

# Space of Dream Data through the Lens of Multilevel Graph



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# EXISTING LITERATURE

**Speech Graphs Provide a Quantitative Measure of Thought Disorder in Psychosis**

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**Schizophrenia**

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

Natalia R. Mota<sup>1</sup>, Mauro Capelli<sup>1</sup> and Silvana Elettre<sup>1</sup>

In chronic psychiatric patients, negative symptoms are often present, whether speech disordered or not. Negative symptoms are memory reports more than reality, and they are associated with the cognitive system. Communication was measured by speech graphs, which were submitted into a single word analysis. The results showed that the control group,  $n = 31$ , had a mean of 2.0 words per sentence, while the patients group,  $n = 21$ , had a mean of 3.0 words per sentence. With accuracy rates of 90% and 95%, respectively, patients and controls were correctly classified.

**SCIENTIFIC REPORTS**

**OPEN** Graph analysis of dream reports is especially informative about psychosis

**SUBJECT AREAS:** APPLIED PSYCHOLOGY | DIALOGUE AND LANGUAGE | DYSFUNCTIONAL MENTAL DISORDERS

**Received:** 23 October 2013 **Accepted:** 25 November 2014 **Published:** 15 January 2015

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**Abstract** Schizophrenia is a severe mental disorder characterized by positive, negative, and cognitive symptoms. Speech, delusions, and hallucinations are the main symptoms of schizophrenia. In addition, negative symptoms are also present. Communication is measured by speech graphs, which were submitted into a single word analysis. The results showed that the control group,  $n = 31$ , had a mean of 2.0 words per sentence, while the patients group,  $n = 21$ , had a mean of 3.0 words per sentence. With accuracy rates of 90% and 95%, respectively, patients and controls were correctly classified.

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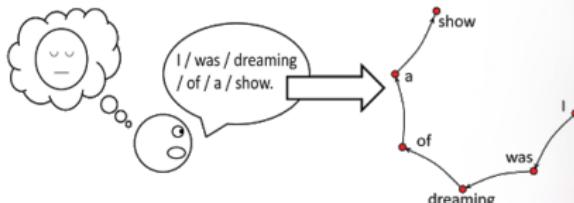
**Differential diagnosis in psychosis**

Differential diagnosis in psychosis is undertaken psychopathologically. Contemporary psychiatry, which includes diseases, has been critical of the lack of objectivity. In search of quantitative insights into the structure of speech, we conducted a study comparing the speech graphs of patients with schizophrenia, healthy volunteers, and non-psychotic controls who reported walking and dream contexts. Schizophrenic patients were compared with healthy volunteers and non-psychotic controls. The speech graphs were measured by standard psychometric tools. Bipolar and control subjects were distinguished by walking reports, while patients with schizophrenia were distinguished by dream reports. Non-psychotic controls performed psychometric tests more rapidly than the walking-related data for the graph writing. Otherwise, the results indicate that the speech graphs of the patients with schizophrenia were similar to those of the healthy volunteers. The results also suggest effects on mood. The P3b latency response differences in the mathematics-relevant areas of the brain were observed in the patients with schizophrenia, but not in the healthy volunteers. The results also indicate that "dreams" are the verbal word in the unconscious. It clinically useful, after all.

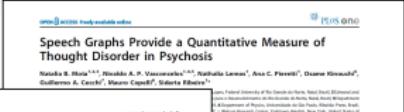
**Results**

Speech samples were collected from the walking patients, non-psychotic controls, and healthy volunteers. Each report was transcribed and expressed as a speech graph, in which every word represented a node, and every temporal connection between words represented an edge. The results showed that the walking reports from the non-psychotic patients (Figure 1b) were more active groups than walking reports from the naïve subjects (Figure 1c).

**Supplementary Information** DOI: 10.1186/s41537-014-0041-1



# EXISTING LITERATURE



**NPJ Schizophrenia**

**ARTICLE OPEN**  
Thought disorder measured as random speech structure classifies negative symptoms and schizophrenia diagnosis 6 months in advance  
[Nataša R. Mitrović\\*](#), [Mladen A. P. Vučenović\\*](#), [Nathalia Lewan\\*](#), [Ana C. Feretti†](#), [Osman Kirov‡](#), [Guillermo A. Caselli§](#), [Vlairo Caputi¶](#), [Silvana Blažević||](#)

In chronic psychiatric patients, negative symptoms and memory reports more frequently than positive symptoms were associated with the diagnosis of schizophrenia. Correspondingly, the negative symptoms of schizophrenia were often observed in a single patient. In contrast, the positive symptoms were observed in all patients. Control group,  $p < 0.05$ . \* $p < 0.05$ ; \*\* $p < 0.01$ . †With accuracy items, it was observed that the negative symptoms of schizophrenia in patients and controls were more frequently reported by patients than controls.  $p < 0.001$ . ||With schizophrenia (30)

**INTRODUCTION**  
Schizophrenia is a severe psychiatric disorder characterized by negative, neutral, and positive symptoms. Delusions, hallucinations, and catatonia are associated with the diagnosis of schizophrenia. The most common symptom in schizophrenia is delusion. Delusions are defined as false beliefs that cannot be explained by normal cognitive tools to justify them. Patients with schizophrenia experience delusions that are related to their personal experiences. Delusions are often accompanied by hallucinations, which represent a distorted interpretation of reality. Hallucinations can be visual, auditory, olfactory, or tactile. They are experienced as if they were real. Delusions and hallucinations are the most common symptoms in schizophrenia. Delusions are often accompanied by negative symptoms, such as depression, anxiety, and social withdrawal. Negative symptoms are characterized by a lack of motivation, lack of interest in social activities, and lack of pleasure. Positive symptoms are characterized by delusions, hallucinations, and catatonia.

**SCIENTIFIC REPORTS**

**OPEN** Graph analysis of dream reports is especially informative about psychosis  
[Nataša R. Mitrović\\*, \[Pedro P. C. Mello\\\*, \\[Vlairo Caputi\\\\*\\\\*, \\\[Silvana Blažević†\\\]\\\(#\\\)\\]\\(#\\)\]\(#\)](#)

Saint Louis University, Faculty of Medicine (U.S.A.), Saint Louis, Missouri 63110-1000, USA; Department of Psychology, Federal University of Paraná (UFPR), Brazil; Brazil; Post Code: 81530-010, Brazil

**SUBJECT AREAS:** APPLIED PSYCHOLOGY | DREAMS AND DREAMING | DYSFUNCTIONAL MENTALITY

**Received:** 23 October 2013 **Accepted:** 25 November 2014 **Published:** 15 January 2015

Correspondence and requests for materials should be addressed to S.R. (✉) [jordana.mitrovic@slu.edu](#)  
\*These authors contributed equally to this work. [http://dx.doi.org/10.1038/srep01493](#) © 2015 Mitrović et al. This work is licensed under a Creative Commons Attribution Non-Commercial-ShareAlike 4.0 International License. A link to the license is available in the online version of the article.

**Results**  
Speech samples were collected from the long-patient (i.e., duration as an estimate of time spent in hospital) and short-patient (i.e., days spent in hospital) groups. Each report was transcribed and expressed as a speech graph, in which every word represented a node, and every temporal connection between words represented an edge. We compared the differentially diagnosed groups of patients (Figure 1) and the control group (Figure 2). The distribution of the reports into the major Western languages was performed as language-related variables.

**Methods**  
Speech samples were collected from the long-patient (i.e., duration as an estimate of time spent in hospital) and short-patient (i.e., days spent in hospital) groups. Each report was transcribed and expressed as a speech graph, in which every word represented a node, and every temporal connection between words represented an edge. We compared the differentially diagnosed groups of patients (Figure 1) and the control group (Figure 2). The distribution of the reports into the major Western languages was performed as language-related variables.

**Data Availability**  
The data that support the findings of this study are available from the corresponding author upon reasonable request.

**Competing Interests**  
The authors declare that they have no competing interests.

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**Author Contributions**  
N.R.M. and P.P.C.M. designed the study and wrote the manuscript. V.C. and S.B. collected the data. All authors reviewed the manuscript.

**Additional Information**  
Correspondence to N.R. Mitrović.  
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**SCIENTIFIC REPORTS | 4:3491 | DOI: 10.1038/srep01491**

**1**

*"In chronic psychotic patients, word graph analysis shows potential as complementary psychiatric assessment."*

*"The results demonstrate the feasibility of the differential diagnosis of psychosis based on the analysis of dream graphs, pointing to a fast, low-cost and language-invariant tool for psychiatric diagnosis and the objective search for biomarkers."*

*"The results also show that dream reports are substantially more informative about the mental state of psychotic subjects than waking reports."*

# SOURCES OF DREAMS



## Sogniario

Sogniario è una applicazione mobile sviluppata dall'Università di Camerino per registrare e catalogare i sogni.

Username —

Password —  

 Entra come utente  Entra come ricercatore

 Scarica l'app (Android)

# SOURCES OF DREAMS

## DreamBank

[www.dreambank.net](http://www.dreambank.net)

**Dream series:**

Filters:  Full dreams  Abbreviated dreams  Headline dreams  Case-sensitive?  More info  Results display:  List  Table  Contingency  Consistency chart:  100  Numbers  Graphs

Search: [HELP]

Dream series: Dream: leaving dream [n=144] Father's voice [date] and [deceased] [n=1112] ...  
 Full dreams  Abbreviated dreams  Headline dreams  Case-sensitive?  More info  Results display:  List  Table  Contingency  Consistency chart:  100  Numbers  Graphs

Number of dreams searched: 1221 Search term: [dreams]

Case-sensitive: no

Number of dreams searched: 1221 Search term: [dreams]

Case-sensitive: no

Dream series: Dreams: 48 years of dreams

Search: [HELP]

Number of dreams searched: 1221 Search term: [dreams]

Case-sensitive: no

Redisplay:  Full dreams  Abbreviated dreams  Highlight matches  Count words

(Click here to jump to the bottom of the list)

#1940-001 We are standing in front of a hotel at a resort and we have to take a boat to another beach where it is "calm," but there is a big storm with breakers out at sea and there are French doors closing off the exit from the boat house to the sea. I remember holding the doors closed against the onslaught of the breakers. Later everyone has to leave the boat house and then, in a few minutes, a huge wave tears the boat house away and whips it out to sea. Only the boatman and a few stragglers remain and they are eventually saved. We must stay at a hotel. (111 words) [\[DODINGS\]](#)

#1940-002 Dr. Brooke (thesis advisor) asks me to go to a night club called "Iowa Park" where they usually drink till 4 AM. I don't want to go but he said that he would not look at my paper otherwise. He even buys me a literal Shift. Mother is still alive (she died 4/13/47). She prevents me from going. She is jealous and she wants me to help her clean the house. (77 words) [\[DODINGS\]](#)

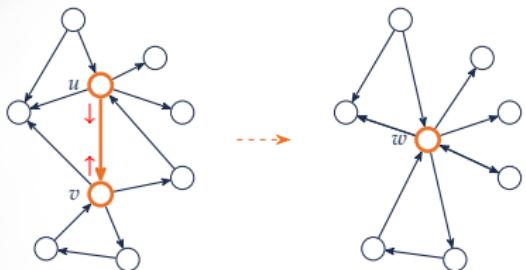
#1948-003 I am a queen, much admired. M. (lover) is at my side and service. Feeling of ultimate achievement. Shift. Mrs. Jones (professor and supervisor) has died. Mr. Jones is very bereft. I offer him help and services. Much ado about it. The newspapers carry headlines and are tacked up all along the corridor of the psychology department. Bouquets of flowers sent. General feeling of sorrow. I am consulted by Mr. Jones about the funeral arrangements and then offer to go to live with him in his house as I am divorcing Edward (first husband). (36 words) [\[DODINGS\]](#)

#1959-001 Driving to mountains with Edward, we go ahead while mother-in-law and my father follow. Father is in a hearse, dragged along the ground by a truck. He said he liked it that way. W. and I have a regular meal but W. forgets to give some to father. I realize that he needs to die already (he had died 1948). Shift. K. (companion), we drive together through them and down the mountain. We stop at a lake. I jump in and swim in the warm water standing on a sand bar and gradually pushes us back against the house, also see my brother somewhere in the background of the house. Shift. I invite K. to stay at our place in L. City telling him that no one will be there, but when we arrive Mrs. L. (our renter) is asleep and father is in my brother's bedroom. Therefore K. is forced to stay with me in my bed. Remember only a few kisses. In the morning father worrying about Mrs. L.'s political views. (207 words) [\[DODINGS\]](#)

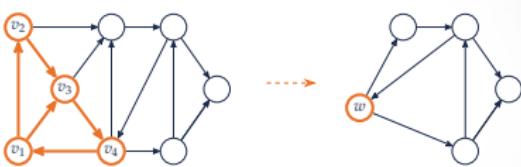
#1950-002 Parents come to life! out of the grave, despite having been cremated. Father looks like a same and mother tries to run my life again. They don't seem astonished. I understand that Forest Lawn is being sued for burying them alive! Shift. I walk along a ramp with A.S. (University instructor) and think of him as my therapist. He says, "In two years mother's cancer could have been cured," but he can't explain it. He is very understanding. At home mother sees a daughter born after mother's death and she says, "So that is what you have been up to." Much commotion and people. Feeling of inexplicable, how could it have happened? But no one seems to care. (100 words) [\[DODINGS\]](#)

# GRAPH CONTRACTION

Edge contraction

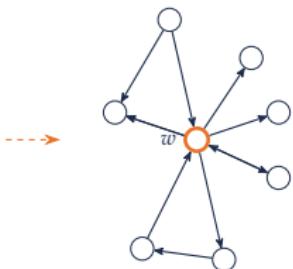
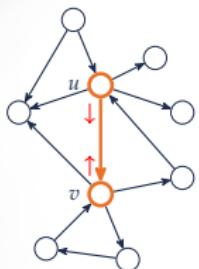


Subgraph contraction



# GRAPH CONTRACTION

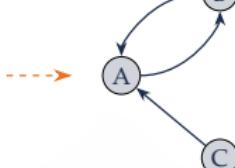
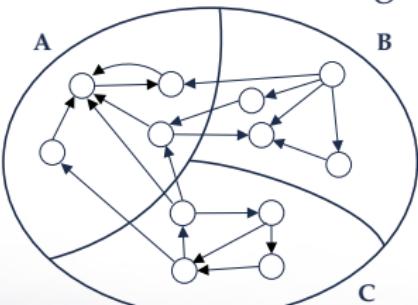
Edge contraction



Subgraph contraction



Quotient graph



# MULTILEVEL GRAPH

## Definition (Multilevel graph)

A **multilevel graph**  $M$  is a couple  $(G, \Gamma)$  where:

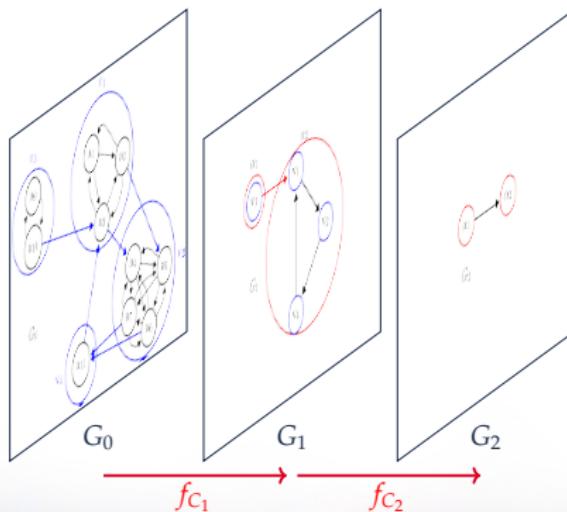
- ▶  $G = (V, E)$  is a graph;
- ▶  $\Gamma = \langle f_{C_1}, f_{C_2}, \dots, f_{C_k} \rangle$  is a sequence of contraction functions.

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INTRODUCTION  
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DEFINITIONS  
oooo

CONTRACTION  
●oooooooo

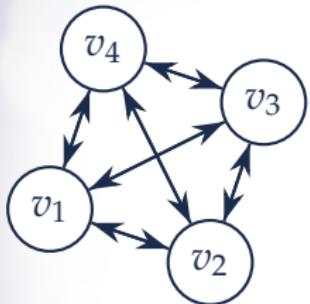
SYNTACTIC DREAM ANALYSIS  
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SEMANTIC DREAM ANALYSIS  
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CONCLUSION  
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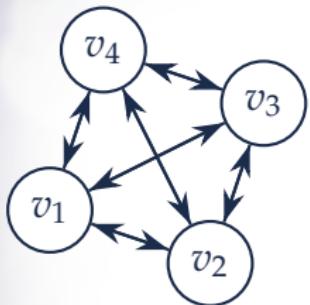
# CONTRACTION SCHEMES

# CONTRACTION SCHEMES

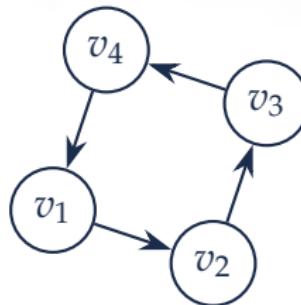


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# CONTRACTION SCHEMES

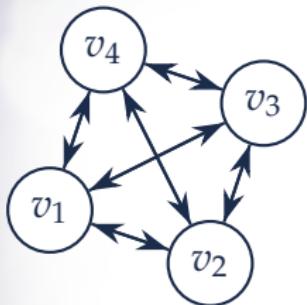


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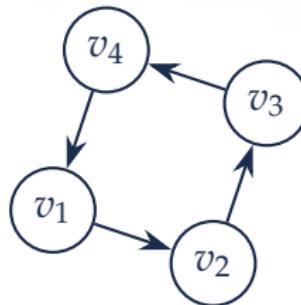


Simple cycles

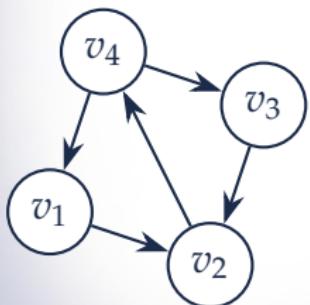
# CONTRACTION SCHEMES



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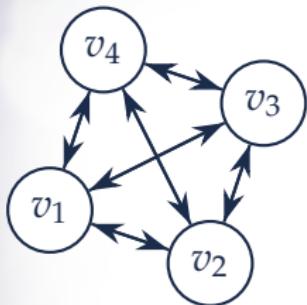


Simple cycles

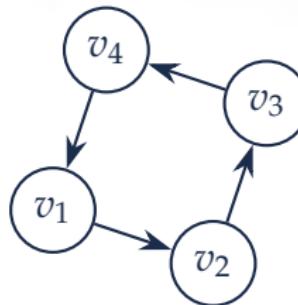


Strongly  
connected  
components

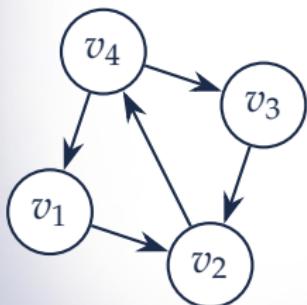
# CONTRACTION SCHEMES



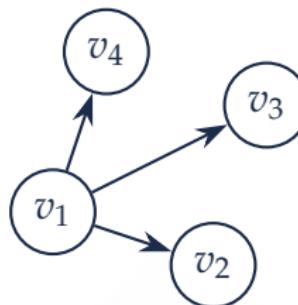
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Simple cycles

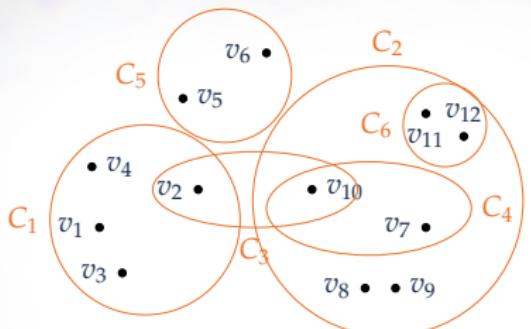


Strongly connected components

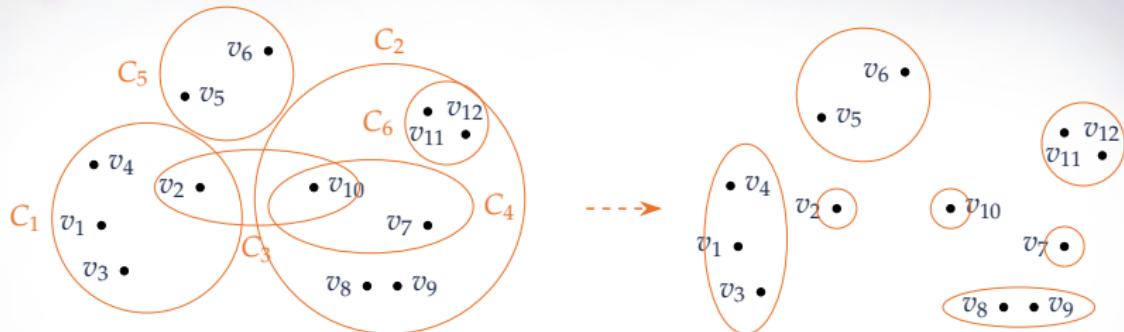


Stars

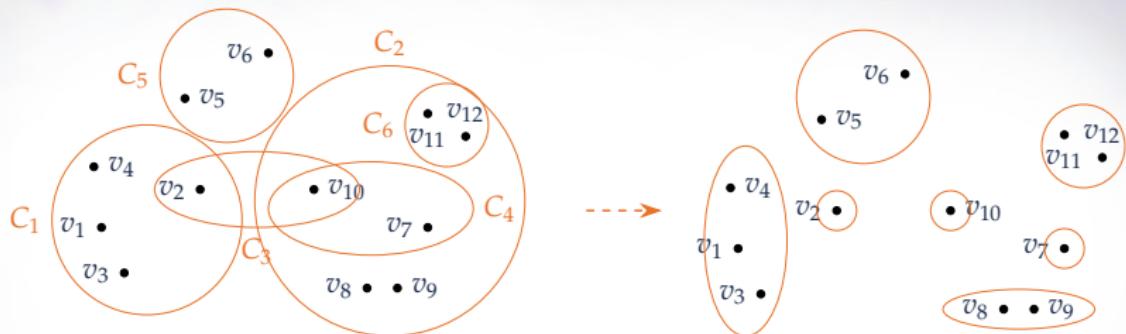
# SUBSETS CONTRACTION



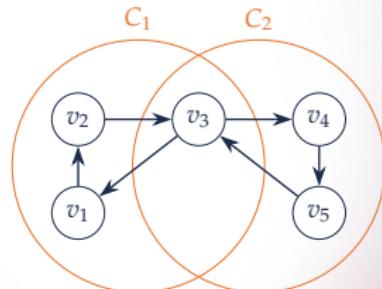
# SUBSETS CONTRACTION



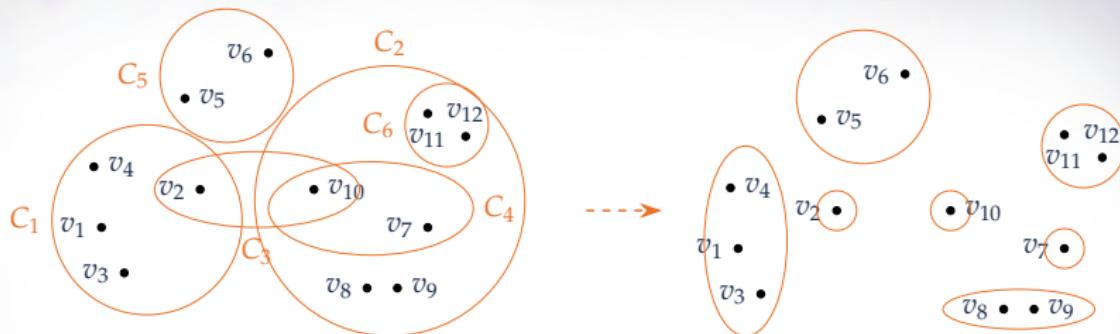
# SUBSETS CONTRACTION

 $T$ 

$v_1$	$\{C_1\}$
$v_2$	$\{C_1\}$
$v_3$	$\{C_1, C_2\}$
$v_4$	$\{C_2\}$
$v_5$	$\{C_2\}$



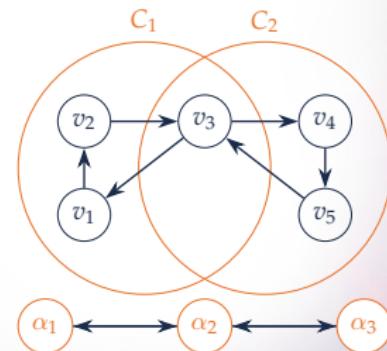
# SUBSETS CONTRACTION

 $T$ 

$v_1$	$\{C_1\}$
$v_2$	$\{C_1\}$
$v_3$	$\{C_1, C_2\}$
$v_4$	$\{C_2\}$
$v_5$	$\{C_2\}$

 $T'$ 

$\{C_1\}$	$\alpha_1$
$\{C_1, C_2\}$	$\alpha_2$
$\{C_2\}$	$\alpha_3$



## SYNTACTIC ANALYSIS OF DREAMS

The aim is to examine the typical syntactic structure of individual dreams of a particular dreamer, with possible implications related to mental health.

## AN ARLIE'S DREAM

*"I am at a lake in my hometown. Something is going on there and we are in a hurry to get away. We get in a station wagon and have a hard time getting two pet deer, with the same names as my son and daughter, corralled. Finally we get them into the vehicle and we are almost all the way out when the wheel goes off one side of the road and the vehicle is stuck and the deer is about halfway out. At this point I notice my mother-in-law is cutting off a Christmas tree which is growing in the water at the end of the dock."*

# AN ARLIE'S DREAM

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STOPWORDS  
REMOVAL

# AN ARLIE'S DREAM

"I am at a lake *in my* hometown. something *is go on there and we are in a* hurry *to* get away. We get *in a* station wagon *and have a* hard time *get* two pet deer, *with the same name as my son and daughter*, corral. finally *we get them into the vehicle and we are almost all the way out when the wheel go off one side of the road and the vehicle is stick and the deer is about halfway out. At this point I notice my mother-in-law is cut off a* christmas tree *which is grow in the water at the end of the dock.*"

STOPWORDS

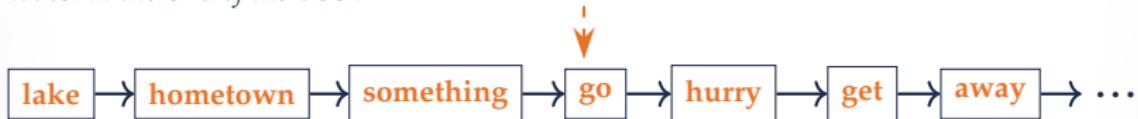
REMOVAL

LEMMATIZATION

# AN ARLIE'S DREAM

"I am at a lake *in my* hometown. something *is go on there and we are in a* hurry *to* get away. We get *in a* station wagon *and have a* hard time *get two pet deer, with the same name as my son and daughter, corral.* finally *we get them into the vehicle and we are almost all the way out when the wheel go off one side of the road and the vehicle is stick and the deer is about halfway out. At this point I notice my mother-in-law is cut off a* christmas tree *which is grow in the water at the end of the dock.*"

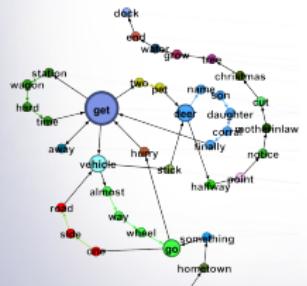
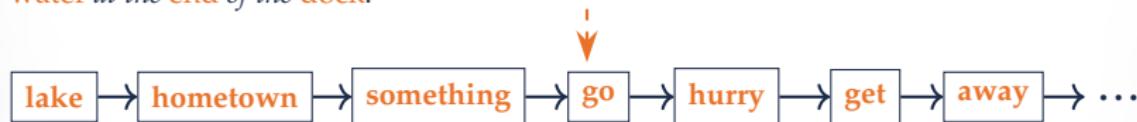
STOPWORDS  
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ZATION



# AN ARLIE'S DREAM

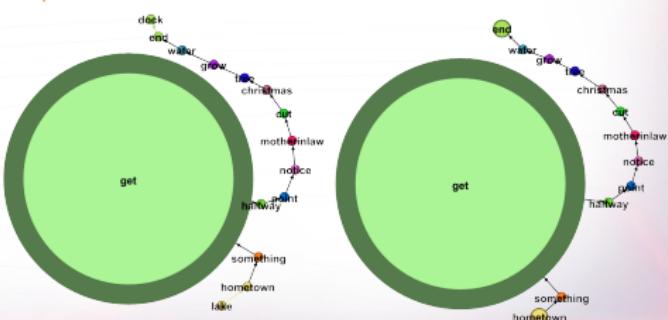
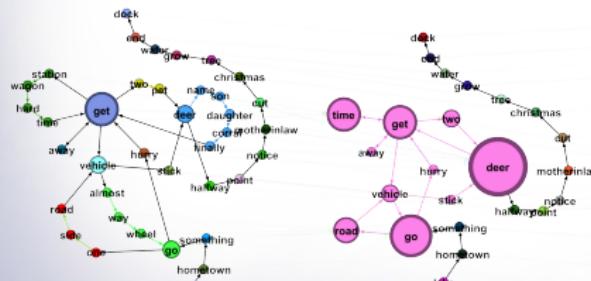
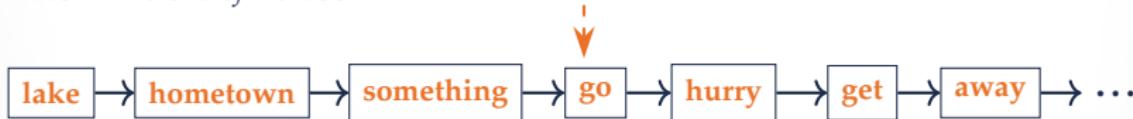
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STOPWORDS  
REMOVAL  
LEMMAТИ-  
ZATION



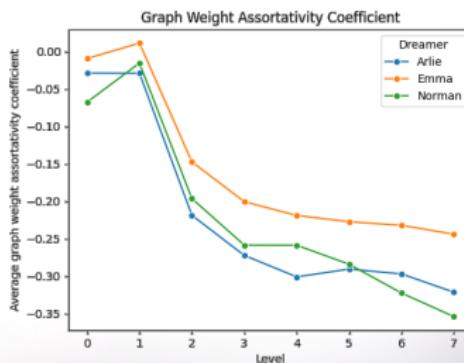
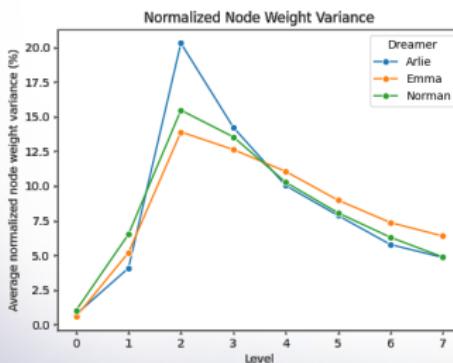
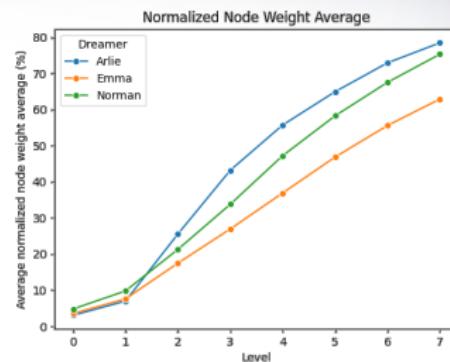
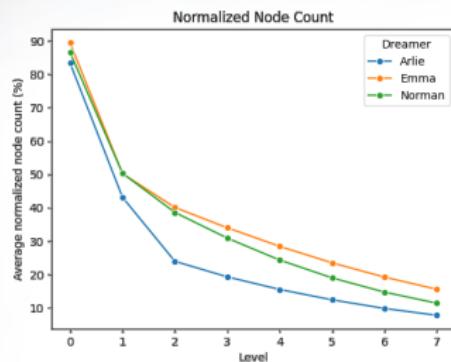
# AN ARLIE'S DREAM

*"I am at a lake in my hometown. something is go on there and we are in a hurry to get away. We get in a station wagon and have a hard time get two pet deer, with the same name as my son and daughter, corral. finally we get them into the vehicle and we are almost all the way out when the wheel go off one side of the road and the vehicle is stick and the deer is about halfway out. At this point I notice my mother-in-law is cut off a christmas tree which is grow in the water at the end of the dock."*

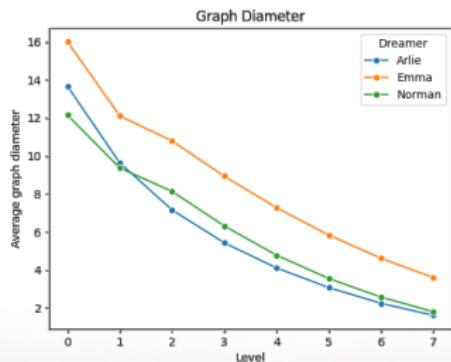
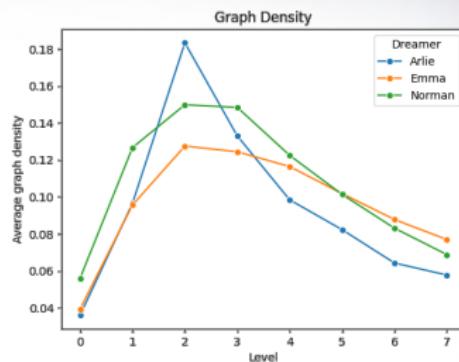
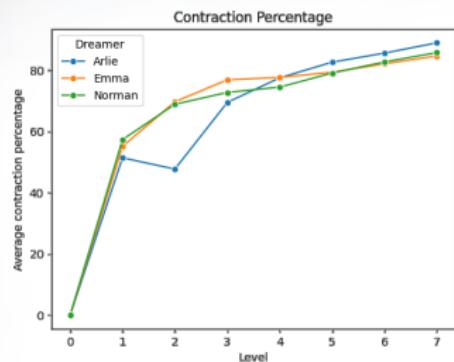


STOPWORDS  
REMOVAL  
LEMMAТИ-  
ZATION

# ARLIE, EMMA AND NORMAN RESULTS



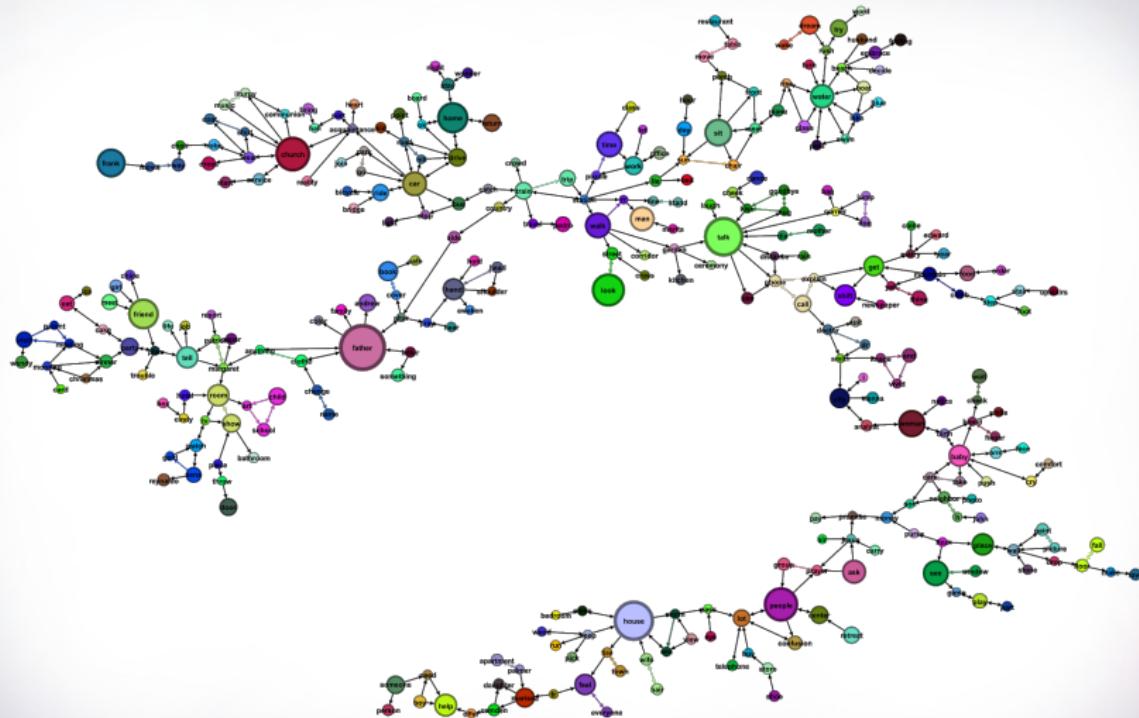
# ARLIE, EMMA AND NORMAN RESULTS



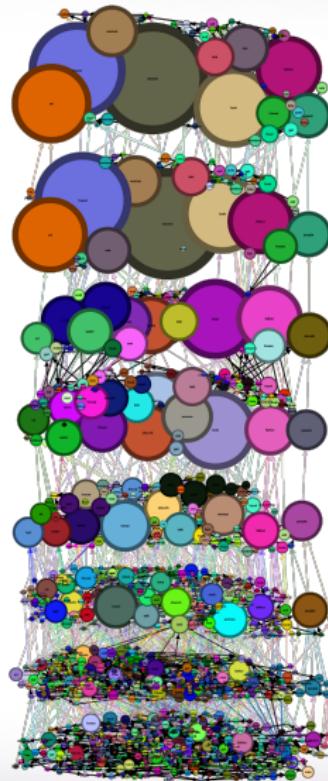
## SEMANTIC ANALYSIS OF DREAMS

The aim is to build a multilevel semantic space of words that depicts the content themes in a collection of dreams of a particular dreamer.

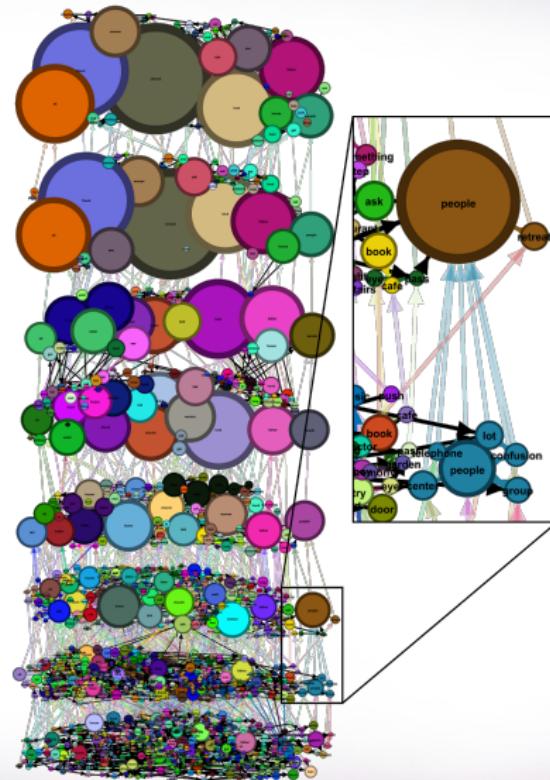
# EMMA'S GRAPH



# EMMA'S MULTILEVEL GRAPH



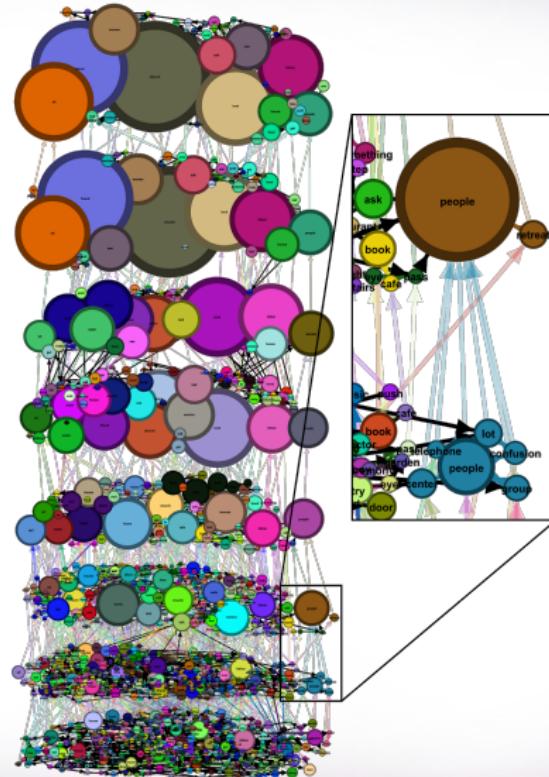
# EMMA'S MULTILEVEL GRAPH



# EMMA'S MULTILEVEL GRAPH

## EXAMPLES OF CYCLES

- ▶ “cake”-“party”
- ▶ “boat”-“lake”-“water”
- ▶ “trip”-“train”-“station”
- ▶ “road”-“car”-“drive”-“hill”
- ▶ “liturgy”-“church”-“music”



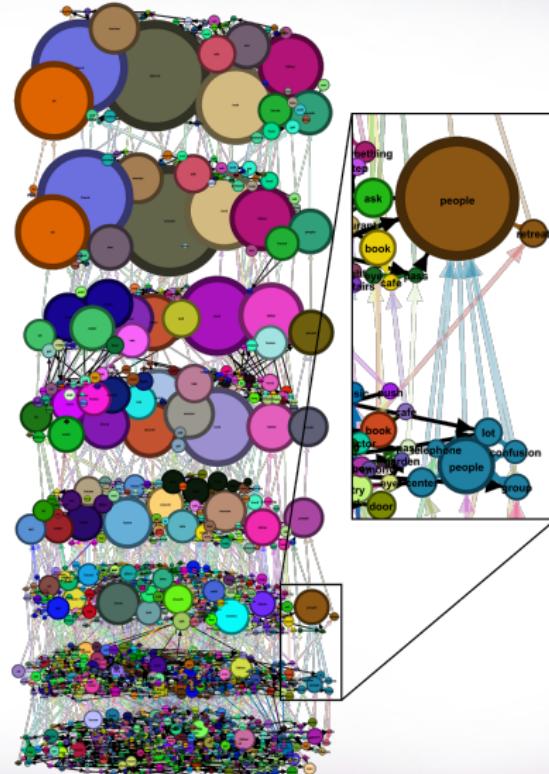
# EMMA'S MULTILEVEL GRAPH

## EXAMPLES OF CYCLES

- ▶ "cake"-“party”
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- ▶ “road”-“car”-“drive”-“hill”
- ▶ “liturgy”-“church”-“music”

## EXAMPLES OF SCCs

- ▶ “sit”-“chair”-“front”-  
“porch”-“seat”-“plane”
- ▶ “lake”-“boat”-“water”-“rise”-  
“pool”-“swim”-“rush”



# CONCLUSIONS AND PROSPECTS

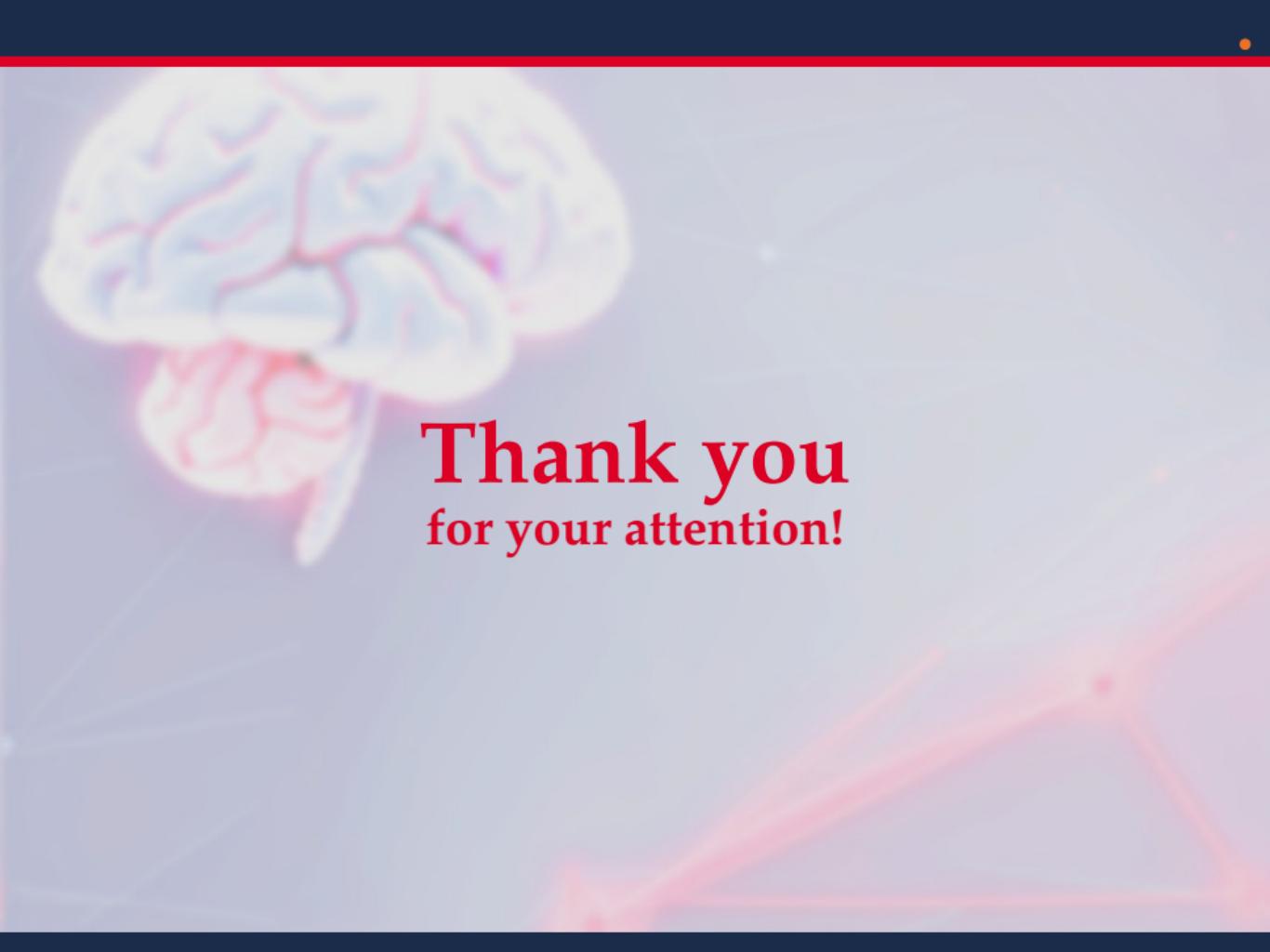
- Global and dynamic perspective, beyond single-level analysis



# CONCLUSIONS AND PROSPECTS

- ▶ Global and dynamic perspective, beyond single-level analysis
- ▶ Application of multi-level analysis techniques to categorized data





**Thank you**  
for your attention!