Bilingualism and dementia: The vulnerable second language

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Bilingualism and Cognition

- Cognitive advantage - Superior executive function & episodic memory.
- Disadvantages- smaller vocabulary, poorer performance on naming
- Cognitive Reserve - ? delays onset of dementia

Background

- >50% of the world's population is bilingual (*Grosjean 1994*). Bilingualism is widespread in India.

- Little is known about language deterioration in bilingual patients with dementia (*Costa et al 2012, Gollan et al 2010, Ardila and Ramos 2008, Mendez et al 2004*).

Language deterioration in dementia
Important Questions

- How does brain degeneration affect language representation & processing?

- Are language networks in a bilingual patient distinct or shared for different languages?

- What is the effect of proficiency & age of acquisition of language?

Cognitive Neurology Clinic, Bangalore: Our Observations

90% patients are BL, educated (>12yrs).

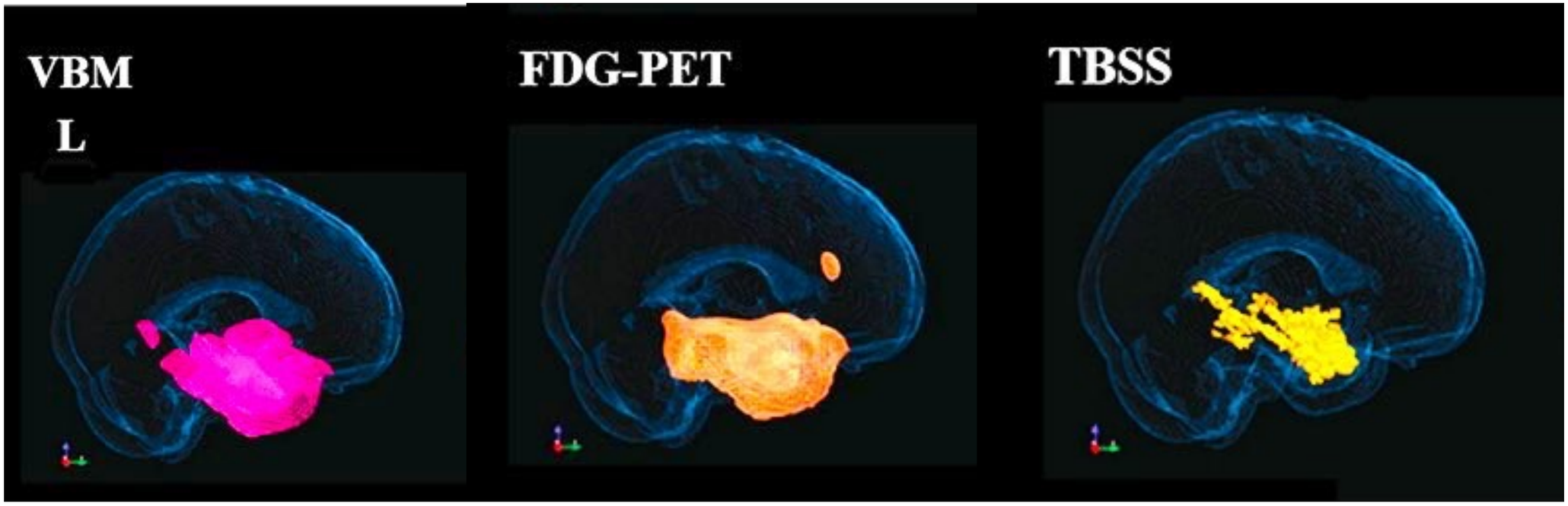
We have noted 2 patterns :

1. L1 ≈ L2 decline

2. L2 strikingly greater decline

Semantic Dementia

- Neuro-degenerative condition. Type of primary progressive aphasia.
- There is transmodal deterioration of semantic knowledge (word meaning, vocabulary, facts)
- But striking in language
- Asymmetric anterior and medial temporal lobe atrophy



Language deficits in SD - both expressive and receptive

What's this?

Picture naming

"It's a horse… but what are these funny things for?"

What's a caterpillar?

Definition

"I don't know… is it some kind of cat?"

What happens in bilingual patients with SD? And why interesting?

Representation/organisation of language in bi- (multi-) lingual brain

Phonology…Orthography…Syntax… Semantics?

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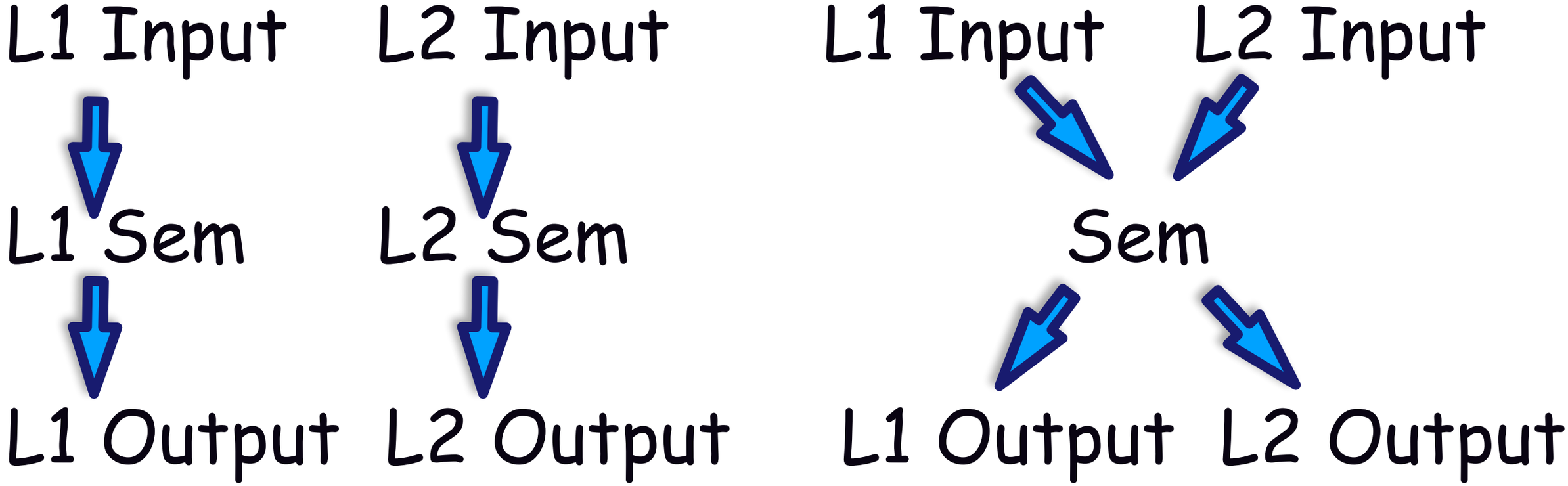


Objective

- To study the nature and severity of naming and comprehension deficits in patients with semantic dementia (SD) in bilinguals.
- To compare the patients' performance in L1 versus L2 on the same tests at the item-specific level.

Methods- Linguistic profile and Tests

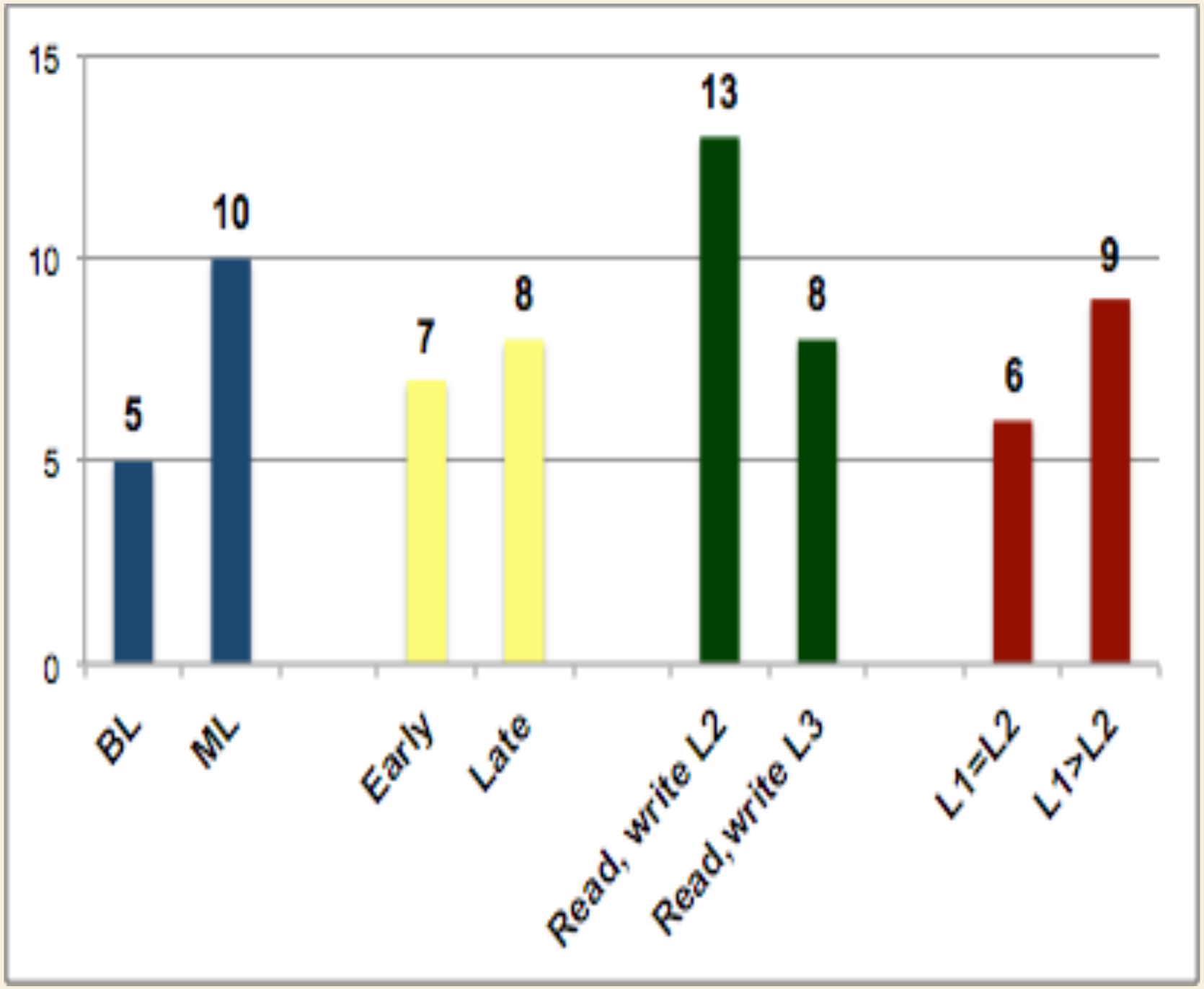
- Patient and 2 caregivers (family members) interviewed
- Assessment in most proficient language L1, NP testing and then in L2 or L3 (different days).
- **Languages - spoken, written, read**
- **Age of acquisition, medium of instruction in school**
- **Proficiency Rating** (self rating 0 to 7- L1, L2, L3)

- **modified Boston Naming Test (mBNT)** - 30 items
  (Adapted for South Indian population)
- **Cambridge Semantic Battery (CSB)**[*Adlam et al.,2010*]
  Naming and comprehension (word-picture matching)

Study Sample

- n=15 (10 men, 5 women)
- Mean age at diagnosis 66 (8.3) years
- All had typical cognitive and neuroimaging features of SD
- L1= Kannada, Telugu, Hindi, Bengali……
- L2= English, Kannada, Hindi, Tamil….
- All patients were using L2 daily socially or at work.
- 25 age matched healthy controls with similar L1 and L2

Linguistic profile of patients



Qualitative observations

- Many (13/15) could no longer converse in L2 in which they were fluent.
- Some could not even identify language that clinician or patient him-/her-self was speaking.

- SK, when spoken to in Kannada [her L2], replied “I cannot understand English”
- PN, when asked which language she was speaking, did not know.

SD- Illustrative Patients

VLK, F 62yrs, Illiterate. Housewife.

Languages: Telugu, Kannada CDR = 1

- Word finding difficulty and using generics e.g., ‘seeds’ for all pulses and ‘insect’ for all animals.
- Could not recognize spoken Kannada. Spoke to her in Kannada, her response …“I cannot understand English”!

VKT, M 58yrs, Graduate. Businessman.

Languages: Kannada, Hindi, English CDR = 1

- Presented with word finding difficulty and misnaming. Able to carry out most chores. Language skills in Hindi & English have declined significantly.

VKT- complaints

Video here

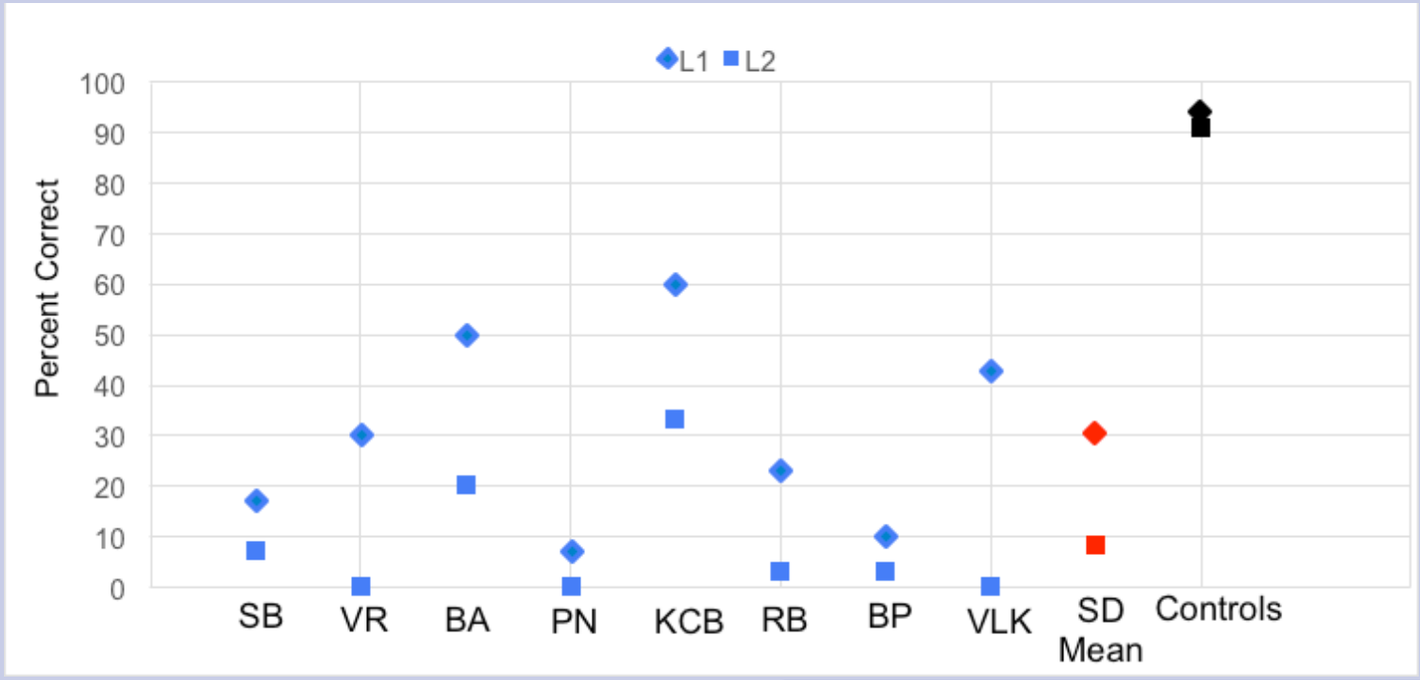
VKT- word-picture matching

Video here

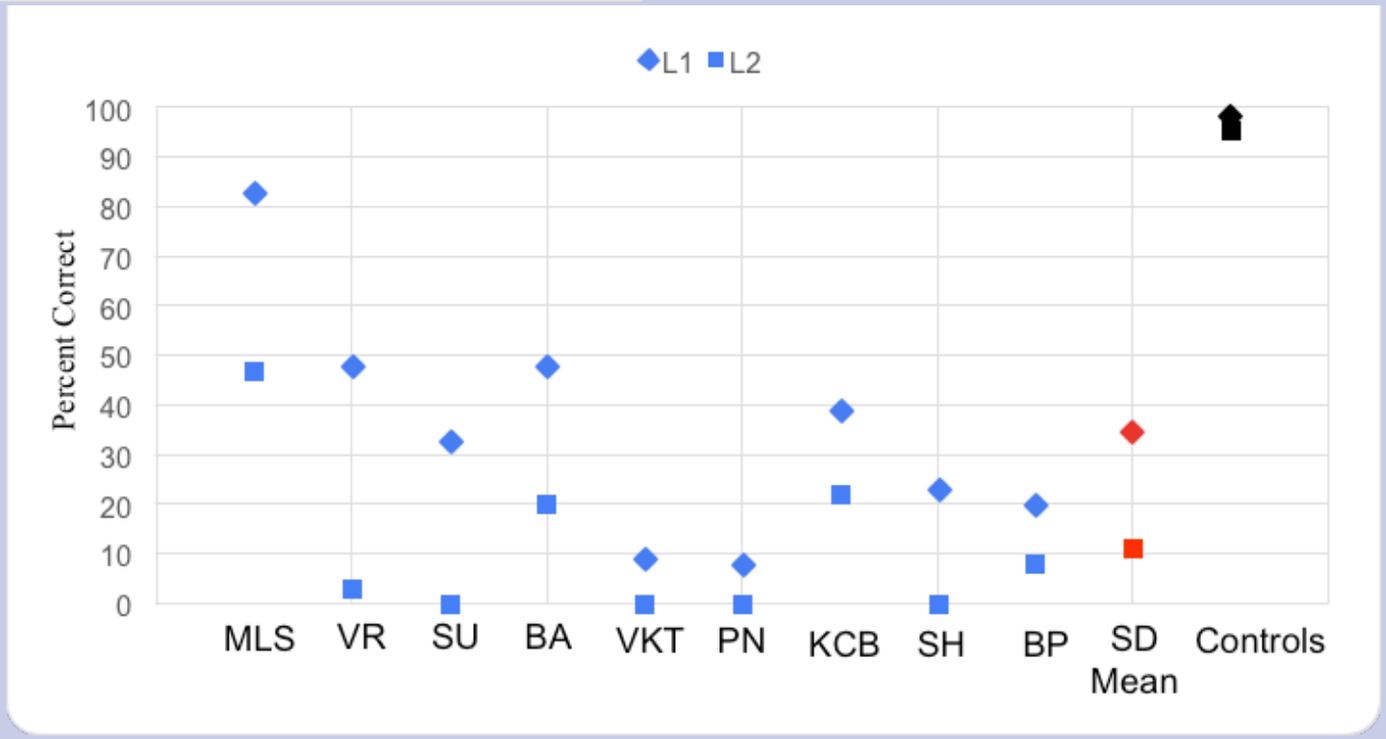
Patient	Naming (mBNT)-30 correct responses (%)		Naming (CSB)-64 correct responses (%)		W-P match -64 correct responses (%)	
	L1	L2	L1	L2	L1	L2
MLS			53 (83)	30 (47)	NA	41 (64)
KCB	18 (60)	10 (33)	25 (39)	14 (22)		
BA	15 (50)	6 (20)	31 (48)	13 (30)	49 (77)	20 (31)
VR	9 (30)	0	31 (48)	2 (3)	46 (72)	19 (30)
VLK	13 (43)	0				
SU			21 (33)	0	41 (64)	19 (30)
RB	7 (23)	1 (3)				
SH			15(23)	0	36 (56)	0
BP	3 (10)	1 (3)	13 (20)	5 (8)	45 (70)	20 (31)
VKT			6	0	22 (34)	0
SB	5 (17)	2 (7)				
PN	2 (7)	0	5 (8)	1 (2)	10 (16)	9 (14)
ADa	0	0	0	0	29 (45)	0
SR	0	0	0	0		
ADe	0	0	0	0		

Naming (% correct) performance in individual patients, SD patient group and controls, across L1 and L2

BNT



CSB



SD naming - errors

Typical pattern for SD: impaired [even in L1]
Errors: mainly “do not know”
Superordinate [goat – “animal”]
Coordinate [goat – “dog”]
Descriptive [saw – “to cut wood”]

SD coordinate errors [animals] often reflect size knowledge
English SD: elephant – “horse”; camel – “horse”
Indian SD: horse in L1 – “elephant”
horse in L2 – “camel”

The theoretically intriguing result

Naming
How often did a patient correctly name a picture in L2 but not in L1?
ONCE
KCB crocodile: L2 (English) L1 (Oriya) d/k

Comprehension (word-picture matching)
How often did a patient select the correct picture in L2 but not in L1?
NEVER

Summary of Results

Naming

- Controls $\bar{x}$ L1 94% L2 90% BNT
  $\bar{x}$ L1 98% L2 95% CSB
- Patients $\bar{x}$ L1 41% L2 13%

(For patients ≥20% correct in L1 on BNT or CSB)

No L2 score ever exceeded 57% of L1

Comprehension

- Controls $\bar{x}$ L1 99% L2 99% CSB
- Patients $\bar{x}$ L1 60% L2 17%

(For patients ≥20% correct in L1 on CSB)

No L2 score ever exceeded 46% of L1 on CSB.

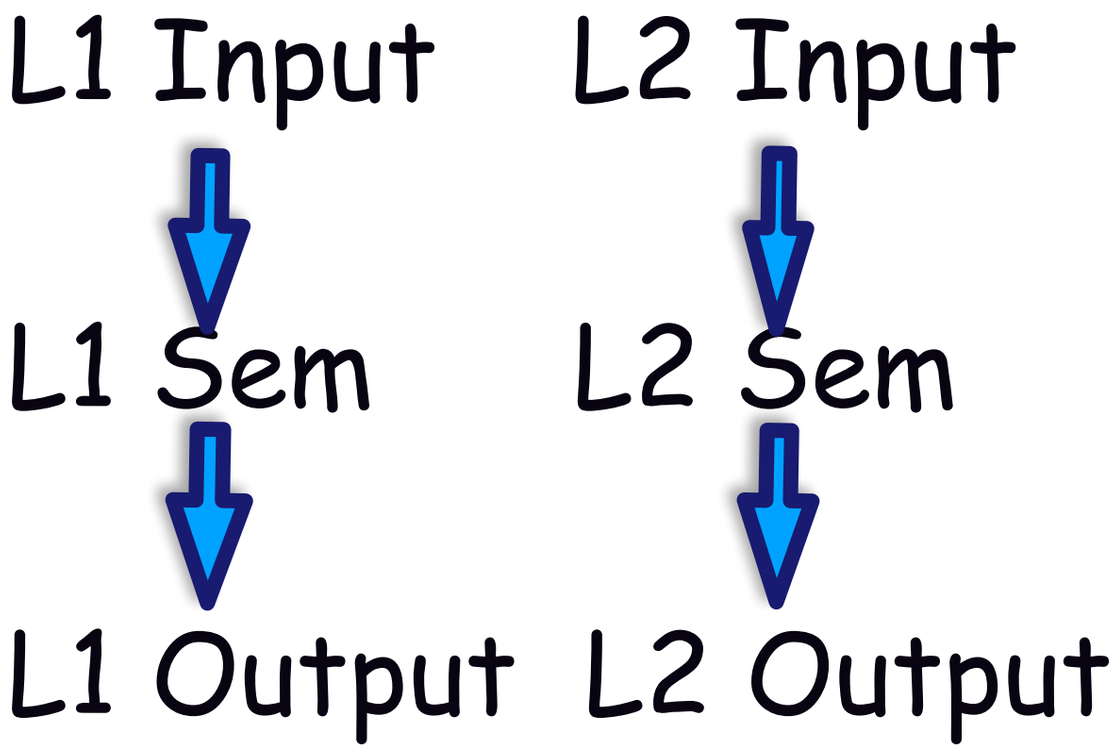
Interpretation of results

Crinion et al (Science 2006): lexical decision study of bilinguals

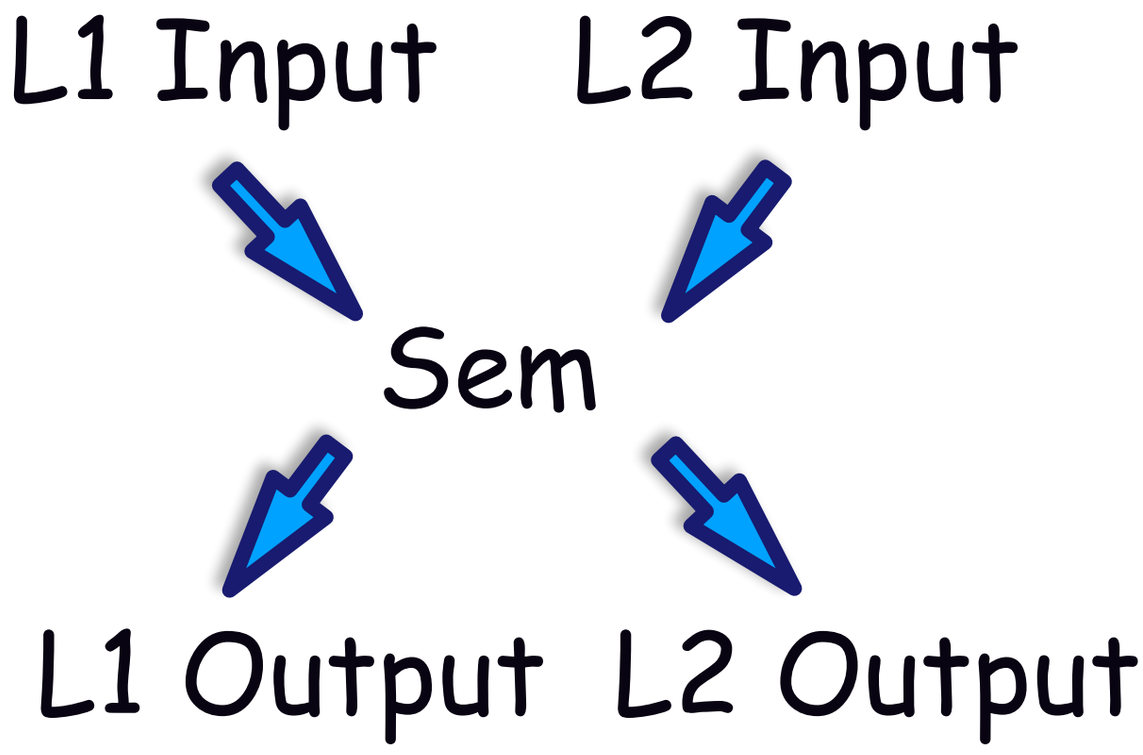
Same degree of semantic priming in both conditions: prime & target in different languages or when prime & target in same language

Neuronal signature of priming in Left rostroventral temporal lobe.

Which Model??



No

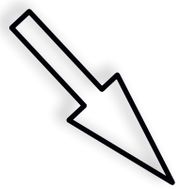


Yes, but not quite

L1 Input

L2 Input

Semantics



L1 Output

L2 Output

Only 1 semantic system

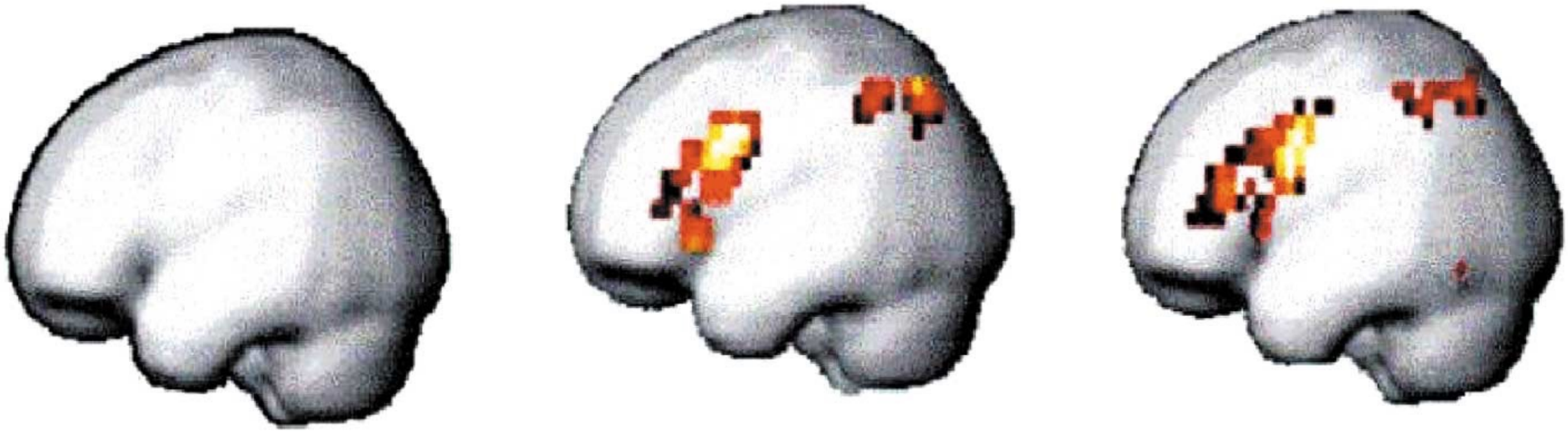
Connections between language representations [both input and output] and language-independent semantic representations stronger for L1 than L2
If semantic representation for GOAT intact enough that SD patient can name or comprehend “goat” in L1, then “goat” in L2 stands a chance if not, then it does not

Grammatical processing in Bilinguals

Early bilinguals

Late bilinguals, High L2 proficiency

Late bilinguals, Low L2 proficiency

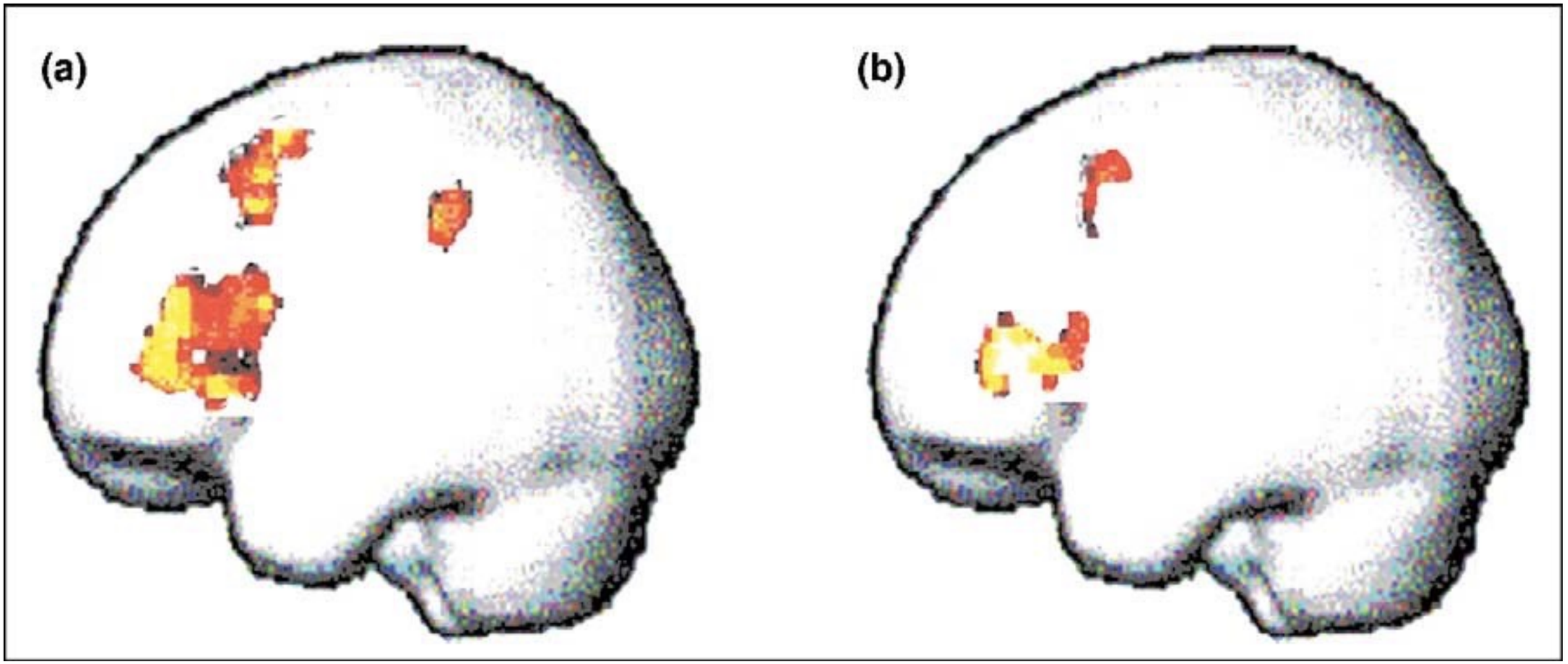


Brain activity during grammatical processing in L2 compared to L1 in 3 different groups of Italian-German bilinguals

- Early bilinguals engage the same neural structures for both L1 & L2.
- Late bilinguals with low or high L2 proficiency engage extended neural substrates in inferior frontal and parietal region for grammatical processing in L2

Wartenburger et al 2003

Lexical-semantic processing in Bilinguals



Catalans -L2 Spanish Vs L1 Catalan **Spaniards- L2 Catalan Vs L1 Spanish**

A reduced amount of left prefrontal activity is necessary for L2 word generation in Spaniards (b) in comparison with that in Catalans less exposed to Spanish (their L2), who activated a more extended network in the left hemisphere.

Perani et al 2003

Conclusions

- We found a dramatic loss of less proficient languages (L2, L3) in our bilingual SD patients. This was seen in both early and late bilinguals, literate and illiterate, equal or different proficiency and language types [similar languages (both Dravidian) or different languages (Dravidian and Indo-Aryan or Dravidian and English)].

- Less proficient languages appear more vulnerable to degeneration. Our results support a common semantic system for different languages.

Part II- other dementias

Objective

- Characterize the language profiles in bilingual patients with mild cognitive impairment (MCI), Alzheimer's disease (AD), behavioural variant Frontotemporal Dementia (bvFTD).

- Compare decline across L1/L2.

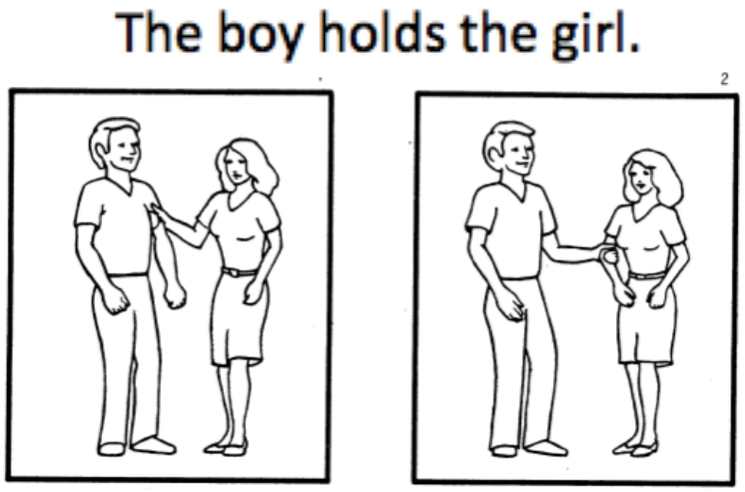
- Relate decline in L1/L2 to degree of language proficiency.

Patients

- Written informed consent & EC approval.
- Performa - demographics, risk factors & language data
- Detailed clinical evaluation
- Neuropsychological tests
- Neuroimaging
- Diagnosis
- MCI *(Petersen et al 2010)* bvFTD (*Rascovsky et al 2011)*
- AD (*Dubois et al 2007)* SD*(Gorno-Tempini et al 2011)*
- Healthy Controls

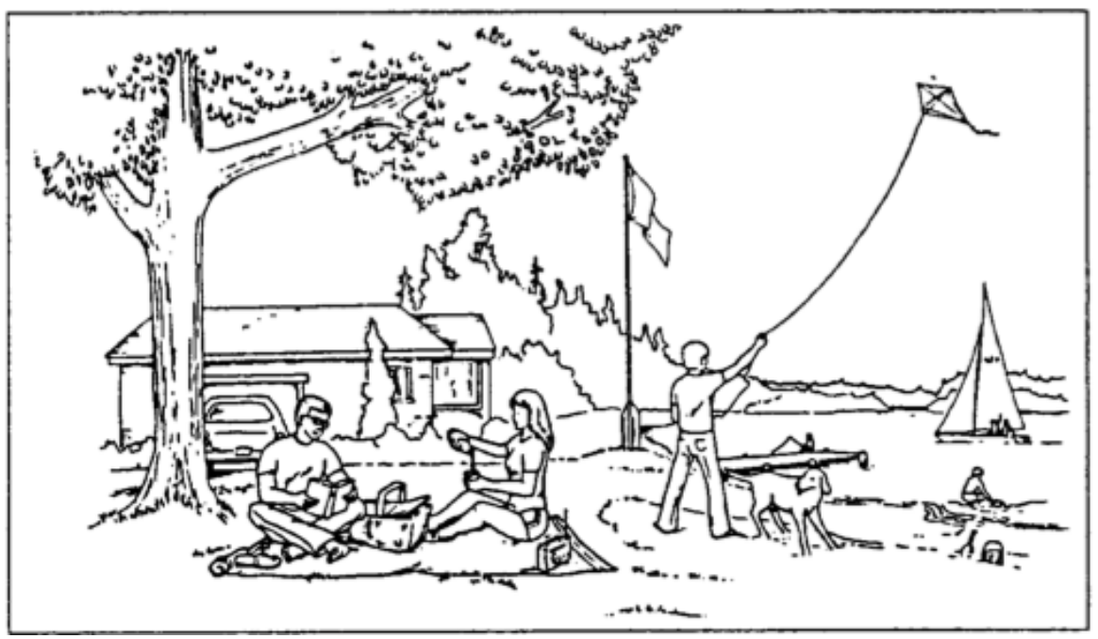
Multilingual tests

BAT(*Paradis & Libben, 1998*) - syntactic comprehension, reading tasks (versions in Hindi, Tamil and Kannada).



Verbal fluency – phonemic (FAS/ka,ma,pa) category (animals)

Picture description task from the WAB –
Indian versions – (*Karanth et al 1989*)



Statistical Analyses

- To assess deficits (Patients vs Controls): *Descriptive statistics and 1-way ANOVA*
- To assess effects of language (L1 vs. L2) across different diseases on measures of naming, fluency, syntactic comprehension and reading: *Repeated measures ANOVA*

Diagnosis Alzheimer's disease

MC, M 68yrs, Postgraduate. Businessman.

Languages: Guajarati, Hindi, English CDR - 1

Presented with memory complaints - forgetting recent events, names of people, misplacing things. Independent for daily activities. He does not talk in other languages and prefers to converse in Gujarati. Family reported increased spelling errors in English.

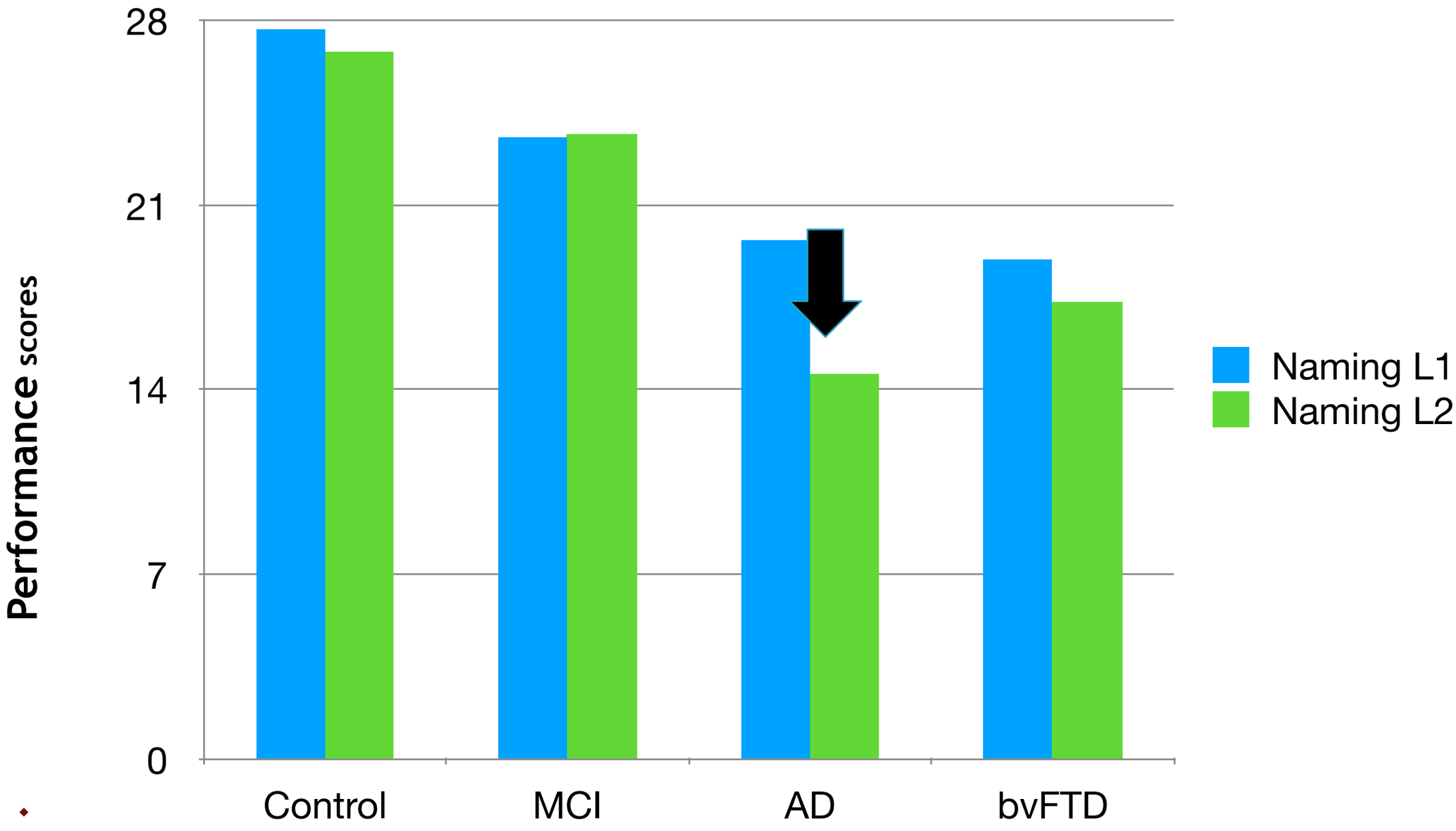
Part II-Results- Participant Characteristics

Group	Controls(41)	MCI (21)	AD (30)	bvFTD (21)	F
Age yrs Mean (SD)	72.7 (6.9)	70.7 (8.0)	76.0 (7.5)*	69.4 (10.0)	3.6 (p=0.02)
Education yrs Mean (SD)	15 (3.6)	12.6 (4.9)	13.2 (3.65)	13.8 (2.5)	1.9 (p=0.12)
ACE III Mean (SD)	94.9 (3.9)	82.7 (9.4) **	55.6 (19.9) **	73.6 (17.8) **	39.9 (p=0.00)
CDR Mean (SD)	0 (0)	0.5 (0.5)**	0.9 (0.5)**	1.04 (0.8)**	21.1 (p=0.00)
Self rating L1	6.9 (0.3)	6.9 (0.3)	6.6 (1.6)	7 (0)	0.6 (0.6)
Self rating L2	5.8 (1.5)	5.8 (2.0)	5.9 (0.7)	5.1 (2.1)	0.4 (0.9)

*** Significant difference from controls, MCI and bvFTD at 0.05 level**

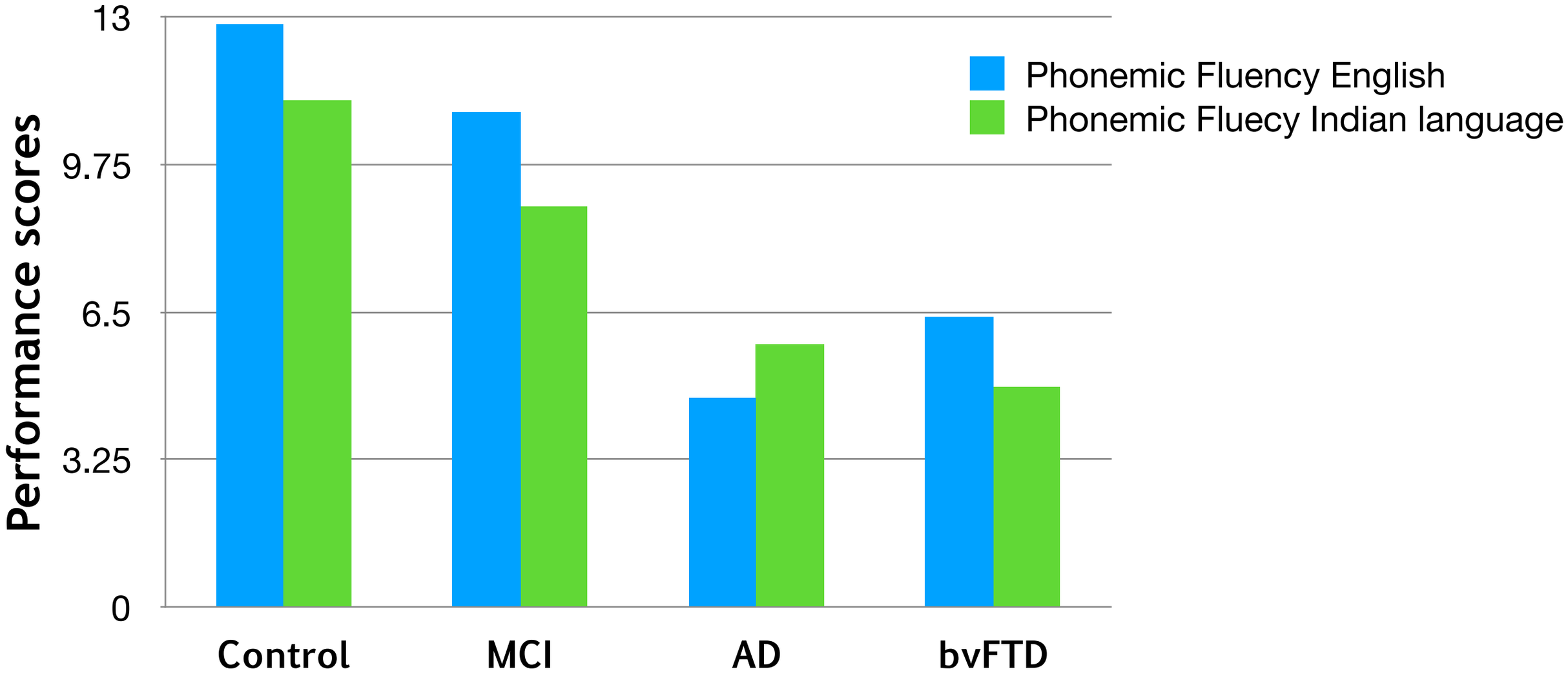
**** significant difference from controls and MCI at 0.01level**

Naming in L1 and L2 on BNT



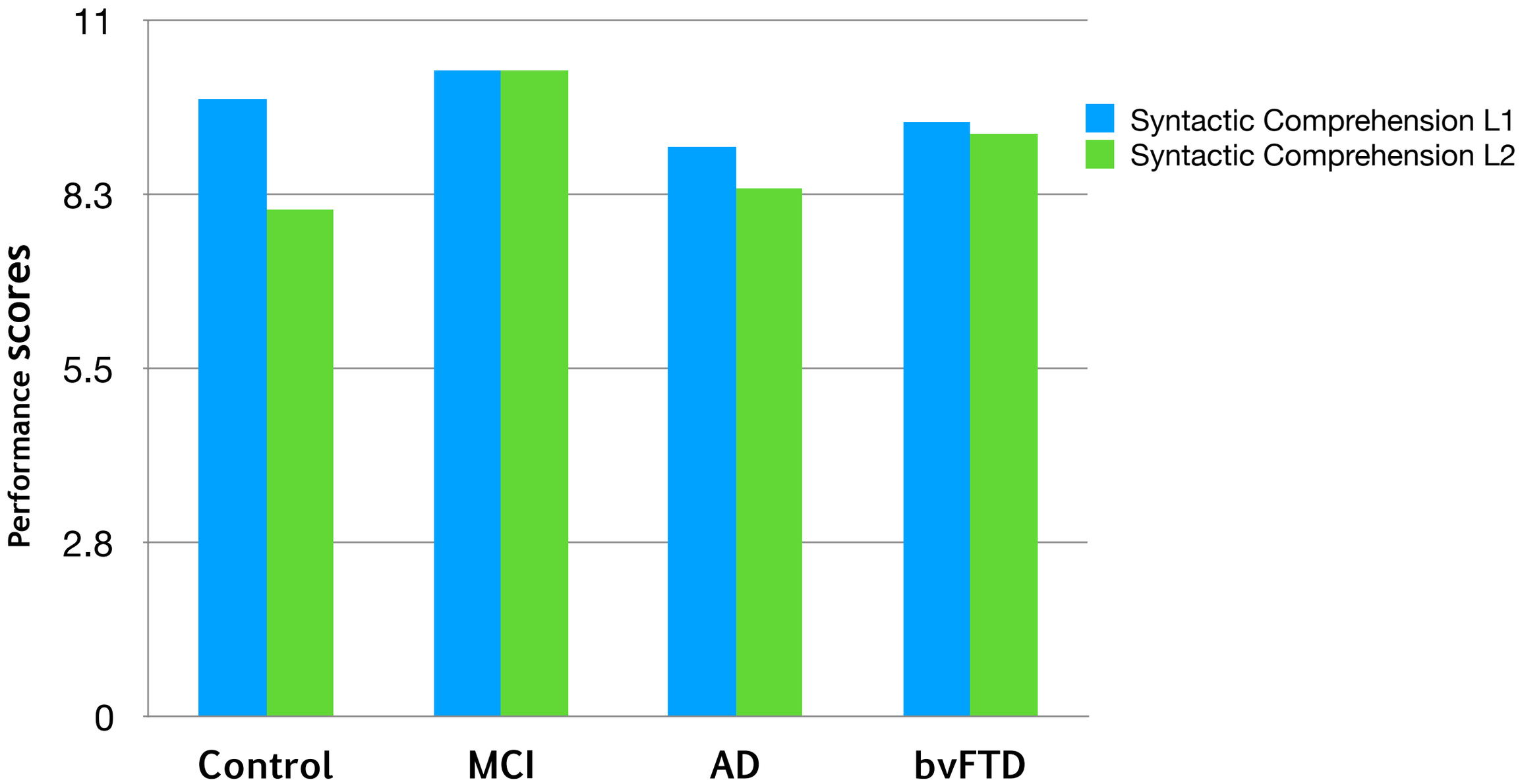
Repeated measures ANOVA controlling for age indicated a significant interaction effect between diagnosis and naming in the two languages

Phonemic fluency performance in English and Indian Languages



Repeated measures ANOVA controlling for age indicated a near significant interaction effect (0.08) between diagnosis and naming in the two languages

Syntactic Comprehension in L1 and L2



Repeated measures ANOVA – no significant differences

Summary of Results II

- Naming in two languages:

  L1 = L2 in MCI and controls

  L1 >> L2 in AD

  L1 > L2 (not significant) in FTD

- Phonemic fluency task:

  Controls, MCI, bvFTD

  English > Indian languages (even if less proficient in English)

  Reverse in AD

- No significant differences on the other language measures

Verbal Fluency in Multilinguals: The dynamic interplay of Language and Education on the verbal fluency task
Jwala Narayanan, Shivani Malik, Nidhi Dev and Ellajosyula Ratnavalli – Manuscript submitted

Conclusions

- Later learned languages -- like later learned vocabulary -- more vulnerable

[Ellis & Lambon Ralph, 2000, JEP:LMC]

- Further studies are required on larger samples using specific language tasks and MRI correlations

Acknowledgments

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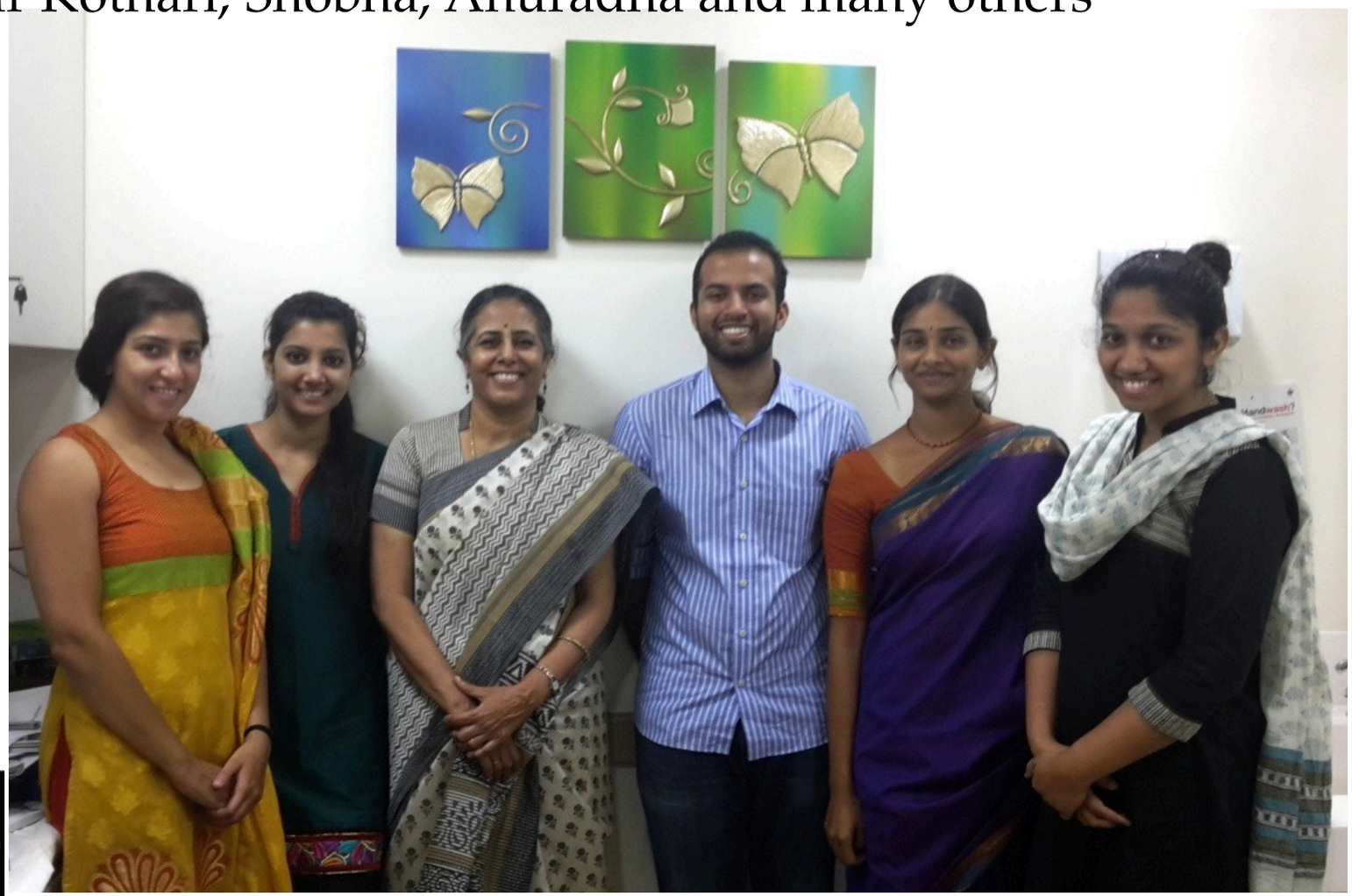

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