ACADEMIA BRASILEIRA DE CIÊNCIAS

MCMXVI

#imaginando o futuro REUNIÃO MAGNA 2018

Mapeamento Mental com Palavras: Aplicações em Psiquiatria e Educação

Sidarta Ribeiro

Universidade Federal do Rio Grande do Norte

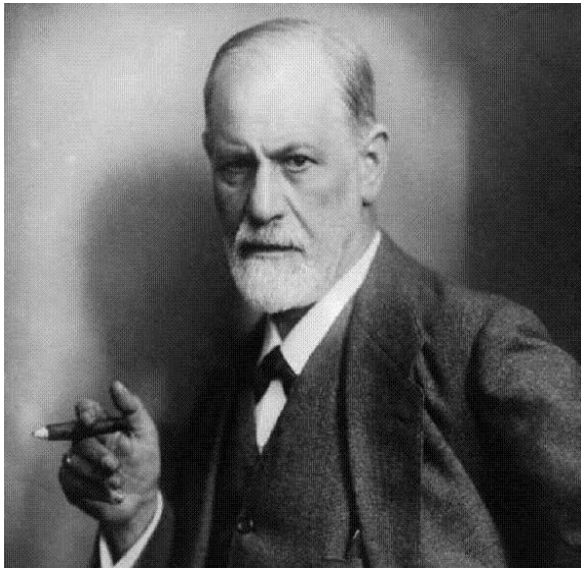
INSTITUTO DO CÉREBRO

Hospital do Juquery

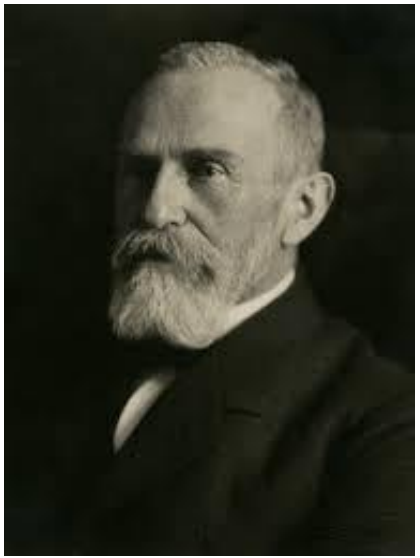
UnB

Marco Marcondes de Moura, M.D., Ph.D.
07/05/2018

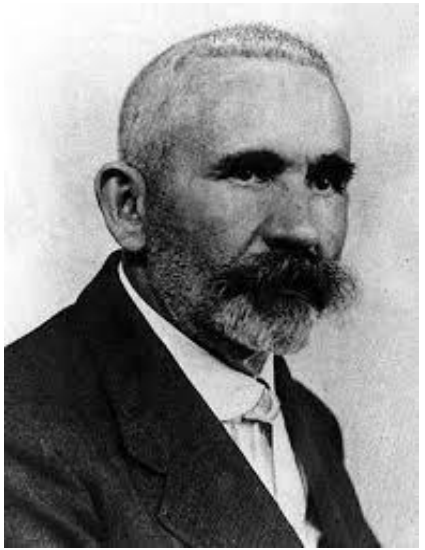
There are major similarities between dream and psychosis



Freud



Bleuler



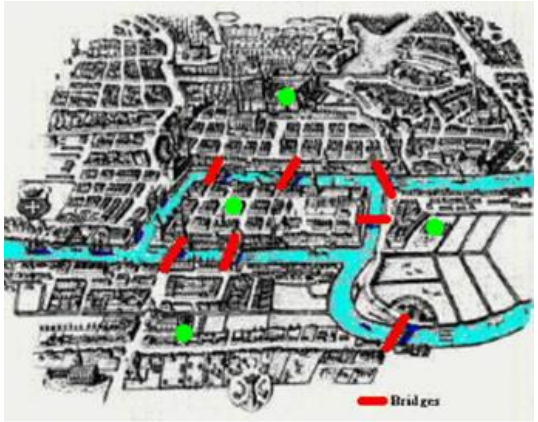
Kraepelin

Psychosis occurs in schizophrenia and bipolar disorder with language symptoms:

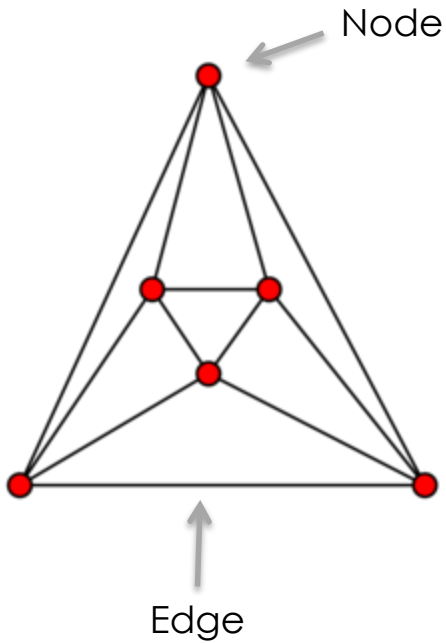
Thought disorganization, Flight of thoughts, Alogia, Logorrhea, Word salad

If psychosis affects language structure, graph theory is a natural tool to study the problem

Leonhard Euler
"Seven bridges of *Konigsberg*"
(1736)



Is there a path that crosses each bridge exactly once and returns to the starting point?



Back in 2006, in Natal...

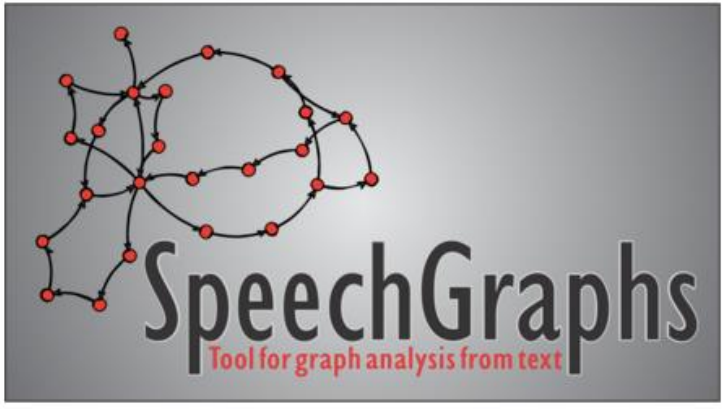
Natália Mota
PhD student

Mauro Copelli, PhD
Federal University of Pernambuco

SPEECHGRAPHS

Introduction

The SpeechGraph software is a graph-theoretical analysis tool that uses text as input and graph features as output. SpeechGraph can run on many different platforms such as Linux, Windows and OSX.



Logo by G. M. Silva

Documentation

We provide a User Guide as a PDF inside the software package, with a thorough explanation of all software functions. Alternatively, you can download it here.

Download

You can download the latest version of the SpeechGraphs tool right here. The current sofware version is 1.0.

LAST ENTRIES

2016-02-05| Pós-graduação em Bioinformática está com inscrições abertas para mestrado e doutorado

2016-01-18| Hippocampal Respiration-Driven Rhythm Distinct from Theta Oscillations in Awake Mice

2016-01-04| Instituto do Cérebro e de Medicina Tropical promovem ação científica e cultural de combate ao Aedes

2015-12-04| Instituto do Cérebro participa de reunião sobre Aedes aegypti em Brasília

2015-12-02| FUNPEC assina contrato para construção do Instituto do Cérebro

2015-12-01| Simpósio sobre Cognição Imune e Neural inicia programação nesta quinta-feira, 3

2015-11-30| Grid Cells and Place Cells: An Integrated View of their Navigational and Memory Function

2015-11-26| Lia Bevilaqua explica como o cérebro pode se "viciar" em aprender

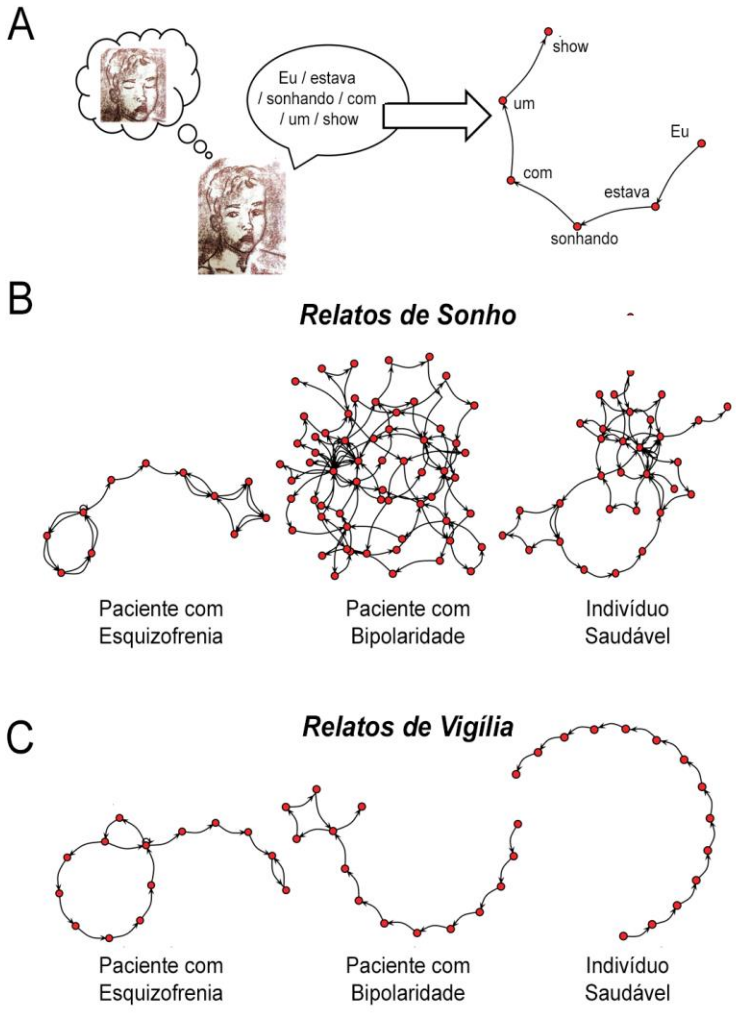
2015-11-24| Impaired Processing in the Primary Auditory Cortex of an Animal Model of Autism

2015-11-18| Marcos Romualdo Costa fala sobre Neurociência

2015-11-12| Instituto do Cérebro abre

Dream Report

Waking Report



OPEN ACCESS Freely available online

PLoS one

Speech Graphs Provide a Quantitative Measure of Thought Disorder in Psychosis

Natalia B. Mota[1,2,3], Nivaldo A. P. Vasconcelos[1,4,5], Nathalia Lemos[1], Ana C. Pieretti[1], Osame Kinouchi[6], Guillermo A. Cecchi[7], Mauro Copelli[8], Sidarta Ribeiro[1]*

1 Brain Institute, Federal University of Rio Grande do Norte, Natal, Brazil, **2** Hospital Onofre Lopes, Federal University of Rio Grande do Norte, Natal, Brazil, **3** Edmond and Lily Safra International Institute of Neuroscience of Natal, Natal, Brazil, **4** Faculdade Natalense para o Desenvolvimento do Rio Grande do Norte, Natal, Brazil, **5** Department of Systems and Computation, Federal University of Campina Grande, Campina Grande, Brazil, **6** Department of Physics, Universidade de São Paulo, Ribeirão Preto, Brazil, **7** Biometaphorical Computing, Computational Biology Center, IBM Research Division, IBM T. J. Watson Research Center, Yorktown Heights, New York, United States of America, **8** Department of Physics, Federal University of Pernambuco, Recife, Brazil

OPEN

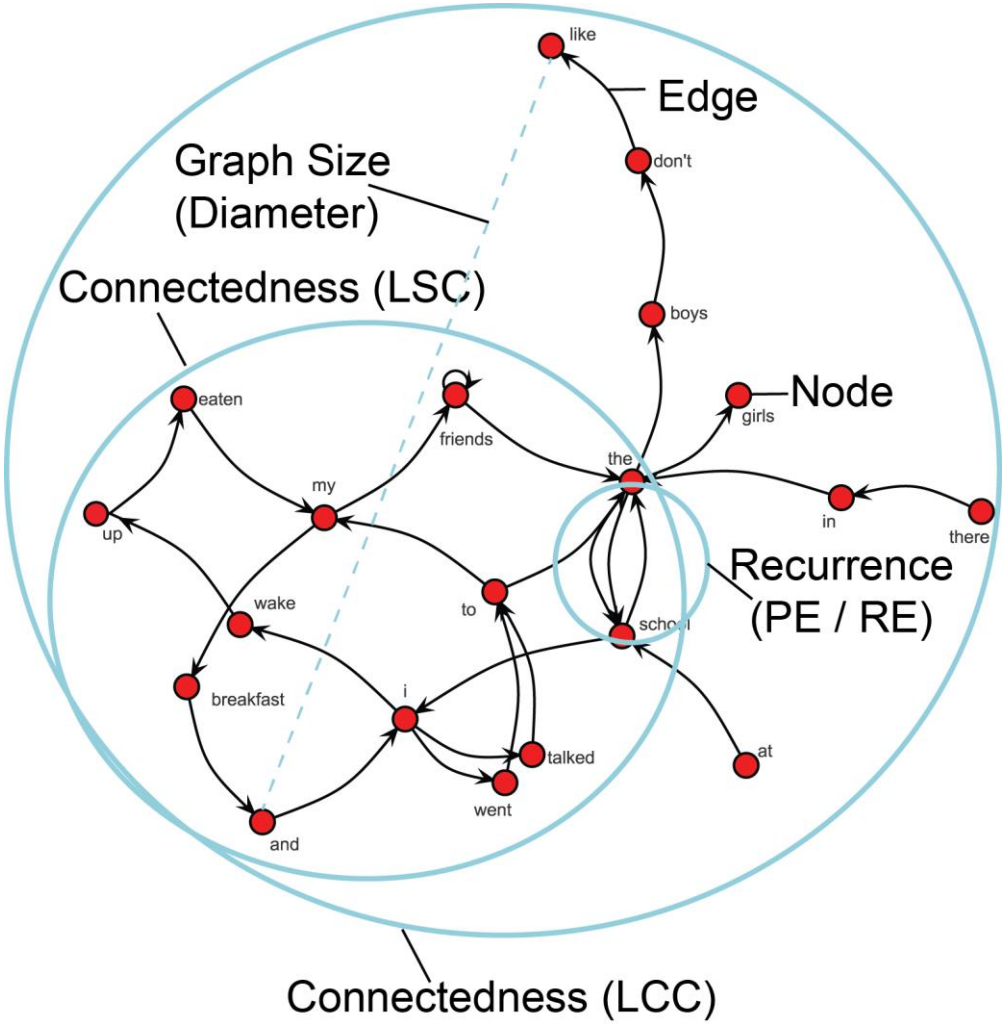
SUBJECT AREAS:
APPLIED PHYSICS
HUMAN BEHAVIOUR
DIAGNOSTIC MARKERS

Graph analysis of dream reports is especially informative about psychosis

Natália B. Mota[1], Raimundo Furtado[1], Pedro P. C. Maia[1], Mauro Copelli[2]* & Sidarta Ribeiro[1]*

[1]Brain Institute, Federal University of Rio Grande do Norte (UFRN), Natal, Brazil, Postal Code: 59056-450, [2]Physics Department, Federal University of Pernambuco (UFPE), Recife, Brazil, Postal Code: 50670-901.

Graph Attributes

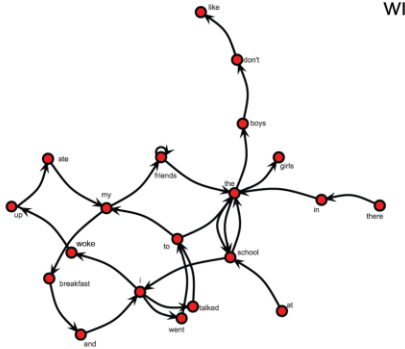


Moving window averages to control for verbosity differences

I woke up, ate my breakfast and I went to the school. There, in the school, I talked to my friends, friends, the girls. At school the boys don't like to play with me. At home I studied, ate my dinner and went to sleep.

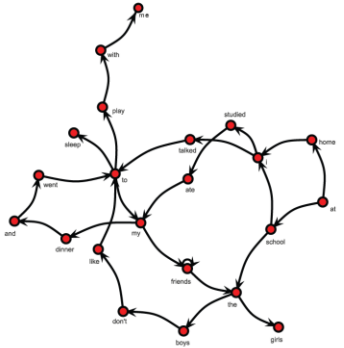
window k

window k+1

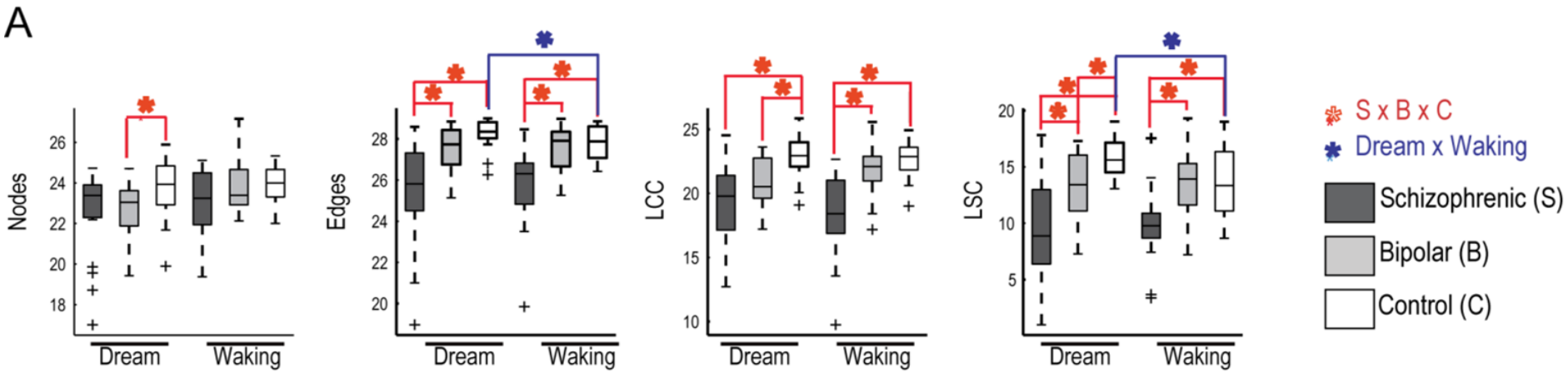


graph for window k

$$\text{Mean value} = \frac{\sum_{k=1}^{n} \text{Graph attribute value per window}}{\text{Number of windows}}$$



graph for window k+1


A
Nodes
Edges
LCC
LSC
Dream
Waking
S x B x C
Dream x Waking
Schizophrenic (S)
Bipolar (B)
Control (C)

How specially informative are the dream reports?

Sample:

21 subjects on first psychotic episode, ages 14.95 ± 3.21

Followed for 6 months and then diagnosed with either schizophrenia or bipolar disorder

21 well-matched healthy subjects

Reports:

1. Dream
2. Negative image
3. Positive image
4. Neutral image
5. Yesterday memory
6. Oldest memory

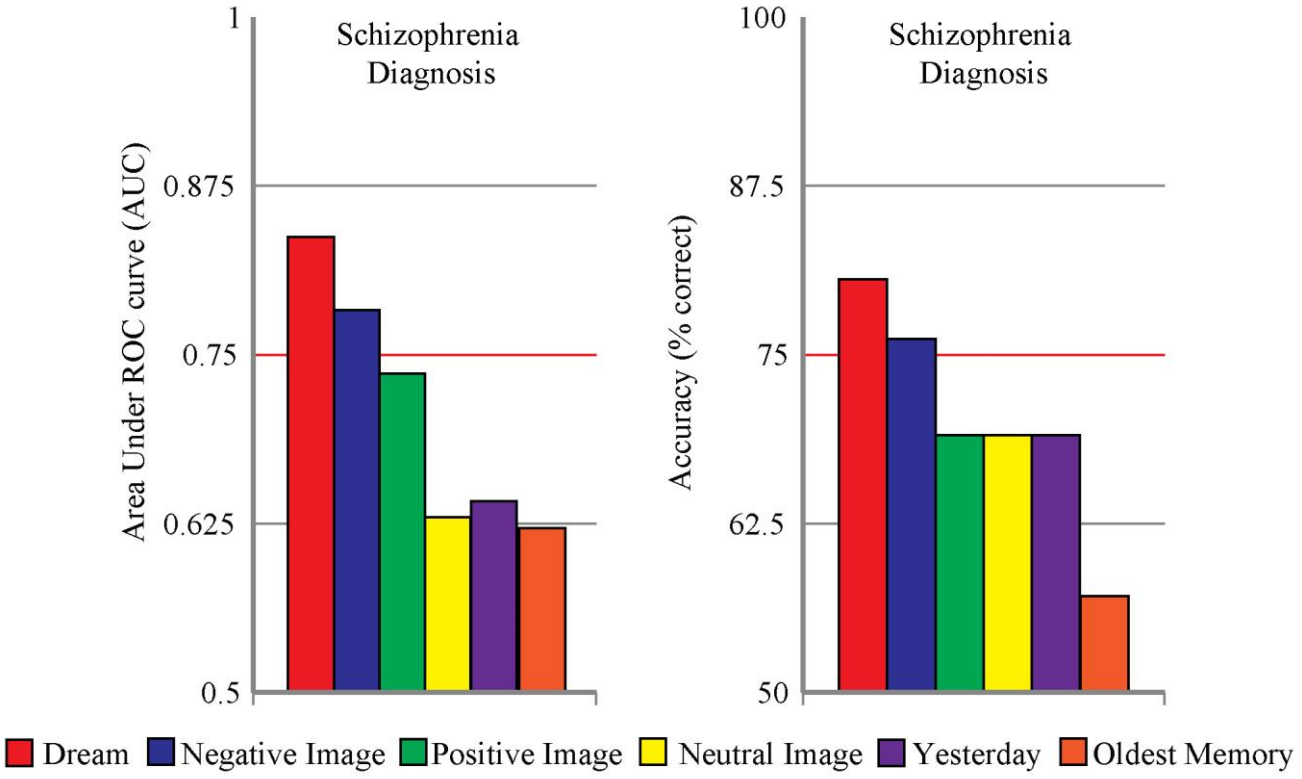
npj | Schizophrenia

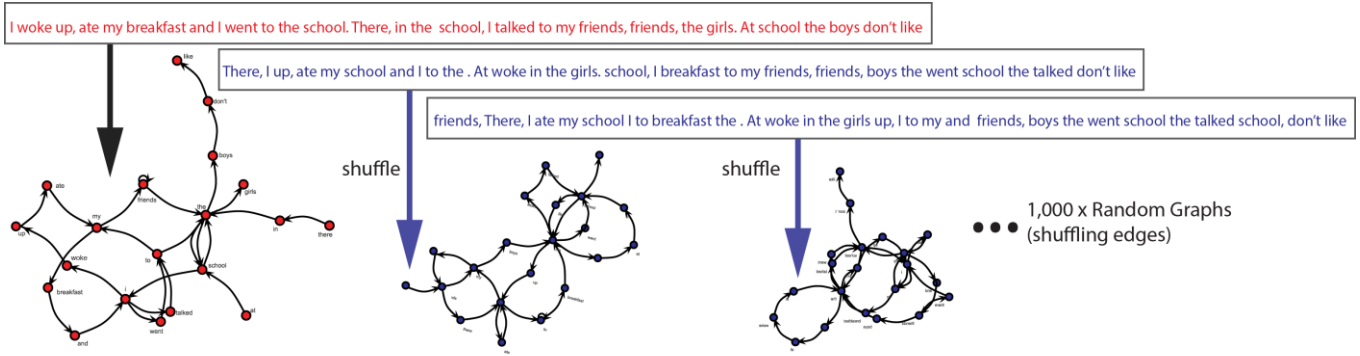
www.nature.com/npjschz

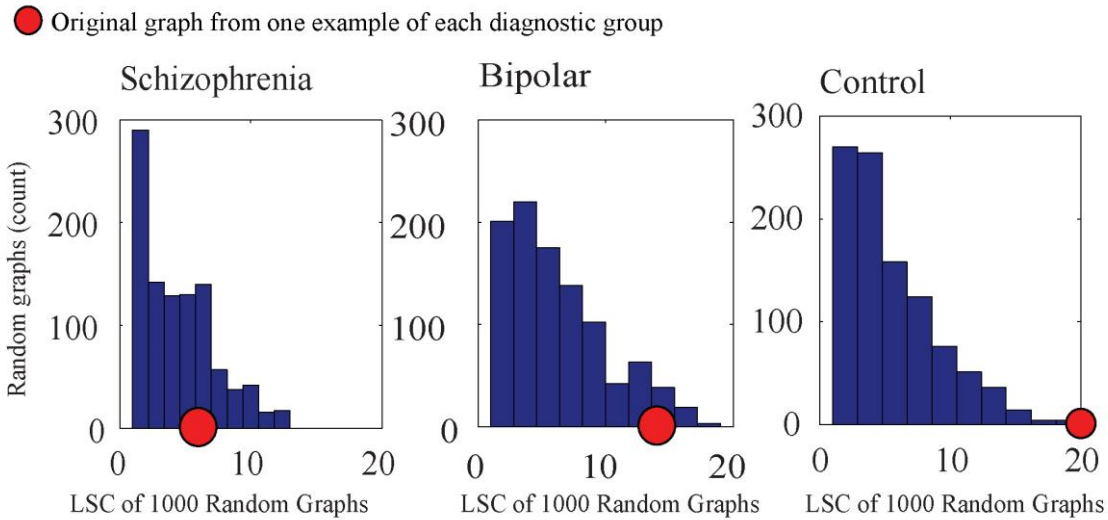
ARTICLE OPEN

Thought disorder measured as random speech structure classifies negative symptoms and schizophrenia diagnosis 6 months in advance

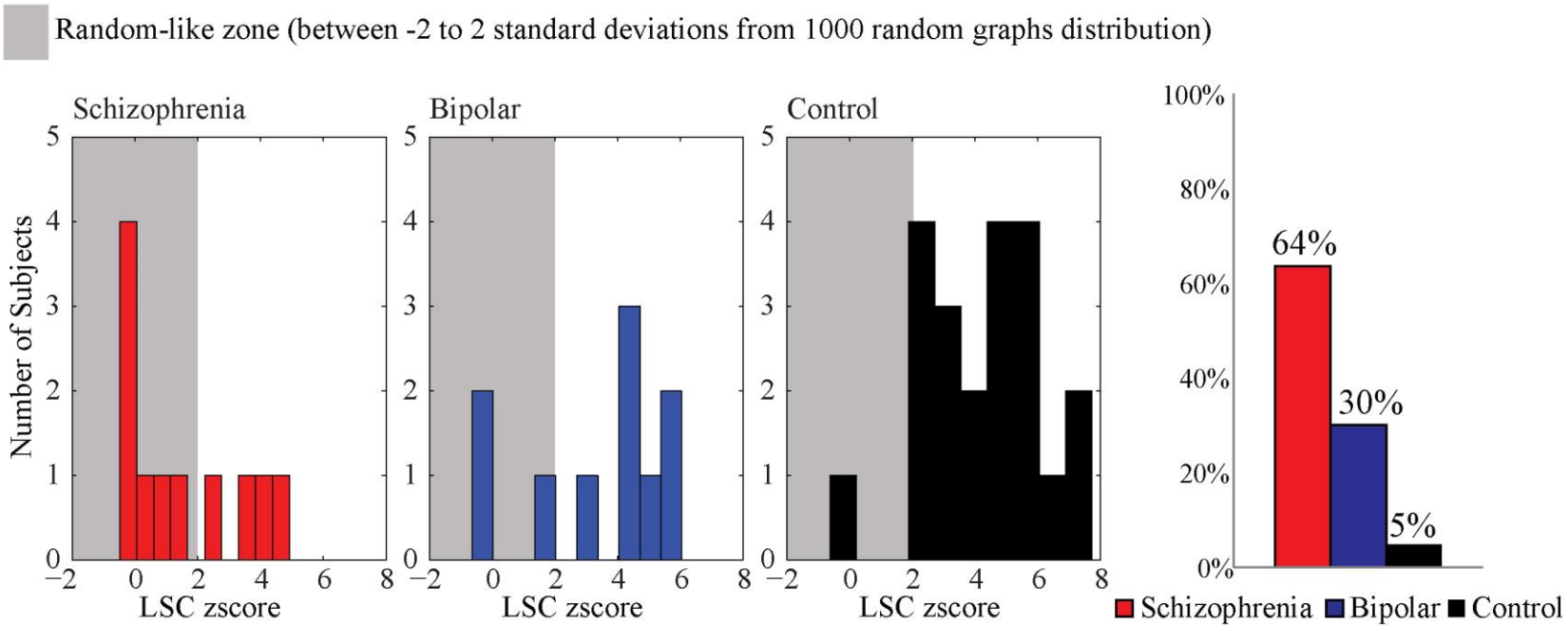
Natália B. Mota[1], Mauro Copelli[2] and Sidarta Ribeiro[1]


Schizophrenia
Diagnosis
Area Under ROC curve (AUC)
1
0.875
0.75
0.625
0.5
Schizophrenia
Diagnosis
Accuracy (% correct)
100
87.5
75
62.5
50
Dream
Negative Image
Positive Image
Neutral Image
Yesterday
Oldest Memory


I woke up, ate my breakfast and I went to the school. There, in the school, I talked to my friends, friends, the girls. At school the boys don't like
There, I up, ate my school and I to the . At woke in the girls. school, I breakfast to my friends, friends, boys the went school the talked don't like
friends, There, I ate my school I to breakfast the . At woke in the girls up, I to my and friends, boys the went school the talked school, don't like
shuffle
shuffle
1,000 x Random Graphs
(shuffling edges)


Original graph from one example of each diagnostic group
Schizophrenia
Bipolar
Control
Random graphs (count)
300
200
100
0
0
10
20
LSC of 1000 Random Graphs

Measuring structural randomness in speech



Cognitive decline during psychosis
can be measured by graph analysis.

Could cognitive enhancement during normal
development and school education
be similarly measured?

MIND, BRAIN, AND EDUCATION

A Naturalistic Assessment of the Organization of Children's Memories Predicts Cognitive Functioning and Reading Ability

Natália Bezerra Mota[1], Janaína Weissheimer[1,2], Beatriz Madruga[3], Nery Adamy[1,4], Silvia A. Bunge[5], Mauro Copelli[6], and Sidarta Ribeiro[1]

Cognitive Development
(n=76 subjects, 6 to 8 years old)

Theory of Mind

Sally-Ann

Picture Sequence

<u>Verbal Reports:</u>

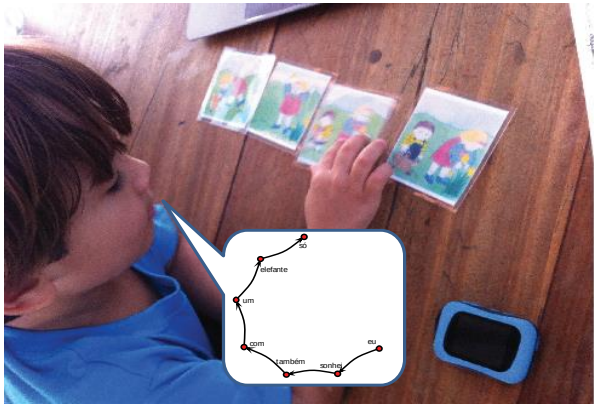
1. Short-term memories
2. Long-term memories

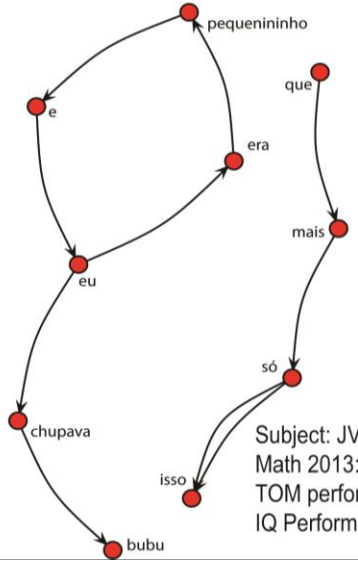
Intelligence Quotient: RAVEN

School Achievement: Reading and Math

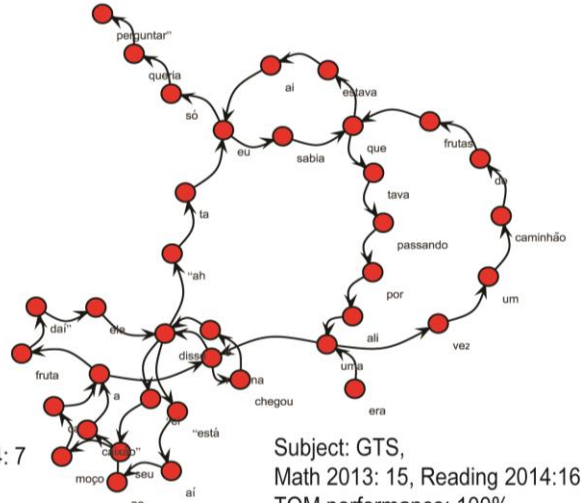
Low IQ, ToM and school performance

High IQ, ToM and school performance



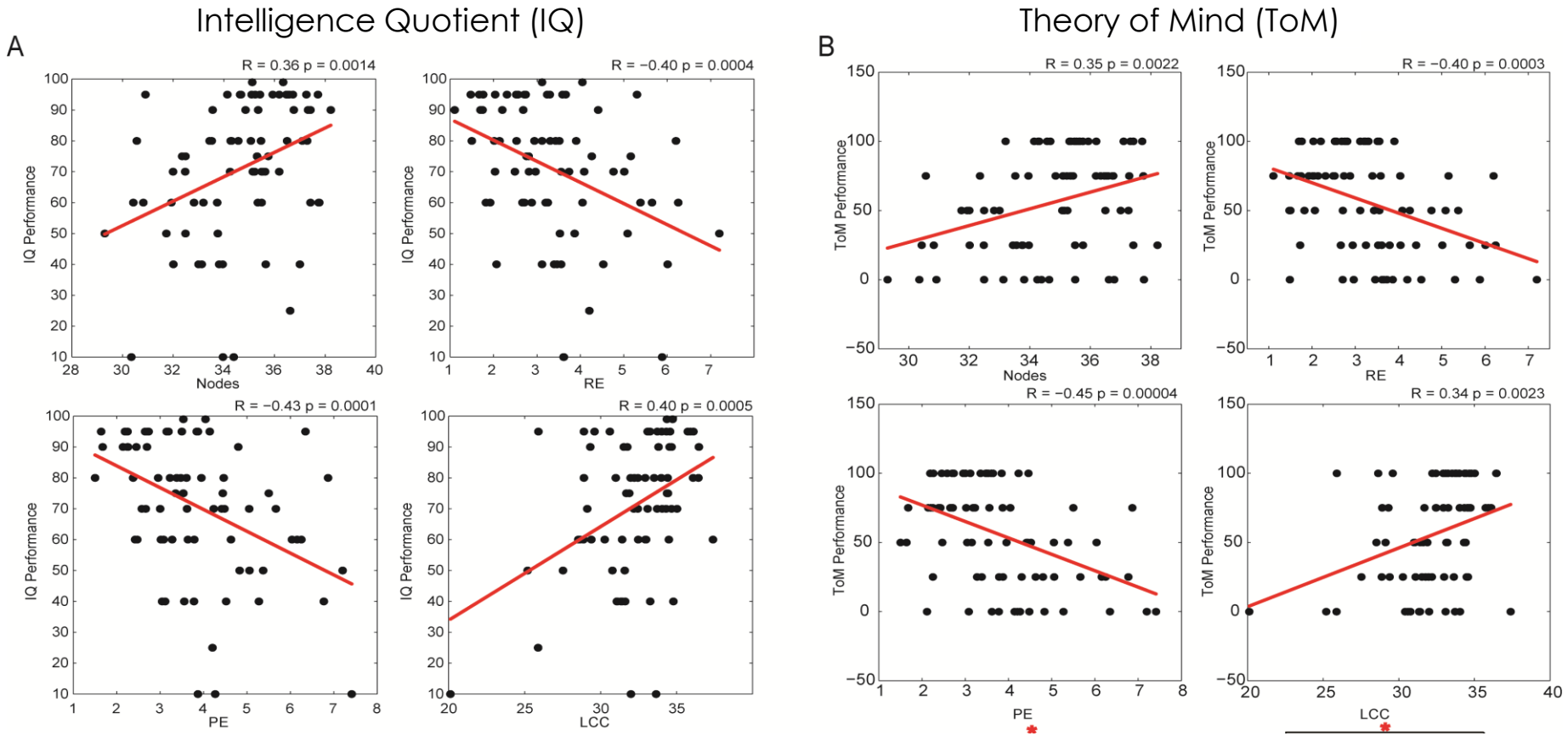


Subject: JVF,
Math 2013: 4, Reading 2014: 7
TOM performance: 0%
IQ Performance: 25%

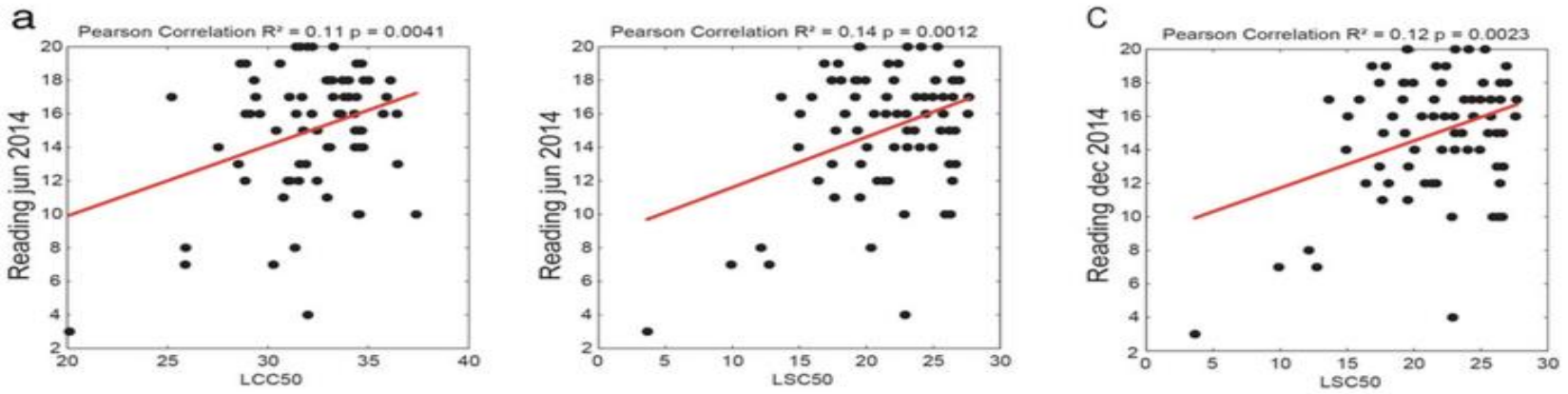


Subject: GTS,
Math 2013: 15, Reading 2014:16
TOM performance: 100%
IQ Performance: 80%

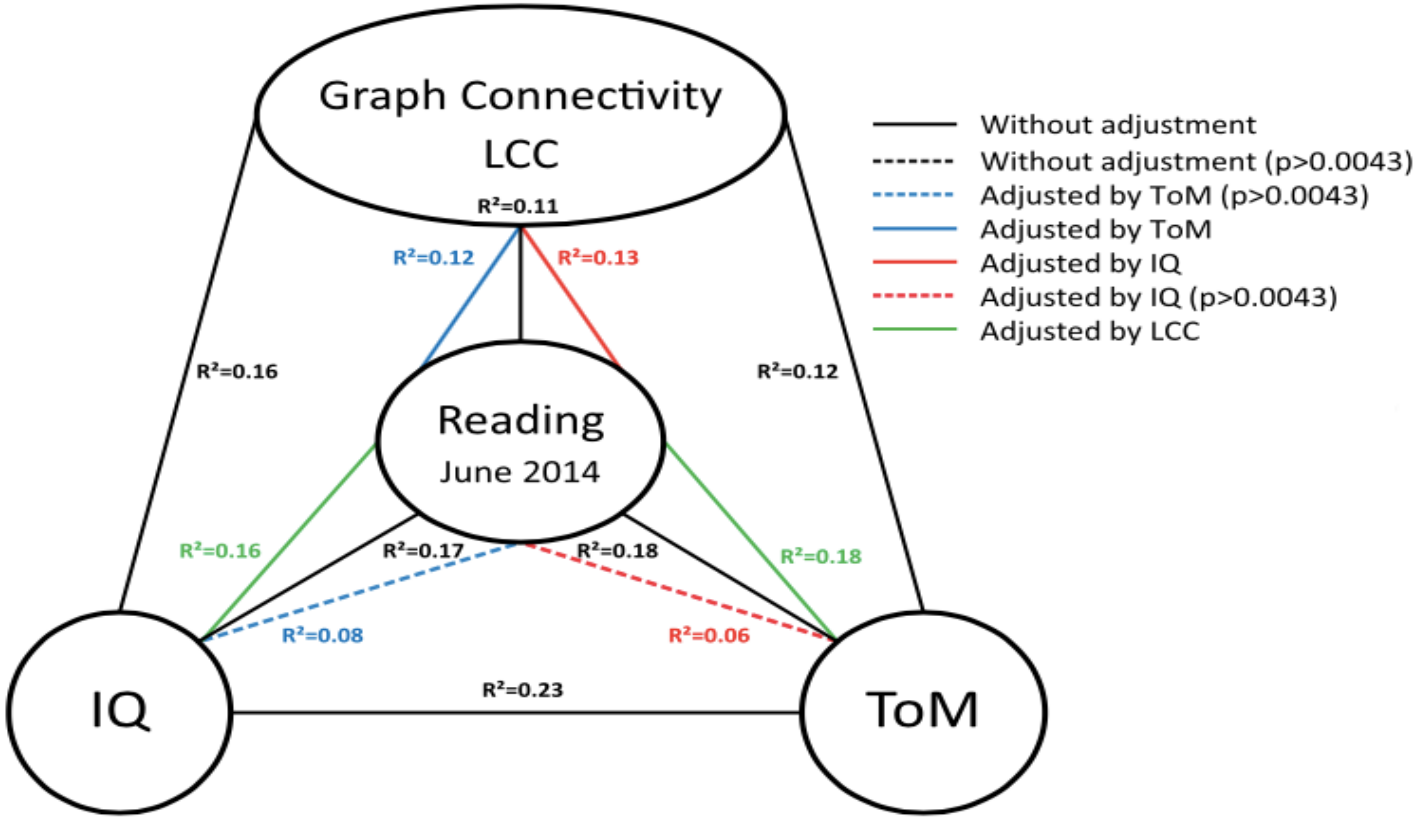
Graph attributes correlate with cognitive performance



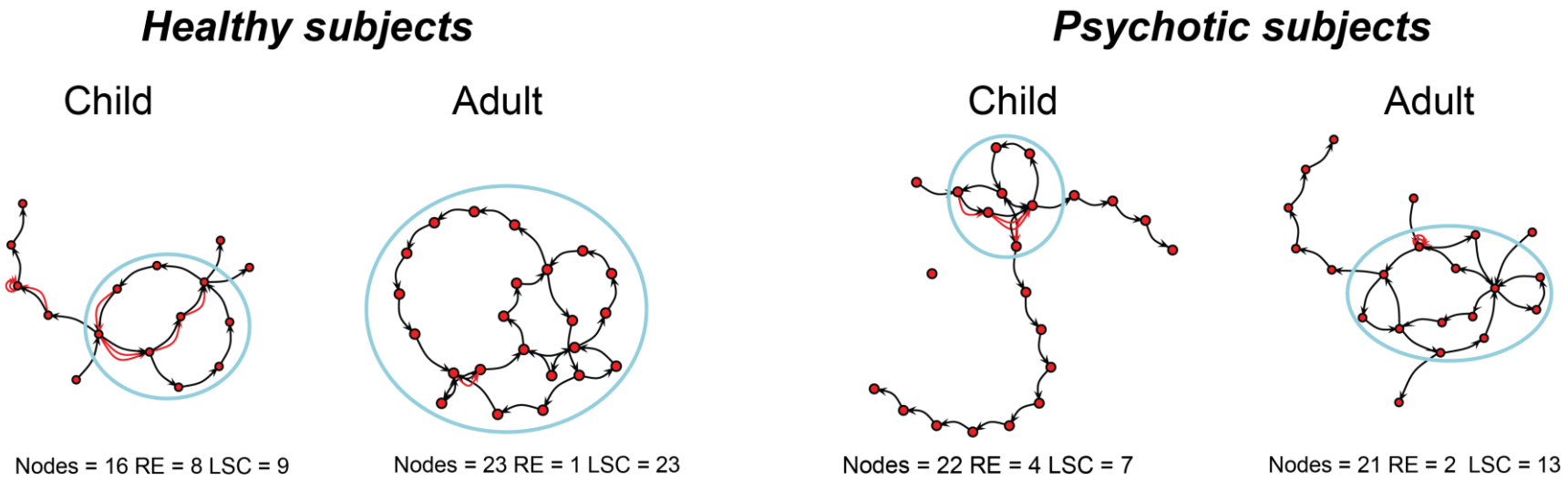
Graph attributes correlate with school performance



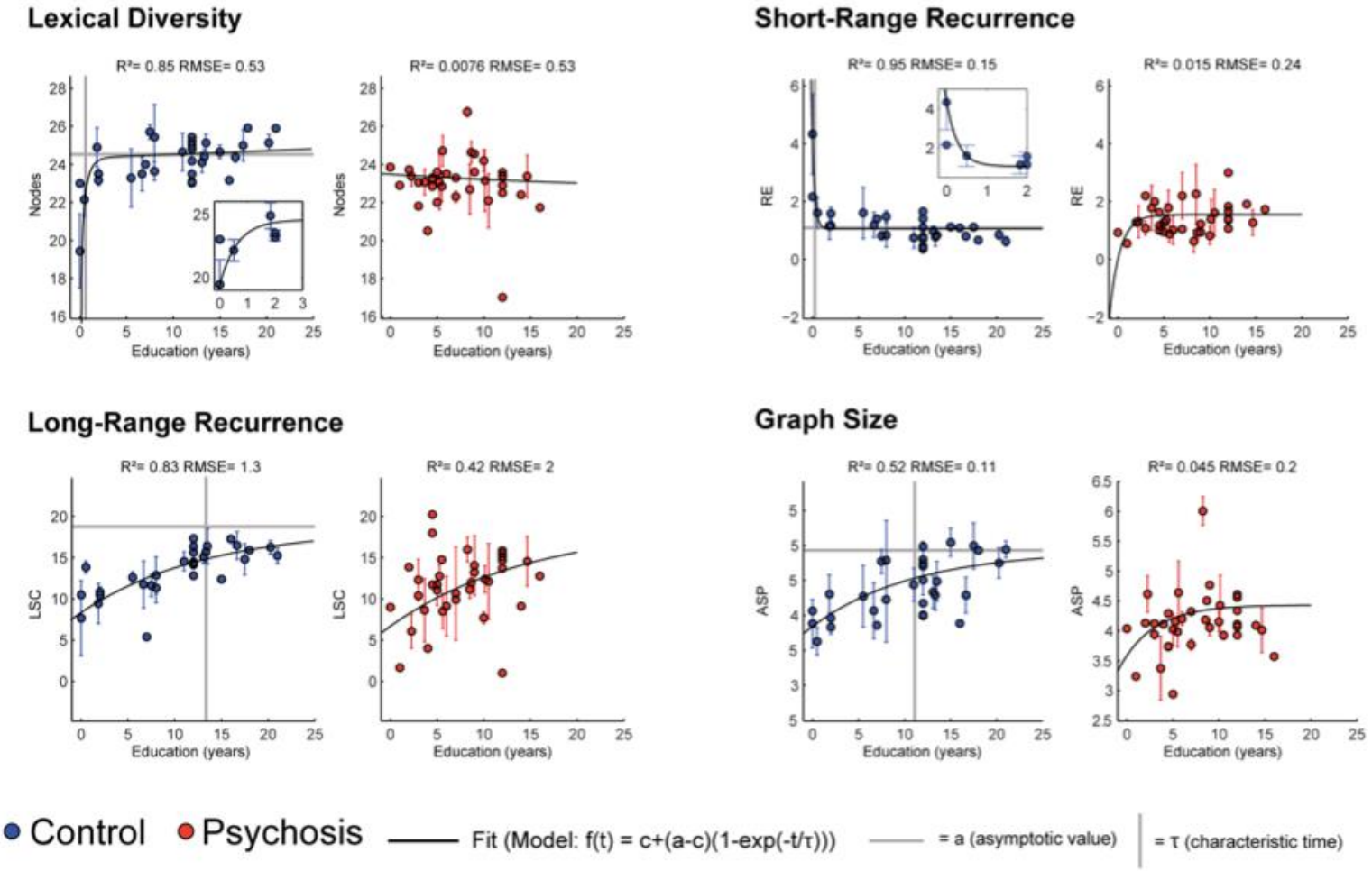
LCC correlates significantly with Reading even after adjusting for IQ or ToM



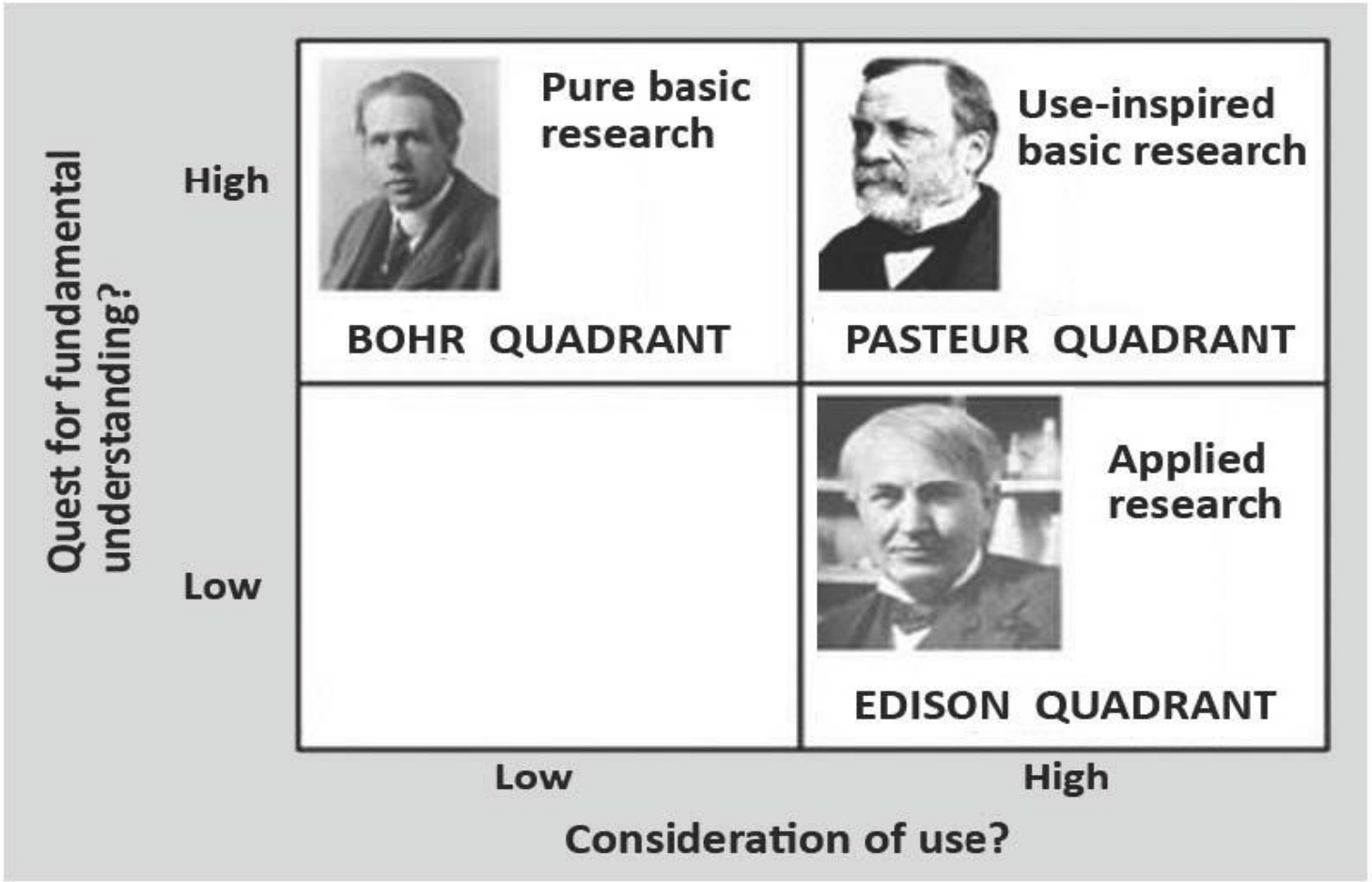
Comparison of typical and atypical development



Mota, Pinheiro et al (in review)

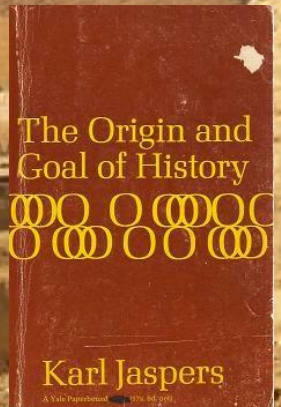


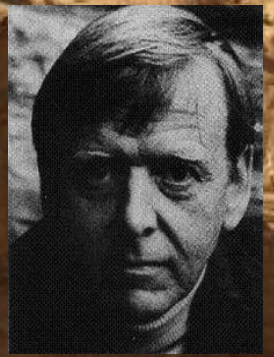
Mota, Pinheiro et al (in review)

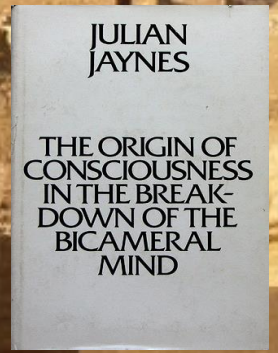

Quest for fundamental understanding?
High
Low
Pure basic research
BOHR QUADRANT
Use-inspired basic research
PASTEUR QUADRANT
Applied research
EDISON QUADRANT
Low
High
Consideration of use?

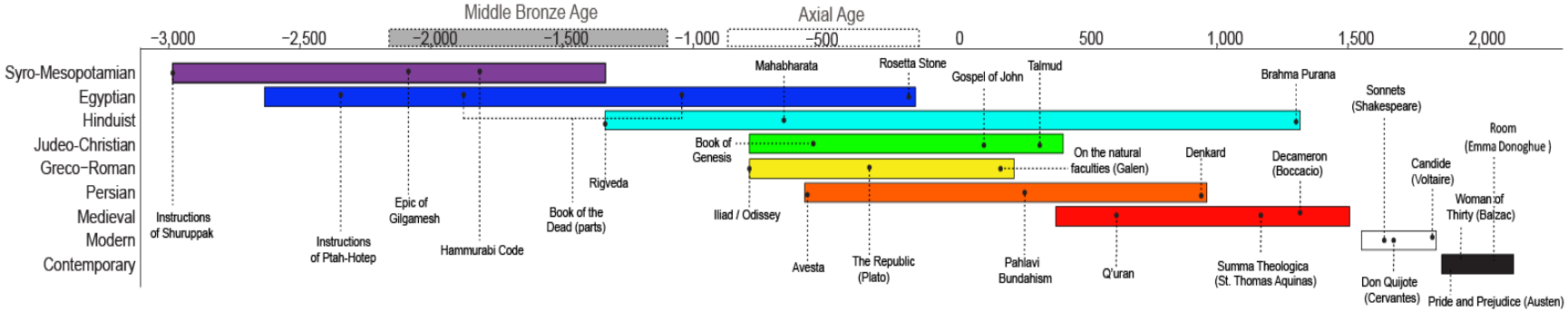
Could psychosis represent a trace of the immature human mind also at the historical level?

Do graph attributes change over time as civilizations mature, like they change as individuals mature?


The Origin and
Goal of History
Karl Jaspers

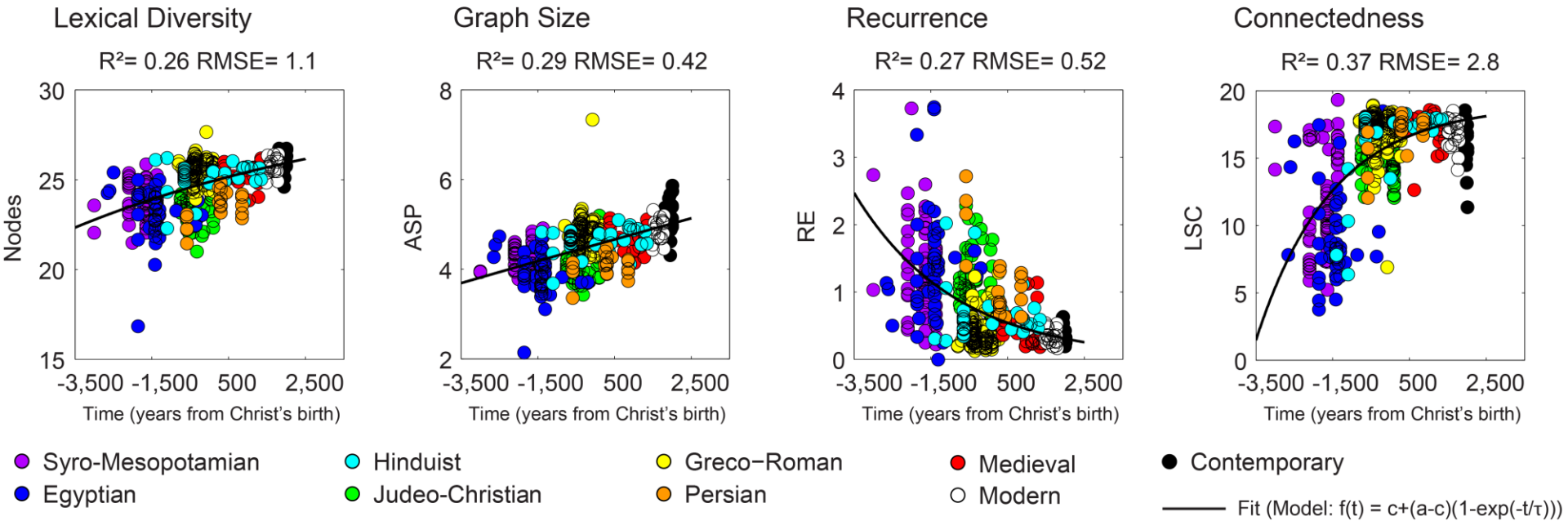


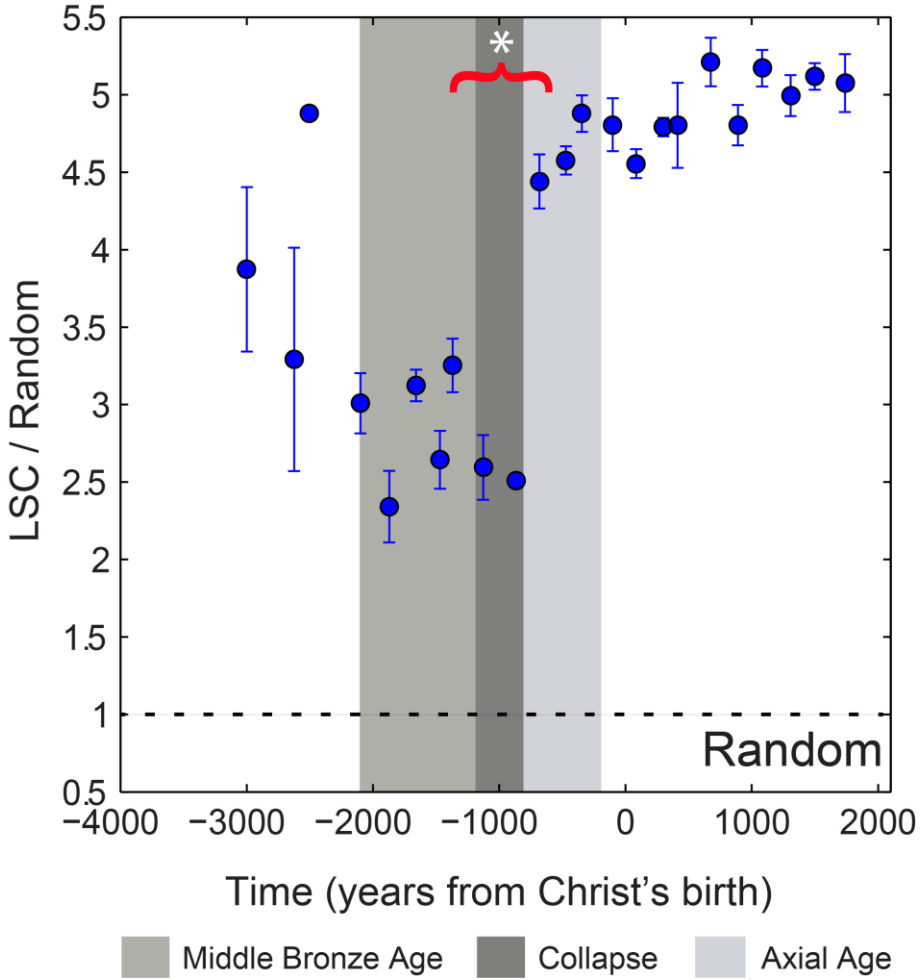

JULIAN
JAYNES
THE ORIGIN OF
CONSCIOUSNESS
IN THE BREAK-
DOWN OF THE
BICAMERAL
MIND



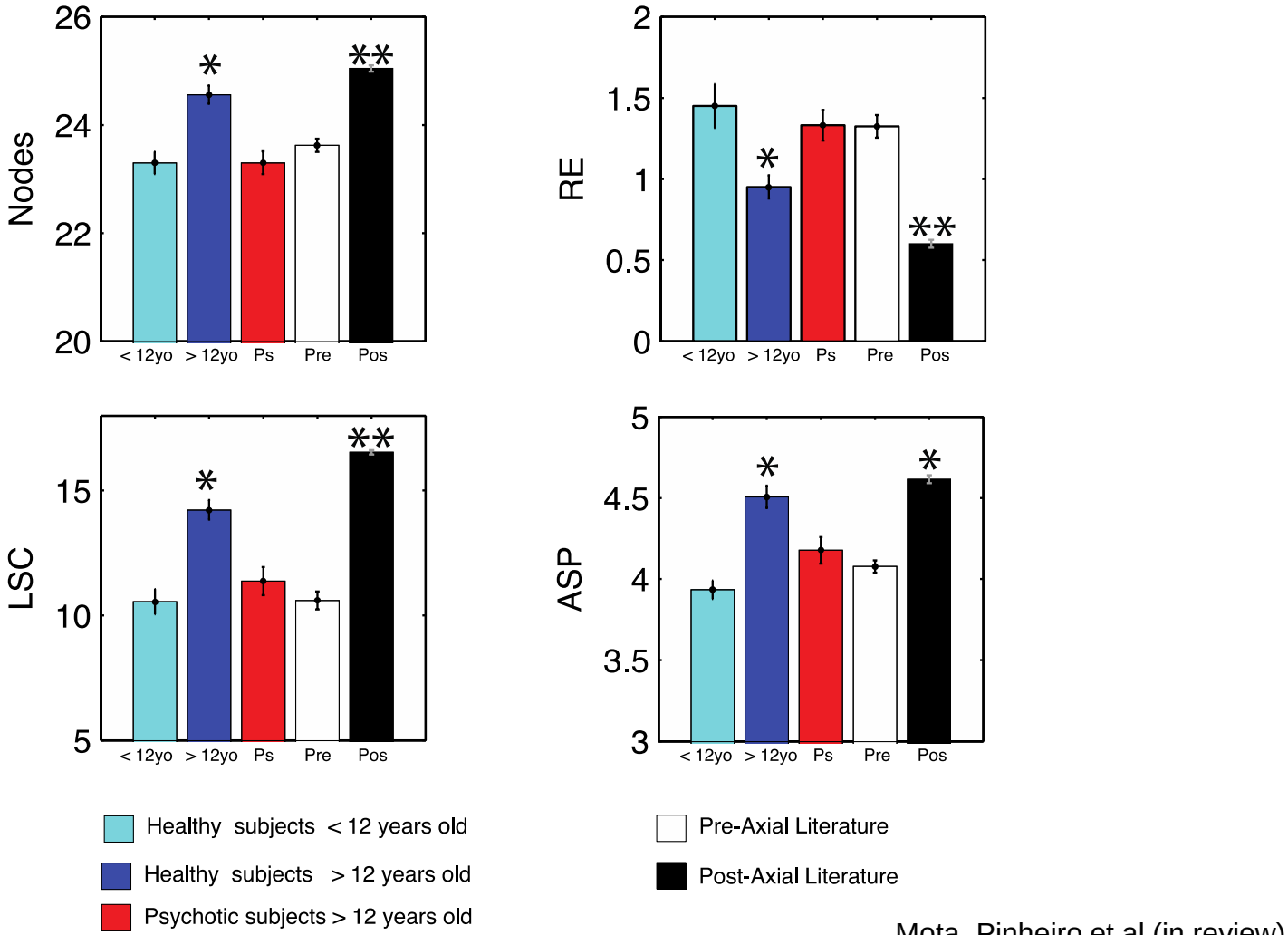
709 texts between -3,000 BCE and 2010 ACE

Syro-Mesopotamian; Egyptian; Judeo-Christian; Hinduism; Greco-Roman; Persian, Medieval; Modern; Contemporary

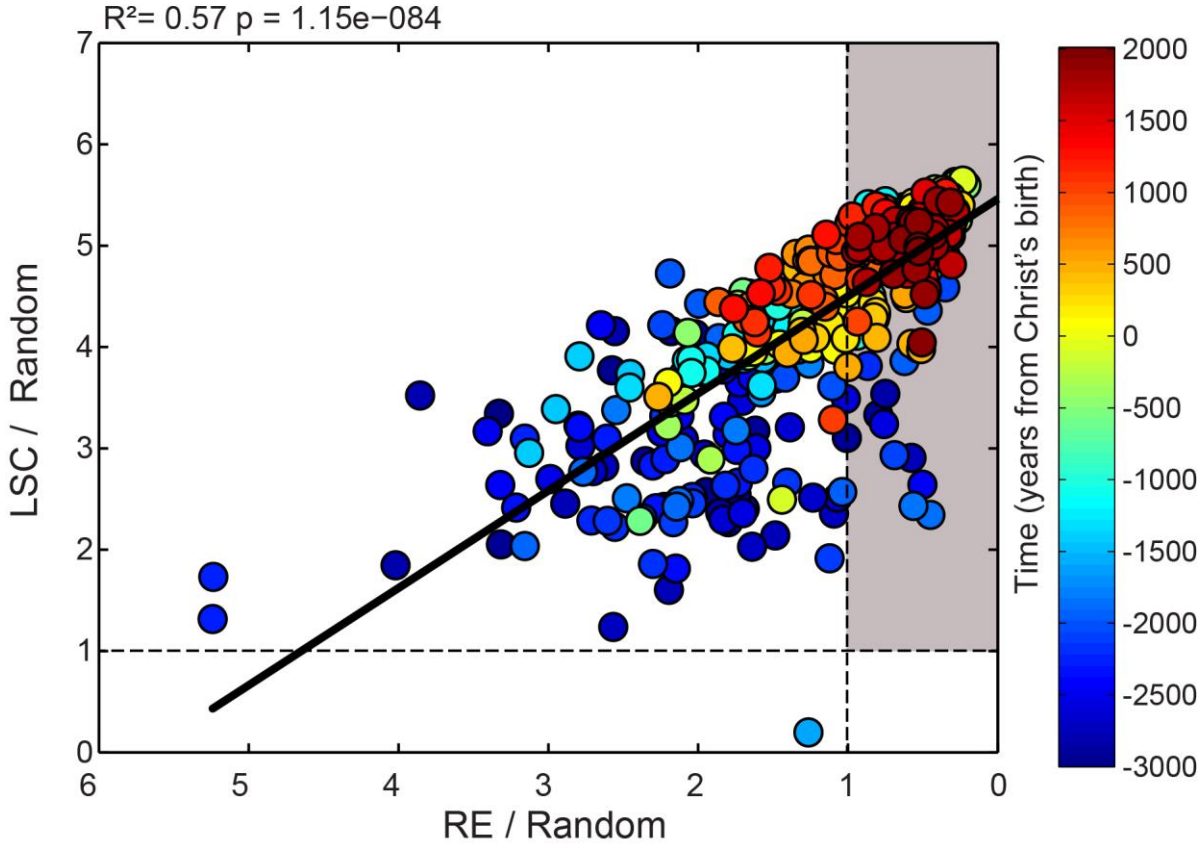

Lexical Diversity
R²= 0.26 RMSE= 1.1
Nodes
30
25
20
15
-3,500 -1,500 500 2,500
Time (years from Christ's birth)
Graph Size
R²= 0.29 RMSE= 0.42
ASP
8
6
4
2
-3,500 -1,500 500 2,500
Time (years from Christ's birth)
Recurrence
R²= 0.27 RMSE= 0.52
RE
4
3
2
1
0
-3,500 -1,500 500 2,500
Time (years from Christ's birth)
Connectedness
R²= 0.37 RMSE= 2.8
LSC
20
15
10
5
0
-3,500 -1,500 500 2,500
Time (years from Christ's birth)
Syro-Mesopotamian
Egyptian
Hinduist
Judeo-Christian
Greco−Roman
Persian
Medieval
Modern
Contemporary
Fit (Model: f(t) = c+(a-c)(1-exp(-t/τ)))



Mota, Pinheiro et al (in review)



Mota, Pinheiro et al (in review)



Mota, Pinheiro et al (in review)

CONCLUSIONS

I. Graph analysis provides useful quantitative information for psychiatric diagnosis and academic assessment.

II. Early literature is structurally similar to psychotic/childish speech.

III. There is a sharp empirical transition in text structure near the onset of the Axial Age (800 BC)

I. The history of writing recapitulates the effects that education has on a healthy adult's speech.

UNICEF 2015

11 children under 5 will die in the world from any cause associated with poverty…


DIADORA
PIRELLI

Most people agree

that the solution must be provided by schools,

but how to achieve effective schooling?

Schools have not changed much in the past 4,500 years…

Sumerian “Eduba”

The daily monitoring of each student's cognitive trajectory is now possible and desirable

Low-cost hardware

One-laptop-per-child (OLPC)

Plan Ceibal (Uruguay)

There is plenty of software available to train and evaluate language (morpheme / grapheme, prosody, syntax, semantics), declarative knowledge, mathematical competence, etc.

Trends in Neuroscience and Education 3 (2014) 18–23

Contents lists available at ScienceDirect

Trends in Neuroscience and Education

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

Review Article

Sleep and school education

Sidarta Ribeiro [a,*], Robert Stickgold [b]

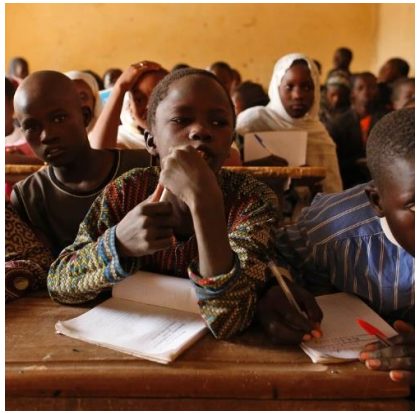
[a] Instituto do Cérebro, Universidade Federal do Rio Grande do Norte (UFRN), Natal, Brazil
[b] Center for Sleep and Cognition, Harvard Medical School, Beth Israel Deaconess Medical Center, Boston, USA

Prospects
DOI 10.1007/s11125-017-9393-x

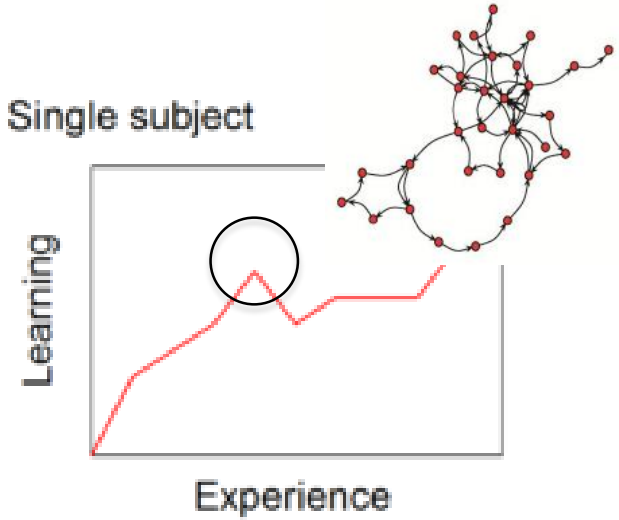
OPEN FILE

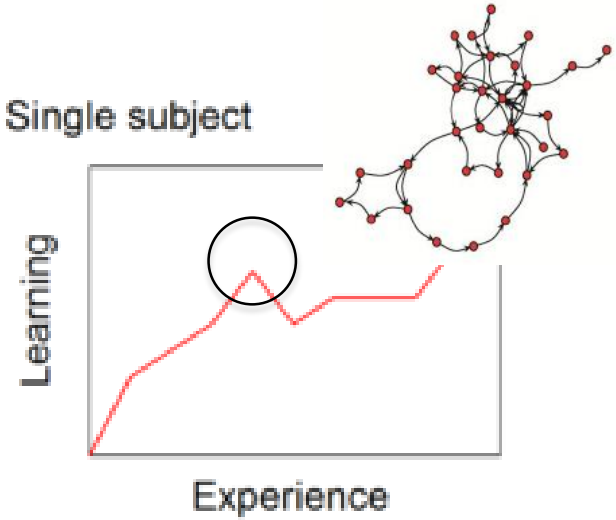
Physiology and assessment as low-hanging fruit for education overhaul

Sidarta Ribeiro[1] · Natália Bezerra Mota[1] · Valter da Rocha Fernandes[2] · Andrea Camaz Deslandes[3] · Guilherme Brockington[4] · Mauro Copelli[5]

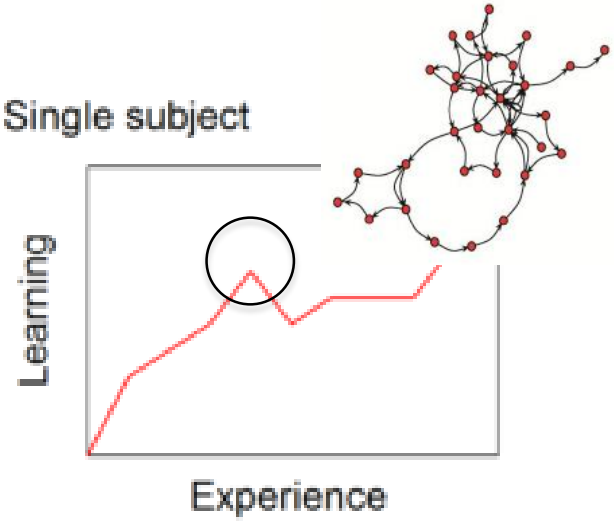



Single subject
Learning
Experience


Single subject
Learning
Experience


Single subject
Learning
Experience

Synergy and Self-Regulation



The optimized rotation of agricultural inputs
enhances food production
without extra inputs

Could the optimized rotation of educational inputs
enhance school learning
at no extra cost?

Towards an ecological cultivation of the mind

THE PEW CHARITABLE TRUSTS | Latin American Fellows Program in the Biomedical Sciences

Boehringer Ingelheim

NeuroMat

CpE

CNPq Conselho Nacional de Desenvolvimento Científico e Tecnológico

CAPES

Acknowledgments

HUOL
Hospital Universitário
Onofre Lopes

The Electronic Text Corpus of Sumerian Literature

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