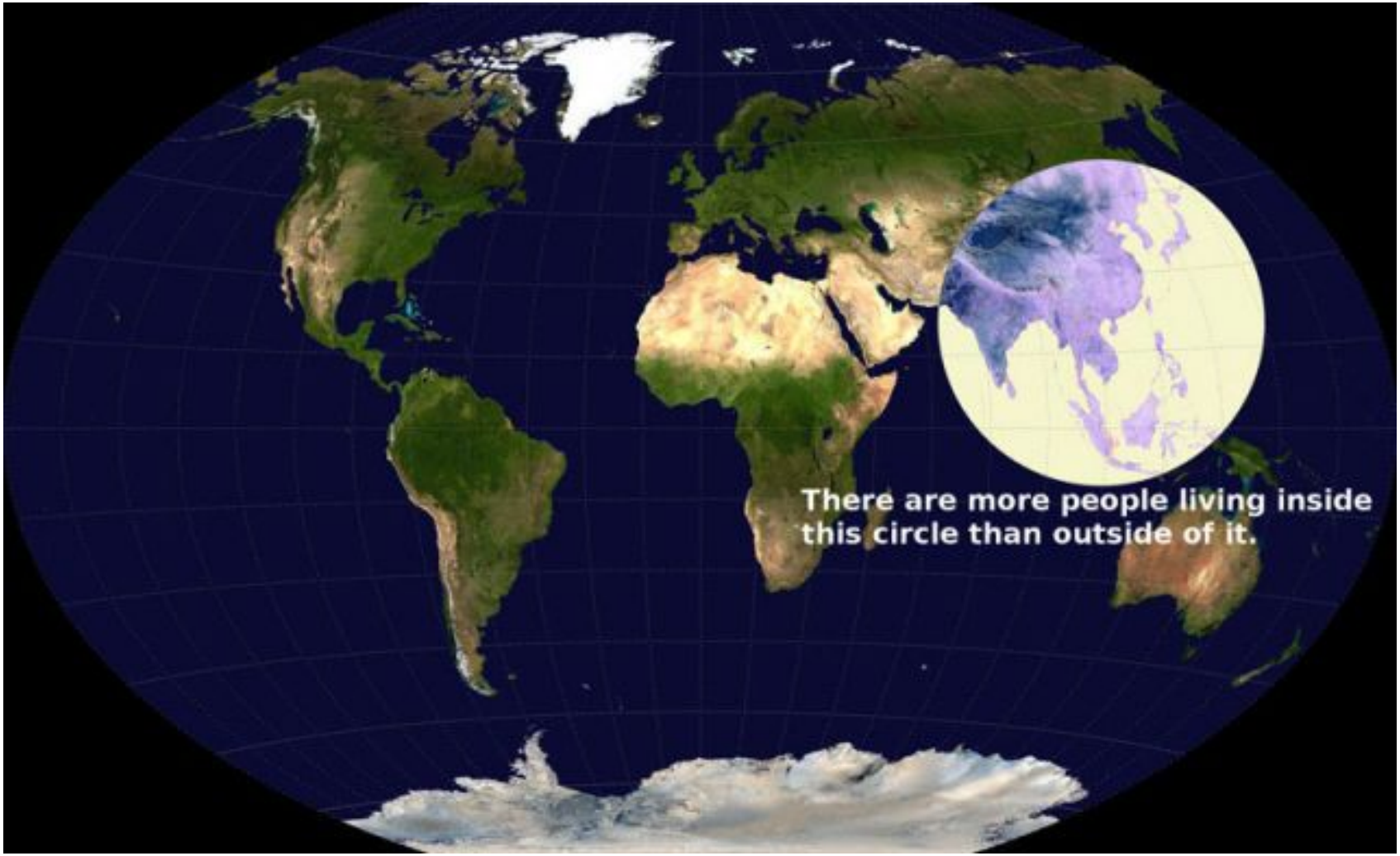
Overview

- Aging, Development and Cognition in Multilingualism
- GMV, MRS, sulcal gyration, white matter microstructure
- Linguistic load reflected in multilingual brains and speech

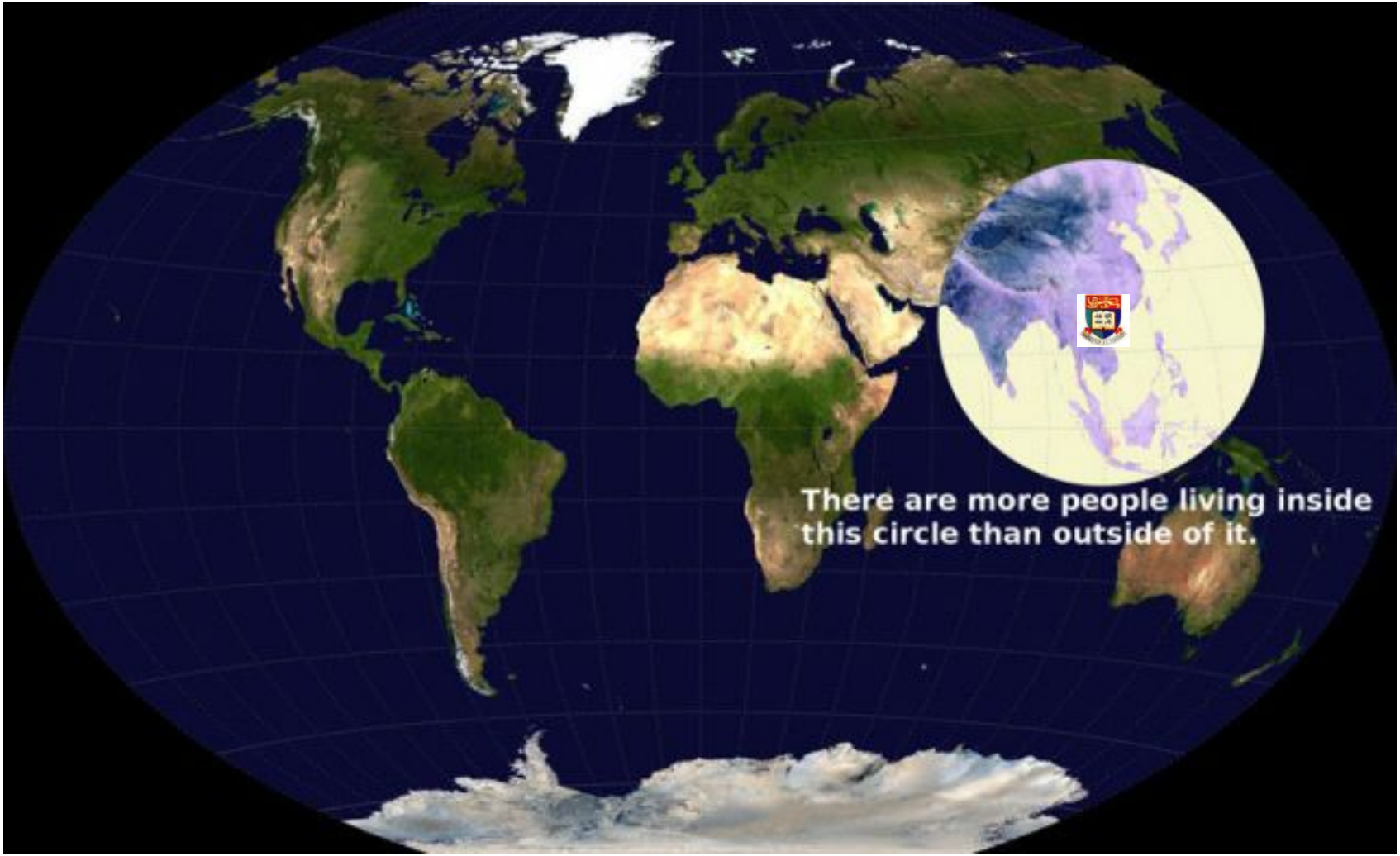
Speaking of language(s)

- Advantage (cultural factors, exposure to print, other language experience, 'bilingual' individual differences)
- Experience (dominance, number of "speaking" years)
- Learning (age of acquisition, duration, formality, style)

Our region


There are more people living inside
this circle than outside of it.

Our region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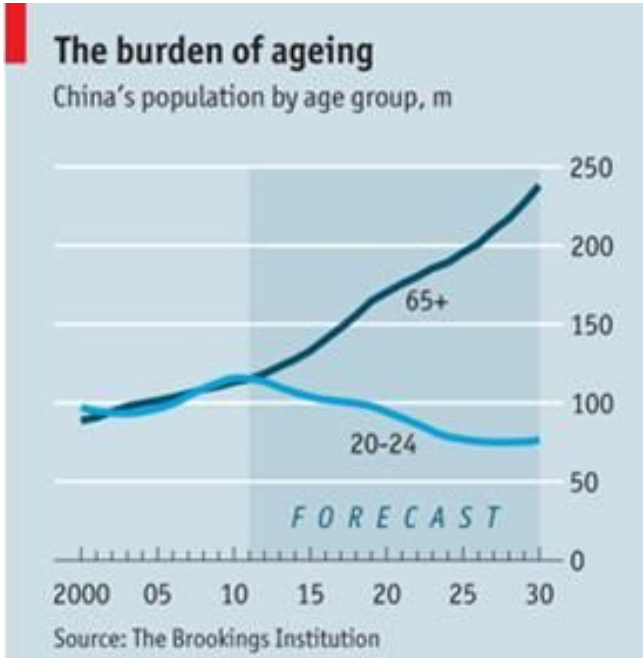
this circle than outside of it.

Our region

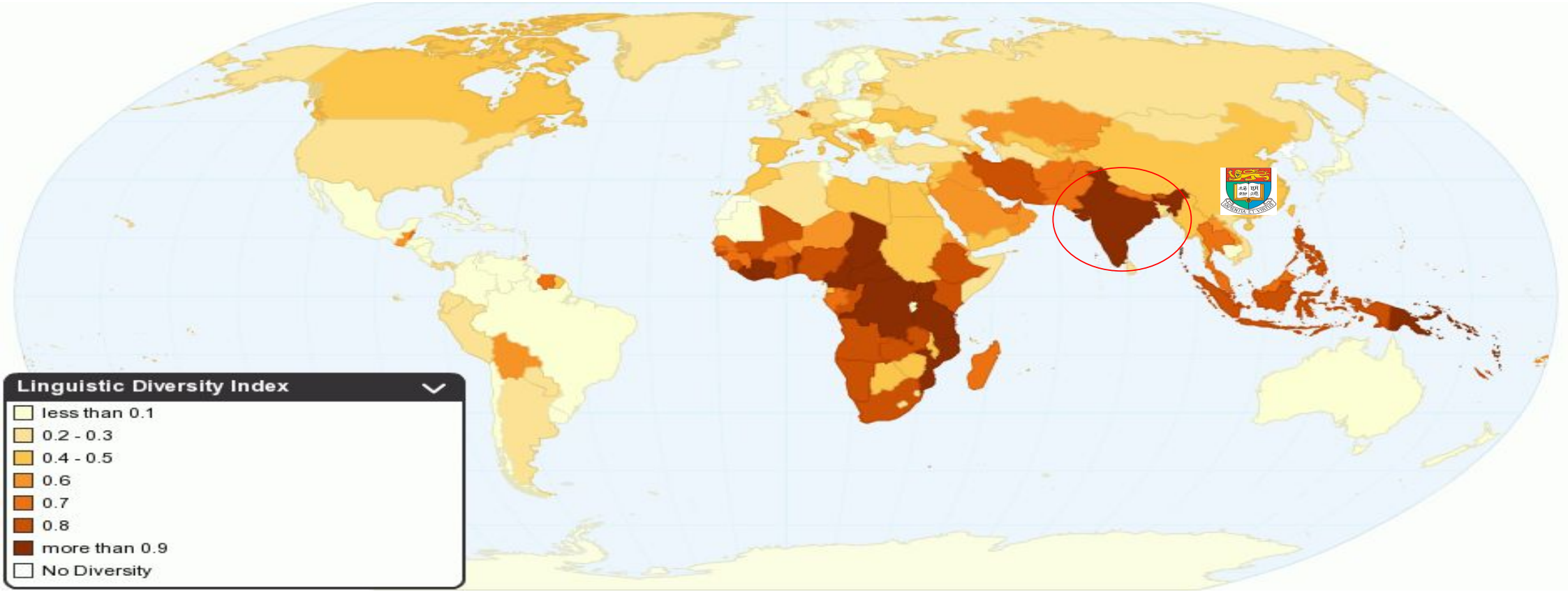
- Filial piety 1+6 rule



Wage Overheads in Emerging Asia			
Country	Avg. minimum annual salary (worker, Intl. dollar)	Avg. mandatory welfare (% against salary)	Total labor cost (Intl. dollar)
Bangladesh	798	n/a	798
Cambodia	672	n/a	672
China	1,500	50	2,250
India	857	10	943
Indonesia	1,027	6	1,089
Laos	1,057	9.5	1,157
Malaysia	4,735	23	5,824
Mongolia	2,004	n/a	2,004
Myanmar	401	n/a	401
Nepal	1,889	n/a	1,889
Pakistan	984	7	1,052
Philippines	2,053	9.4	2,246
Sri Lanka	1,619	n/a	1,619
Thailand	2,293	6.9	2,451
Vietnam	1,002	15	1,152

Source: IMF World Economic Outlook Database, October 2010

Our region



22 official languages

Bilingualism: Language and Cognition: page 1 of 14 © Cambridge University Press 2017 doi:10.1017/S1366728917000438

Microstructural anatomical differences between bilinguals and monolinguals*

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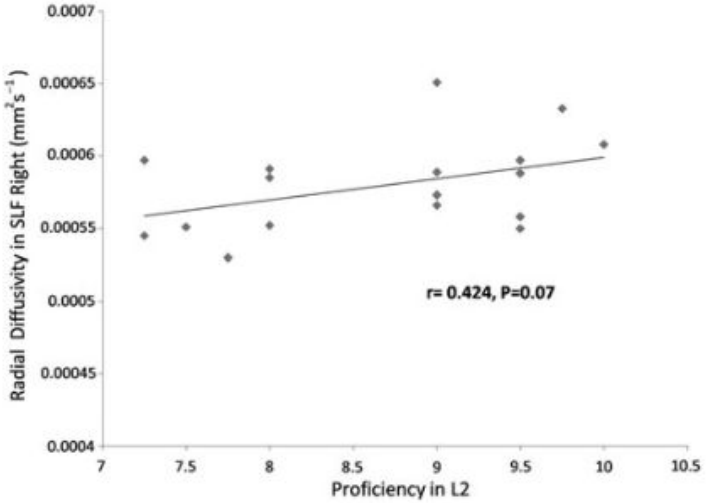


Figure 4. Correlation between Radial Diffusivity in the right SLF and the L2 proficiency scores for Bilinguals.

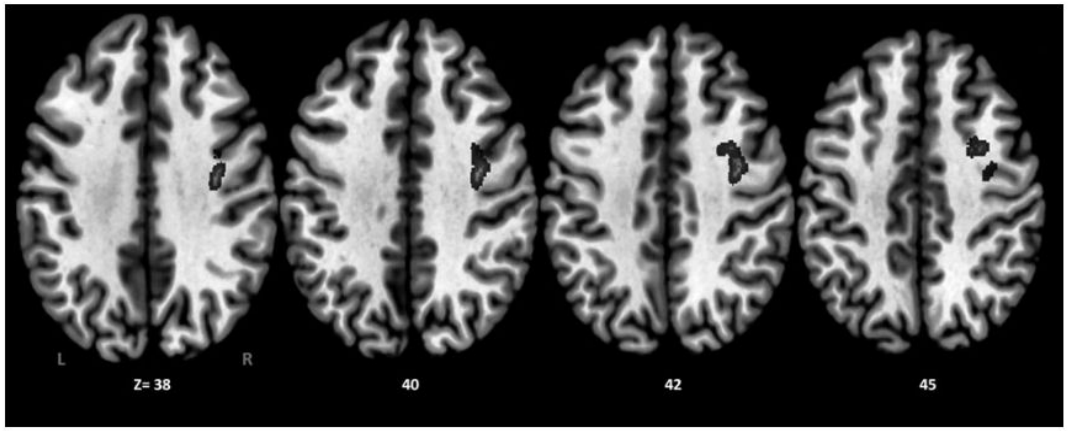
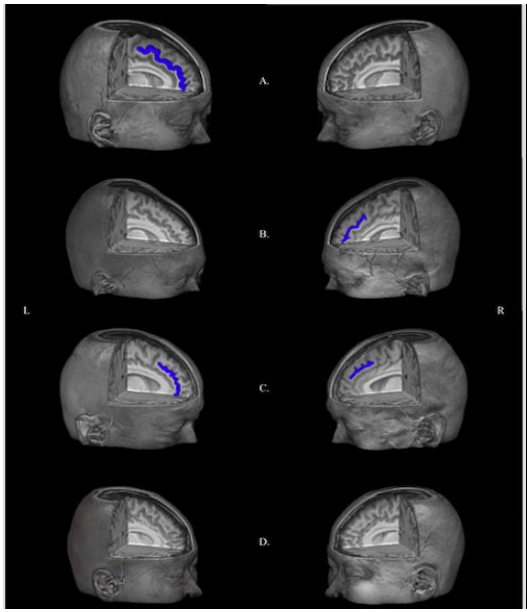
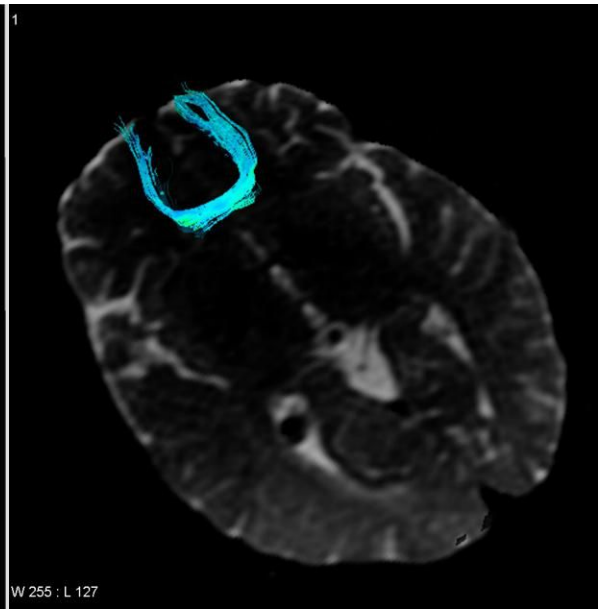
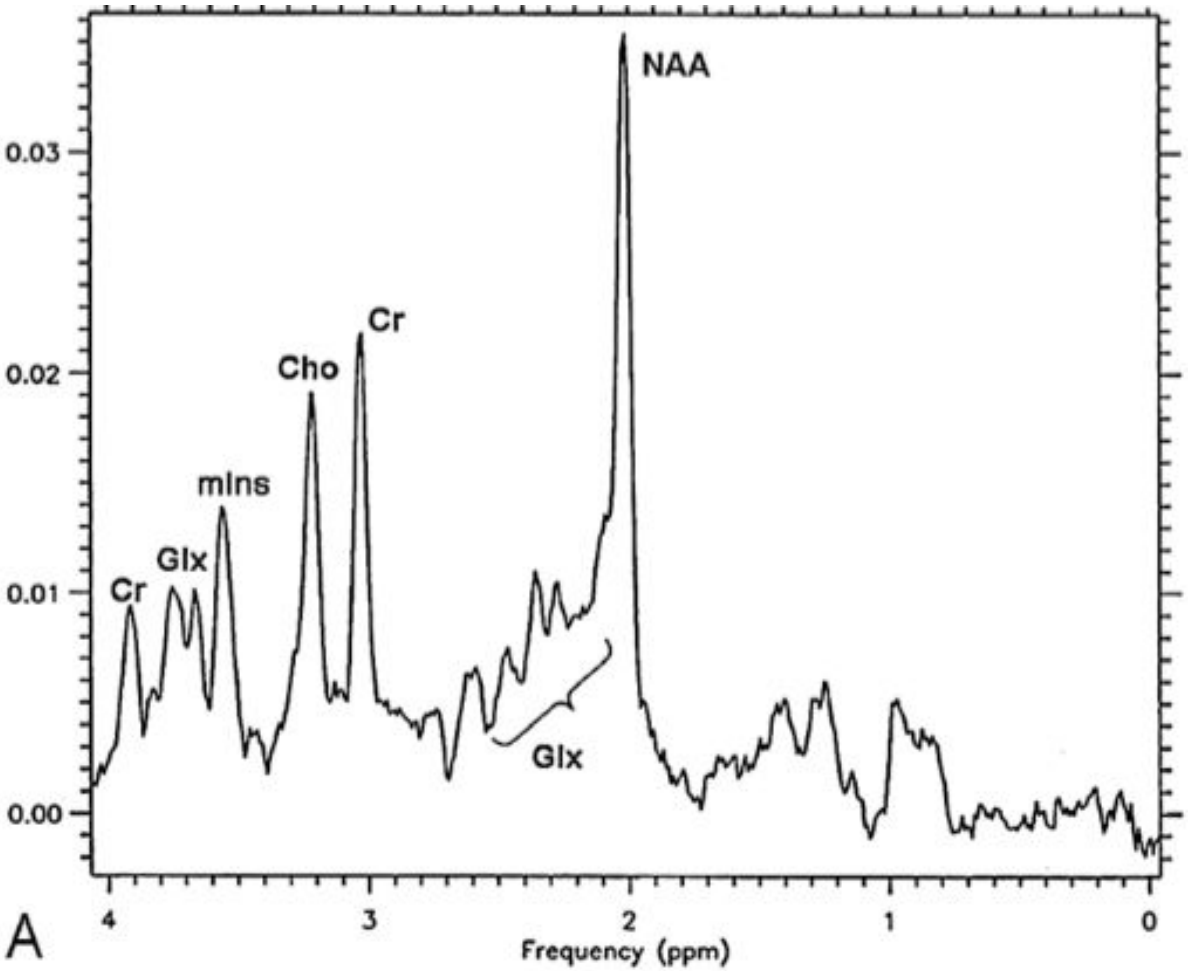


Figure 5. Correlation between Radial Diffusivity in the right SLF and the L2 proficiency scores for Bilinguals. Results of TBSS analysis with Threshold Free Cluster Enhancement and permutation testing (5000 permutations), at $p < 0.097$.

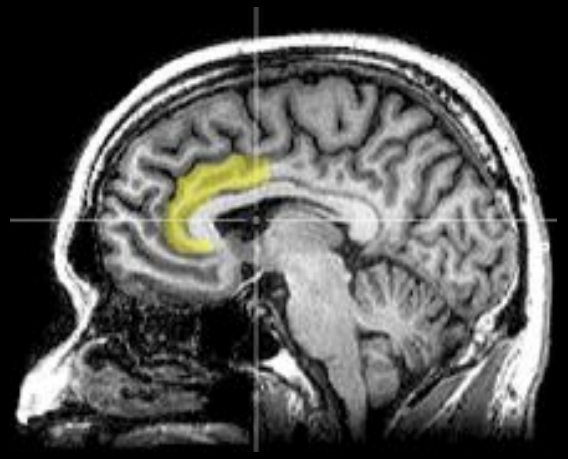




Magnetic Resonance Spectroscopy



Hong Kong	Milan
Bilingual	Monolingual
21 subjects scanned	20 subjects scanned
24.19 ± 2.25 y/o	24.40 ± 2.11 y/o
17.60 ± 1.55 Edu years	16.80 ± 1.61 Edu years



Dorsal Anterior Cingulate Cortex

Bilingual vs Monolingual

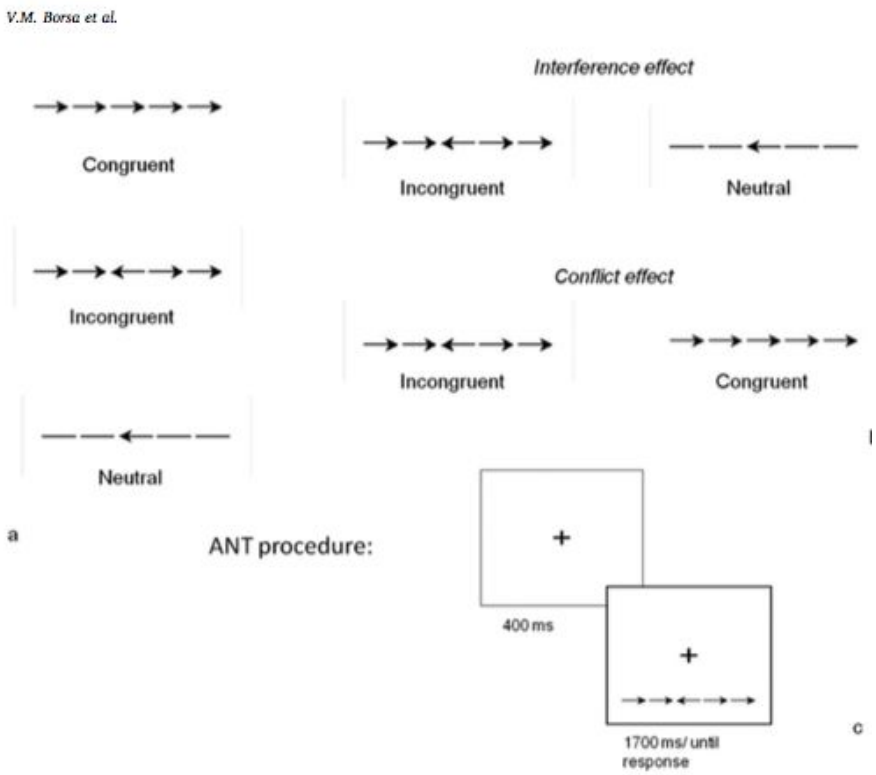
			p-value
$[Cho]_{abs}$	Bilingual	2.22±0.39	**0.025**
	Monolingual	2.39±0.23	
$[Cr]_{abs}$	Bilingual	13.63±1.84	**0.006**
	Monolingual	14.00±3.06	
$[NAA]_{abs}$	Bilingual	10.91±1.79	**<0.001**
	Monolingual	12.00±0.76	
$[mI]_{abs}$	Bilingual	6.23±1.79	0.419
	Monolingual	6.00±3.33	
$[Glx]_{abs}$	Bilingual	14.66±1.87	**0.045**
	Monolingual	15.13±1.42	

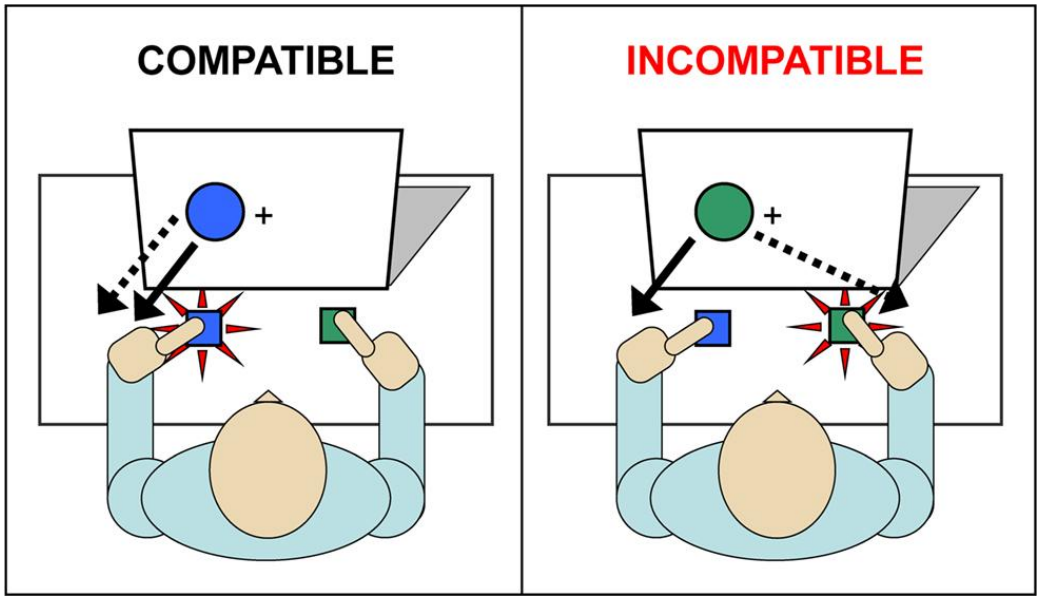
Nonparametric Mann-Whitney test

Results

	Mean Concentration (mM)	Pearson correlation (r)	*p*-value	
$[Cho]_{abs}$	3.04±1.10	0.561	<0.01	↑
$[Cr]_{abs}$	15.03±2.86	0.505	<0.01	↑
$[NAA]_{abs}$	12.46±3.34	0.717	<0.01	↑
$[mI]_{abs}$	9.71±3.89	0.167	0.245	-
$[Glx]_{abs}$	13.54±5.43	0.480	<0.01	↑

Eriksen Flanker task (ANT Fan et al.)





YELLOW BLUE ORANGE
BLACK RED GREEN

PURPLE YELLOW RED
ORANGE GREEN BLUE

BLUE RED PURPLE
YELLOW RED GREEN

Asymmetric (left) ACC

Age 5 (Cachia et al., 2014)

Age 9 (Borst et al., 2014)

GMV (Abutalebi et al., 2012-2016 HKU)

CORTEX 49 (2013) 605–608

Available online at www.sciencedirect.com

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Journal homepage: www.elsevier.com/locate/cortex

Letter to the Editor

A neural interactive location for multilingual talent

Pasquale Anthony Della Rosa [a], *Gerda Videsott* [b], *Virginia Maria Borsa* [a], *Matteo Canini* [a], *Brendan S. Weekes* [c], *Rita Franceschini* [b] *and Jubin Abutalebi* [a,c,*]

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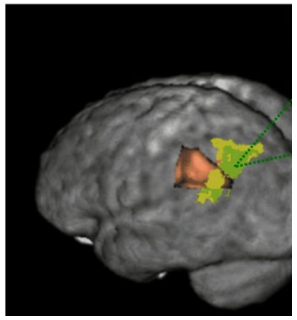
[c] Division of Speech and Hearing Sciences, University of Hong Kong, Hong Kong



CORTEX 49 (2013) 905–911

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Note

Language proficiency modulates the engagement of cognitive control areas in multilinguals

Jubin Abutalebi [a,b], *Pasquale A. Della Rosa* [a], *Guosheng Ding* [c], *Brendan Weekes* [b], *Albert Costa* [d] *and David W. Green* [e,*]

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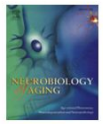

Bilingualism protects anterior temporal lobe integrity in aging

Jubin Abutalebi [a,b,*], Matteo Canini [b,c], Pasquale A. Della Rosa [c], Lo Ping Sheung [a], David W. Green [d], Brendan S. Weekes [a]

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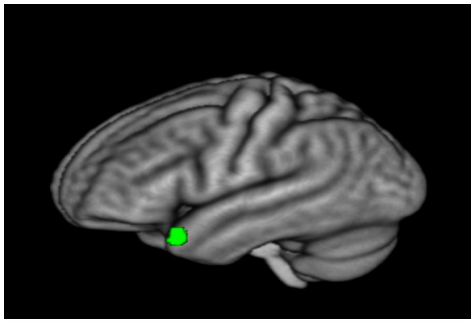

Neuropsychologia

Volume 69, March 2015, Pages 201-210

Bilingualism provides a neural reserve for aging populations

Jubin Abutalebi [a, b], Lucia Guidi [b, c], Virginia Borsa [b], Matteo Canini [b, d], Pasquale A. Della Rosa [d], Ben A. Parris [a], Brendan S. Weekes [a]

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https://doi.org/10.1016/j.neuropsychologia.2015.01.040

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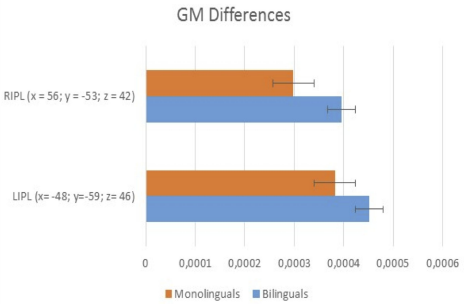
Highlights

- Aging affects cognitive performance of bilinguals less as compared to monolinguals.
- Aging induced effects correlate only for monolinguals to decreased gray matter in the prefrontal cortex.
- Bilingualism is associated with increased gray matter in the ACC.
- Bilingualism provides a neural reserve during aging.



Eriksen Flanker task (ANT Fan et al.)

Neuropsychologia 111 (2018) 51–61

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Neuropsychologia

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Bilingualism and healthy aging: Aging effects and neural maintenance

Virgina M. Borsa[a,b,c], Daniela Perani[a], Pasquale A. Della Rosa[a], Gerda Videsott[d], Lucia Guidi[a], Brendan S. Weekes[e,f], Rita Franceschini[d], Jubin Abutalebi[a,e,*]

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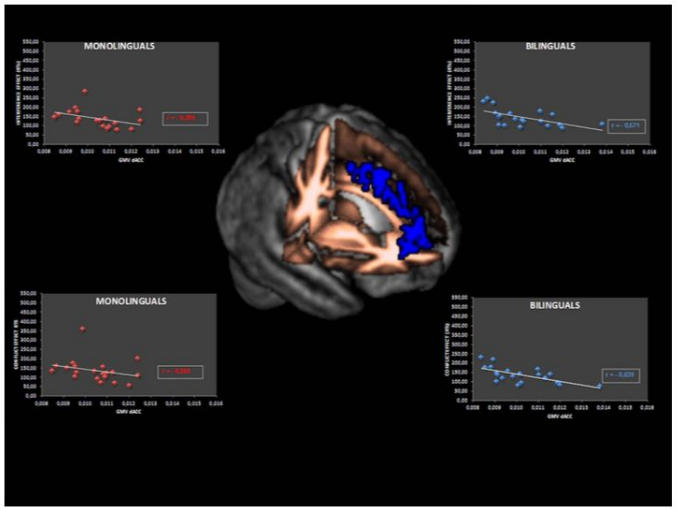

Brain and Language 175 (2017) 57–63

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Brain and Language

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Anterior cingulate cortex sulcation and its differential effects on conflict monitoring in bilinguals and monolinguals

Arnaud Cachia[a,b,c,d], Nicola Del Maschio[e], Gregoire Borst[a,b,c], Pasquale Anthony Della Rosa[e], Christophe Pallier[f], Albert Costa[g], Olivier Houdé[a,b,c], Jubin Abutalebi[e,*]

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[f] Cognitive Neuroimaging Unit, CEA DSV/I2BM, INSERM, Université Paris-Sud, Université Paris-Saclay, NeuroSpin Center, Gif-sur-Yvette, France
[g] Universitat de Pompeu Fabra, Barcelona & ICREA, Spain

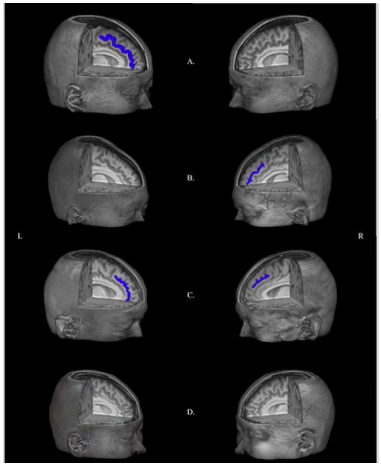
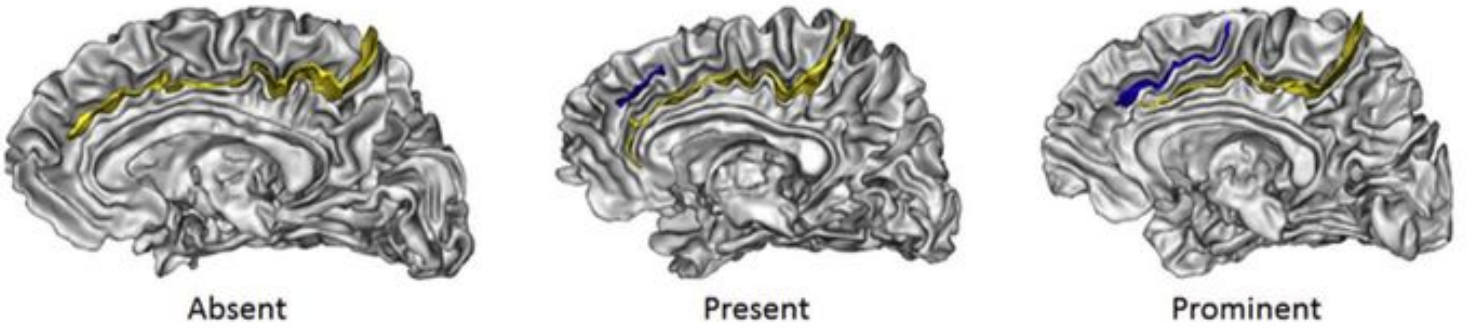


Table 6
Correlation analysis between Age and selected ROIs (i.e. Left and Right Calcarine; Left and Right Cuneus) not associated to cognitive control and language control network. Result are reported for the whole sample (N = 40) and for each group separately (i.e. monolinguals and bilinguals).

		Left Calcarine	Right Calcarine	Left Cuneus	Right Cuneus
All sample					
Age	*Pearson correlaion*	−0.45	−0.43	−0.46	−0.43
	Sign. (two tailed)	0.00	0.01	0.00	0.01
	N	40	40	40	40
Monolinguals					
Age	*Pearson correlaion*	−0.45	−0.40	−0.46	−0.48
	Sign. (two tailed)	0.05	0.08	0.04	0.03
	N	20	20	20	20
Bilinguals					
Age	*Pearson correlaion*	−0.46	−0.47	−0.46	−0.42
	Sign. (two tailed)	0.04	0.04	0.04	0.06
	N	20	20	20	20

Paracingulate sulcus (PCS) (Cachia et al. 2017)



A. Cachia et al.

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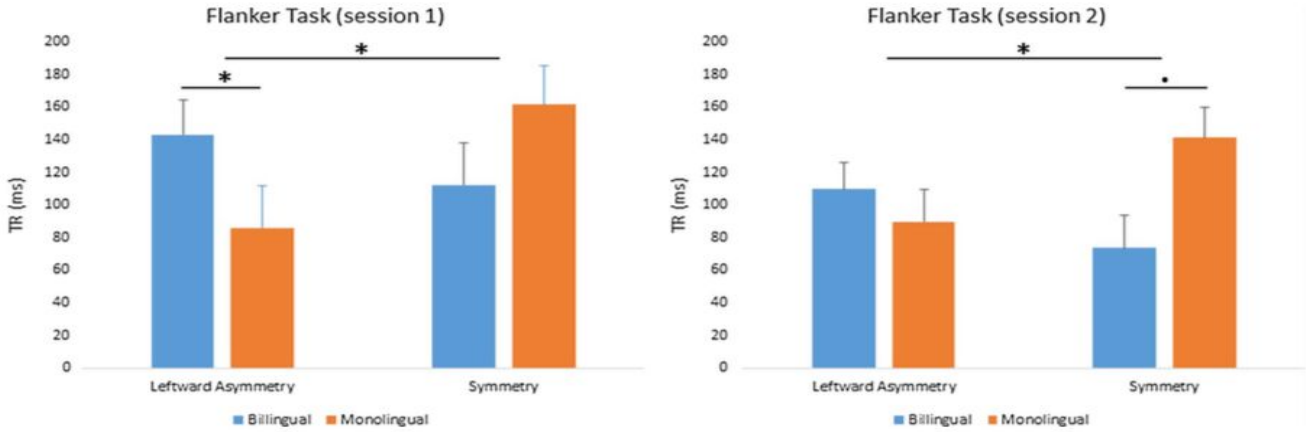

Fig. 2. Asymmetry of the anterior cingulate cortex (ACC) and cognitive control efficiency in bilinguals and monolinguals in Sessions 1 and 2. Conflict effect scores (differential RTs: Incongruent minus Congruent trials) in bilinguals and monolinguals with different ACC morphology. Error bars denote the standard error of the mean. *: $p < 0.05$; .: $p < 0.1$.

Eriksen Flanker task (ANT Fan et al.)

Neuropsychologia 111 (2018) 51–61

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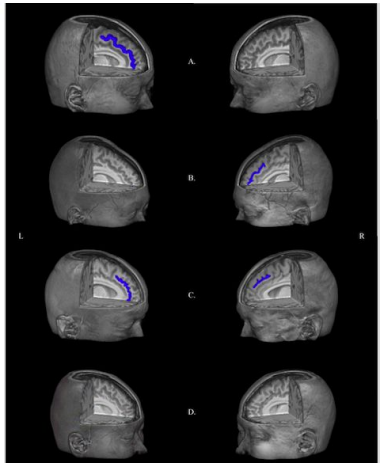

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Journal of Neurolinguistics

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

A diffusion model approach to analysing the bilingual advantage for the Flanker task: The role of attentional control processes

Gabriel Ong [a,*], David K. Sewell [a,c], Brendan Weekes [a,b], Meredith McKague [a], Jubin Abutalebi [d]

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Journal of Neurolinguistics 33 (2015) 3–13

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Journal of Neurolinguistics

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The neuroprotective effects of bilingualism upon the inferior parietal lobule: A Structural Neuroimaging Study in Aging Chinese Bilinguals

Jubin Abutalebi [a,b,*], Matteo Canini [b,c], Pasquale A. Della Rosa [c], David W. Green [d], Brendan S. Weekes [a]

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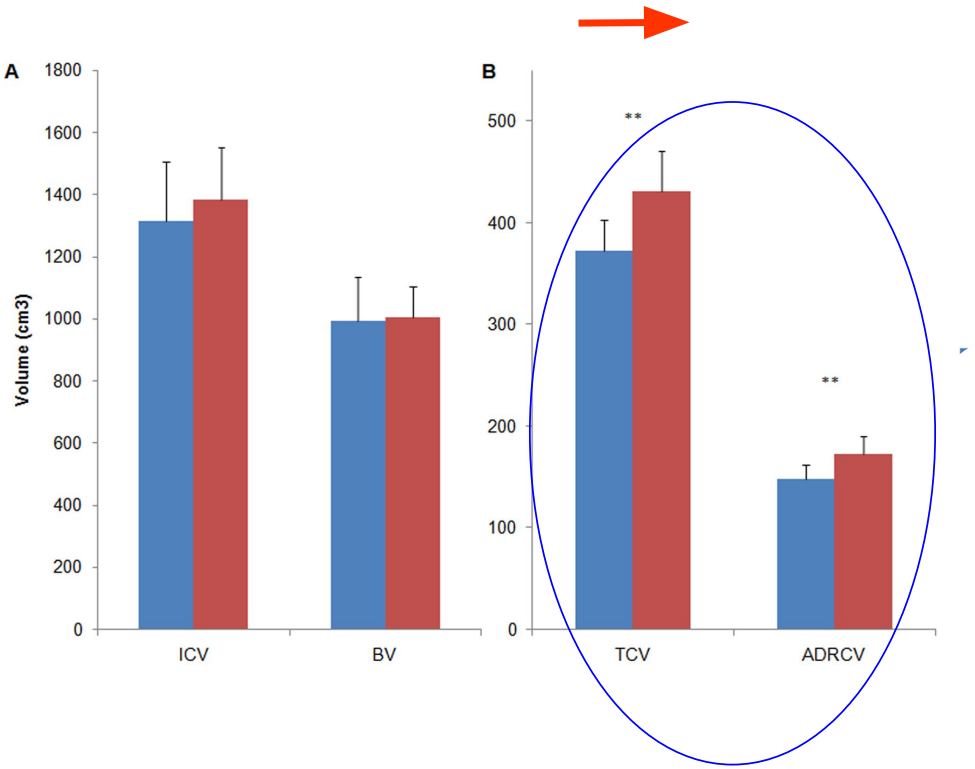
Summary

- Multilingual brains are different - why?
- Is multilingual language experience *really* an advantage?
- 'Zooming' attention amidst distracting information.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ICV
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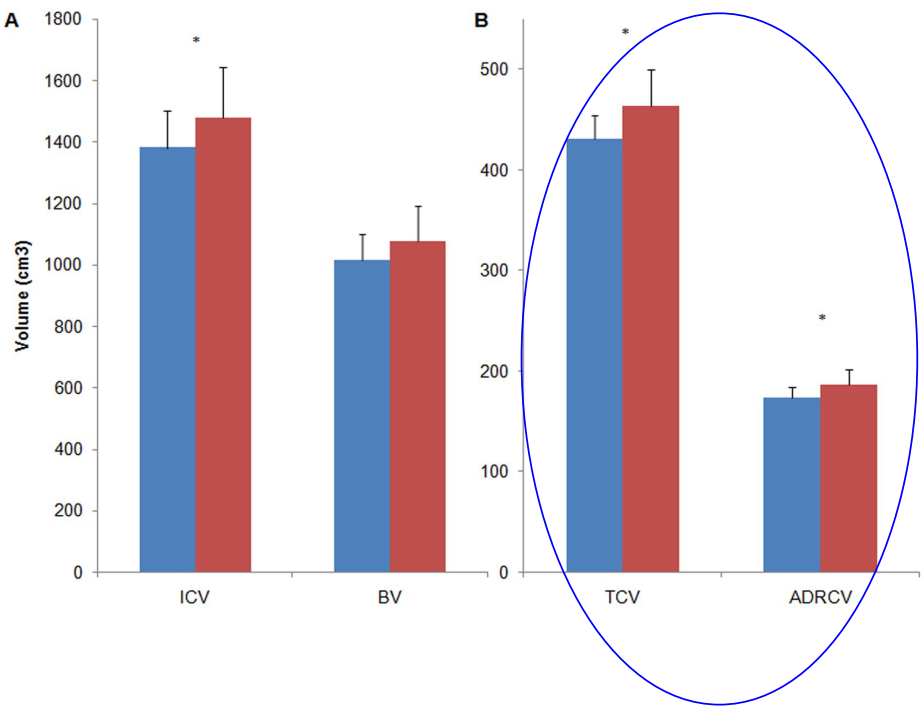
TCV
ADRCV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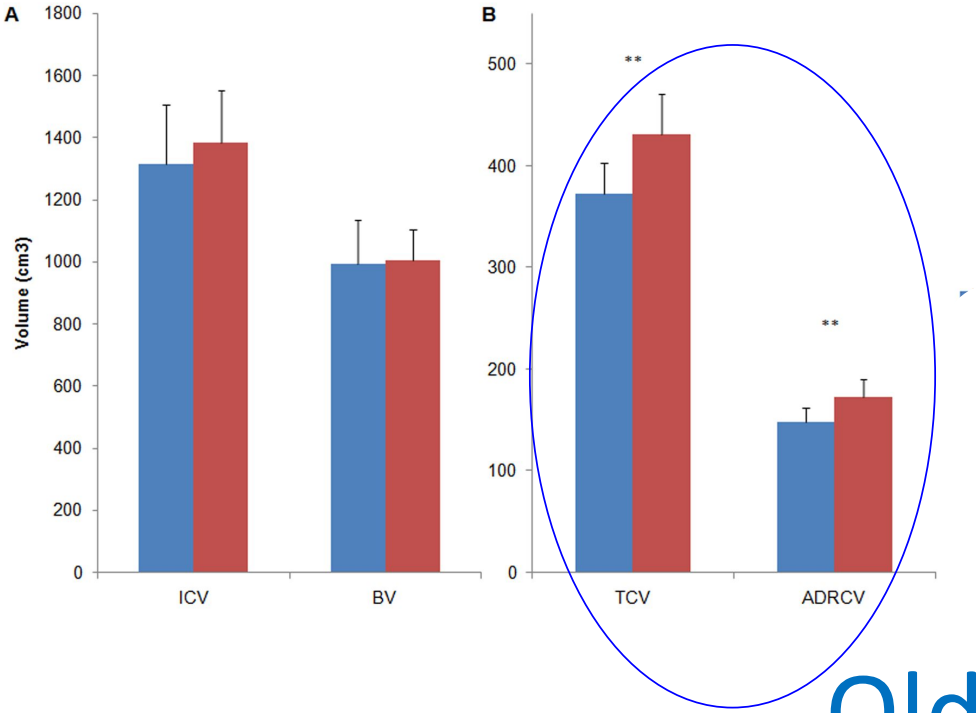
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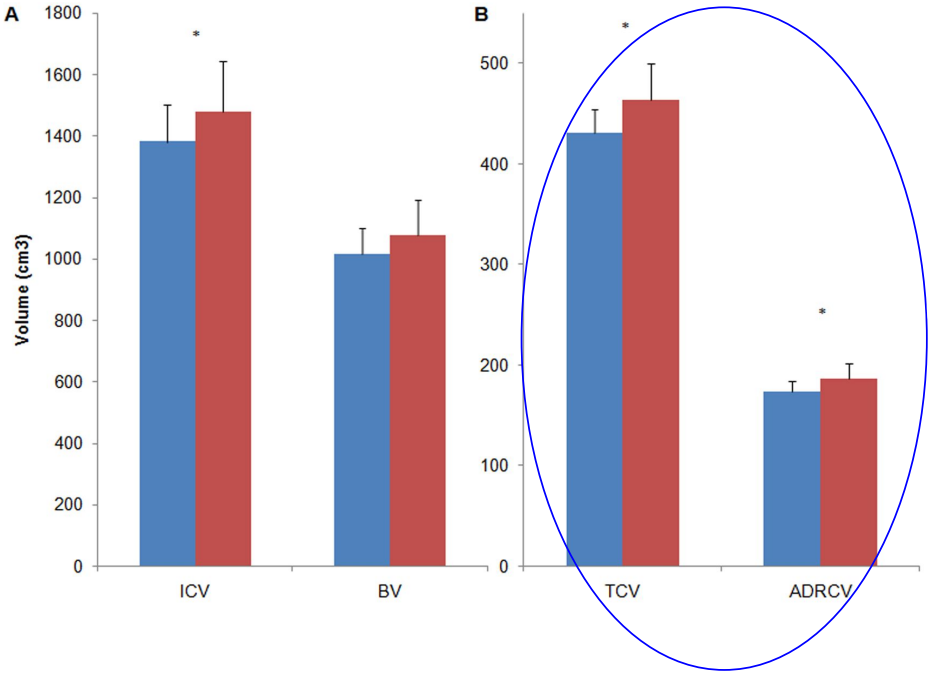
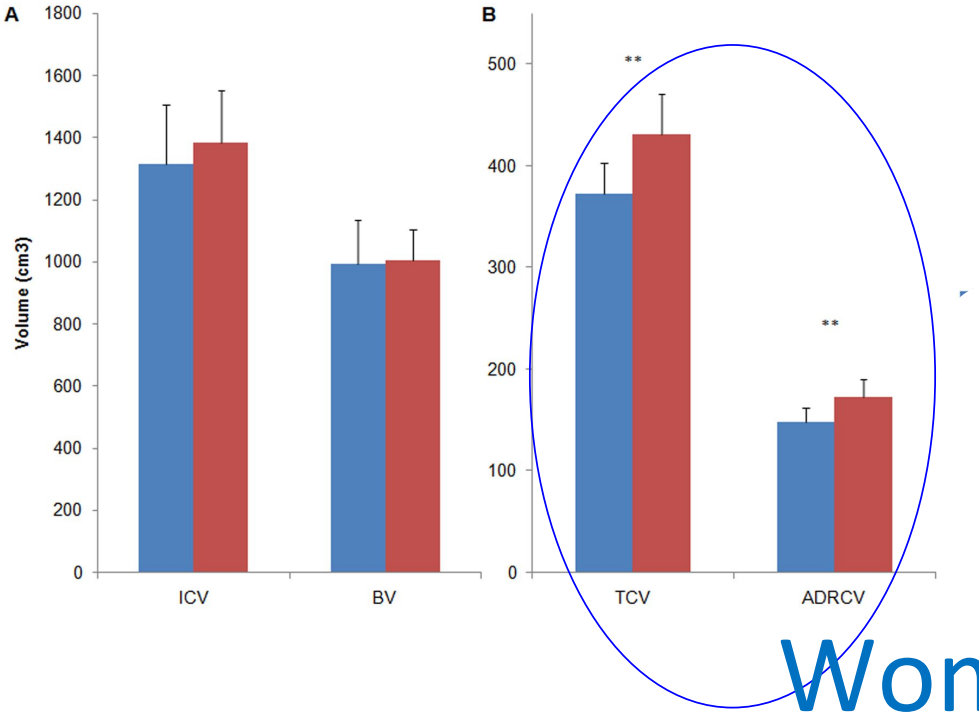
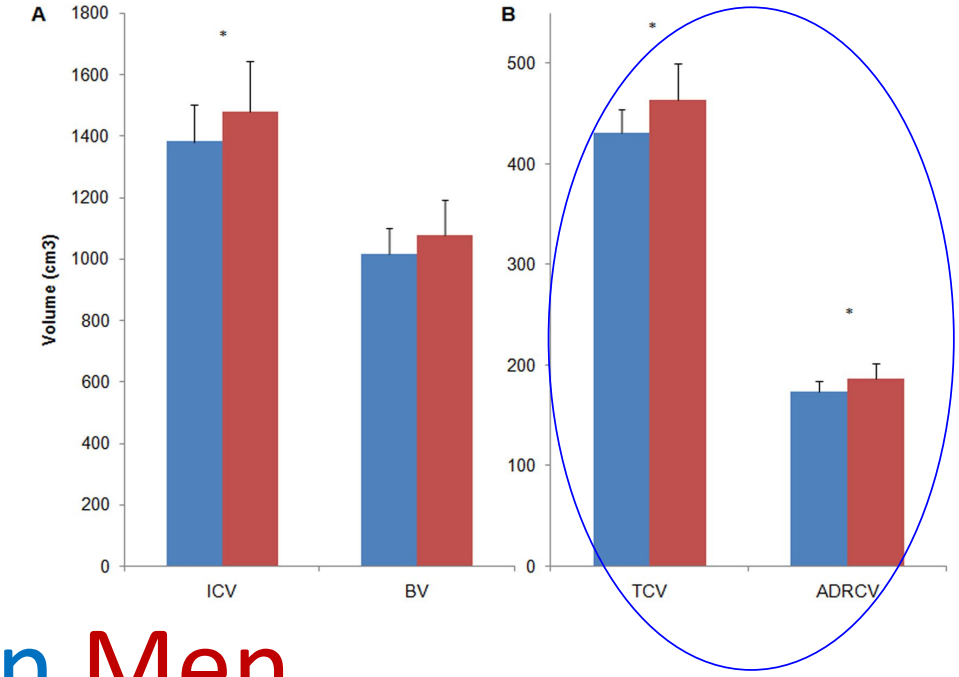
TCV
ADRCV

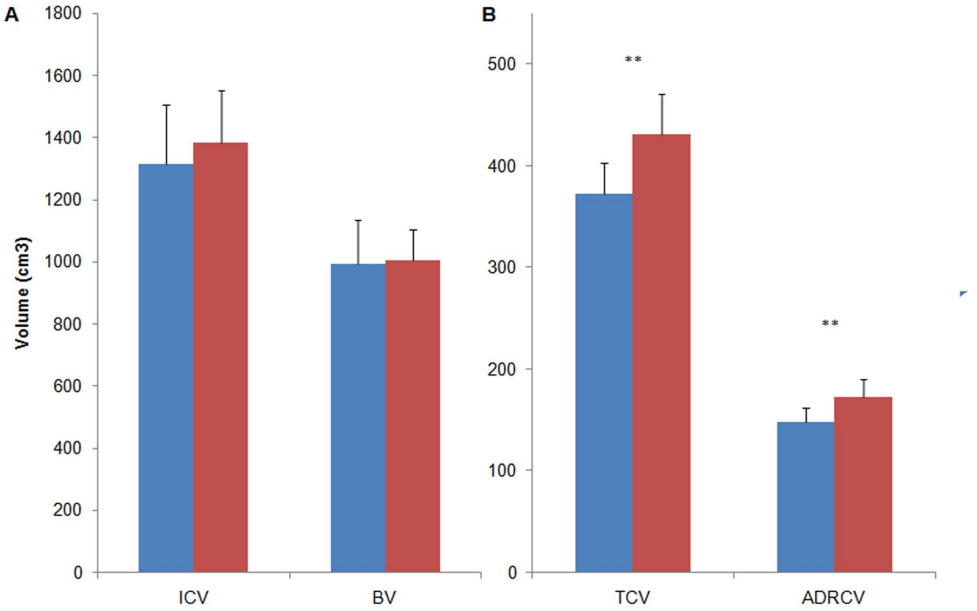

A
B
Volume (cm3)
1800
1600
1400
1200
1000
800
600
400
200
0
500
300
100
*
ICV
BV
TCV
ADRCV

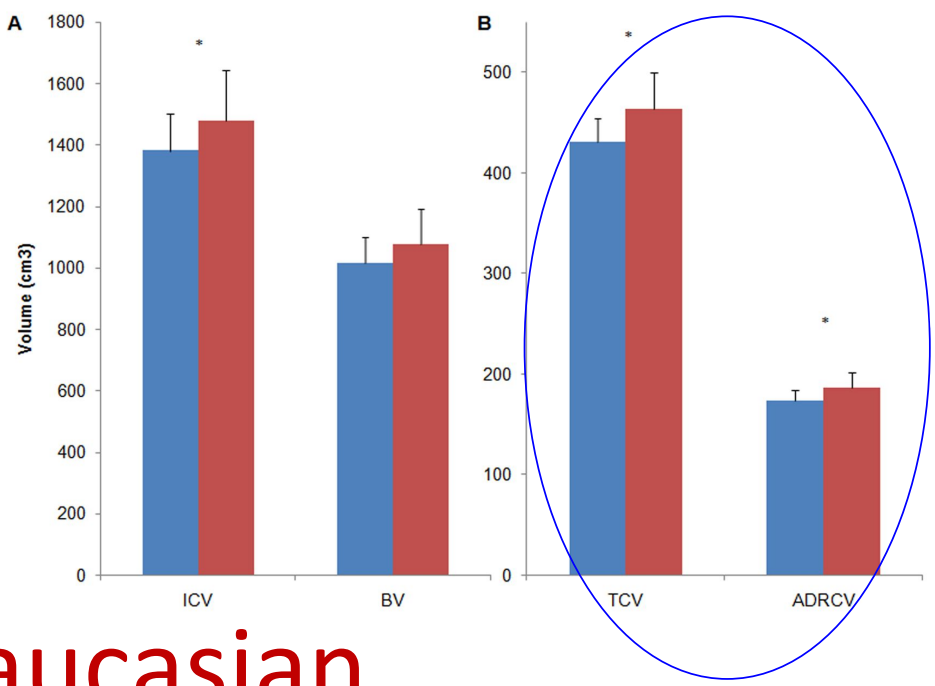
Old Young


A
B
Volume (cm3)
1800
1600
1400
1200
1000
800
600
400
200
0
500
300
100
**
**
ICV
BV
TCV
ADRCV

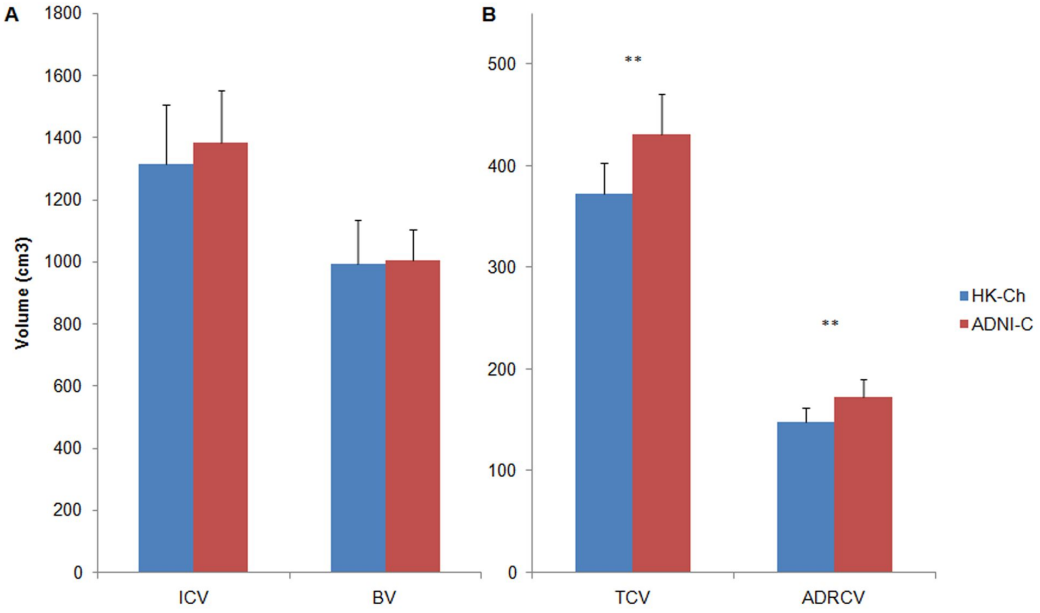

A
B
Volume (cm3)
1800
1600
1400
1200
1000
800
600
400
200
0
500
300
100
*
*
*
ICV
BV
TCV
ADRCV

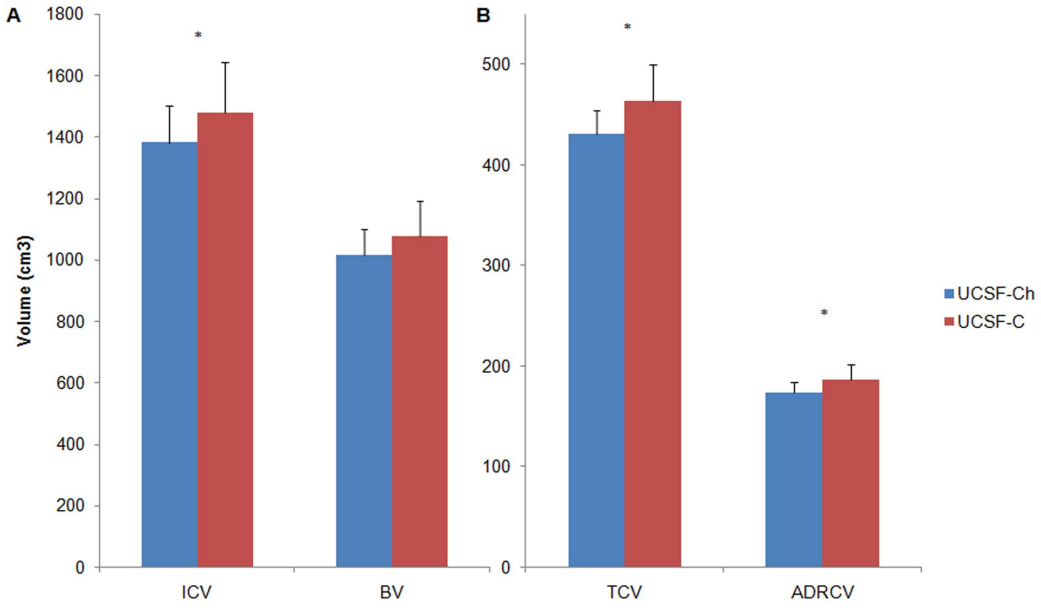
Women Men





Chinese Caucasian





Hong Kong ADNI

Chinese Caucasian

Alzheimer's Disease Neuroimaging Initiative (ADNI)

UCSD

Diffusion modelling (Ong et al. 2017)

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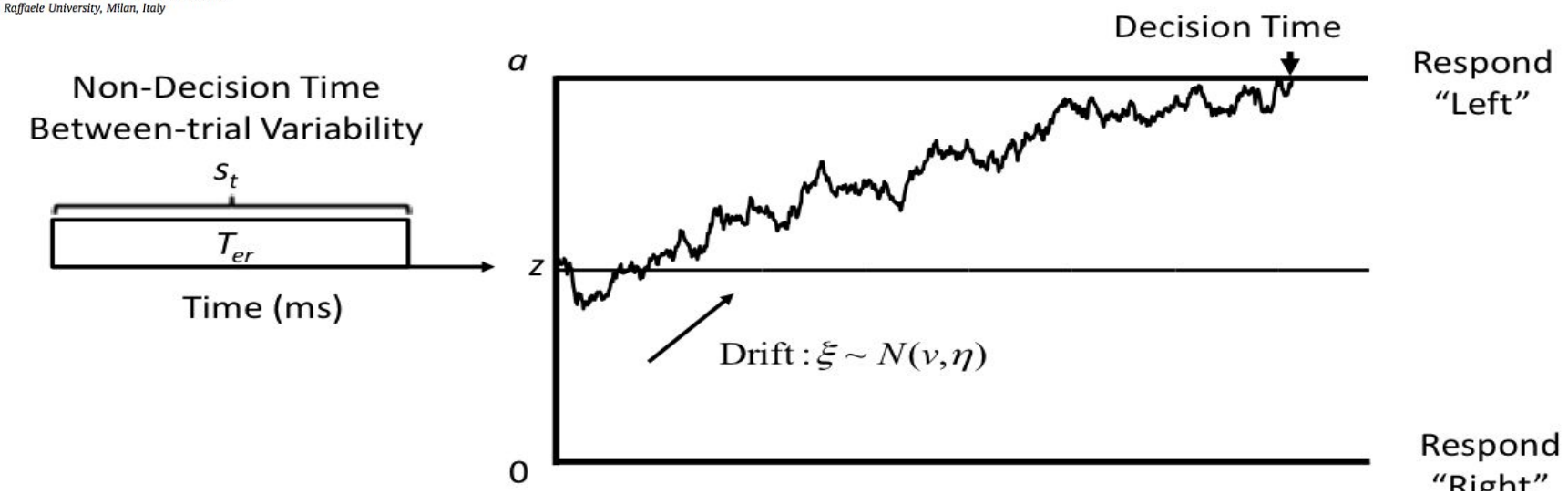
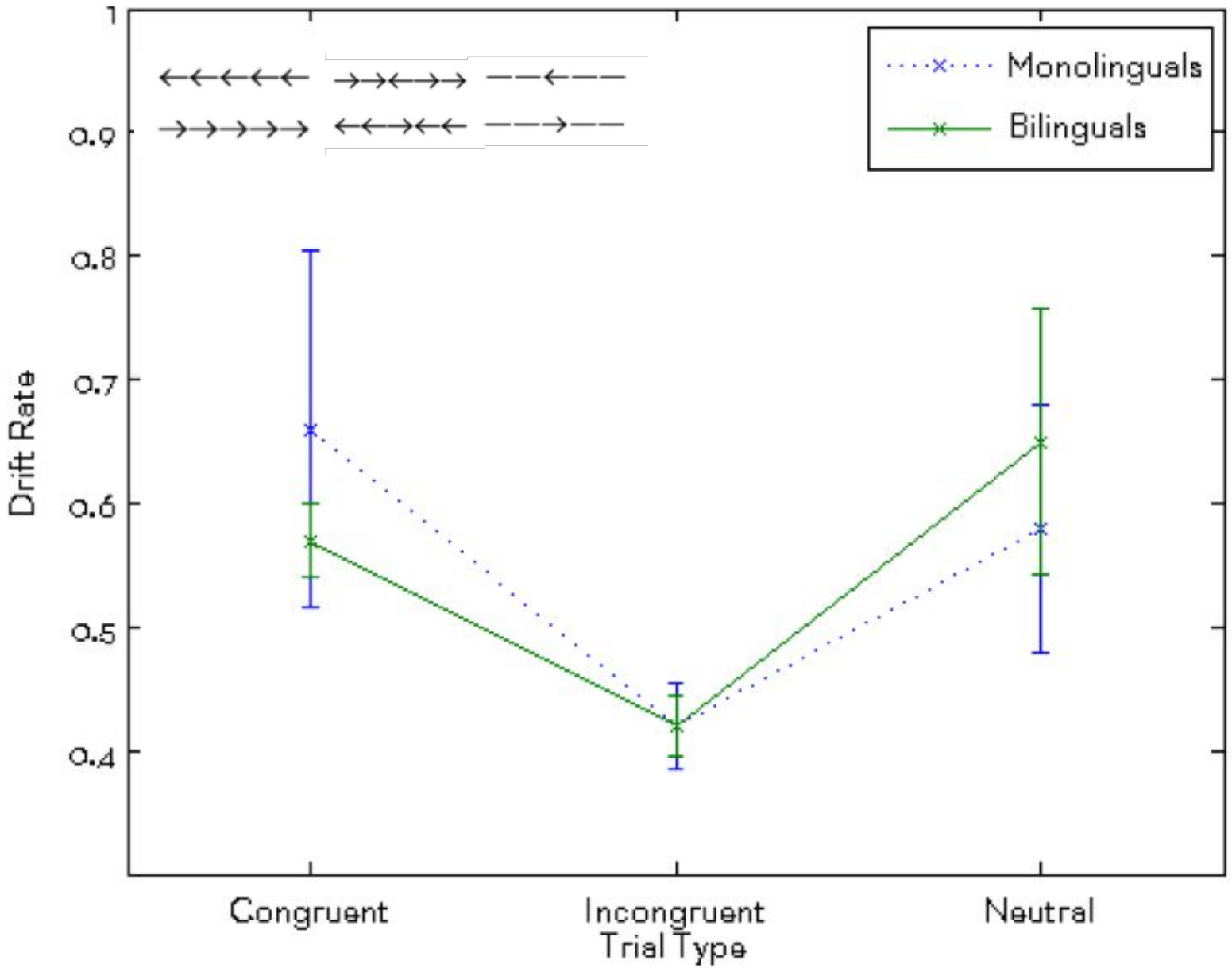
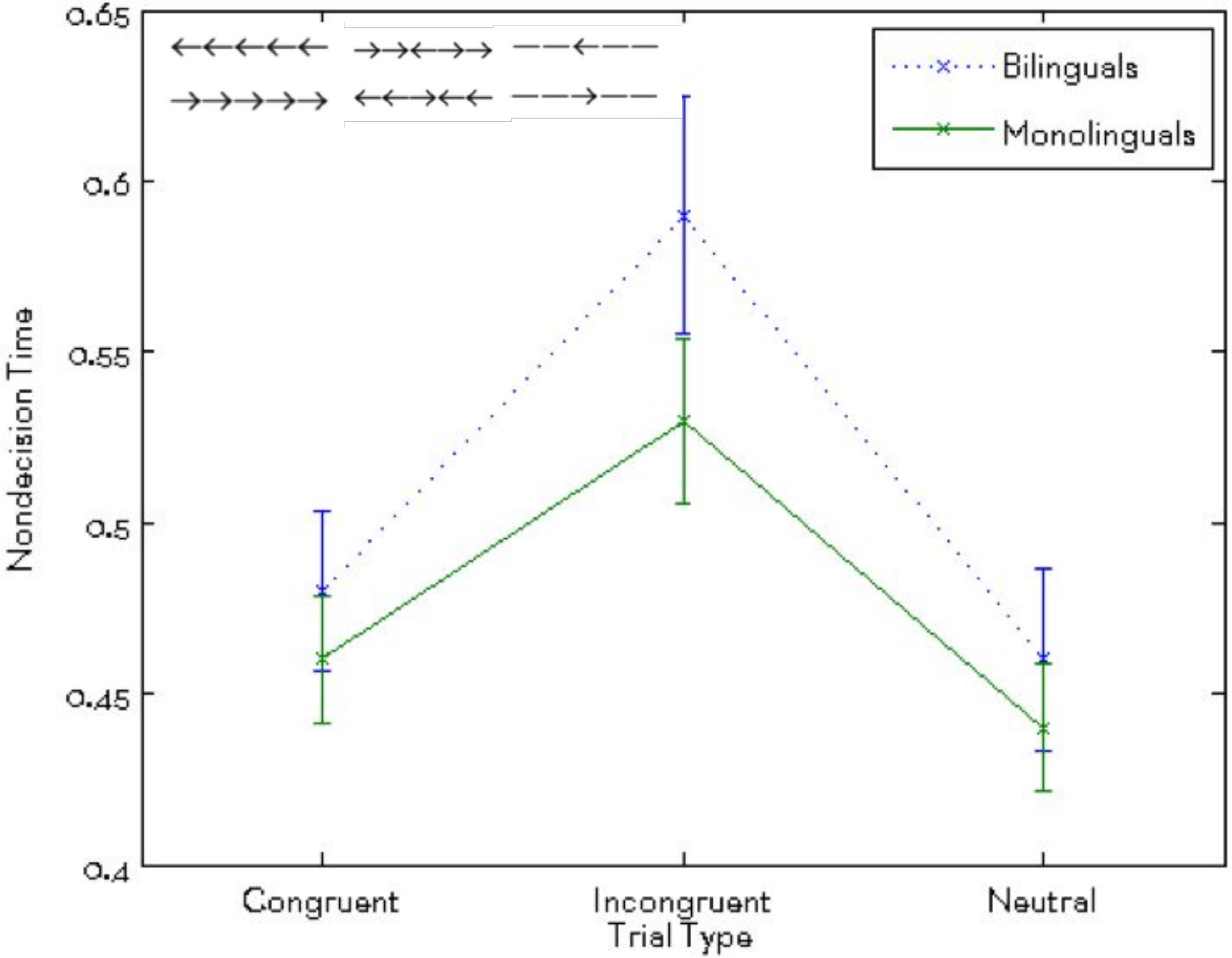
A diffusion model approach to analysing the bilingual advantage for the Flanker task: The role of attentional control processes

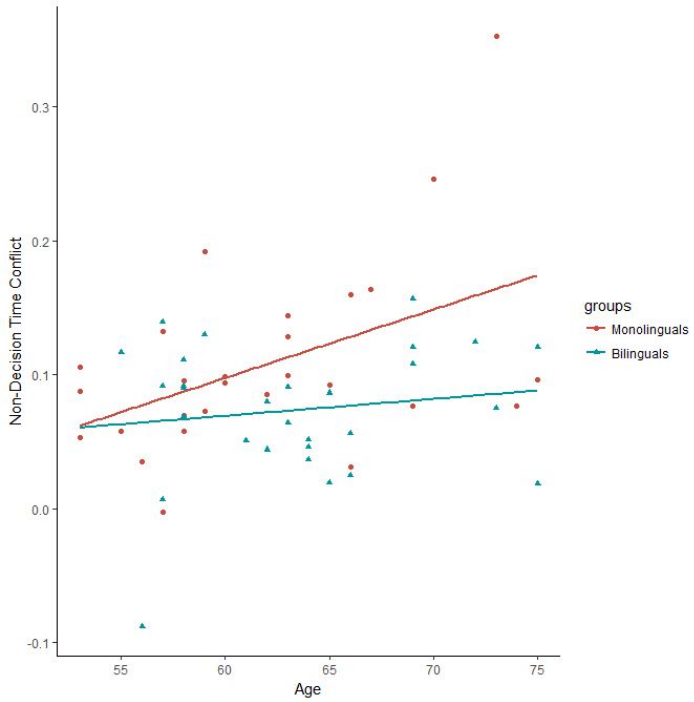
Gabriel Ong [a, *], David K. Sewell [a, c], Brendan Weekes [a, b], Meredith McKague [a], Jubin Abutalebi [d]

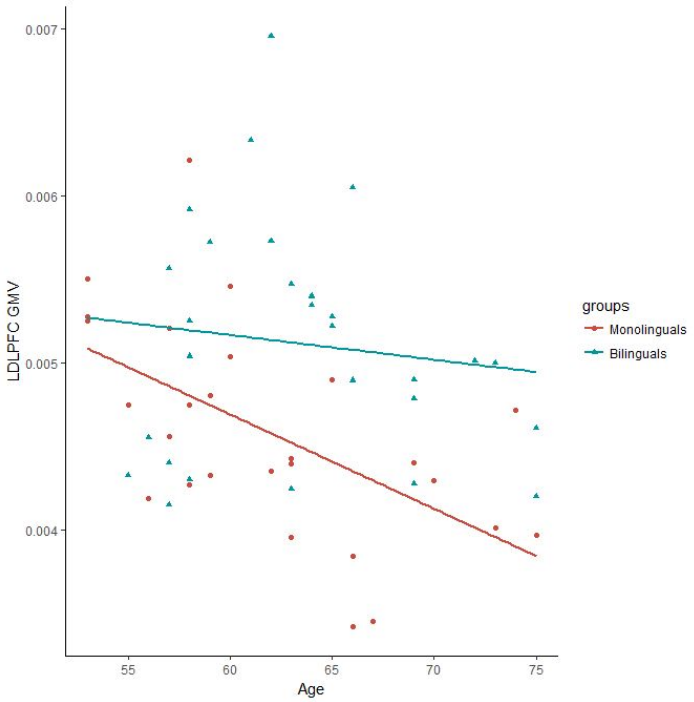
[a] University of Melbourne, Victoria, Australia
[b] University of Hong Kong, Hong Kong
[c] University of Queensland, Queensland, Australia
[d] San Raffaele University, Milan, Italy

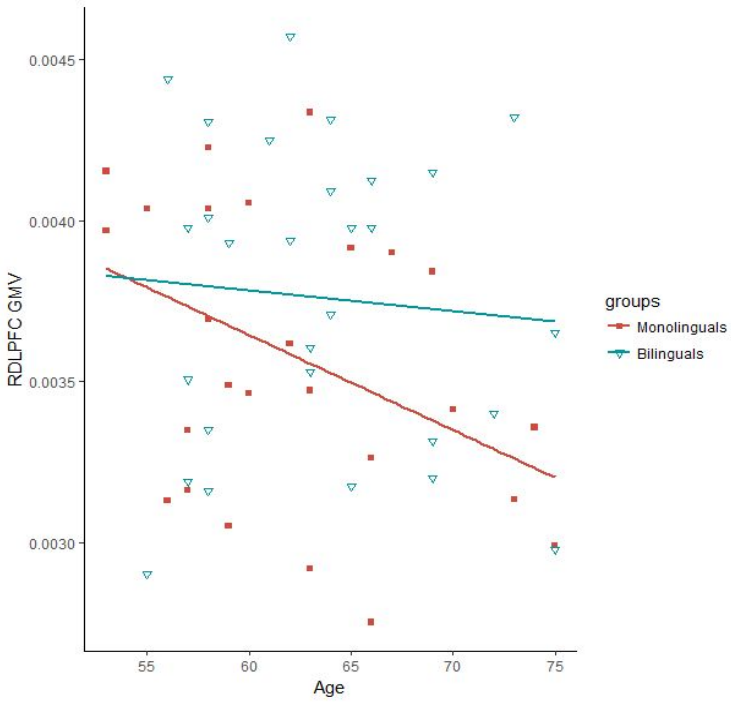


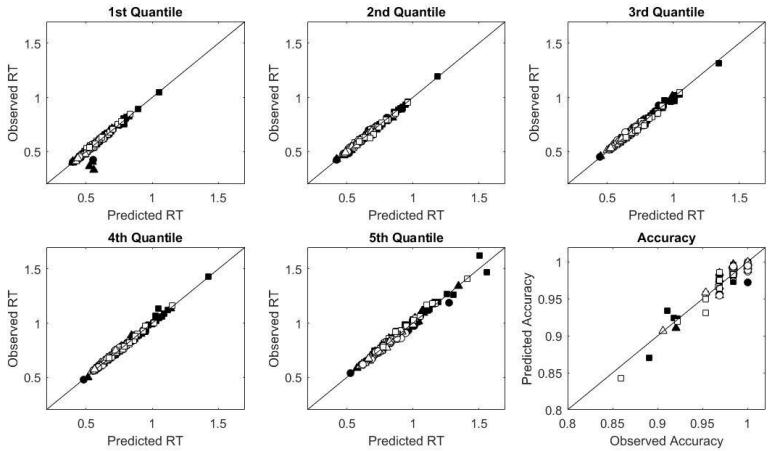

1
0.9
0.8
0.7
0.6
0.5
0.4
Drift Rate
Monolinguals
Bilinguals
Congruent
Incongruent
Neutral
Trial Type


0.65
0.6
0.55
0.5
0.45
0.4
Nondecision Time
Bilinguals
Monolinguals
Congruent
Incongruent
Neutral
Trial Type









Non-Decision Time Conflict

	Monolinguals	Bilinguals
L Caudate	-0.02916	-0.32234
R Caudate	-0.14629	-0.11705
L ACC	0.085286	-0.172
R ACC	0.125462	-0.17156
L DLPFC	-0.41714*	-0.05666
R DLPFC	-0.27678	-0.42127*

Summary

Diffusion Measure	Contrast	Structures
FA	ML >BL	Anterior Thalamic Radiation (Cummine et. al.) Right Inferior Fronto-Occipital Fasciculus Right Inferior Longitudinal Fasciculus
MD	BL > ML	Forceps Minor **Right Superior Longitudinal Fasciculus** Left Superior Longitudinal Fasciculus
RD	BL > ML	Forceps Minor **Right Superior Longitudinal Fasciculus** Inferior Longitudinal Fasciculus Anterior Thalamic Radiation
AD	BL > ML	Forceps Minor **Right Superior Longitudinal Fasciculus** Right Anterior Thalamic Radiation

Conclusion

- Multilingualism is not harmful for Hong Kong citizens.
- Multilingual speakers have a brain and cognitive reserve.
- 'Zooming' visual attention amidst distracting information.

Thank you

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Co-chair, The Enfranchisement Foundation
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Daniel Leeds is founder and president of the National Public Education Support Fund, which organizes the Education Funders Strategy Group, the Partnership for the Future of Learning, and the Education Justice Network. He chairs the Alliance for Excellent Education, which he helped found. In addition to these organizations, his extended family (the Leeds/Jobin-Leeds) launched the Schott Foundation for Public Education and the Institute for Student Achievement. Along with his wife Sunita, Dan co-chairs the Enfranchisement Foundation, which focuses on breaking the cycles of poverty and intolerance in the United States as well as on women's issues.