Effect of Early Language Education on Students' Academic Performance: POMNATHS case study

Presentation @ the SHSS UPNG Seminar

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Outline:

Introduction

Status quo:

- Dropping standards of students' academic performance in schools & universities worry teachers, parents, government
- Threat to national socio-economic development

Research Purpose:

- Understand the **causes** of the decline, in order to
- Help shape effective language education strategies

Critical Period Hypothesis

- In developmental psychology:
  - a maturational stage in the lifespan of an organism during which the nervous system is especially sensitive to certain environmental stimuli (vision, hearing, vestibular, etc.)

  - Also relates to human ability to acquire first language

- States that the ability to acquire language is biologically linked to age
  - First proposed by neurologists Penfield & Roberts (1959)

  - Popularized by linguist Eric Lenneberg (1967)

- Debate on CPH effects extending to SLA

In the multilingual society of
Papua New Guinea, where
English is the **language of education**
at primary, secondary and tertiary levels,
**RESOLVING THIS ISSUE IS
IMPERATIVE
FOR NATIONAL DEVELOPMENT.**

To understand how/why SLA outcomes are affected, we must look at the

MECHANISM OF LEARNING

Neurobiological basis for all learning (including language acquisition) - **connections** between neurons (networking)
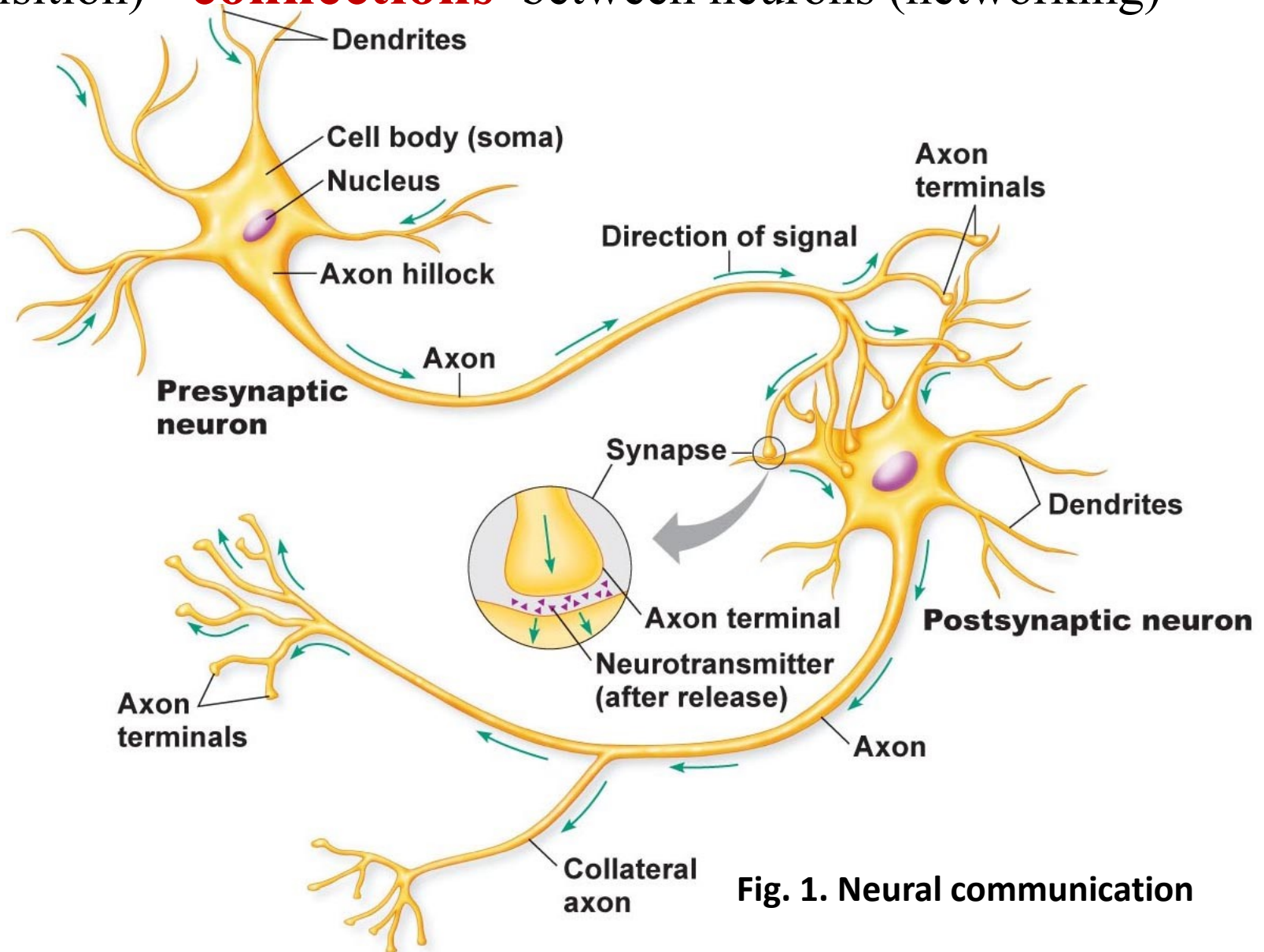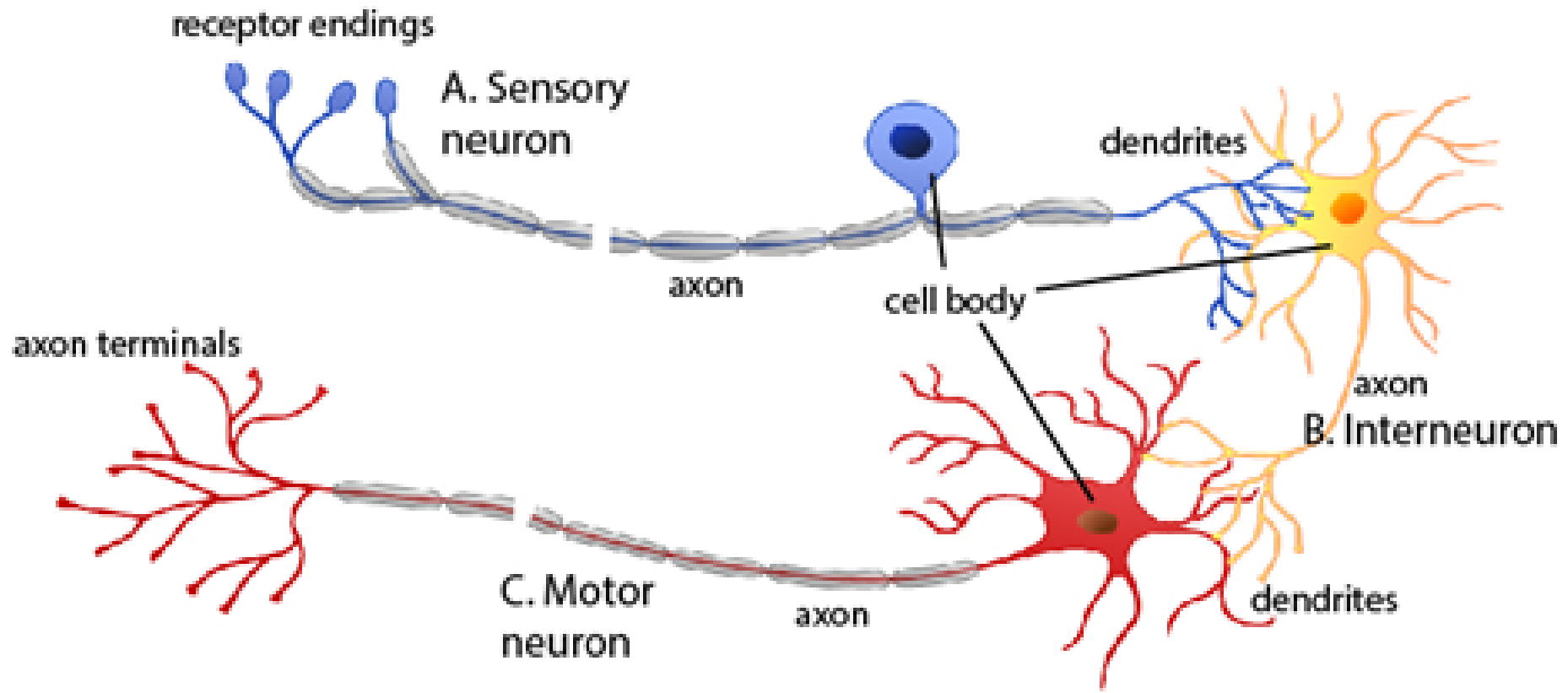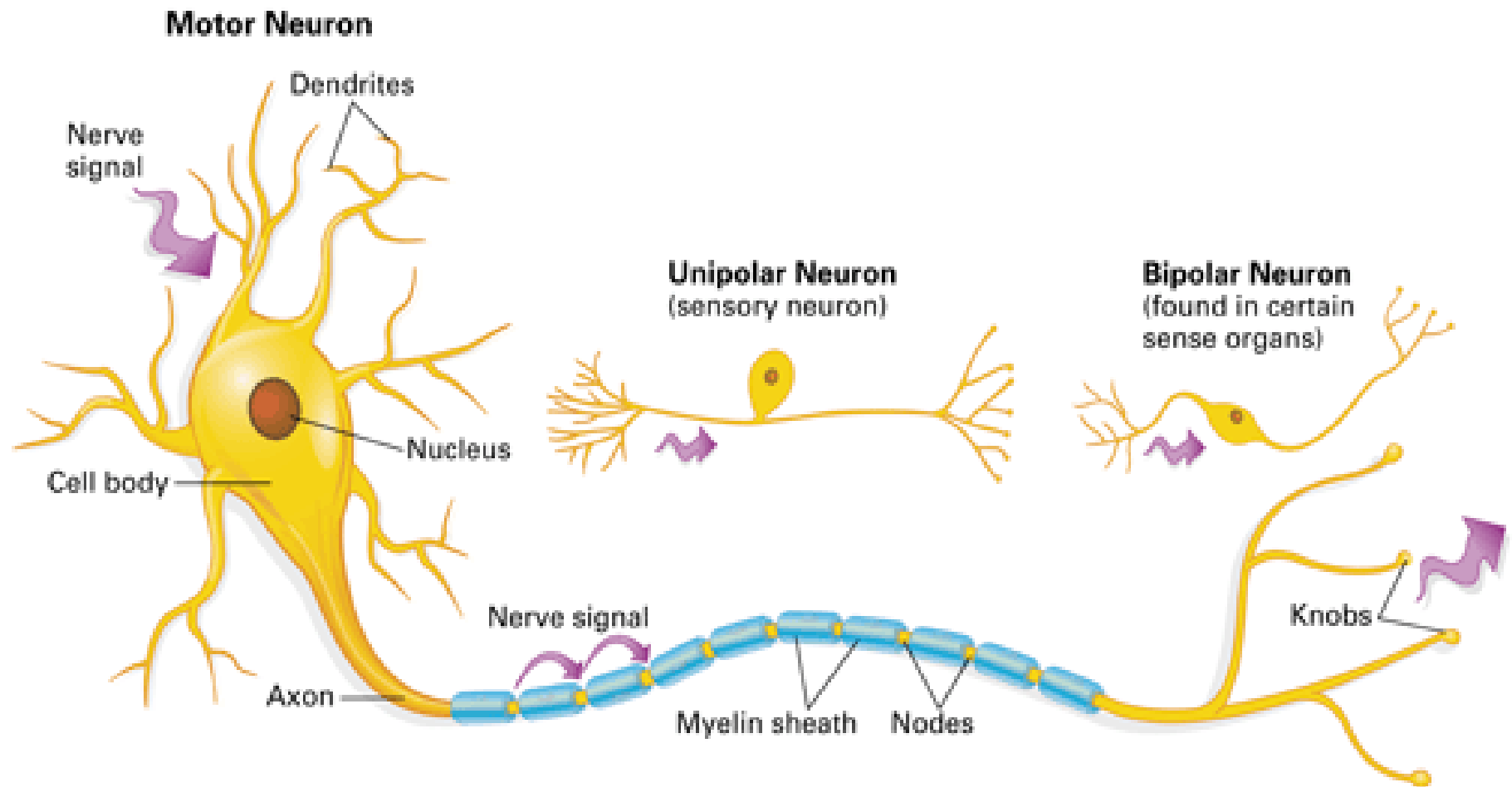

Fig. 1. Neural communication

Fig. 2.

Axons can be over 1 m long (10 000 x cell body) – thus,
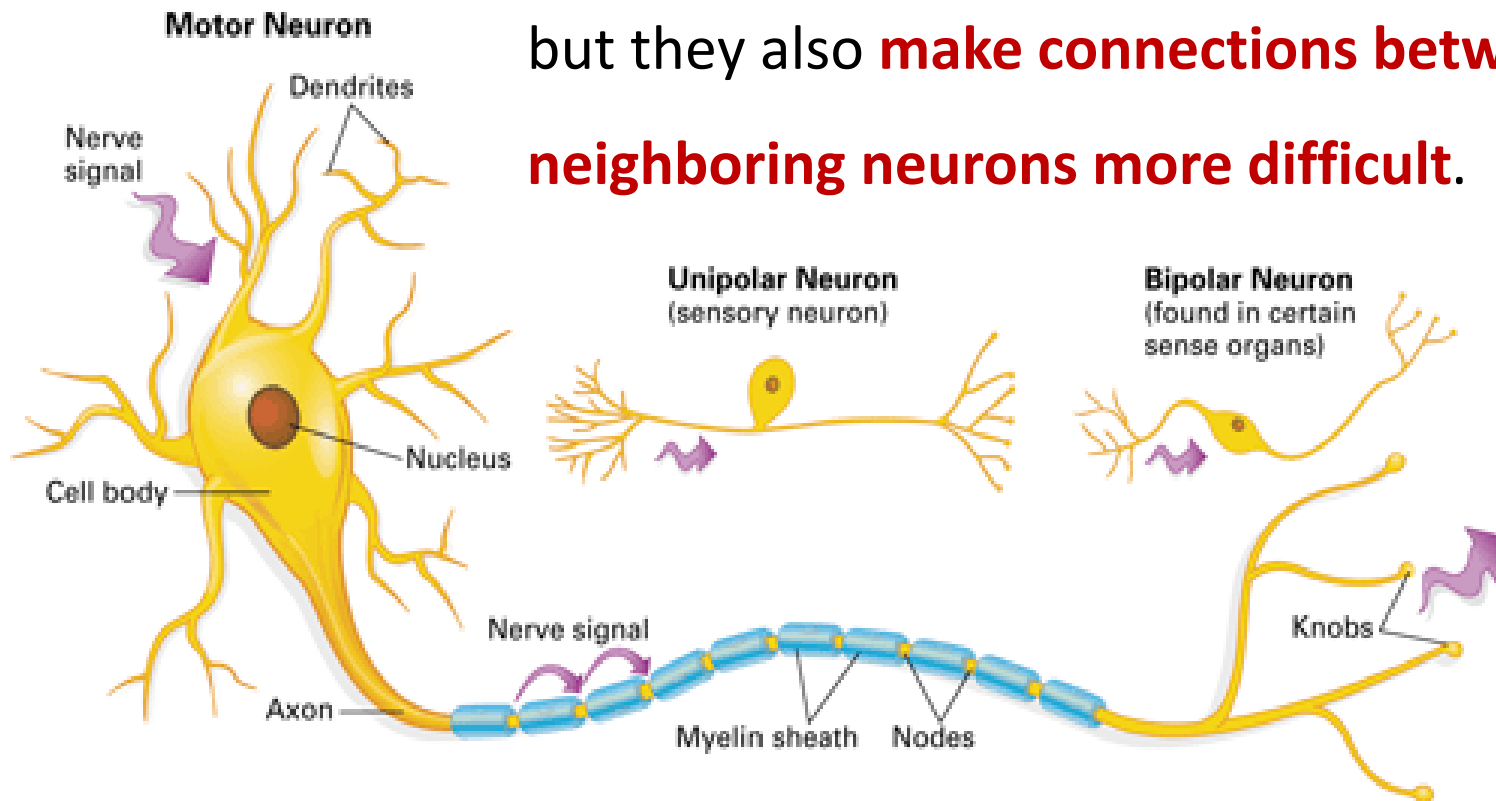
Need for faster connections

Neurotransmission becomes much faster, if axon is insulated by a segmented sheath – the electrical signals can jump over its nodes (Fig. 3):

Motor Neuron

Dendrites

Nerve signal

Nucleus

Cell body

Nerve signal

Axon

Myelin sheath   Nodes

Unipolar Neuron
(sensory neuron)

Bipolar Neuron
(found in certain sense organs)

Knobs

Myelin coating – faster connections

Myelin sheaths provide neurons with nutrition and **increase their ability to conduct electrical signals more rapidly** and to greater cerebral distances, but they also **make connections between neighboring neurons more difficult**.

Motor Neuron

Dendrites

Nerve signal

Nucleus

Cell body

Axon

Nerve signal

Myelin sheath   Nodes

Unipolar Neuron
(sensory neuron)

Bipolar Neuron
(found in certain sense organs)

Knobs

Brain development after birth

- In the past, the structure of the human brain could only be studied during post-mortems →

- We believed that the brain was fully formed in early childhood.

- We now know that the **brain continues to develop** after /throughout childhood – and that **myelination** is a major part of this process.

- 1st stage of cognitive development: **sensory-motor**

Synthesis of 'connections' in speech production
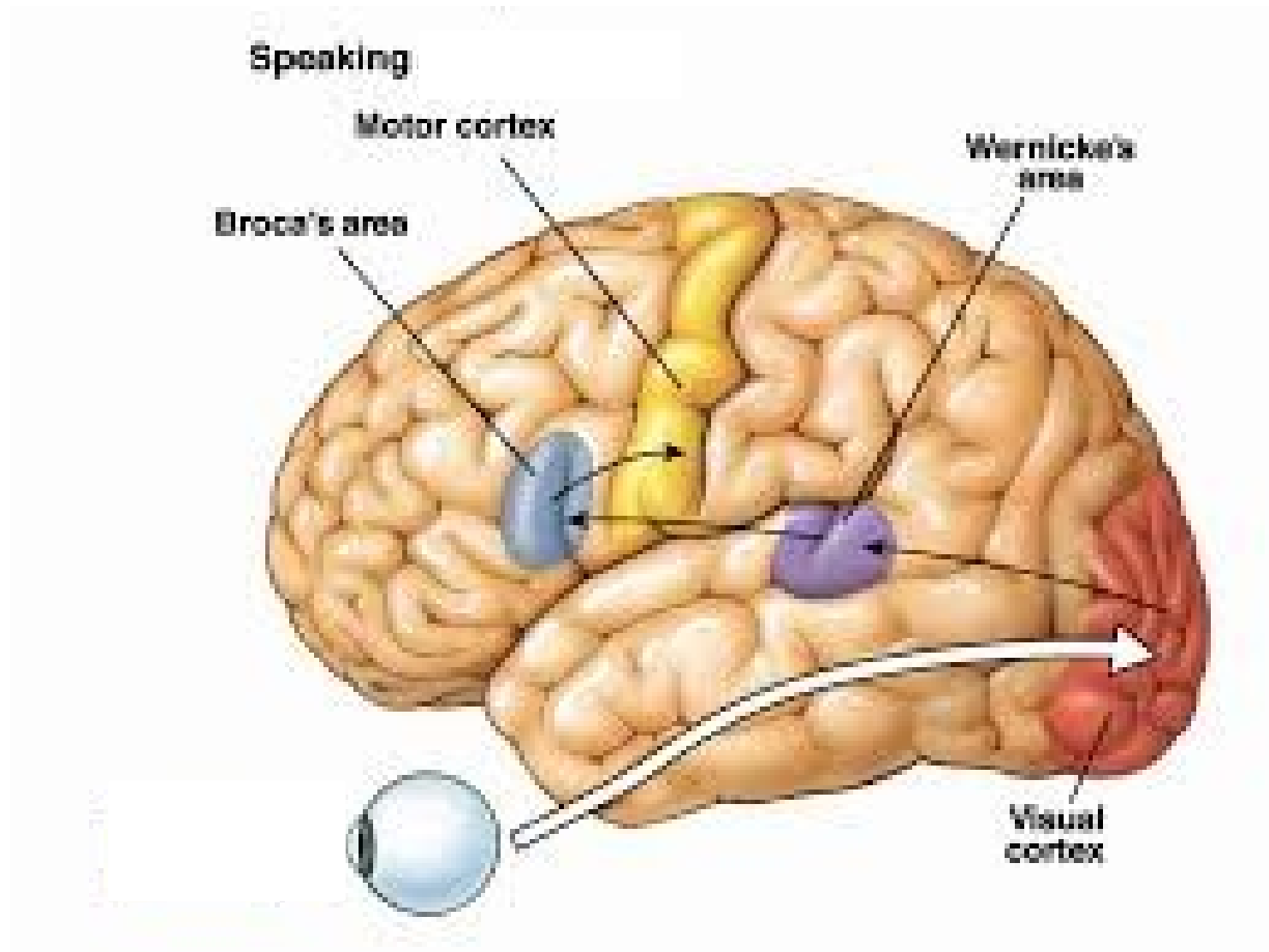
The process of **myelination**

- Starts at the fetus stage

- By the age of twelve months, the **primary sensory and motor areas** are myelinated

- **Higher-order association areas** of the cortex are myelinated much later, and it is in these regions that some neurons remain unmyelinated in adults

Schwann cell

Axon

Nucleus

Schwann cell

Axon

Myelin sheath
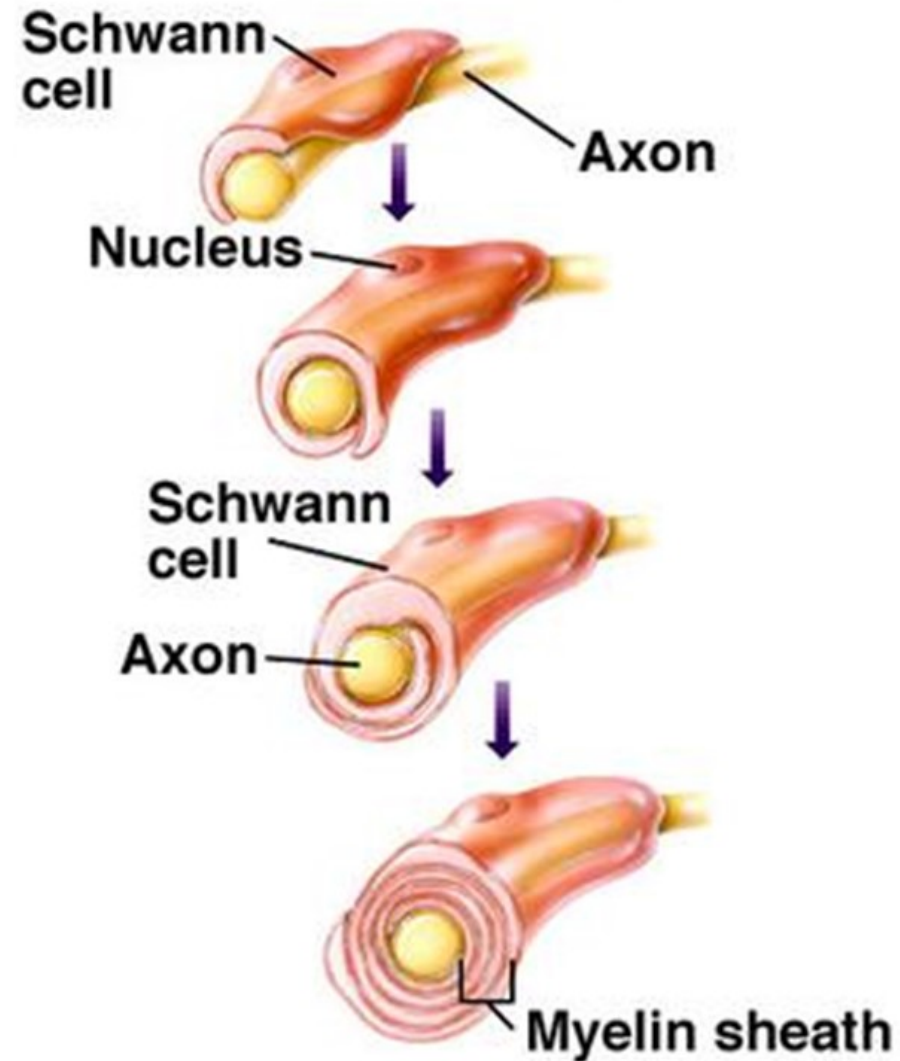
Process of **myelination**

The language areas myelinate after the primary sensory and motor areas, but before the higher-order association areas:

"Around puberty, all cortical areas, except perhaps the higher-order association cortices, have reached their full level of myelination."

Hyltenstam & Abrahamsson 2003
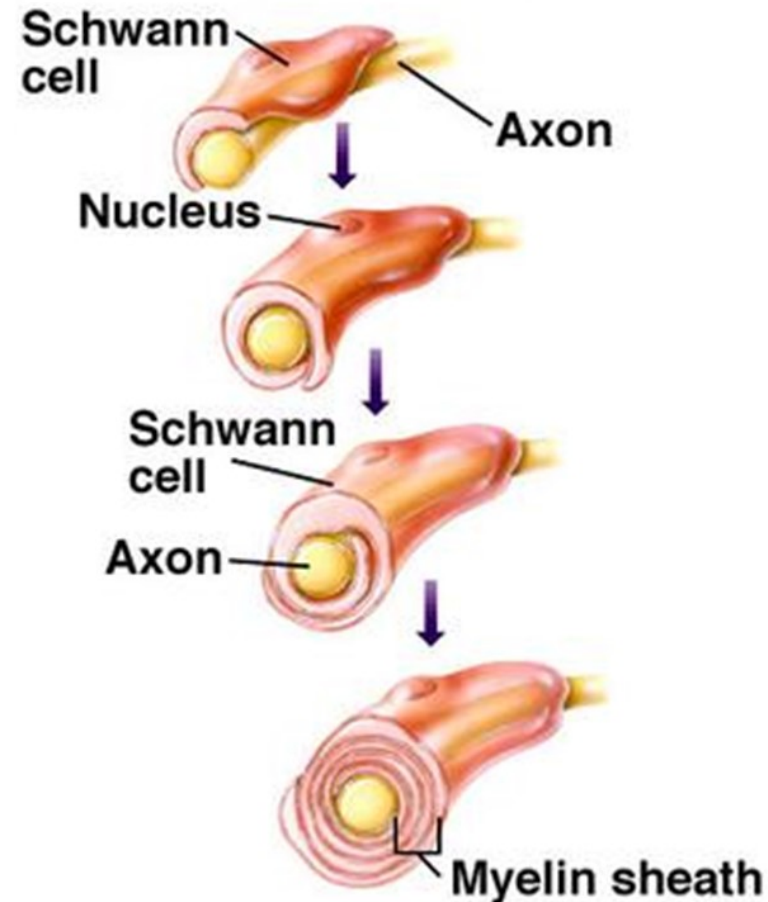
<u>Myelination</u> = <u>Maturation of the Brain</u>

MRI studies have consistently found that there is a steady increase in **white matter***in certain brain regions in childhood and adolescence.

Blakemore & Choudhury 2006

* '**White matter** is composed of bundles of **myelinated** nerve cell projections (or axons), which connect various grey matter areas (the locations of nerve cell bodies) of the brain to each other, and carry nerve impulses between neurons. (Wikipedia)

# <u>Myelination</u> = <u>Maturation of the Brain</u>

Recent studies have also revealed that myelination of language-related areas occurs in two stages – in infancy, and then again at **adolescence**:
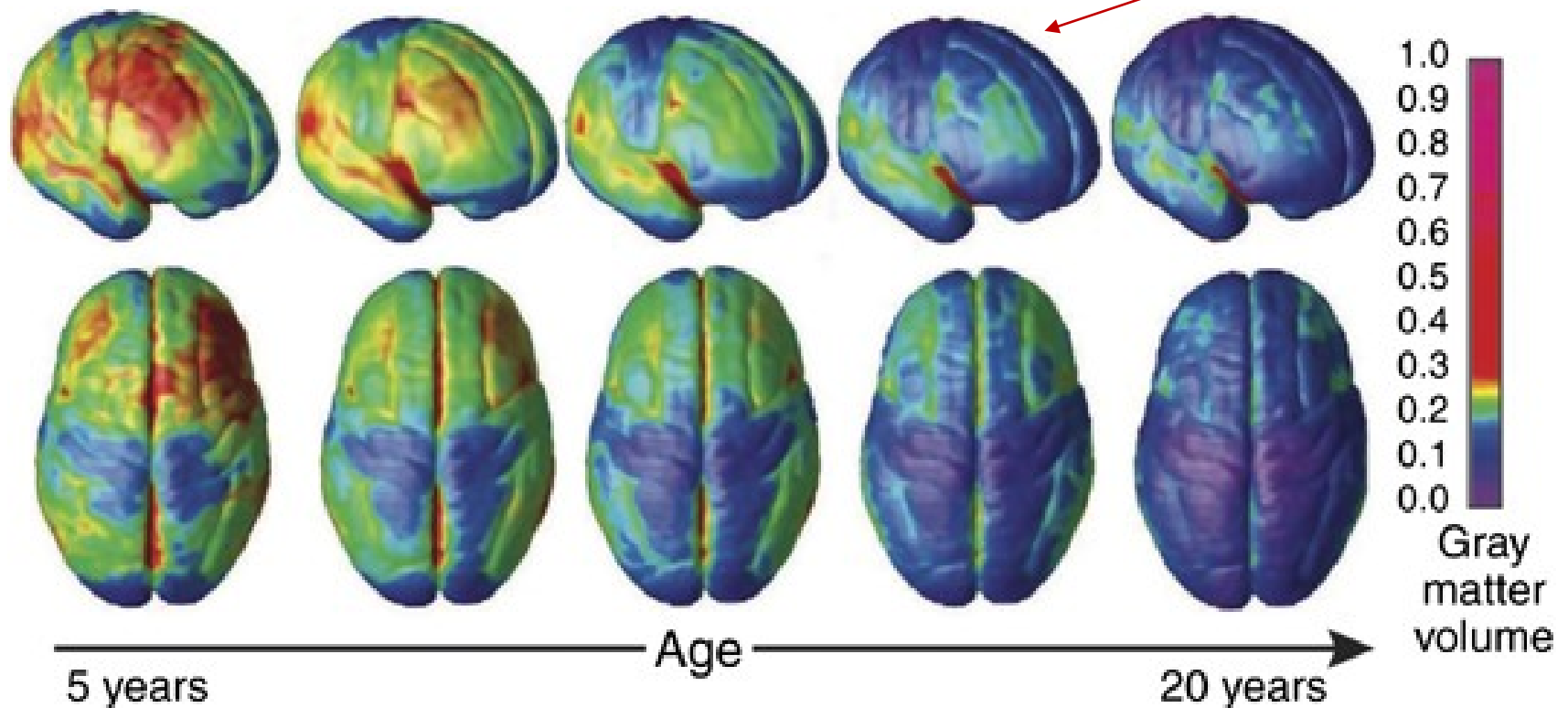
Language acquisition potential depends on the type & speed of connections in the cortical network

There are two types of cortical connections between neurons:

- **long-distance** type uses *apical dendrites and axons* to reach far from the cell body and connect different cortical areas,

- **short-distance** type uses *basal dendrites* to make 'local' connections.
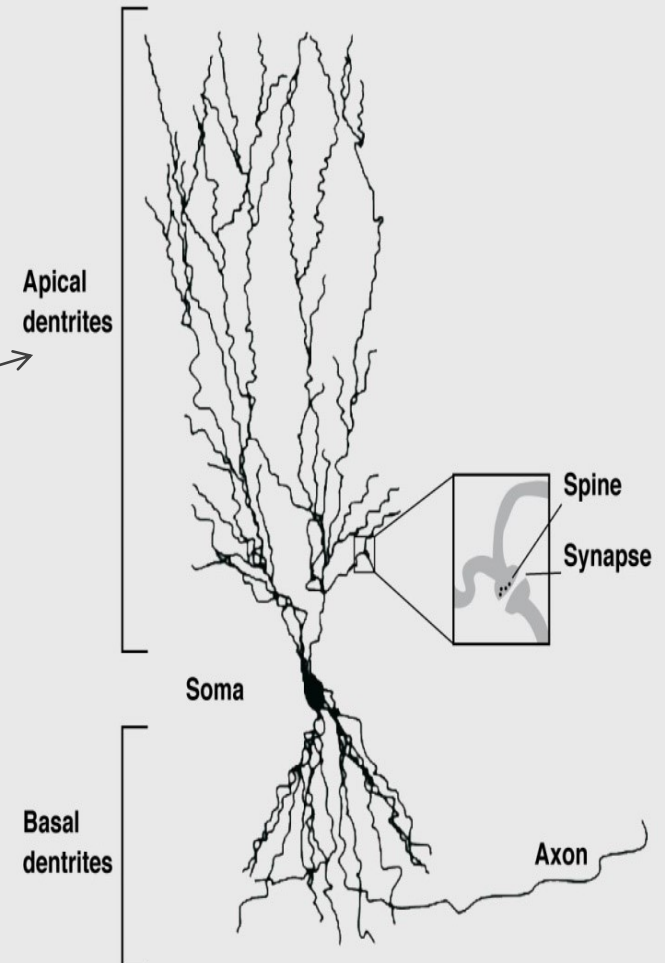
Myelination 'rewires' the brain:

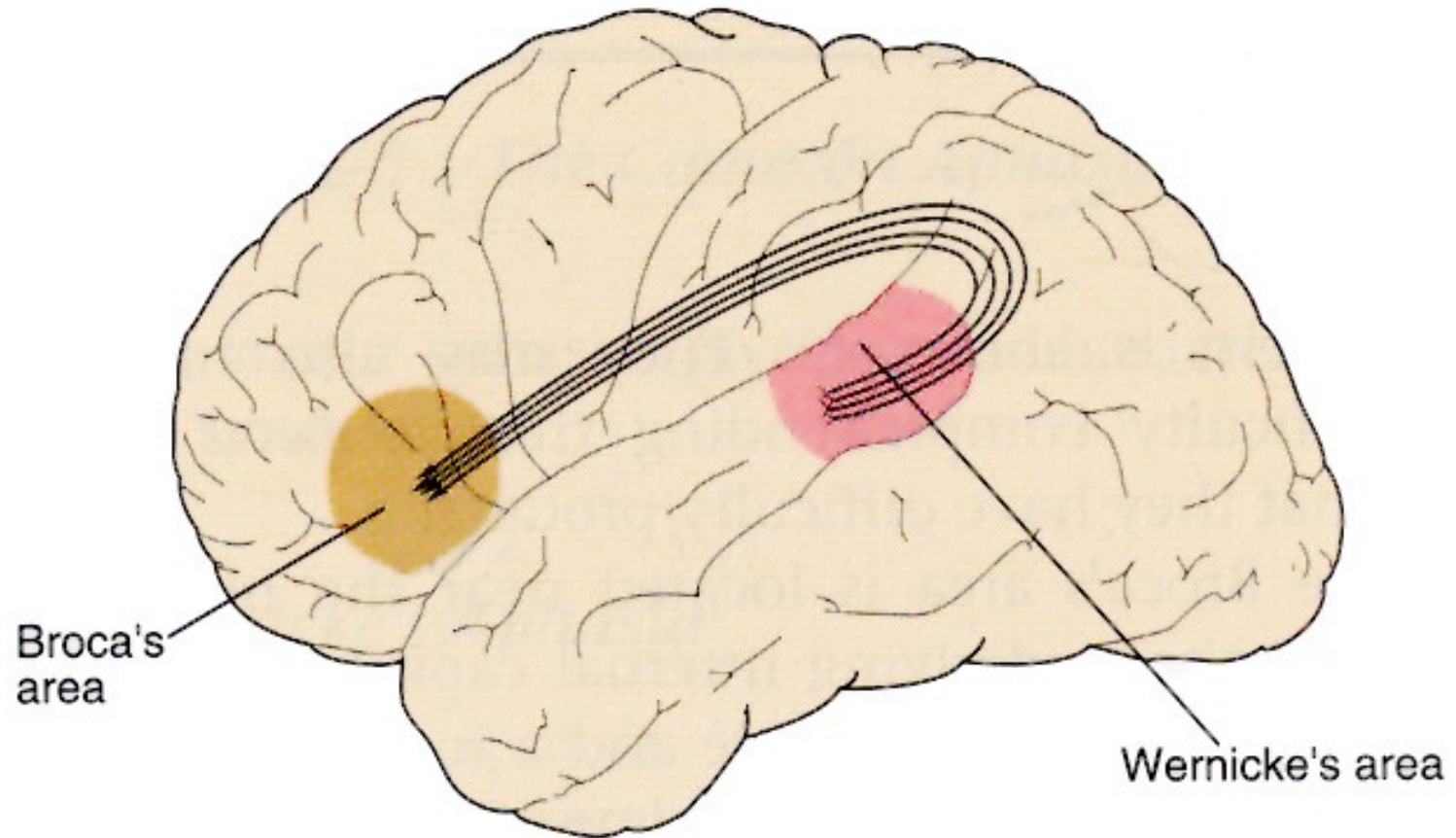It **speeds up long-distance** signal transmission through the axons

At the same time, myelin sheaths **inhibit** axons' ability to make **'local' connections** with

- **basal dendrites** which are close to the cell body and
- **local branches of the axons** (axon 'collaterals').

Language acquisition relies on 'local' connections
within the 'language areas' -

Broca's area

Wernicke's area

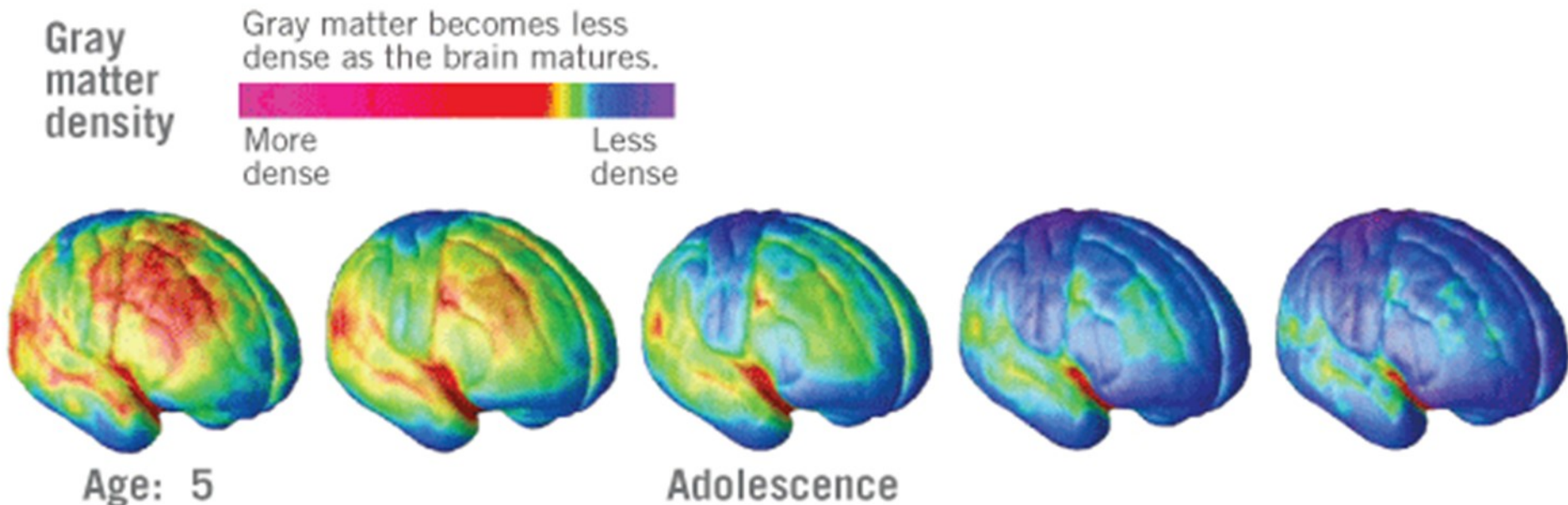# Language acquisition relies on 'LOCAL' connections
within the 'language areas'

This is why

- **FLA** becomes **impossible** after puberty

&

- **SLA** becomes **much more effortful** with the process of myelination in the 'language areas'

Hyltenstam & Abrahamsson 2003

CPH : the 'age advantage' disappears after puberty, when language learning becomes a conscious effort

SLA after puberty involves the higher-order association areas in the frontal lobe (by then, most of the 'local' connections in the 'language' areas have become unavailable through myelination and reduction in the 'grey matter' density:

Gray matter density

Gray matter becomes less dense as the brain matures.

More dense   Less dense

Age: 5   Adolescence

RE-CAP of the theoretical basis of our research:

Structural changes in the brain during adolescence 'rewire' the neural connections which underlie language acquisition.

Brain 'rewiring' changes the *mechanism* of SLA:

- Learning from direct input/mere exposure becomes ineffective
- Higher-order association areas in the frontal lobe become involved in SLA
- Therefore, AO impacts students' potential in SLA

VE consequences: delayed AO; ELL → OUR RESEARCH

Aims

– To establish whether there is any correlation between POMNATHS students' **AO**/ **Age at Literacy**/ **ELL** and their academic performance

Objectives

– To contribute to the development of an effective language education policy in multilingual PNG and, thus,

– To promote sustainable national development in PNG

– To contribute to the ongoing debate on whether CPH extends to SLA

Research Questions

1. Is there a **correlation** between the **AO** and the students' overall academic performance and average English scores?

2. Is there a **correlation** between the students' Age at Literacy **(A@L)** and their overall academic performance and mean English scores?

3. Is there a **correlation** between the students' Early Learning Language **(ELL)** backgrounds and their academic performance?

Materials & Methods

Data collection tool:

A short pre-tested questionnaire, designed to elicit information on

- When, where, and in which language POMNATHS students first learned to read & write
- At what age they were exposed to/learned English

Methods:

- Purposive sampling
- SPSS 20 was used for multiple comparisons and correlation analyses (ANOVAs)

Sample Questions

The effect of early language education on POMNATHS students' performance

You are invited to participate in a research project conducted by the School of Humanities & Social Sciences, UPNG. This study aims to help develop effective education strategies for sustainable national development.

The success of this study depends on the accuracy of your responses. **We guarantee total confidentiality –** none of your personal information shared with us will be disclosed in this study.
Your participation, however, is entirely voluntary.

PLEASE ANSWER THE EIGHT (8) QUESTIONS BELOW:

1. Please state your name, surname and academic ID #

Name and Surname _____

Student ID# _____

2. Gender   o Male   o Female

3. Grade details:

- o Grade 11 (Arts)   o Grade 11 (Science)
- o Grade 12 (Arts)   o Grade 12 (Science)

4. What is the 1st language you spoke at home as a child?
- o Vernacular (give the language name): _____
- o Tok Pisin
- o English

5. At what age were you taught to read and write?
- o 5 years old   o 8 years old
- o 6 years old   o 9 years old
- o 7 years old   o Other (please specify): _____

6. Where did you do your elementary schooling?

o Port Moresby	o Milne Bay	o Jiwaka	o Enga
o Central Province	o EHP	o Hela	o ENB
o Gulf	o SHP	o WNB	o Bougainville
o Oro	o Manus	o New Ireland	o East Sepik
o Simbu	o Madang	o Morobe	o West Sepik
o Other			

7. How old were you when you first started learning English?
- o 5 years old   o 8 years old
- o 6 years old   o 9 years old
- o 7 years old   o 10 years old
- o Other (specify)_____

8. In what language did you first learn to read and write?
- o Vernacular
- o Tok Pisin
- o English

Our Questionnaire had 8 questions:

1. Your name & surname

2. Gender

3. Grade details:
o   Grade 11 (Arts)   ○ Grade 11 (Science)
o   Grade 12 (Arts)   ○ Grade 12 (Science)

4. What is the 1st language you spoke at home as a child?

5. At what age were you taught to read and write?

6. Where did you do your elementary schooling?

7. How old were you when you first started learning English?

8. In what language did you first learn to read and write?

Research Procedures:

- We obtained
  - permission from POMNATHS Administration, and secured their collaboration
  - Survey data (from students)
  - Academic scores (from school records)

- Data entry & coding
  - Information contained in 512 questionnaires was entered into Excel spreadsheets, coded, and matched with the respective academic scores, forming the final dataset.

- Data analysis using SPSS20
  - Descriptive statistics, comparison of means
  - A series of ANOVAs, correlation and linear regression analyses
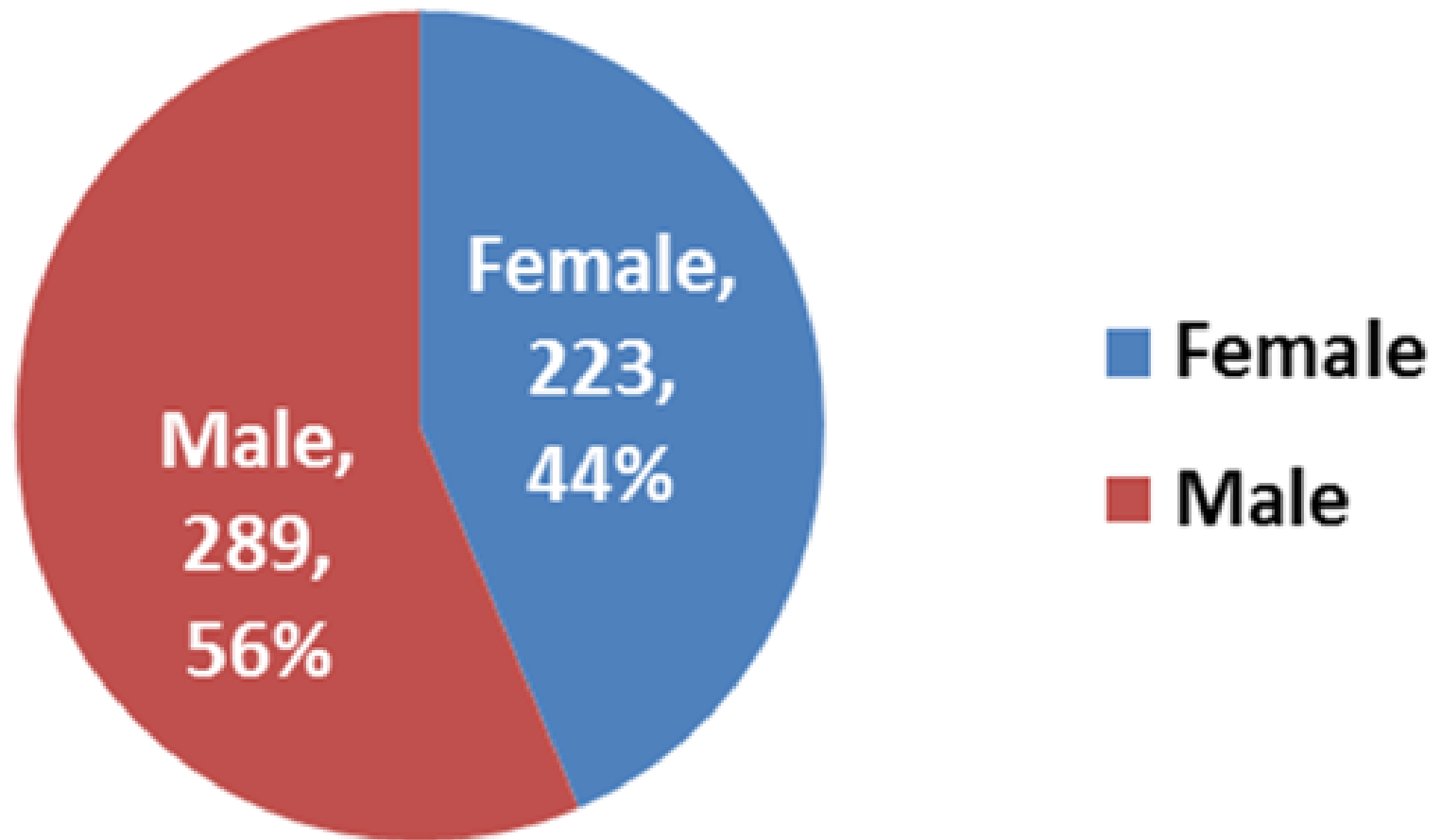
RESEARCH FINDINGS &

DISCUSSION OF RESULTS

Response rates by grade level & overall
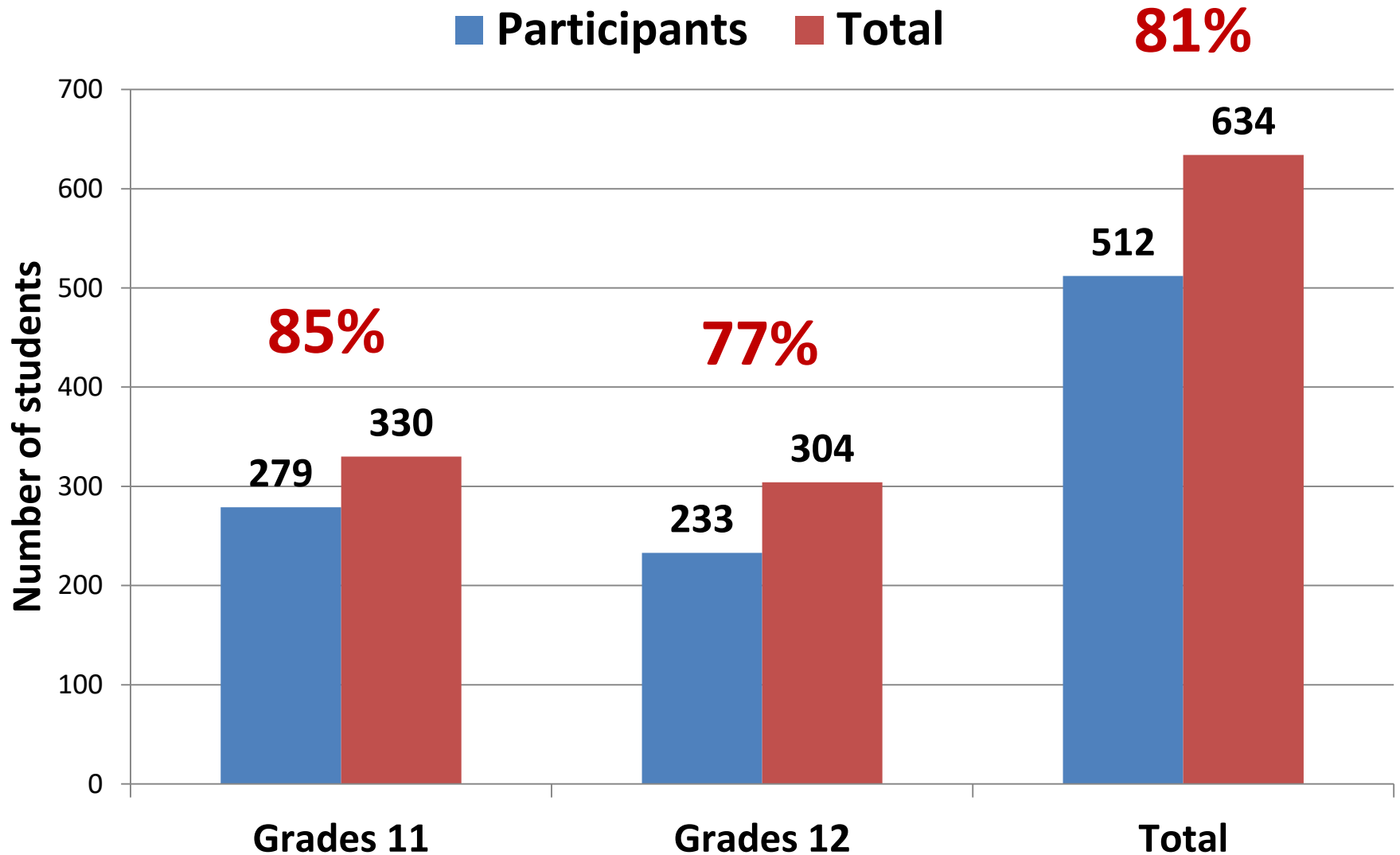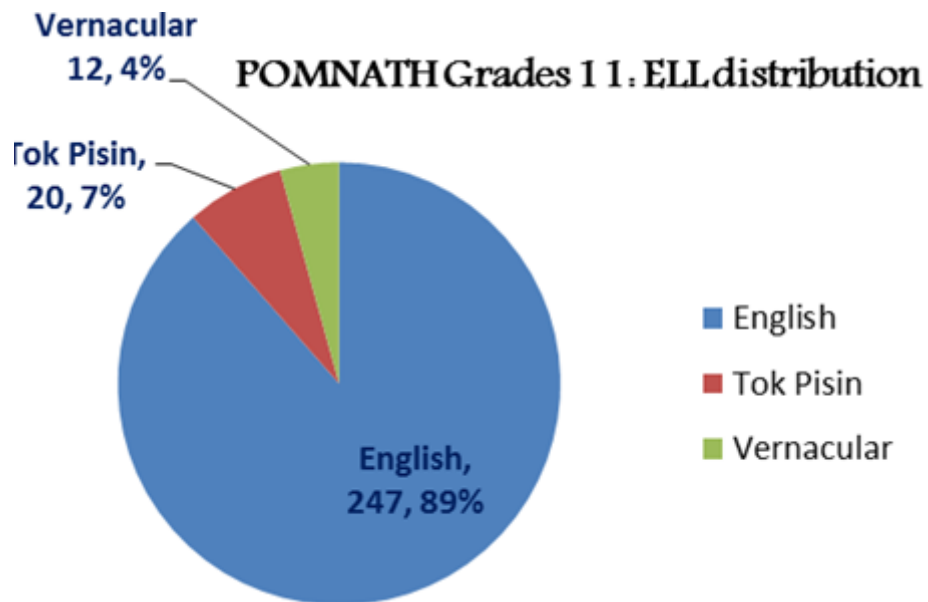
POMNATH Gender Distribution

Fig. 14-A. ELLs in Grades 11
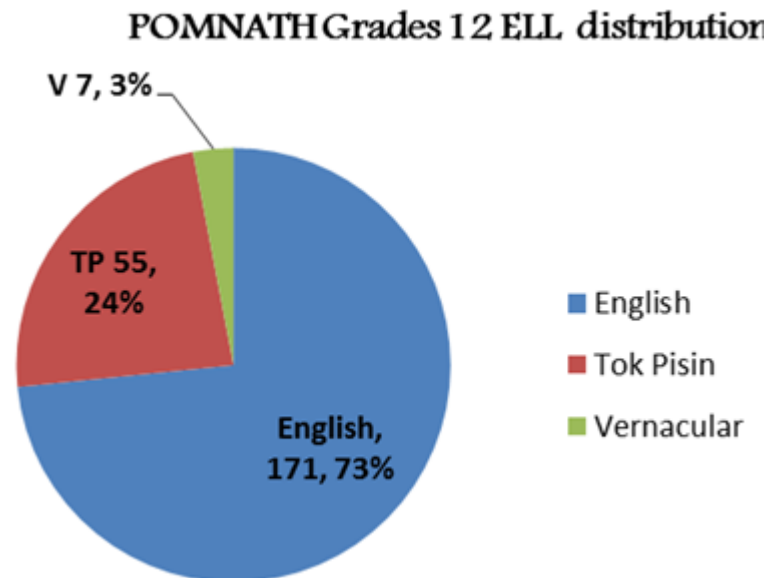
Fig. 14-B. ELLs in Grades 12

POMNATH Grade 11s by location
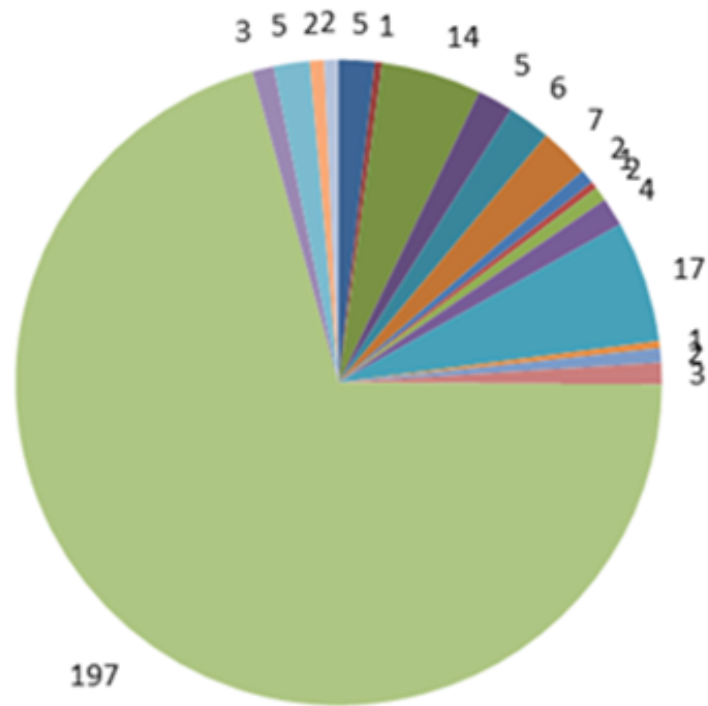
Legend:
AUS · AROB · CENTRAL · ESP · EHP · ENGA · GULF
JIWAKA · MADANG · MANUS · MOROBE · NEW IRELAND · ORO · OTHER
POM · SHP · SIMBU · WESTERN · WHP

Data labels: 3, 5, 2, 2, 5, 1, 14, 5, 6, 7, 2, 2, 4, 17, 1, 1, 1, 3, 197

POMNATH Grades 1 2 by location

Pie chart data labels (clockwise from top): 9, 6, 03, 21, 4, 21, 9, 4, 5, 1, 2, 04, 1, 6, 03, 6, 163

Legend:
- AUS
- AROB
- CENTRAL
- ESP
- EHP
- ENGA
- GULF
- JIWAKA
- MADANG
- MANUS
- MOROBE
- NEW IRELAND
- ORO
- OTHER
- POM
- SHP
- SIMBU
- WESTERN
- WHP
- ENBP
- MILNE BAY
- WNBP

English & Overall Achievement by Age of Onset
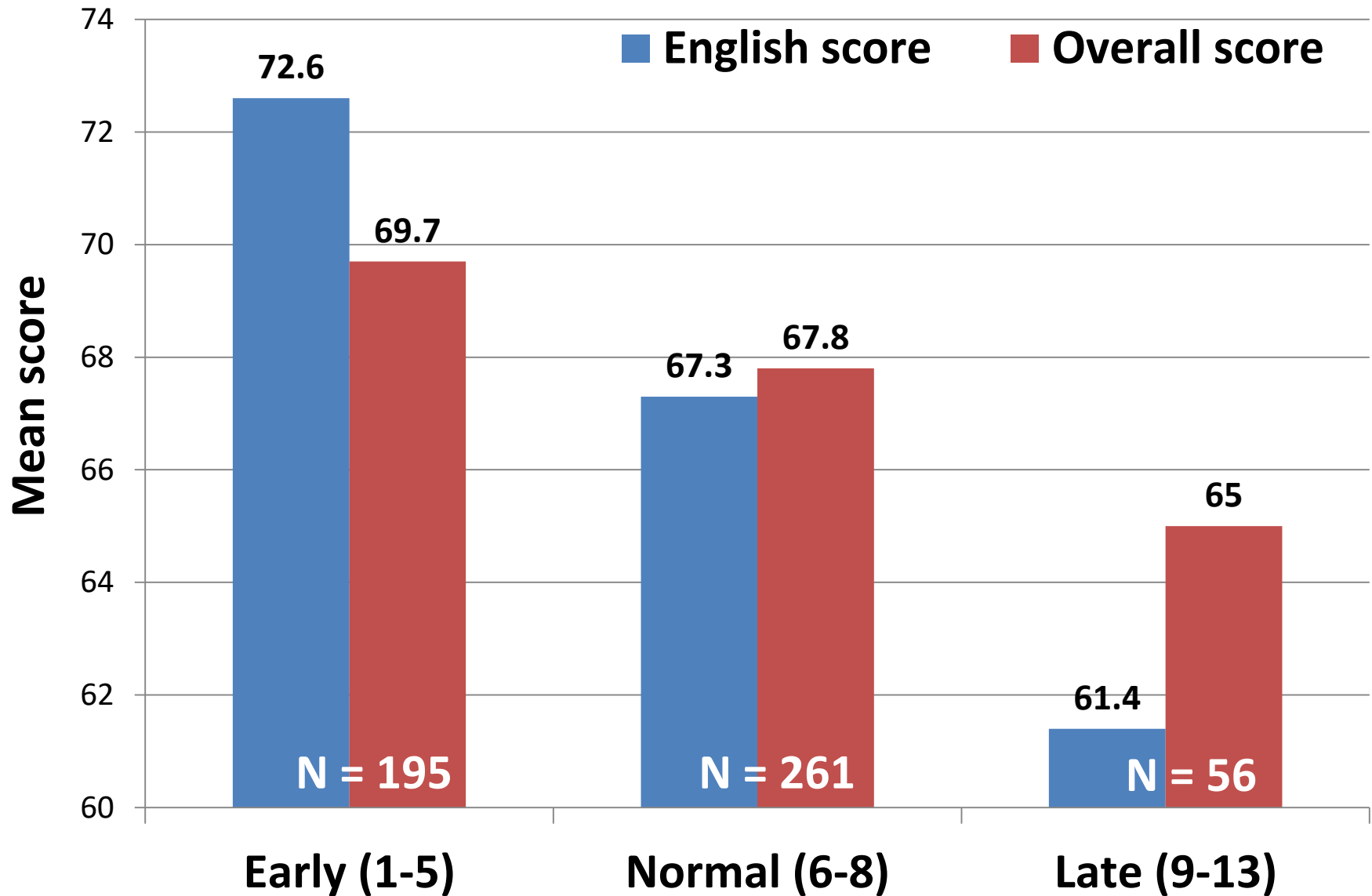
Result 1: Significant inverse correlation between AO and English/Overall mean scores
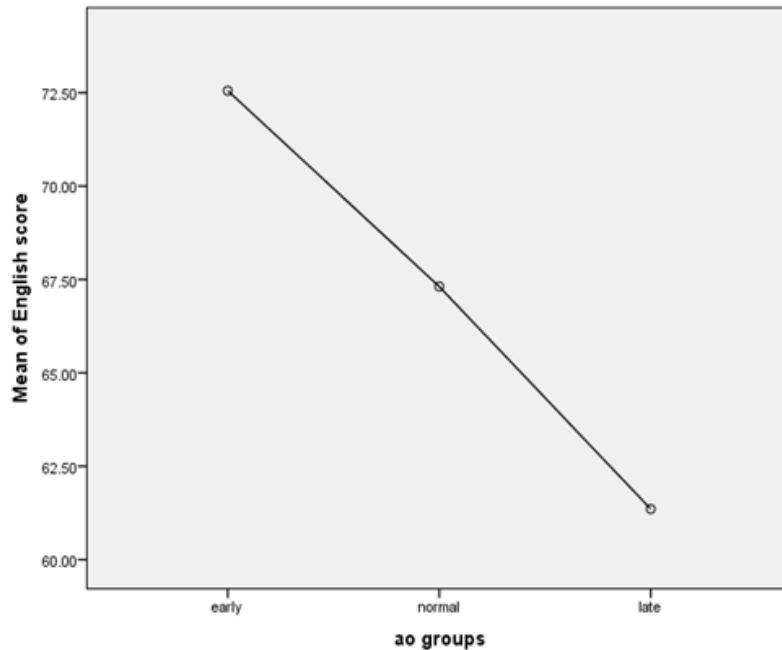
Fig. 17A. Mean English Scores by AO groups
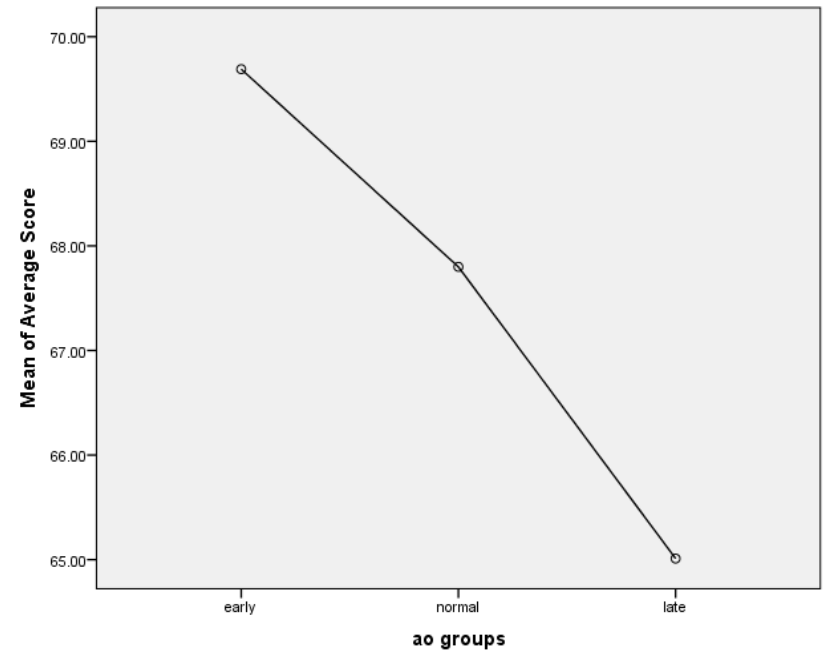
Fig. 17B. Mean Overall cores by AO groups

Result 1: Parametric test: inverse correlation between AO and mean English scores

Correlations

		English score	ao groups
English score	Pearson Correlation	1	-.348**
	Sig. (2-tailed)		.000
	N	512	512
ao groups	Pearson Correlation	-.348**	1
	Sig. (2-tailed)	.000	
	N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

Result 1: Parametric test of the correlation between AO and mean OVERALL scores

Correlations

		ao groups	Average Score
ao groups	Pearson Correlation	1	-.180[**]
	Sig. (2-tailed)		.000
	N	512	512
Average Score	Pearson Correlation	-.180[**]	1
	Sig. (2-tailed)	.000	
	N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

Result 1: Nonparametric test of the correlation between AO and mean English scores

Correlations

			English score	ao groups
Spearman's rho	English score	**Correlation Coefficient**	1.000	**-.349**[**]
		Sig. (2-tailed)	.	.000
		N	512	512
	ao groups	**Correlation Coefficient**	**-.349**[**]	1.000
		Sig. (2-tailed)	.000	.
		N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

Result 1: Nonparametric test of the correlation between AO and mean OVERALL scores

Correlations

			ao groups	Average Score
Spearman's rho	ao groups	Correlation Coefficient	1.000	-.191[**]
		Sig. (2-tailed)	.	.000
		N	512	512
	Average Score	Correlation Coefficient	-.191[**]	1.000
		Sig. (2-tailed)	.000	.
		N	512	512

[**]. Correlation is significant at the 0.01 level (2-tailed).

English Proficiency by Age of Onset Groups
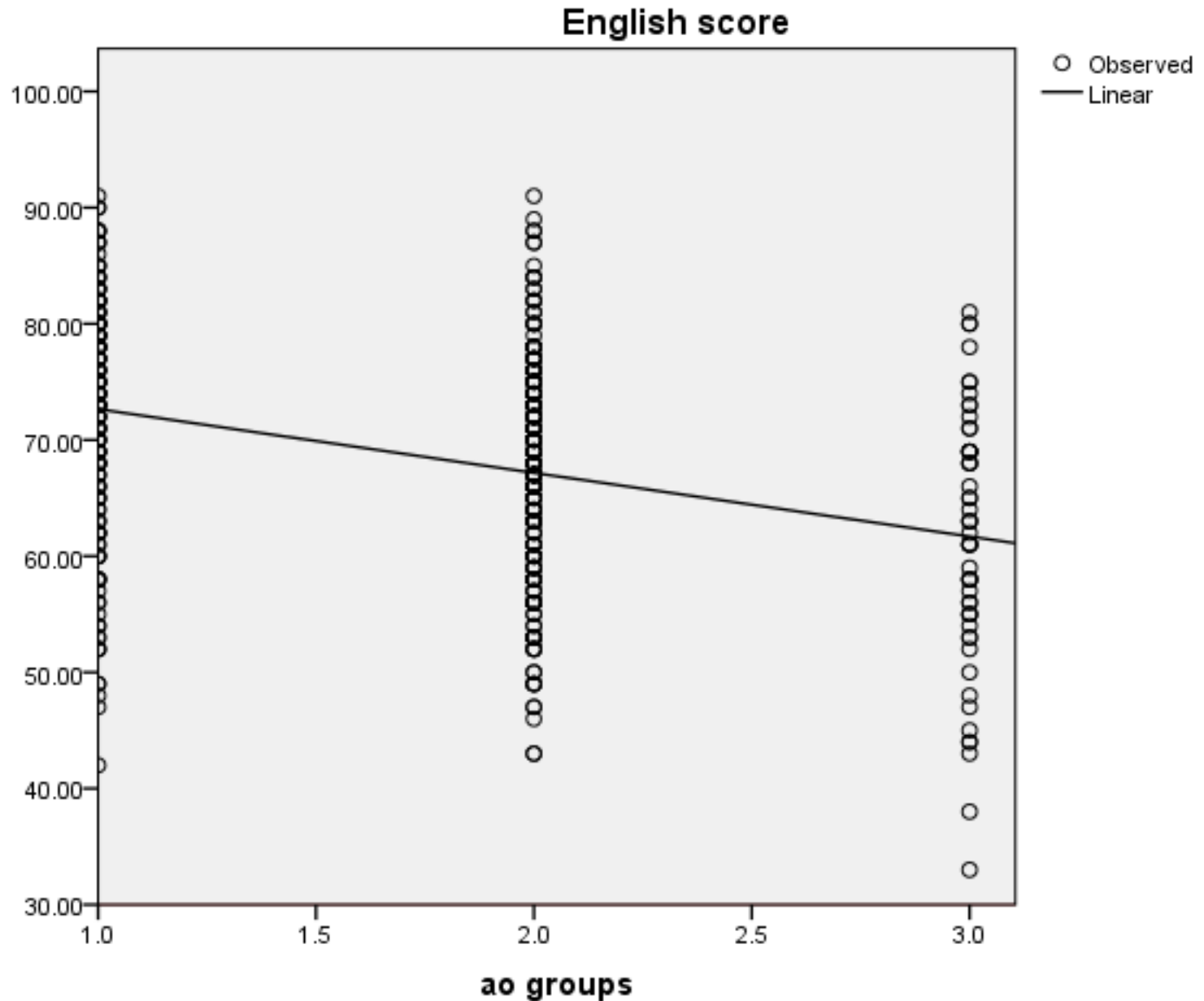
Overall mean scores by Age of Onset groups (slope less steep)
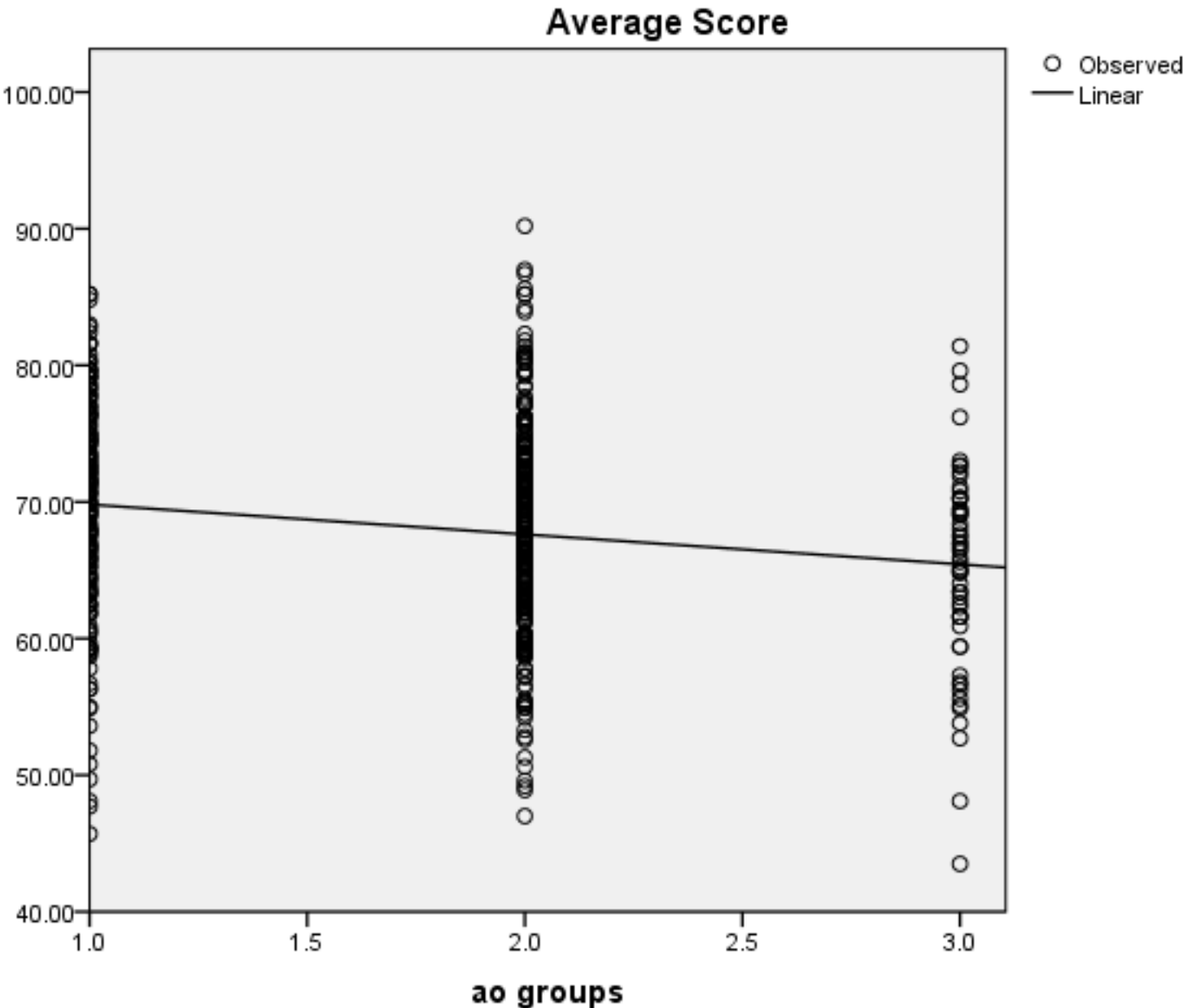
English & Overall Scores by Age at Literacy groups

Result 2: Significant Variance in the mean scores by A@L
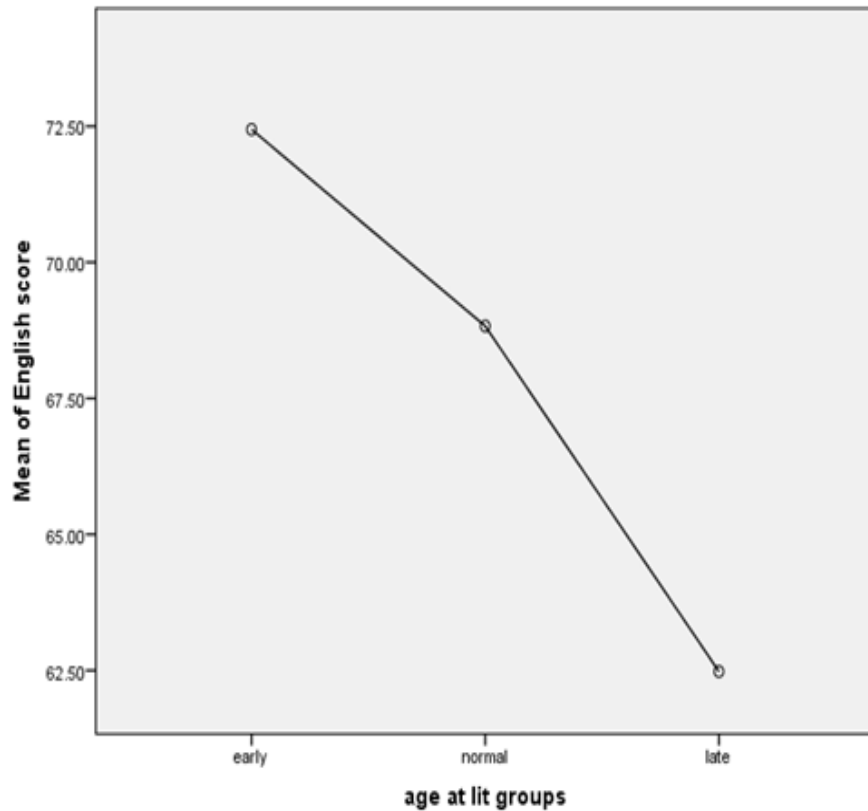
Parametric Analysis: correlation between A@L and English scores

Correlations

		age at lit groups	English score
age at lit groups	**Pearson Correlation**	1	**-.294**[**]
	Sig. (2-tailed)		**.000**
	Sum of Squares and Cross-products	196.326	-946.719
	Covariance	.384	-1.853
	N	512	512
English score	**Pearson Correlation**	**-.294**[**]	1
	Sig. (2-tailed)	**.000**	
	Sum of Squares and Cross-products	-946.719	52961.500
	Covariance	-1.853	103.643
	N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

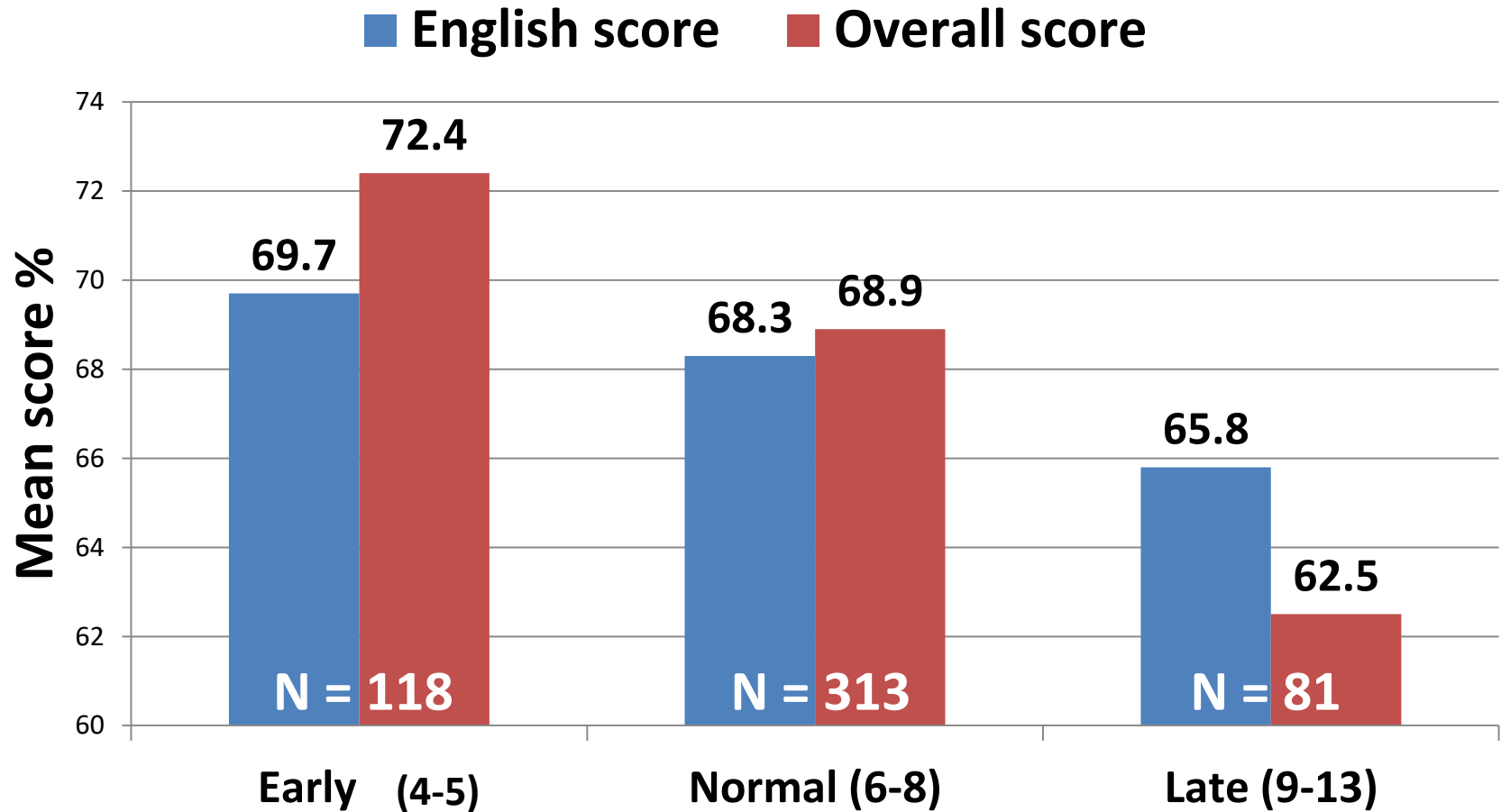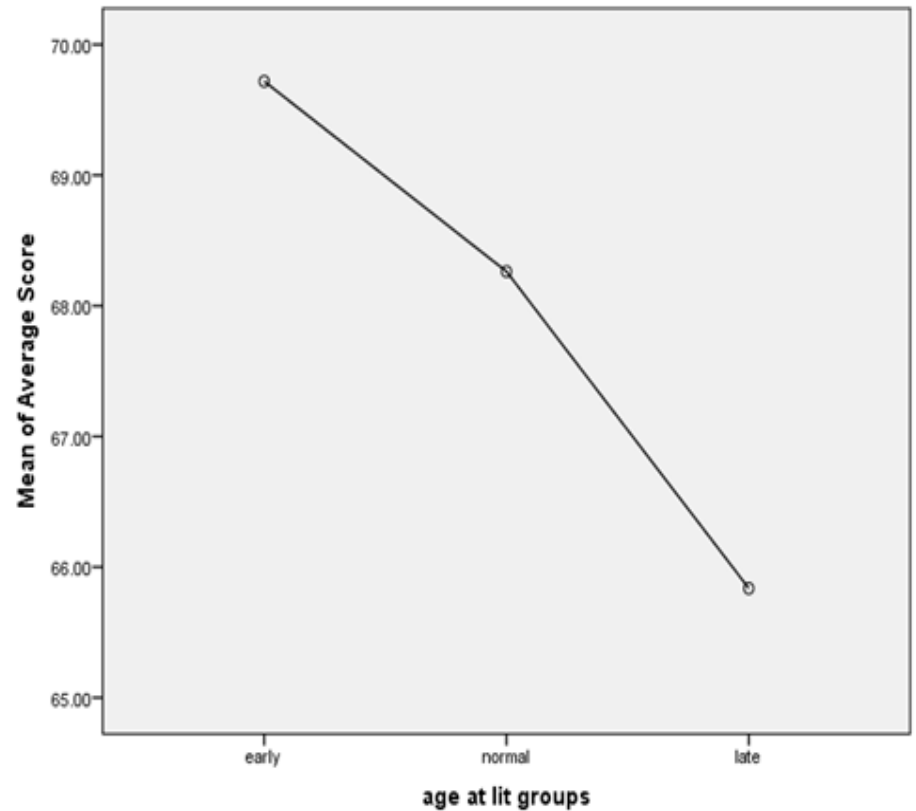# Nonparametric Analysis: correlation between A@L & English scores

Correlations

			age at lit groups	English score
Spearman's rho	age at lit groups	**Correlation Coefficient**	1.000	**-.293**[**]
		Sig. (2-tailed)	**.**	**.000**
		N	512	512
	English score	**Correlation Coefficient**	**-.293**[**]	1.000
		Sig. (2-tailed)	**.000**	**.**
		N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

English scores by Age at Literacy groups
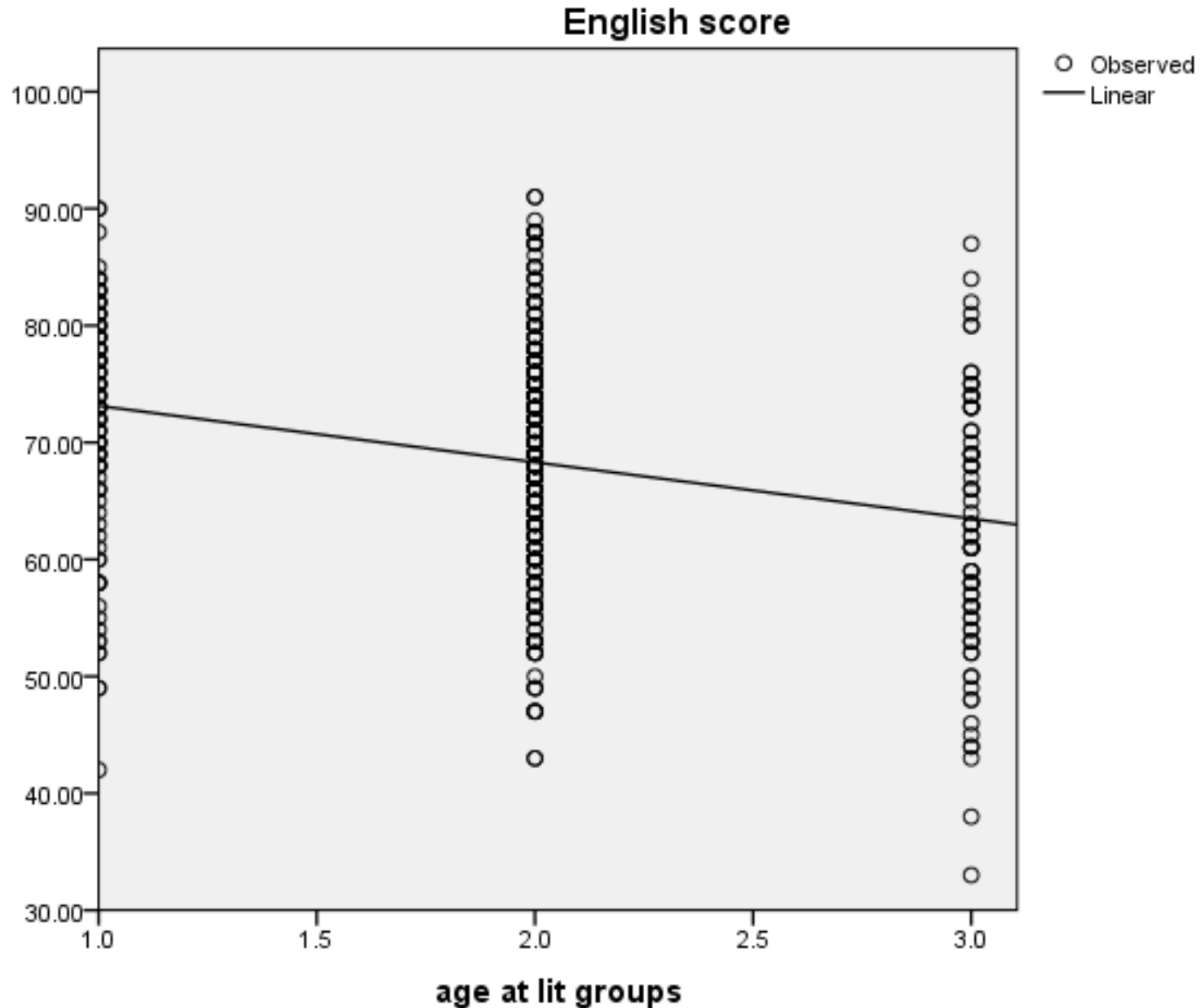
Overall performance scores by Age at Literacy groups
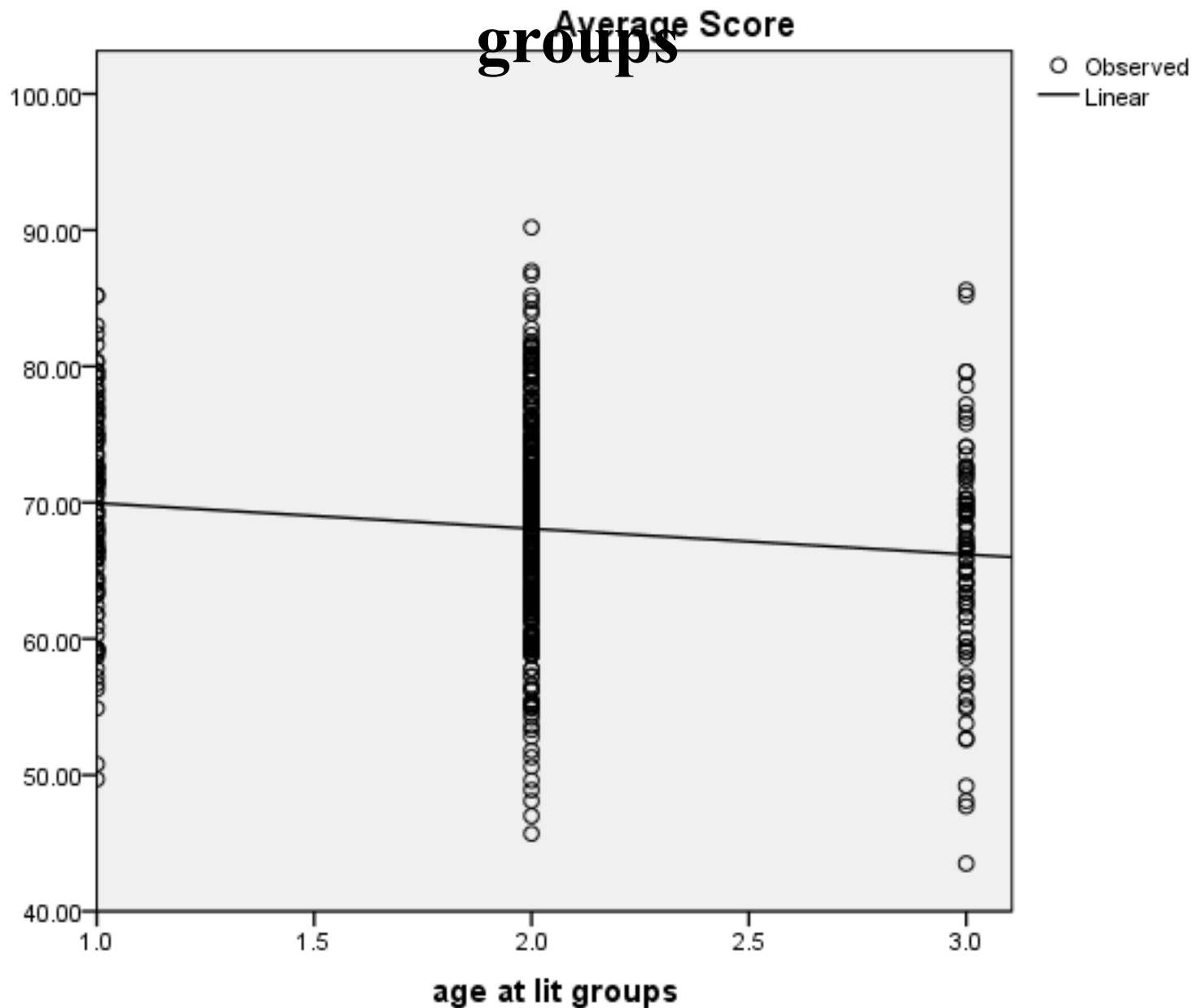
Overall & English mean scores by ELL

■ Overall ■ English

Largest group

Weakest overall

Weakest in English

68.40

69.50

66.00

65.00

67.20

63.00

N = 419

N = 74

N = 19

70.00
69.00
68.00
67.00
66.00
65.00
64.00
63.00
62.00
61.00
60.00

Mean Score %

English   Tok Pisin   Vernacular

Early Learning Language
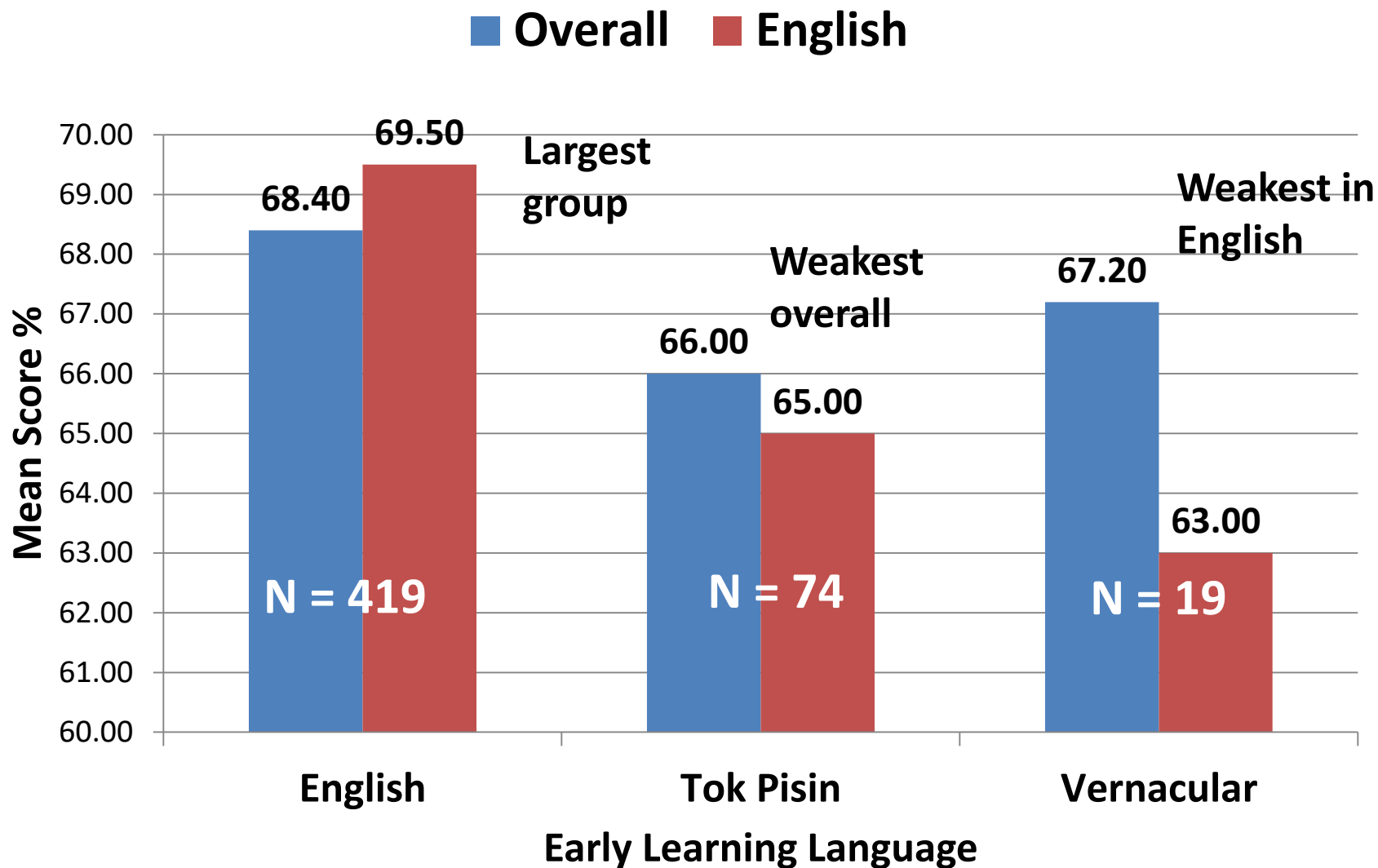
Result 3: Significant Variance in the mean scores by ELL
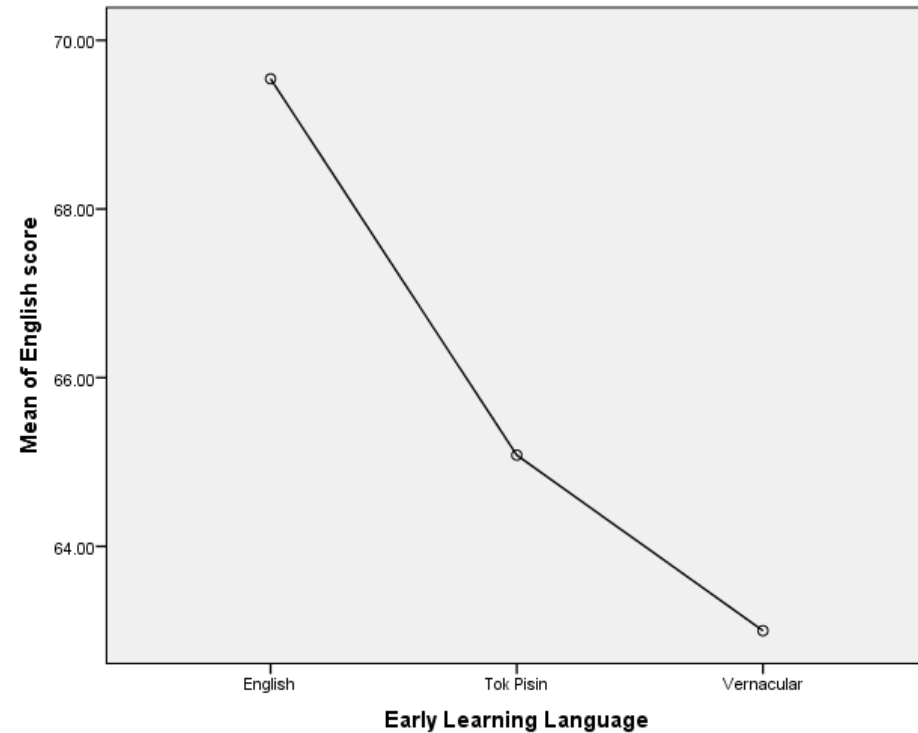
Fig. 20A. English mean scores by ELL groups
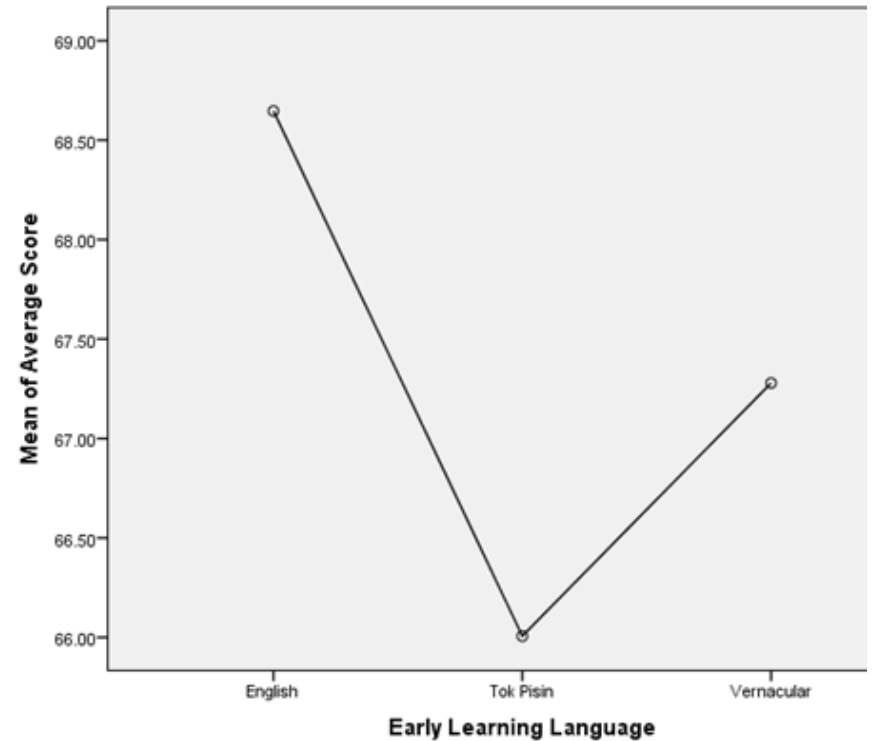
Fig. 20B. Overall mean scores by ELL group

Parametric Analysis: inverse correlation between ELL & English scores

Correlations

		English score	ELL
English score	**Pearson Correlation**	1	**-.186**[**]
	Sig. (2-tailed)		**.000**
	Sum of Squares and Cross-products	52961.500	-479.500
	Covariance	103.643	-.938
	N	512	512
ELL	**Pearson Correlation**	**-.186**[**]	1
	Sig. (2-tailed)	**.000**	
	Sum of Squares and Cross-products	-479.500	125.500
	Covariance	-.938	.246
	N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

Nonparametric Analysis: inverse correlation between ELL and English scores

Correlations

			English score	Early Learning Language
Spearman's rho	English score	**Correlation Coefficient**	**1.000**	**-.210**[**]
		Sig. (2-tailed)	**.**	**.000**
		N	512	512
	Early Learning Language	**Correlation Coefficient**	**-.210**[**]	1.000
		Sig. (2-tailed)	**.000**	**.**
		N	512	512

**. Correlation is significant at the 0.01 level (2-tailed).

English mean scores by Early Learning Language (ELL) groups

English score
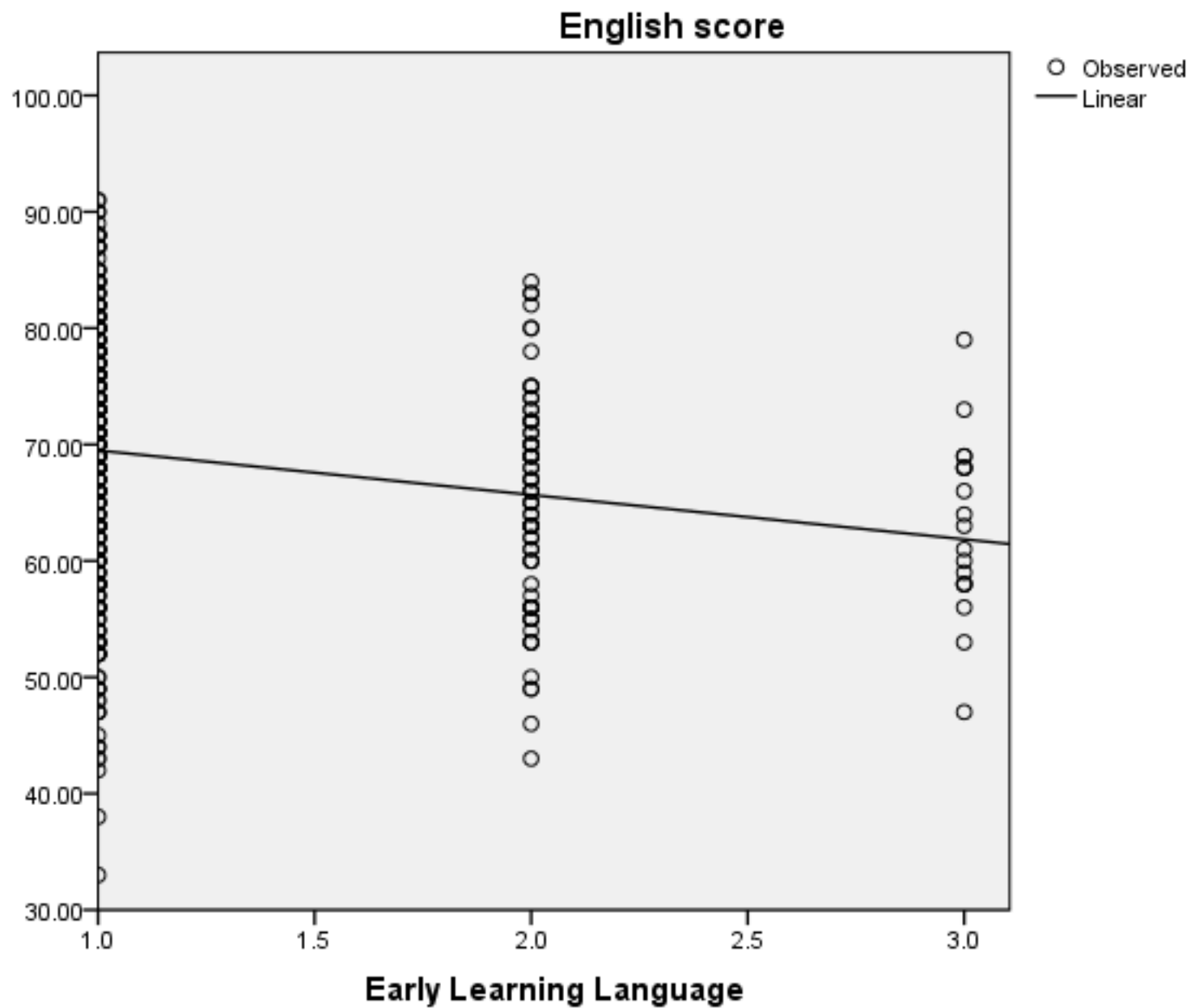
Overall mean scores by Early Learning Language (ELL) groups

Average Score
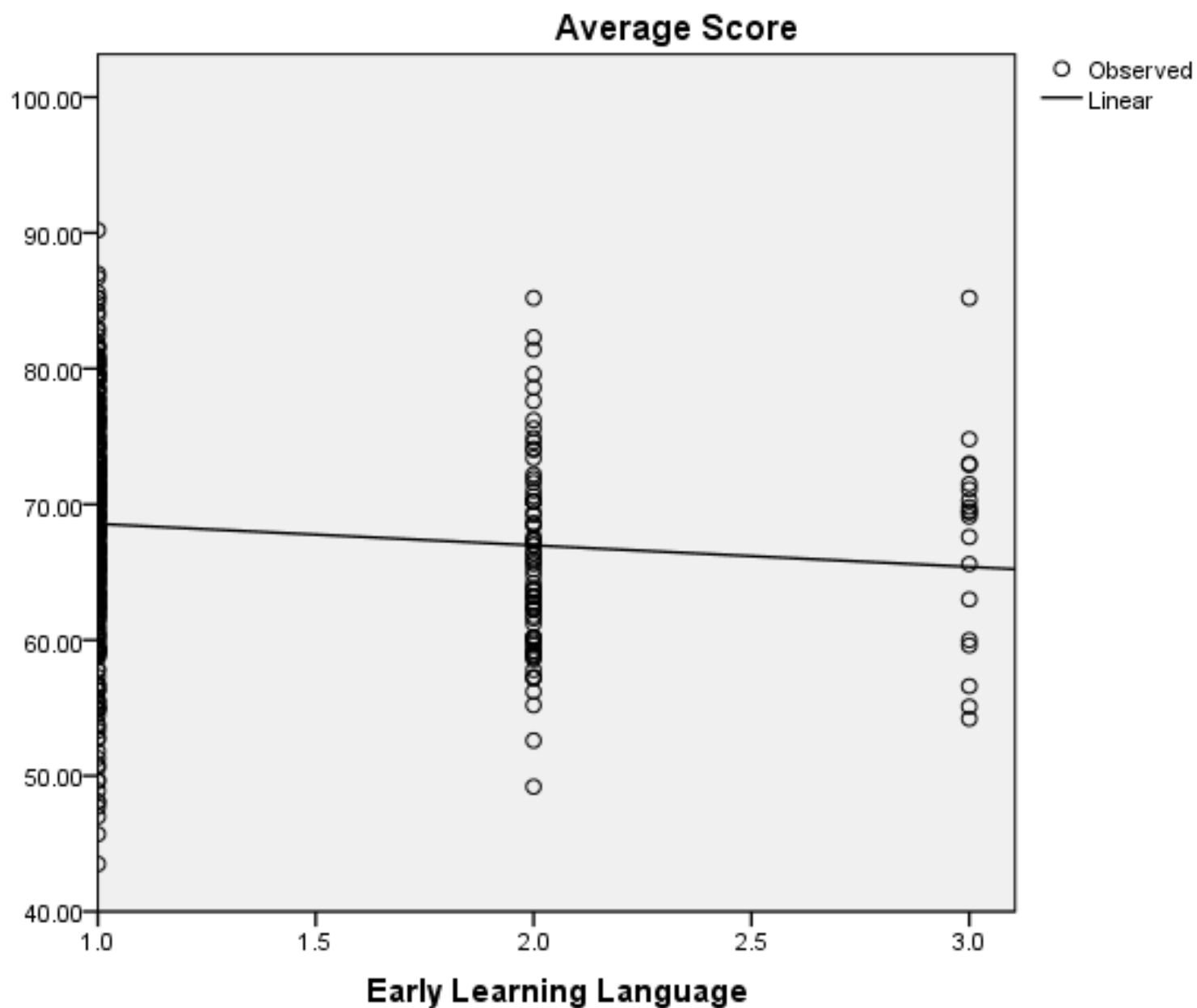
Correlation does not necessarily mean causation

Many complex, interrelated socio-economic and cultural factors are at play:

- logistical difficulties
- Low literacy rates
- Low family incomes
- lack of government funding
- Lack of planning
- Lack of infrastructure/ trained teachers /teaching materials
- Cultural perceptions/attitudes (particularly to girls' education), etc.

These issues present serious challenges in raising education and literacy levels in PNG.

Kanabea: 2012 El. 3 class (>100 students)

CONSEQUENCIES: Ages in Grade Levels for Kikori District
(R. & D. Petterson: 2016)

	EP	1	2	3	4	5	6	7	8
Median	8	10	11	13	13	14	16	18	19
Min	4	4	5	8	8	10	12	14	12
Max	**14**	**16**	**17**	**22**	**18**	**19**	**22**	**24**	**23**
N	326	307	301	168	86	162	114	72	47

Main Conclusions

1. All the ANOVAs showed statistically significant variance ($p < 0.05$) between
   - **AO** and students' mean overall/ English scores
   - **A@L** and students' mean overall/ English scores
   - **ELL** and the students' mean overall/ English scores.

2. All correlation and regression tests run showed a weakish but significant inverse correlation (Sig. < 0.01, two-tailed) between

   - **AO** and students' mean overall/ mean English scores
   - **A@L** and mean overall/ mean English scores
   - **ELL** (English, Tok Pisin & Vernacular) and the students' mean overall/ mean English scores.

3. These results follow the trends observed in our 2015 UPNG study (LSPNG Proceedings 2015)

More research will be done

This study – 1st stage of a larger project

Our expanded study will analyze data from all six NHSs in PNG (Sogeri, Aiyura, Wawin, PASSAM and Kerevat)

With a database in excess of 3000 students, we hope to make a more meaningful contribution to the debate on the effects AO on SLA and help shape an effective bilingual education policy for PNG.

THANK YOU VERY MUCH FOR YOUR ATTENTION!

THANK YOU ALL VERY MUCH FOR YOUR ATTENTION!

And **SPECIAL THANKS** to all the NHS Principals without whose collaboration this study would not have happened!

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