Structural differences between non-lucid, lucid dreams and out-of-body experience reports assessed by graph analysis

Gallo Francisco[1,2], Tommasel Antonela[3], Herrero Nerea[1,2], Forcato Cecilia[1,2], Godoy Daniela[3] & Gleiser Pablo[4,5]

1 Laboratorio de Sueño y Memoria, Depto de Ciencias de la Vida, Instituto Tecnológico de Buenos Aires (ITBA), Buenos Aires, Argentina.
2 Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET), Buenos Aires, Argentina.
3 ISISTAN - Instituto Superior de Ingeniería de Software Tandil (CONICET/UNCPBA), Tandil, Bs. As., Argentina.
4 Department of Medical Physics, National Atomic Energy Commission (CNEA) Bariloche.
5 National University of Rio Negro.

ABSTRACT

It has been recently found using graph theory that measures of network structure can predict ratings of dream complexity, where increases in connectedness and decreases in randomness are observed in relation to increasing dream report complexity. This approach proved to be useful to differentiate dream reports in the pathological population as well as NREM and REM dream reports, but it has not yet been used to study the differences between different oneiric experiences.

In this work we analyze dream reports that include non-lucid, lucid dreams and out-of-body experiences initiated from sleep paralysis. The reports are presented as directed graphs, where each different word plays the role of a node, and consecutive words are connected by a directed, unweighted edge. We analyze different network measures to compare the graphs.

Preliminary results presented here suggest that both local measures, such as the degree of nodes, and global measures, such as clustering and the number of strongly connected components, allow for a categorization of different dream experiences.

METHODS

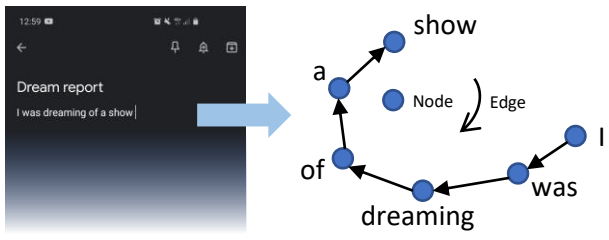
Data collection

Gender		Age	Dreams	
Female	97	34,81±10, 6	Normal	824
Male	76	33,13±11,5	Lucid	122
Other	1	31	OBE	68
			Sleep Paralysis	15
Total	**174**		False Awakening	9
			Total	1034

63 of 174 completed a Dream Journal for 2 month.

The collected dream narratives were converted into a graph using SpeechGraph java software developed by *Mota NB et.al. 2012,2013* (http://neuro.ufrn.br/softwares/speechgraphs)

What is a speech graph?



Speech Graphs are **directed multigraphs** that represent sequential word relationships in a speech.
Only the structure is kept, semantics is disregarded.

Lemmatization is a linguistic process that consists of finding the corresponding *lemma*, given an inflected form (i.e., plural, feminine, conjugated, etc.). The lemma is the form that by convention is accepted as representing all the inflected forms of the same word.

Speech graph examples

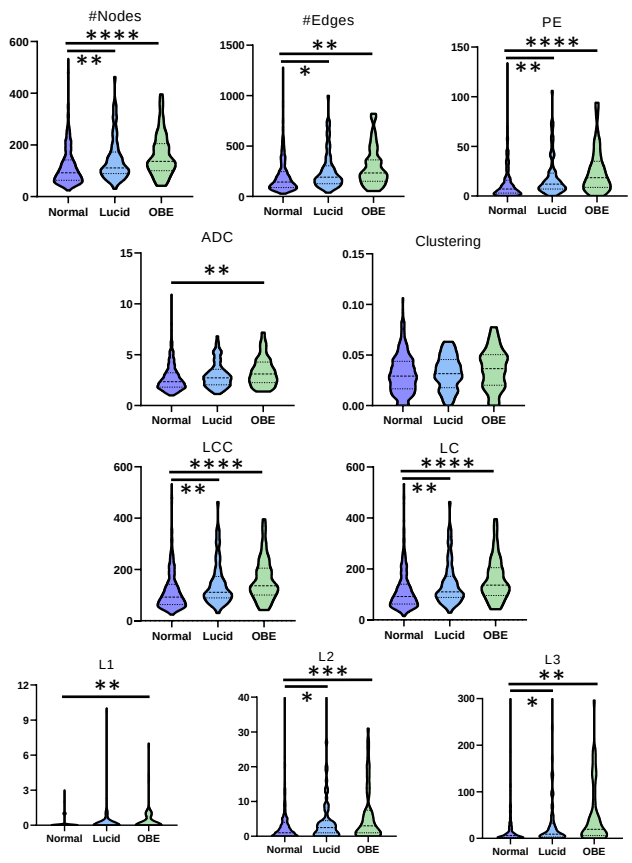
Naive graph

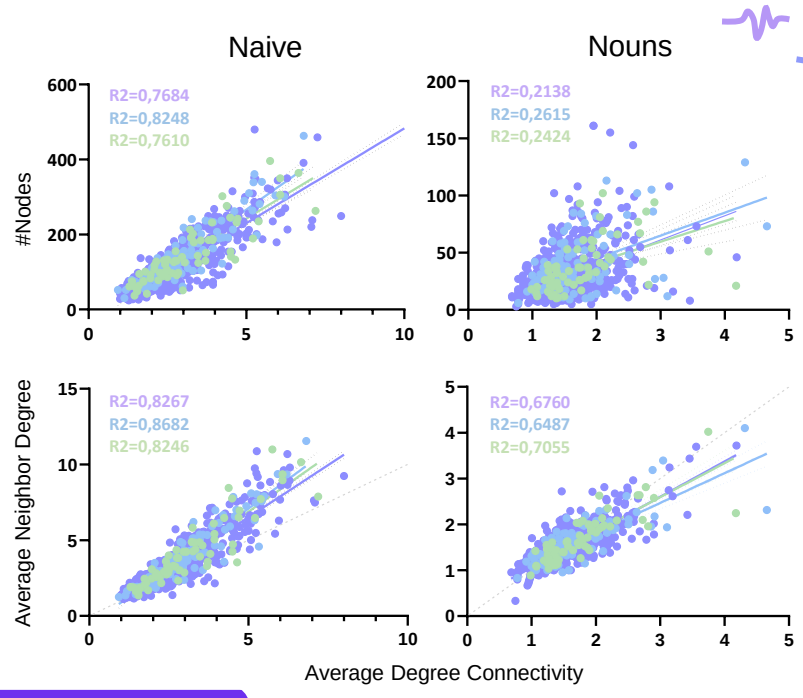
Lemmatization +noun selection

Noun graph

RESULTS

Speech Graph Attributes





CONCLUSIONS

We analyze different graph measurements and find non-trivial correlations.
We believe this is the first step in finding quantitative differences in graph structure for the characterization of dream experiences.

1) Mota, N.B., Furtado, R., Maia, P.P.C., Copelli, M. & Ribeiro, S. Graph analysis of dream reports is especially informative about psychosis. Sci. Rep. 4, 3691; DOI:10.1038/srep03691 (2014)
2) Mota NB, et al. (2012) Speech Graphs Provide a Quantitative Measure of Thought Disorder in Psychosis. PLoS ONE 7(4): e34928. doi: 10.1371/journal.pone.0034928