
NA PUTU
DO MEDALJE
IYNT 2019.

Voditelji hrvatskog tima

Domagoj Pluščec, Zoe Jelić Matošević

Donatori i sponzori

MINISTARSTVO ZNANOSTI I OBRAZOVANJA REPUBLIKE HRVATSKE

OPĆINA DONJI KRALJEVEC

ALFA

školska knjiga

ELEMENT

LJEVAK

Zagreb HRVATSKA

Studio antikvarijat-knjižara

DAVOR ŠKRLEC Zastupnik u Europskom parlamentu

Slike

sudionici Državnog turnira mladih prirodoslovaca 2019. i IYNT 2019.

Zbornik izradili

Dora Špoler i Domagoj Pluščec

kolovoz 2021., Zagreb

SADRŽAJ

1.1 IZVJEŠTAJ IZ BJELORUSIJE

Dora Špoler

IYNT je u svakom pogledu bio izazov svima nama. Većina nas se po prvi put upustila u izradu istraživačkih radova, a uz samu izradu svog rada morali smo i procjenjivati i izazvati tuđe. Nije uvijek bilo lako, no definitivno mogu reći da se sve isplatilo. Nakon svih napornih sati rada na grafovima, teoriji, rezultatima i uvježbavanju govornih vještina naš trud je urodio uspjehom. Sam put u Bjelorusiju meni je bila dovoljna nagrada. Upoznavanje novih ljudi i kulture te stjecanje dugoročnih prijateljstava s ostatkom tima. U cijelom ovom iskustvu razvila sam mnoge vještine poput prezentiranja, planiranja i provođenja znanstvenog rada, obrade podataka, komunikacija na engleskom jeziku te svakako timski rad. Sva ova iskustva pomoć će mi u daljnjem školovanju i profesiji, a sjećanje na Bjelorusiju će mi zauvijek ostati kao jedan od najljepših tjedana.

Marko Drozdek

Sudjelovanje na IYNT-u nije mi samo pomoglo u znanstvenom pogledu na svijet oko sebe, već mi je i donijelo mnoga neprocjenjiva prijateljstva. Tijekom dvije godine sudjelovanja upoznao sam i družio se s izvrsnim ljudima iz cijele Hrvatske. Pripreme, turniri, putovanje... Siguran sam da će mi sve to još dugo godina ostati u sjećanju.

Rea Pešušić

International Young Naturalists' Tournament bio je jedno od najpamtljivijih iskustava u mom životu. Nakon mjeseci pripremanja, provođenja eksperimenata i istraživanja, sve je urodilo plodom kada smo osvojili zlato. A ipak, meni najdragocjeniji trenuci bili su oni mali, intimni. Kada mi je djevojka iz jednog od ruskih timova poželjela sreću prije finala i našalila se da se mi Slaveni moramo držati skupa. Kada smo se svi zezali pripremajući prezentacije i vježbajući. Kada smo u dva i pol ujutro igrali Uno s bugarskim timom na podu aerodroma čekajući naš let. Trenutci kada nismo bili predstavnici svojih država u stranoj zemlji, već djeca koja su se spajala i radovala unatoč svim kulturnim razlikama.

Magdalena Žokalj

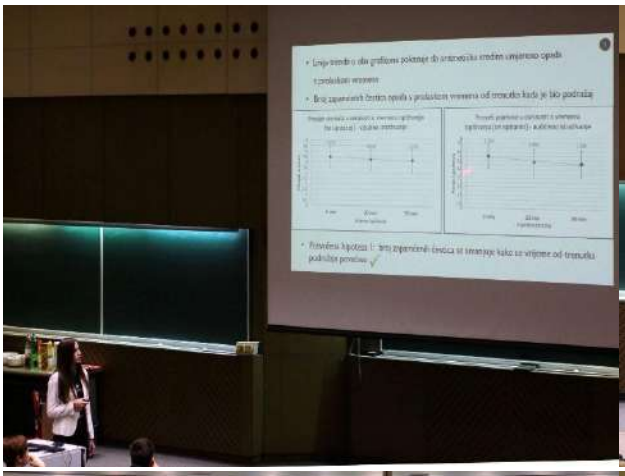
Sudjelovanje na IYNT-u bilo je divno te vrlo poučno iskustvo. Naučila sam mnogo o znanstvenoj metodi, proširila svoje znanje o područjima koja me zanimaju te se zainteresirala za područja koja su mi prije bila manje privlačna. Shvatila sam koliko rad na znanstvenom projektu može biti frustrirajući, ali opet predivan ukoliko radiš nešto što zaista voliš te koliko se u par mjeseci emocionalno povežeš s temom svoga istraživanja, bilo pozitivno ili negativno. Kao najbitnije što sam naučila pripremajući se za ovo natjecanje izdvojila bih ustrajnost i strpljivost, vještine korisne u bilo kojem aspektu života, a osobitu u bavljenju znanstvenim radom, pogotovo tada kada se čini da je sve krenulo krivim putem. Posjet Minsku je bio jedno unikatno iskustvo jer nisam sigurna bih li se ikad usudila samostalno turistički posjetiti tako zatvorenu zemlju s nedorečenom političkom situacijom kao što je Bjelorusija. Na samom natjecanju imala sam priliku vidjeti primjere dobrih, ali i loših istraživačkih radova te iz njih puno naučiti za buduće vlastite radove. Najljepša komponenta sudjelovanja u ovom natjecanju mi je ipak bilo upoznavanje vršnjaka sličnih interesa te sklapanje lijepih prijateljstava. IYNT bih preporučila svim učenicima koje interesira prirodoslovlje te su voljni žrtvovati brojne sate slobodnog vremena i živce za bavljenje znanstvenim radom. Mogu garantirati da se isplati svaka suza i kap znoja :). I nakon sudjelovanja na natjecanju nastavila sam se baviti istraživačkim projektima te su mi iskustva stečena na natjecanju bila vrlo korisna i bavljenje istraživačkim radom iz prirodoslovnog područja mogu vidjeti kao svoju buduću profesiju.

SLIKE S DRŽAVNOG TURNIRA MLADIH PRIRODOSLOVACA

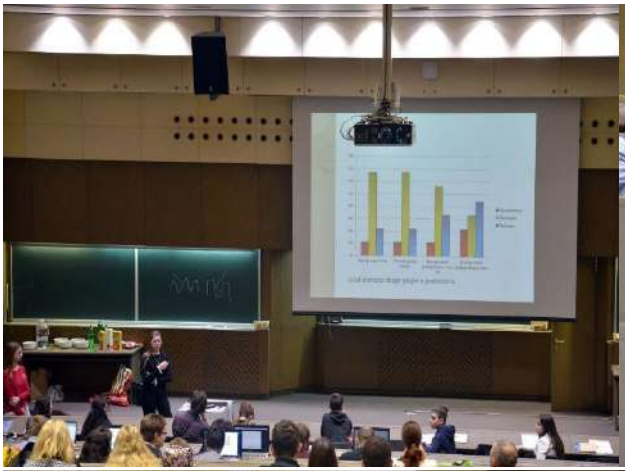

5. državni turnir
mladih prirodoslovaca

Vrednovanje
Rad 30%
Test 30%
Prezentacija
30%






Nedostatci, prednosti, prijedlozi i dodatni efekti





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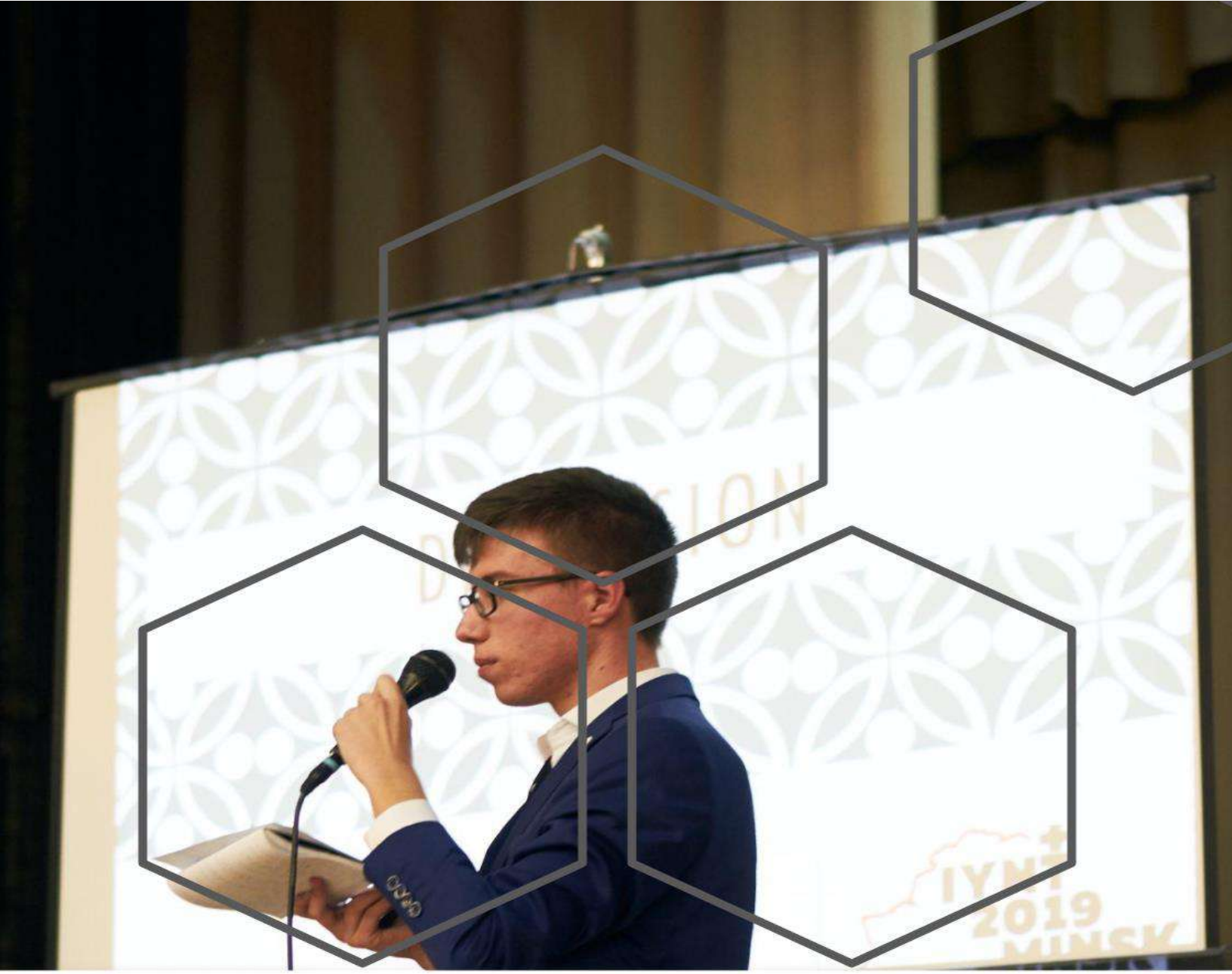
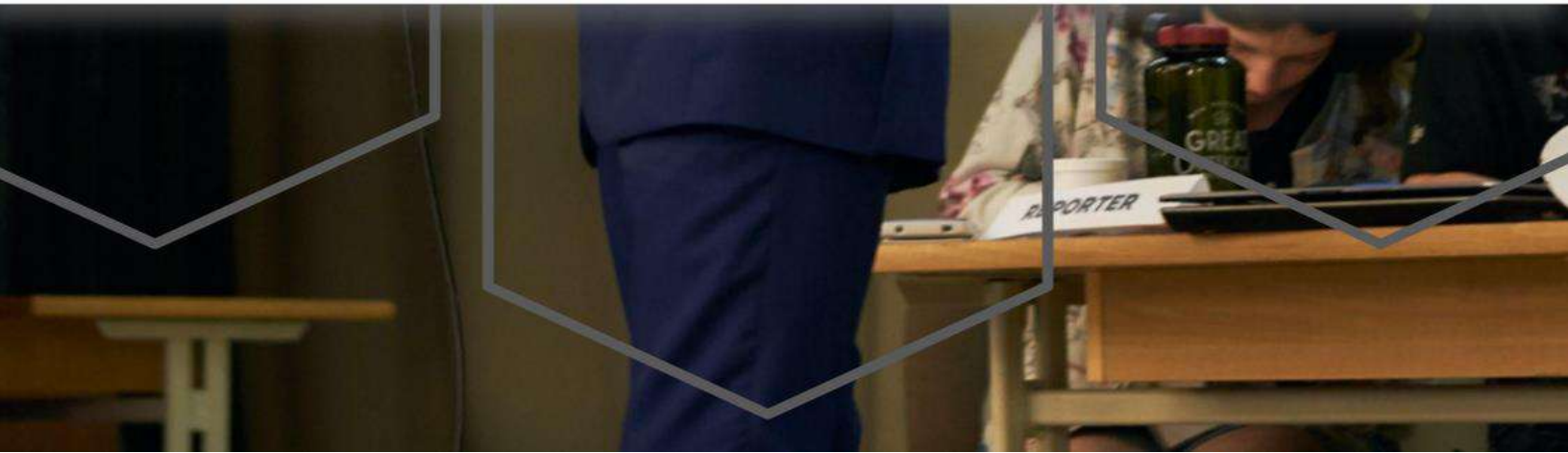
5. državni turnir
mladih prirodoslovaca



SLIKE S MEĐUNARODNOG NATJECANJA IYNT 2019 MINSK, BJELORUSIJA





Departure
Registracija
Check-in




МІНСК
КАНЦЭРТНАЯ ЗАЛА


Сувениры


КАНЦЭРТНАЯ ЗАЛА


МІНСК
КАНЦЭРТНАЯ ЗАЛА



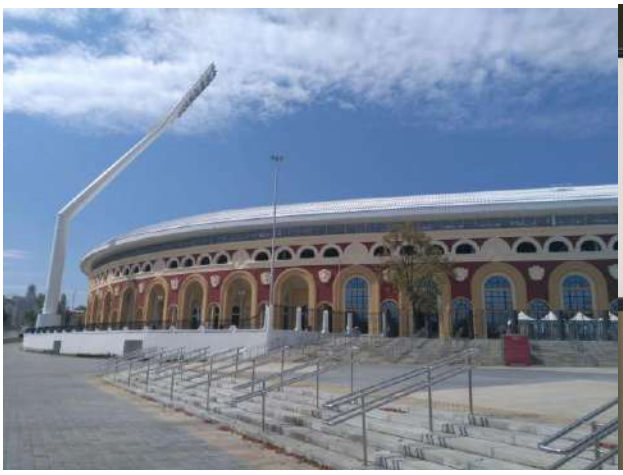








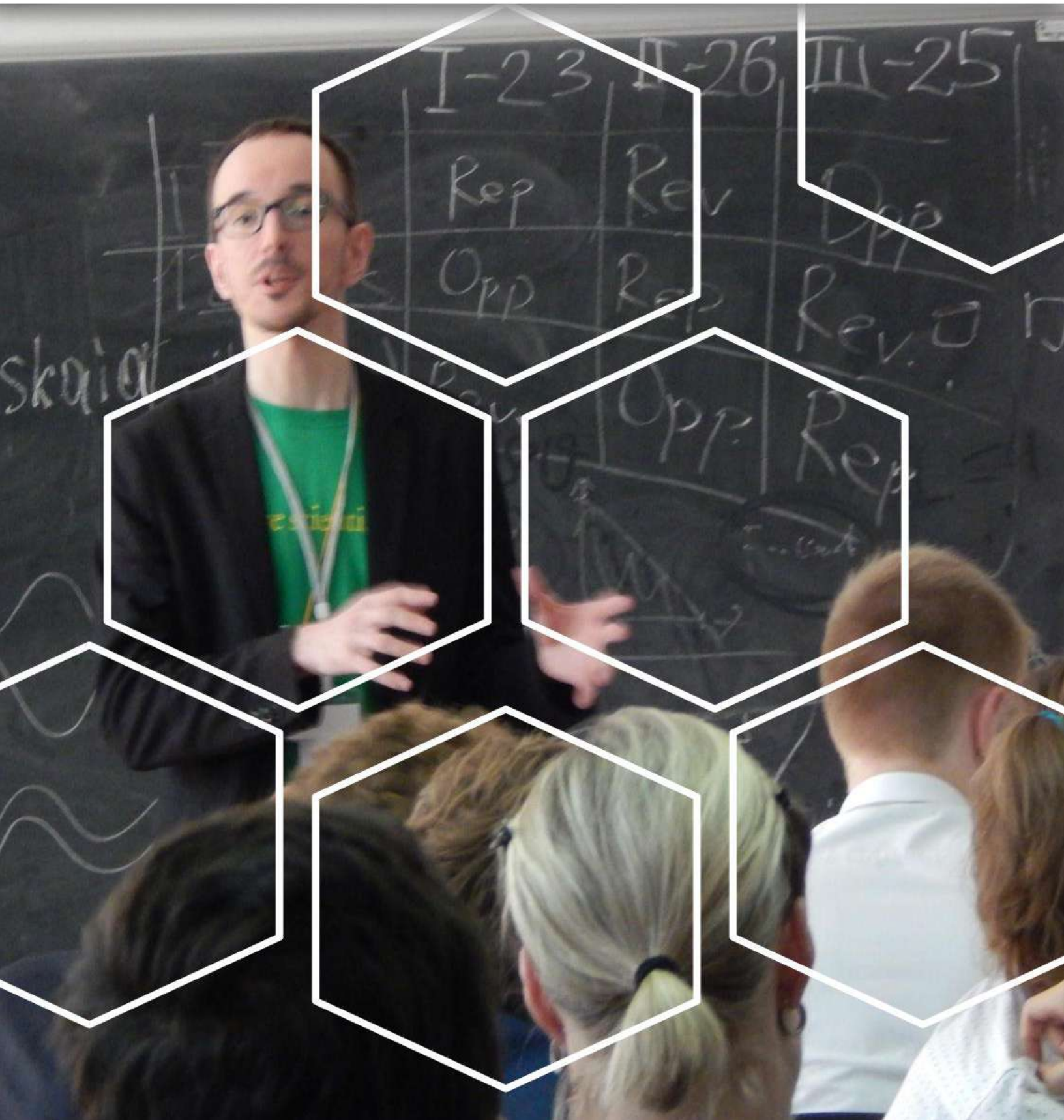






ЛІЦЭЙ
БЕЛАРУСКАГА
ДЗЯРЖАЎНАГА
УНІВЕРСІТЭТА

PREZENTACIJE PROBLEMA HRVATSKE EKIPE



1. 2D FOAM

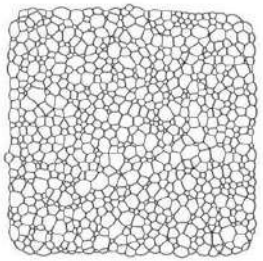
Team Croatia
Reporter: Andrej Todić

PROBLEM STATEMENT

Soap foam enclosed between two glass sheets appears as a network of **polygons**. Such foams **evolve with time**, as individual bubbles move and coalesce, and the liquid drains out. Investigate the **structure** and **evolution** of 2D foams.

2

DEMONSTRATION OF THE PHENOMENON



3

OUTLINE

- Theoretical Introduction
  - How are foams formed
  - Plateau's laws
- Experiment
  - Mass fraction
  - Plate distance
- Results
  - Changes over time
  - Polygon structure

4

HOW FOAMS ARE MADE

- Monolayer of bubbles
- Spreading in 2 space direction
- Ideal are dry
- Thickness depends on liquid
- Appear as polygons in tight spaces

5

PLATEAU'S LAWS

- Soap films made of unbroken smooth surfaces
- Bubbles meet in:
  - threes along an edge (Plateau border)

    $\propto = \cos^{-1}(-\frac{1}{2}) = 120°$
  - fours at a vertex

    $\propto = \cos^{-1}(-\frac{1}{3}) \approx 109.47°$

6

HYPOTHESES

Evaluation of dynamics:

1. Greater mass fraction → Stagnation achieved quicker
2. Greater distance → smaller area, simpler bubbles
3. Intersection angle ≈ 120°

Foam structure analysis:

1. Majority of bubbles → four edges
2. More edges → appear less times
3. Soap films meet in 3 or 4

7

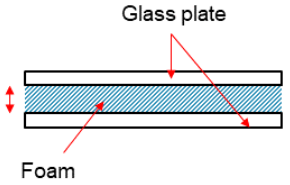
FOAM EVOLUTION

- Soap film minimizes energy and surface area
- Multiple bubbles can merge into one
- Observing polygon structure for different moments in time
- Experiments:
  - Mass fraction
  - Distance between plates

8

EXPERIMENTAL SETUP

- 2 glass plates (75 x 50 cm)
- Water
- Regular soap
- Containers
- Scale (for measuring mass of substances)
- Ruler



9

PREPARATION OF FOAMS

- Mixing soap with water
- Using different mass fractions
- Shaking the solution

- Mass fraction:

$$w = \frac{m_s}{m_{tot}}$$

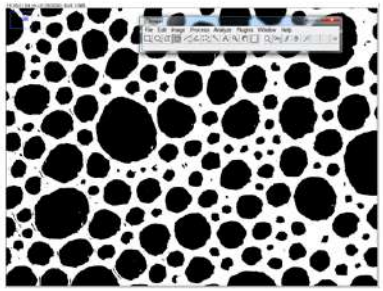
$m_s -$ *mass of substance*

$m_{tot} -$ *total mass of mixture*

10

SOFTWARE ANALYSIS

- ImageJ
  - Measuring bubble area
  - Determining angles
  - Counting polygon vertices



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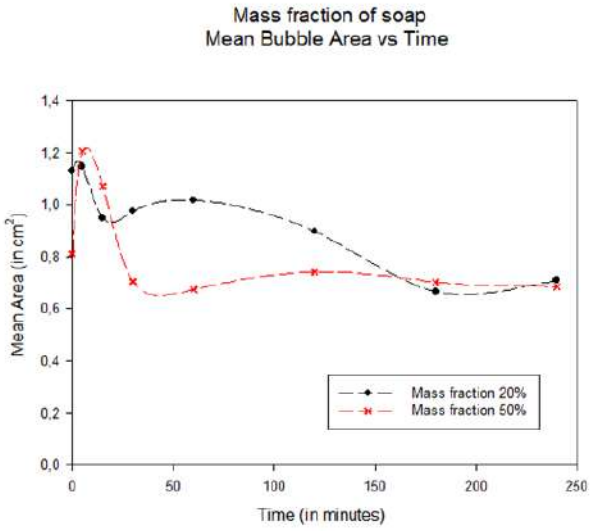

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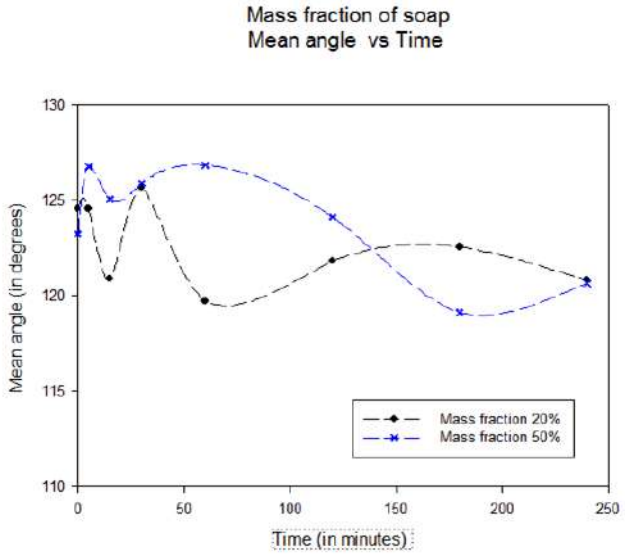

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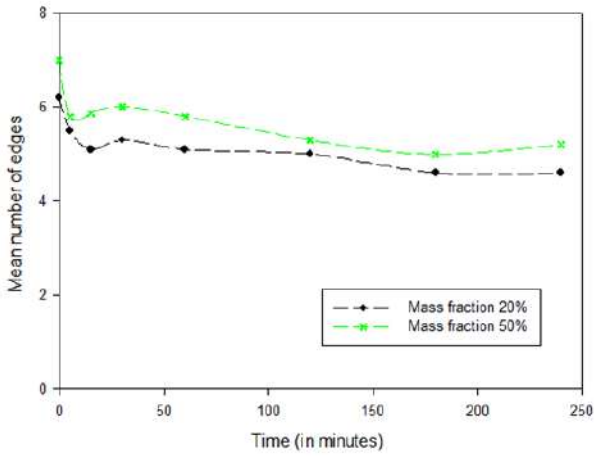
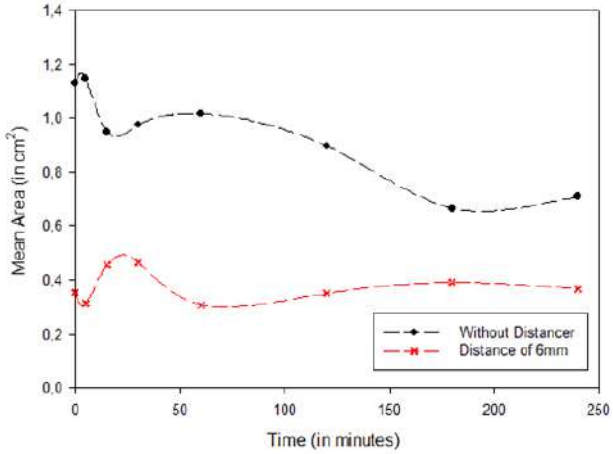
Mass fraction of soap
Mean number of edges vs Time



14

Glass plate distance
Mean Bubble Area vs Time



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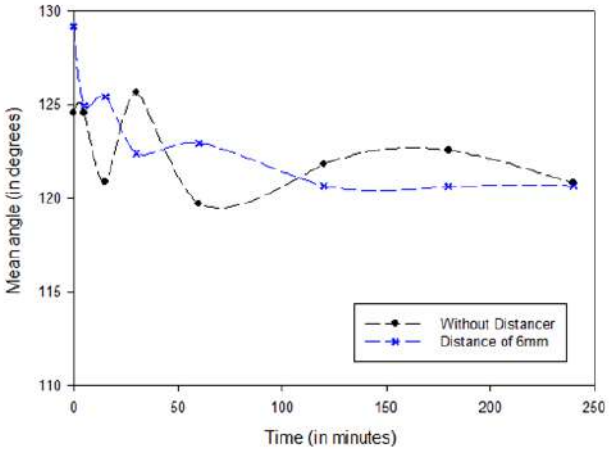
Glass plate distance
Mean angle vs Time



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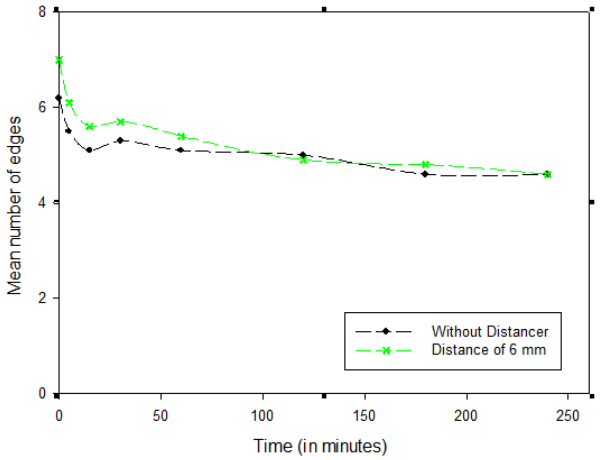
Glass plate distance
Mean number of edges vs Time



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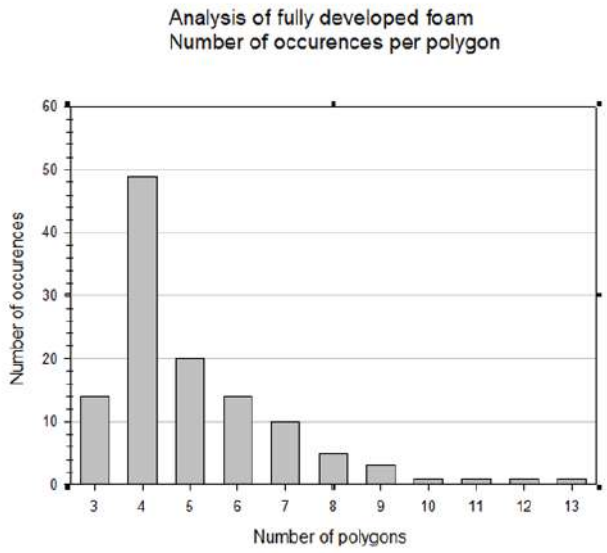

ANGLES OF CONTACT

- Most meeting points for 3 edges
- 1 occurence of a meeting point for 4 edges
- No other types of meeting points

CONCLUSION

Evaluation of dynamics :

1. Greater mass fraction → Stagnation achieved faster ✓
2. Greater distance → smaller area, simpler bubbles ✓
3. Intersection angle ≈ 120° ✓

Foam structure analysis :

1. Majority of bubbles → four edges ✓
2. More edges → appear less times ✓
3. Soap films meet in 3 or 4 ✓

LITERATURE

- https://www.google.hr/url?sa=i&source=images&cd=&cad=rja&uact=8&ved=2ahUKEwiQ9dyozvPgAhUO26QKHRDLDccQjRx6BAgBEAU&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DxatGqwC8WEc&psig=AOvVaw2LoLn-qGVwc2kspV_ROct7&ust=1552171095443463
- http://mathworld.wolfram.com/PlateausLaws.html
- https://www.revolvy.com/page/Plateau%27s-laws
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- https://www.matec-conferences.org/articles/matecconf/pdf/2018/51/matecconf_iceast2018_01011.pdf

THANK YOU!

Team Croatia
Reporter: Andrej Todić

IYNT 2019 MINSK

SLOPE EXPERIMENT

- Foam evolution on a slope:
  - 30° - Polygons disappear after 90 minutes
  - 60° - Polygons disappear after 30 minutes
- Water escapes, dries out
- Bubbles not visible enough for further analysis

PLATEAU'S LAWS

- Mean curvature of portion of soap film constant on any point of film
- Soap films made of unbroken smooth surfaces

- Bubbles meet in:
  - threes along an edge (Plateau border)

    $\propto = \cos^{-1}(-\frac{1}{2}) = 120°$
  - fours at a vertex

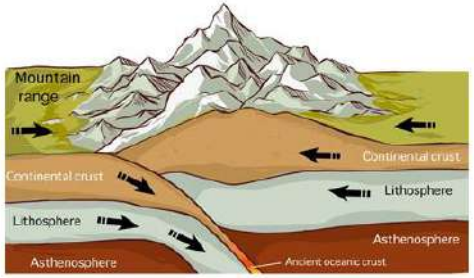
    $\propto = \cos^{-1}(-\frac{1}{3}) \approx 109.47°$

2. MOUNTAINS

Team Croatia
Reporter: Andrej Todić

1. PROBLEM DESCTIPTION

What are the tallest **mountains** in the Solar System? Propose and analyze the theoretical **models** that can allow predicting the **maximum** altitudes of mountains on various celestial bodies.



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OUTLINE

- **Theoretical slides**
  - Formation of mountain
  - Models
  - Hypotheses
- **Experiment**
  - Verification of models
  - Application of models
- **Results**
  - Application of models
  - Evaluating results

3

HIGHEST MOUNTAIN

Different results based on the criteria

- Distance from center of Earth:
  - Chimborazo – Ecuador
  - 6,384.4 km

- Distance from base to peak
  - Mauna Kea – Hawai
  - 10200 m

- Altitude according to mean sea level (choice)
  - Mount Everest – Nepal
  - 8.848 m

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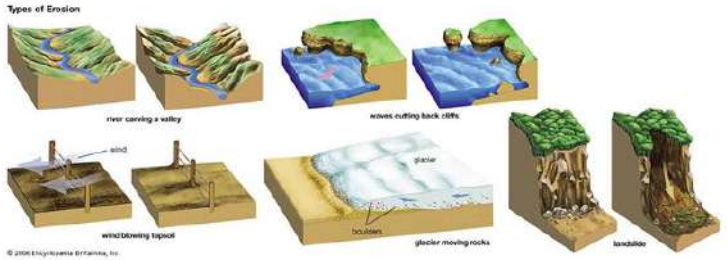
MOUNTAIN FORMATION - EARTH

- Volcanism – underground forces and eruption of magma
- Tectonic activity – heap mountains and trenches
- Erosions – wind, water and gravity activity



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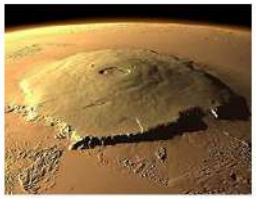
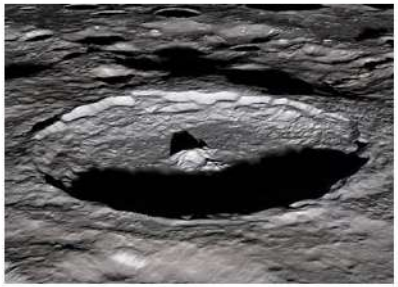
OTHER BODIES

- Weak or unexistant tectonics
- Meteors showers
- Unpredictability





THERMODYNAMIC MODEL

- Melting of material under ground because of pressure
- Energy of phase transition of the melted material
- Gravitational potential energy of sedimented particles

$$Q_T = E_{GP}$$
$$Q_T = m\lambda$$
$$E_{GP} = mgh$$

$$h = \frac{\lambda}{g}$$
$$h = \frac{3}{4G\pi} \cdot \frac{\lambda}{\rho R}$$

- λ: latent heat of melting
- g: gravitational acceleration
- m: mass of rock layer
- h: maximum mountain height
- ρ: astronomical object density
- R: astronomical object mean radius

SHEAR STRENGTH MODEL

- Mountain's weight applies pressure to underground particles
- Maximum height – mountain's pressure equal to shear strength of material

$$V_p = \frac{Ah}{3}$$
$$\sigma = \frac{F_g}{A} = \frac{\rho_{mat} V_p g}{A}$$

V_p: mountain volume; F_g: mountain weight; σ: crust material shear strength; A: area of mountain base

$$\sigma = \frac{\rho_{mat} g h}{3}$$
$$h = \frac{3\sigma}{\rho_{mat} g} = \frac{9}{4G\pi} \cdot \frac{\sigma}{\rho_{mat}} \cdot \frac{1}{\rho R}$$

ρ_{mat}: crust material density

HYPOTHESES

1. Greater pressure applied on a surface

   ↓

   More material melted

2. Model heights ≥ actual maximum heights on astronomical objects
3. Correlation between heights (model and formula) ≈ 1
4. Difference between model heights ≤ 10 km

EXPERIMENTAL SETUP

- Simulation of thermodynamic model
- 2 razors situated on a shallow container
- Setup on temperature 0°C

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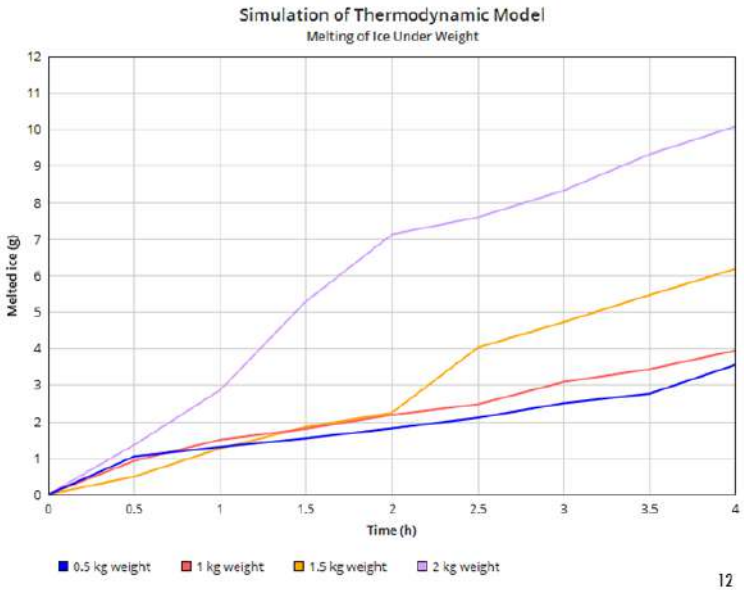

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EXPERIMENTAL SETUP

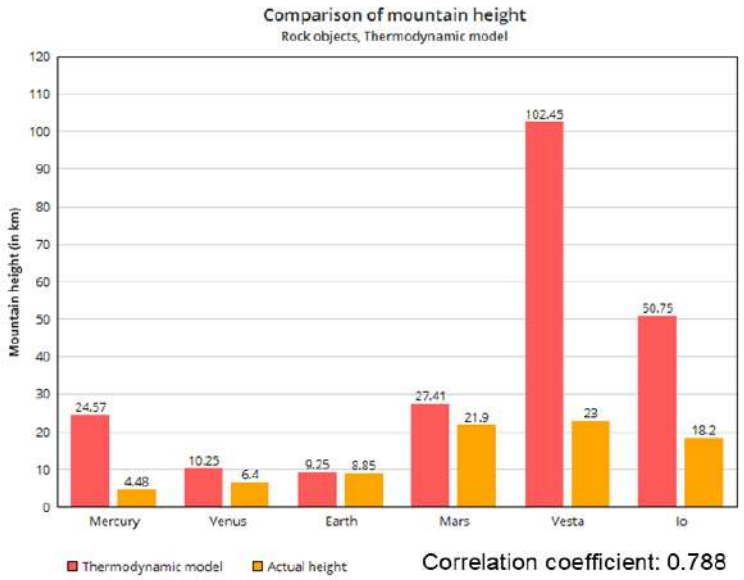
- Block of ice put on razors and weights laid on it
- Measurement every 0.5 h (8 in total)
- Experiment repeated for 4 different weights

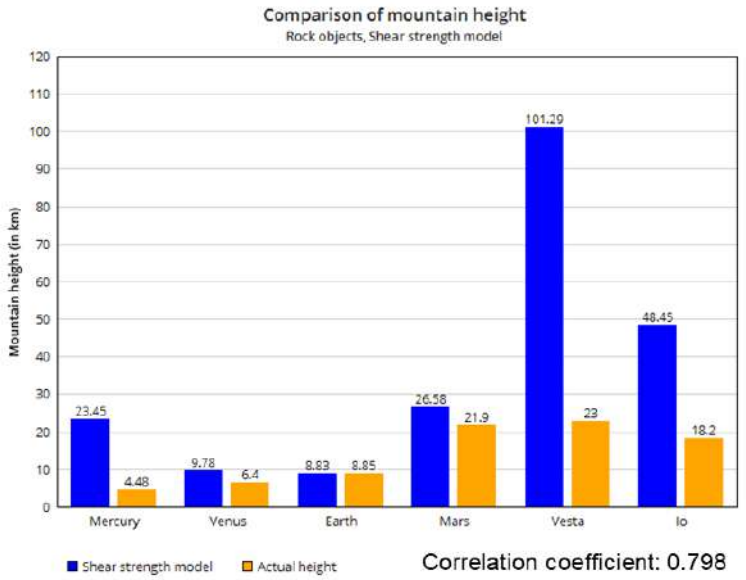
13

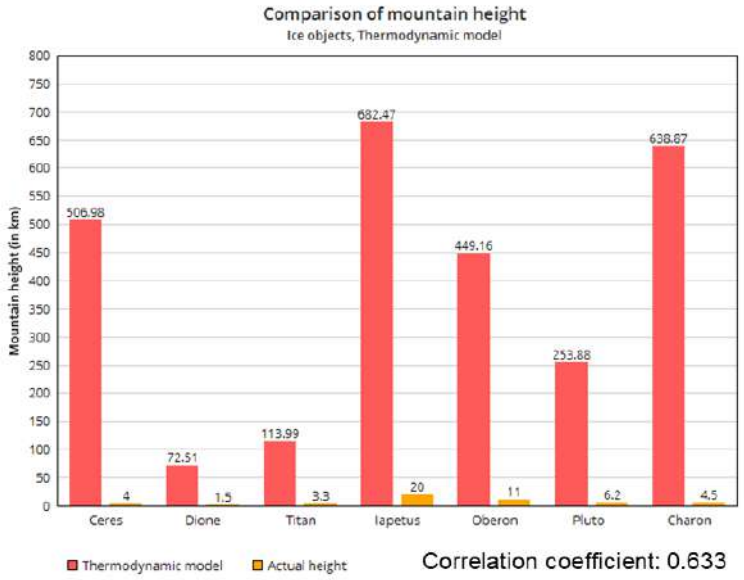
APPLICATION OF MODELS

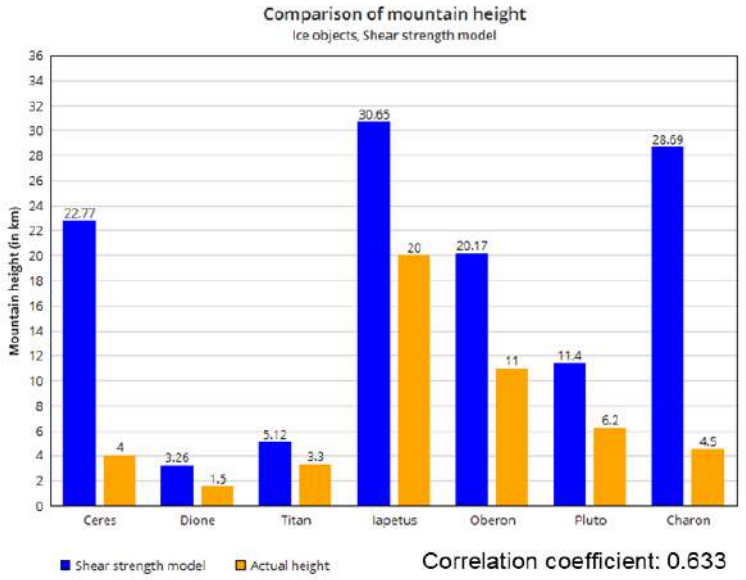
- Actual height on celestial bodies
- Mimas, Moon not taken into consideration – volcanic activity, tectonics
- Formula gives total height
- Coefficient for altitude above sea level

$$x = \frac{8{,}848\ km}{19{,}42\ km} \approx \frac{5}{11}$$


Comparison of mountain height
Rock objects, Thermodynamic model
Mountain height (in km)
120
110
100
90
80
70
60
50
40
30
20
10
0
24.57
4.48
10.25
6.4
9.25
8.85
27.41
21.9
102.45
23
50.75
18.2
Mercury
Venus
Earth
Mars
Vesta
Io
Thermodynamic model
Actual height
Correlation coefficient: 0.788


Comparison of mountain height
Rock objects, Shear strength model
Mountain height (in km)
120
110
100
90
80
70
60
50
40
30
20
10
0
23.45
4.48
9.78
6.4
8.83
8.85
26.58
21.9
101.29
23
48.45
18.2
Mercury
Venus
Earth
Mars
Vesta
Io
Shear strength model
Actual height
Correlation coefficient: 0.798


Comparison of mountain height
Ice objects, Thermodynamic model
Mountain height (in km)
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
506.98
4
72.51
1.5
113.99
3.3
682.47
20
449.16
11
253.88
6.2
638.87
4.5
Ceres
Dione
Titan
Iapetus
Oberon
Pluto
Charon
Thermodynamic model
Actual height
Correlation coefficient: 0.633


Comparison of mountain height
Ice objects, Shear strength model
Mountain height (in km)
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
22.77
4
3.26
1.5
5.12
3.3
30.65
20
20.17
11
11.4
6.2
28.69
4.5
Ceres
Dione
Titan
Iapetus
Oberon
Pluto
Charon
Shear strength model
Actual height
Correlation coefficient: 0.633

DEVIATIONS

- Volume of astronomical object
- Mountain shape
- Erosion
- Crust composition

18

CONCLUSION

- Shear strength model better for determining maximum height
- Rocky objects – small differences between results for both models
- Ice objects – big difference between results because of huge latent heat of melting (λ)

19

CONCLUSION - HYPOTHESES

1. Greater pressure applied on a surface

   ↓

   More material melted

2. Model heights ≥ actual maximum heights on astronomical objects

20

CONCLUSION - HYPOTHESES

3. Correlation between heights (model and formula) ≈ 1
   - Rocky objects (closer to 1) ✓
   - Ice objects (further from 1) ✗

4. Difference between model heights ≤ 10 km
   - Rocky objects ✓
   - Ice objects ✗

21

LITERATURE

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- https://geek.hr/e-kako/znanost/kako-nastaju-planine/
- http://fakulteti.edukacija.rs/zanimljivosti/kako-nastaju-planine
- http://www.enciklopedija.hr/natuknica.aspx?id=48589
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- https://prezi.com/dccwcsgdbqvk/postanak-i-poznavanje-planina/
- https://www.reddit.com/r/explainlikeimfive/comments/3dmseo/eli5_how_are_mountains_and_canyons_formed_on
- https://earthsky.org/space/mars-mountains-mounds-formation-wind-climate-change
- https://www.reddit.com/r/askscience/comments/240o0h/if_earths_mountains_are_formed_by_shifting/
- https://www.deccanchronicle.com/science/science/310818/nasa-mission-to-find-how-giant-mars-mountains-formed.html
- http://www.hk-phy.org/articles/mount_high/mount_high_e.html
- http://www-old.ias.ac.in/jarch/jaa/2/165-169.pdf
- https://www.icevirtuallibrary.com/doi/pdf/10.1680/geot.1962.12.4.251
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- https://mountainscholar.org/bitstream/handle/11124/170000/Jacobs_mines_0052N_10901.pdf?sequence=1&isAllowed=y
- https://books.google.hr/books?id=-i-6ssRi8okC&pg=PA28&lpg=PA28&dq=height+of+mountains+yield+strength&source=bl&ots=AqqWSvi-Sm&sig=SMe_OGpSkrlLfABHU154VZS7pl8&hl=hr&sa=X&ved=2ahUKEwiutu6JvaXfAhVNkMMKHWwJDQoQ6AEwAnoECAIQAQ#v=onepage&q=height%20of%20mountains%20yield%20strength&f=false
- https://talkingphysics.wordpress.com/2011/09/08/how-high-can-mountains-be/
- https://www.engineeringtoolbox.com/compression-tension-strength-d_1352.html

THANK YOU!

Team Croatia
Reporter: Andrej Todić

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	Celestial body	Greatest altitude	Height in km
Rock objects	Mercury	Unnamed	4,48
	Venus	Skadi Mons	6,4
	Earth	Mount Everest	8,85
	Mars	Olympus Mons	21,9
	Vesta	Rheasilvia	23
	Io	Boösaule Montes	18,2
Ice objects	Ceres	Ahuna Mons	4
	Dione	Janiculum Dorsa	1,5
	Titan	Mithrim Montes	3,3
	Iapetus	Equatorial trench	20
	Oberon	Unnamed	11
	Pluto	Tenzing Montes	6,2
	Charon	Butler Mons	4,5

APPLICATION OF MODELS

Astronomical object	Density (kg / m³)	Radius (m)	Material that takes up most of the crust	Density of material (kg / m³)	Latent heat of melting (J / kg)	Shear strength (Pa)
Mercury	5427	2439000	Granite	2750	200000	175000000
Venus	5243	6052000	Granite	2750	200000	175000000
Earth	5514	6378000	Granite	2750	200000	175000000
Mars	3933	3393500	Basalt	2750	225000	200000000
Vesta	3460	277500	Diogenite	3260	60500	65000000
Ceres	2090	512500	Ice	1000	334000	5000000
Io	3530	1815000	Granite	2750	200000	175000000
Dione	1480	5060000	Ice	1000	334000	5000000
Titan	1850	2575000	Ice	1000	334000	5000000
Iapetus	1090	730000	Ice	1000	334000	5000000
Oberon	1560	775000	Ice	1000	334000	5000000
Pluto	1860	1150000	Ice	1000	334000	5000000
Charon	1700	500000	Ice	1000	334000	5000000

Astronomical object	Relative difference ($p\% = \frac{\lvert h_{observed} - h_{assumed} \rvert}{h_{observed}}$)	
	Thermodynamic model	Shear strength model
Mercury	448%	423%
Venus	60%	53%
Earth	4%	0%
Mars	25%	21%
Vesta	345%	340%
Ceres	12574%	469%
Io	179%	166%
Dione	4734%	117%
Titan	3354%	55%
Iapetus	3312%	53%
Oberon	3983%	83%
Pluto	3995%	84%
Charon	14097%	538%

26

3. SALTY SOILS

Team Croatia
Reporter: Magdalena Žokalj

3. SALTY SOILS

Saline soils may **affect plant growth.** How do **salts** affect the **growth** and **development** of **plants?**

2

OUTLINE

Theoretical introduction
- Salt
- Soil
- Common bean

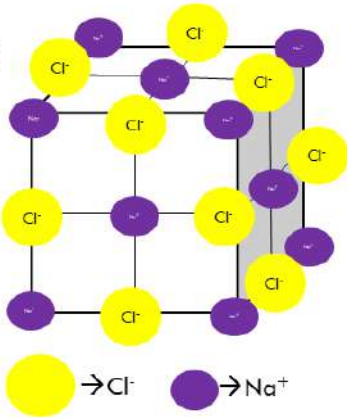
Experiment
- Experimental methods
- Experimental setup

Results
- 1st experiment→watered after seeding
- 2nd experiment→watered after first leaves have appeared
- 3rd experiment→watered after cotyledons have fallen

3

THEORETICAL INTRODUCTION

- **SALT**→chemical compound made of cations and acid residue
- **SOIL**→the upper layer of earth consisting of organic remains and rock particles



4

COMMON BEAN

- *Phaseolus vulgaris* L.
- grows relatively fast
- grows on room temperature
- easy discrimination of morphological attributes

http://1ofdmq2n8tc36m6i46scovo2e-wpengine.netdna-ssl.com/wp-content/uploads/2014/06/common-bean-plant_web_RoyKaltschmidt.jpg

5

HYPOTHESES - GERMINATION

will germinate	won't germinate
table salt sea salt $NaHCO_3$ $CaCO_3$ KNO_3 $CaCl_2$ $ZnSO_4$ NH_4Cl	$Pb(NO_3)_2$ borax $K_2Cr_2O_7$ KI $CuSO_4x5H_2O$

6

HYPOTHESES – PLANT GROWTH

Watered with salt solutions	Positive effect	No effect	Negative effect
from seeding	KNO_3	table salt	$Pb(NO_3)_2$ borax
after first leaves appeared	$ZnSO_4$ NH_4Cl	sea salt $NaHCO_3$	$K_2Cr_2O_7$ KI
after cotyledons fallen	$CaCl_2$	$CaCO_3$	$CuSO_4x5H_2O$

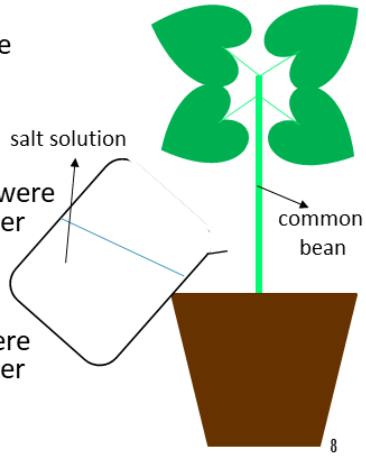
7

EXPERIMENTAL METHODS

First experiment → plants were watered with solutions from **seeding**

Second experiment → plants were watered with salt solutions after **first leaves appeared**

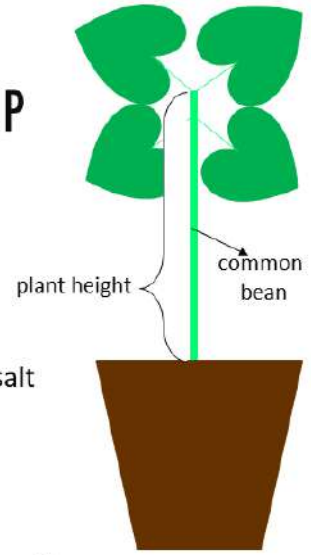
Third experiment → plants were watered with salt solutions after **cotyledons have fallen**



8

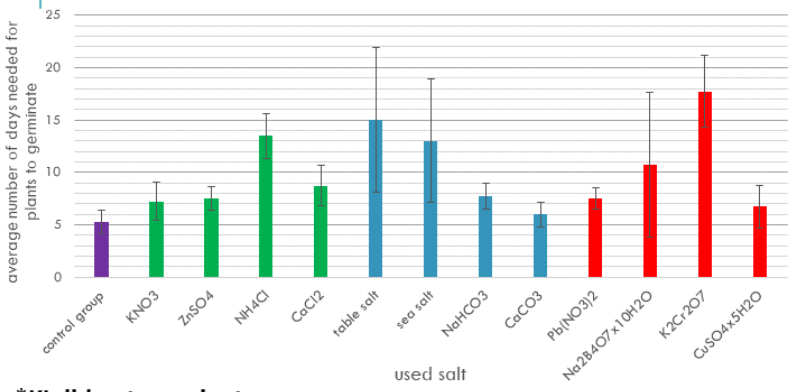
EXPERIMENTAL SETUP

- **1% salt solutions**
- control group → 8 plants
- 52 plants per experiment, 4 per salt
- plant height mesured
- qualitative assessment of plant health



9

RESULTS-GERMINATION



*KI did not germinate

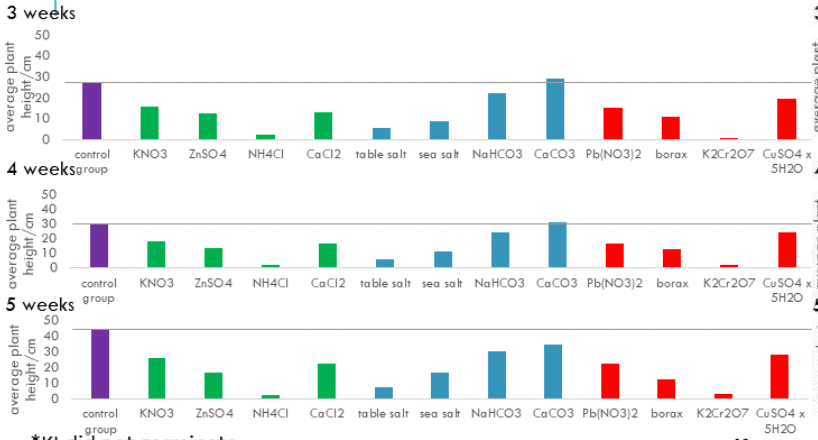
10

CONCLUSIONS-GERMINATION

will germinate	won't germinate
table salt ✓ sea salt ✓ $NaHCO_3$ ✓ $CaCO_3$ ✓ KNO_3 ✓ $CaCl_2$ ✓ $ZnSO_4$ ✓ NH_4Cl ✓	$Pb(NO_3)_2$ ✗ borax ✗ $K_2Cr_2O_7$ ✗ KI ✓ $CuSO_4x5H_2O$ ✗

11

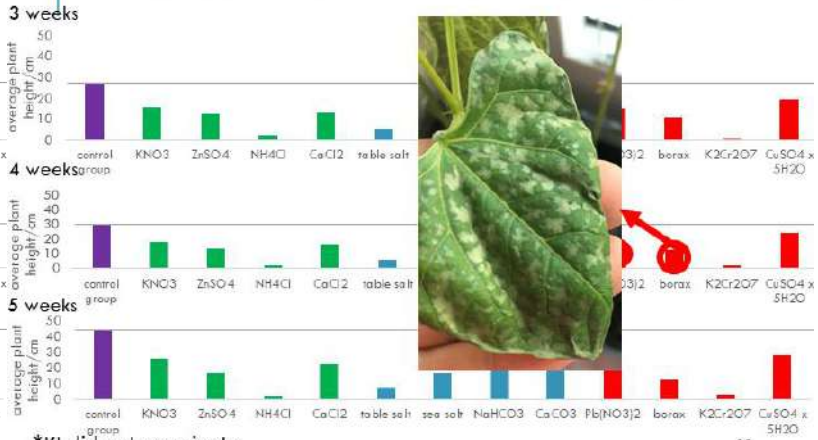
FIRST EXPERIMENT→AFTER SEEDING



*KI did not germinate

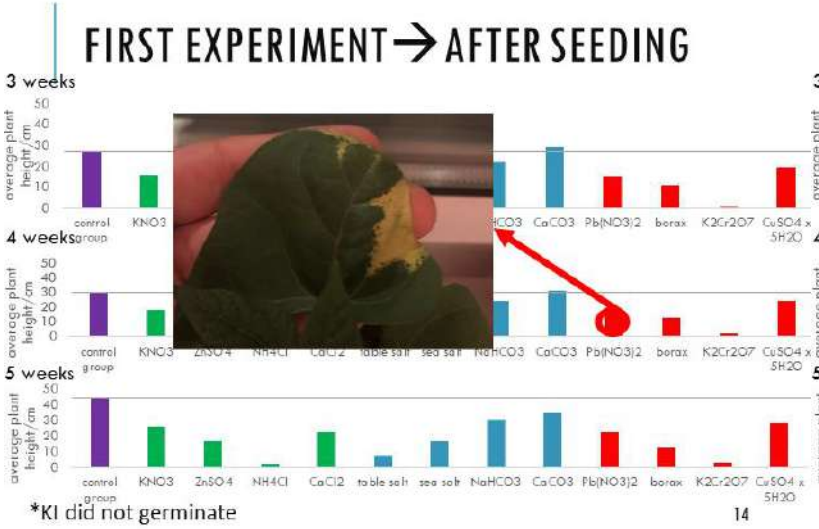
12

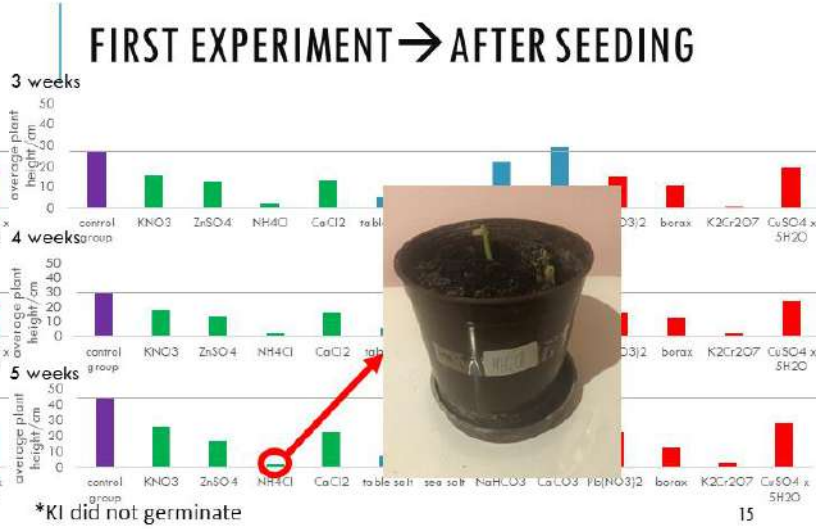
FIRST EXPERIMENT→AFTER SEEDING

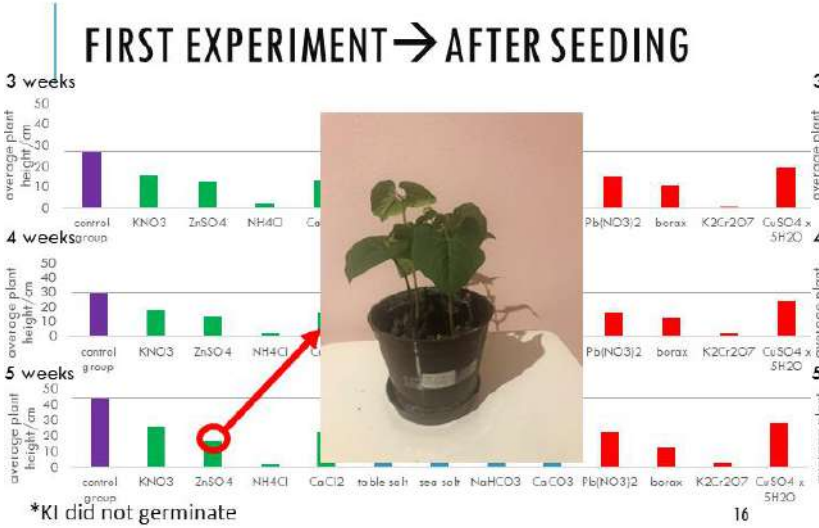


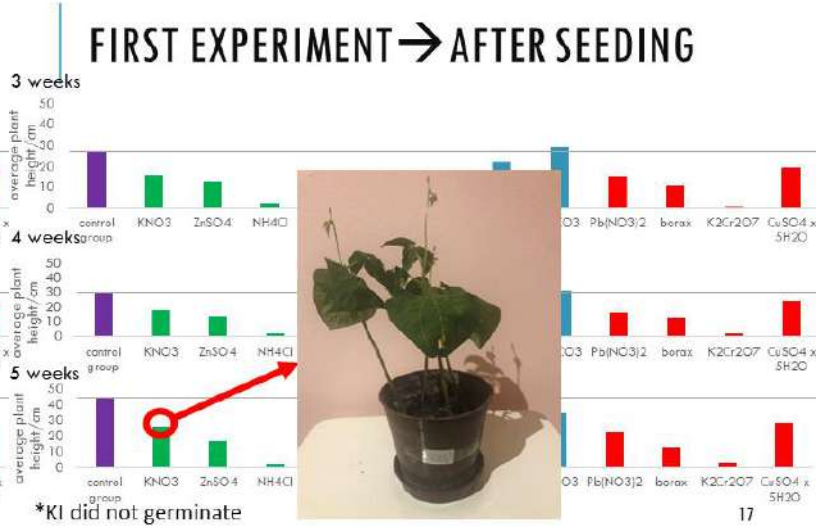
*KI did not germinate

13

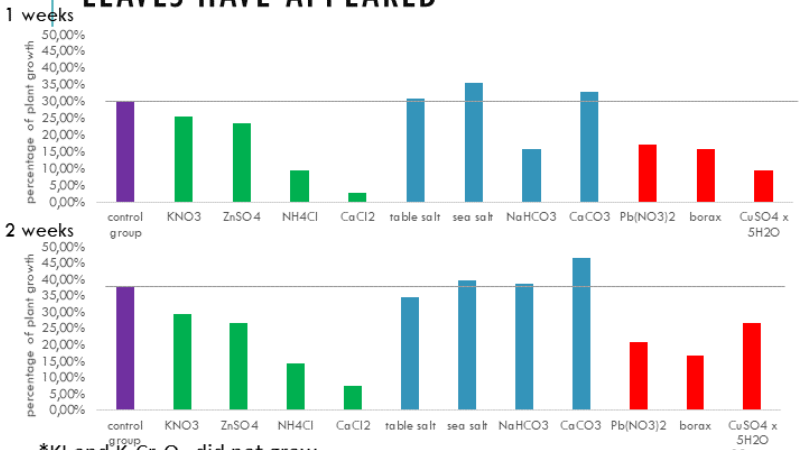

FIRST EXPERIMENT → AFTER SEEDING
3 weeks
4 weeks
5 weeks
average plant height/cm
control group
KNO3
ZnSO4
NH4Cl
CaCl2
table salt
sea salt
NaHCO3
CaCO3
Pb(NO3)2
borax
K2Cr2O7
CuSO4 x 5H2O
*KI did not germinate
14


FIRST EXPERIMENT → AFTER SEEDING
3 weeks
4 weeks
5 weeks
average plant height/cm
control group
KNO3
ZnSO4
NH4Cl
CaCl2
NaHCO3
CaCO3
Pb(NO3)2
borax
K2Cr2O7
CuSO4 x 5H2O
*KI did not germinate
15


FIRST EXPERIMENT → AFTER SEEDING
3 weeks
4 weeks
5 weeks
average plant height/cm
control group
KNO3
ZnSO4
NH4Cl
CaCl2
table salt
sea salt
NaHCO3
CaCO3
Pb(NO3)2
borax
K2Cr2O7
CuSO4 x 5H2O
*KI did not germinate
16


FIRST EXPERIMENT → AFTER SEEDING
3 weeks
4 weeks
5 weeks
average plant height/cm
control group
KNO3
ZnSO4
NH4Cl
Pb(NO3)2
borax
K2Cr2O7
CuSO4 x 5H2O
*KI did not germinate
17

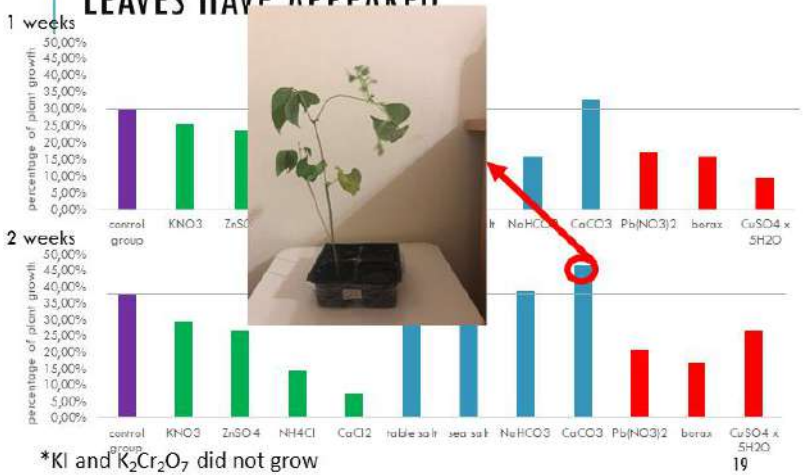
SECOND EXPERIMENT→AFTER FIRST LEAVES HAVE APPEARED



*KI and $K_2Cr_2O_7$ did not grow

18

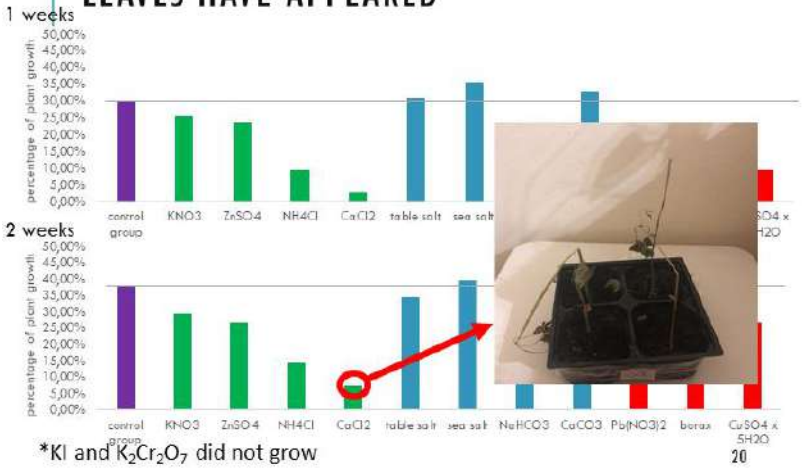
SECOND EXPERIMENT→AFTER FIRST LEAVES HAVE APPEARED



*KI and $K_2Cr_2O_7$ did not grow

19

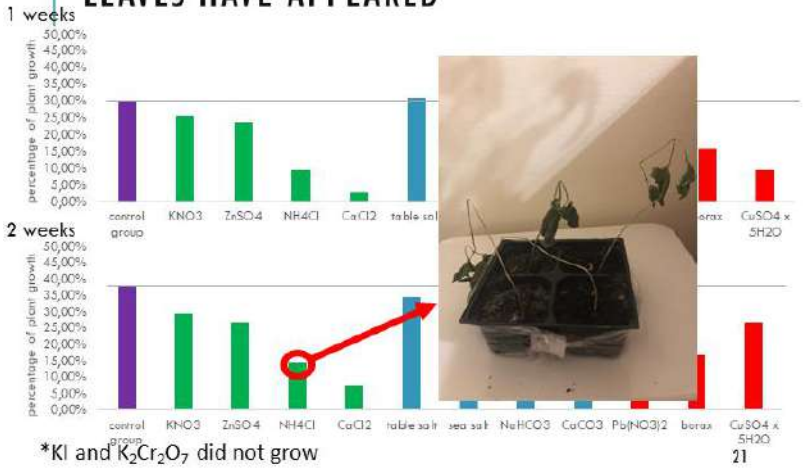
SECOND EXPERIMENT→AFTER FIRST LEAVES HAVE APPEARED



*KI and $K_2Cr_2O_7$ did not grow

20

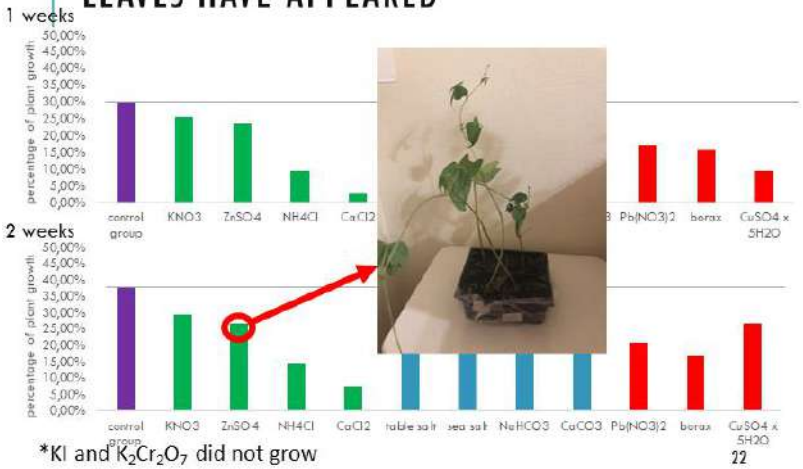
SECOND EXPERIMENT→AFTER FIRST LEAVES HAVE APPEARED



*KI and $K_2Cr_2O_7$ did not grow

21

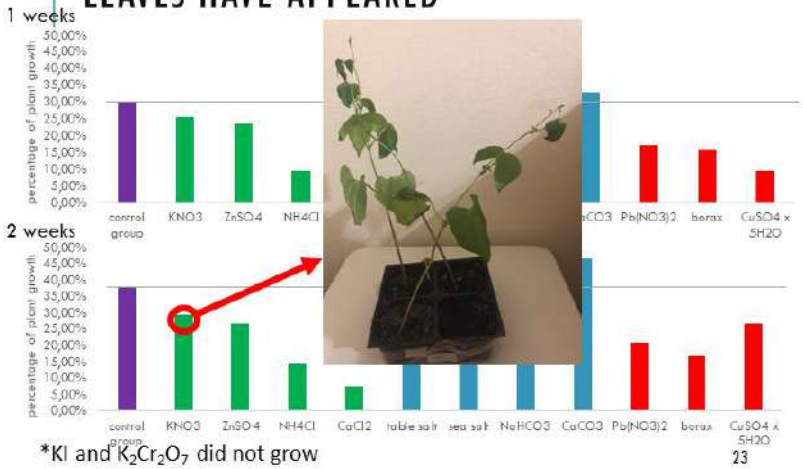
SECOND EXPERIMENT→AFTER FIRST LEAVES HAVE APPEARED



*KI and $K_2Cr_2O_7$ did not grow

22

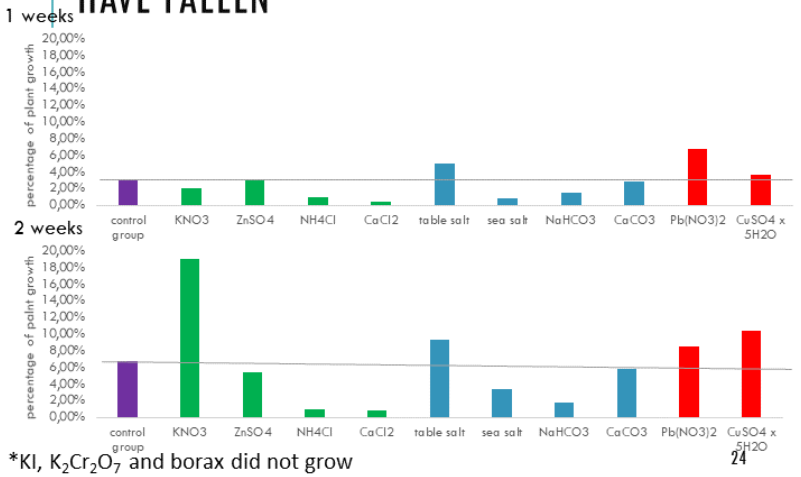
SECOND EXPERIMENT→AFTER FIRST LEAVES HAVE APPEARED



*KI and $K_2Cr_2O_7$ did not grow

23

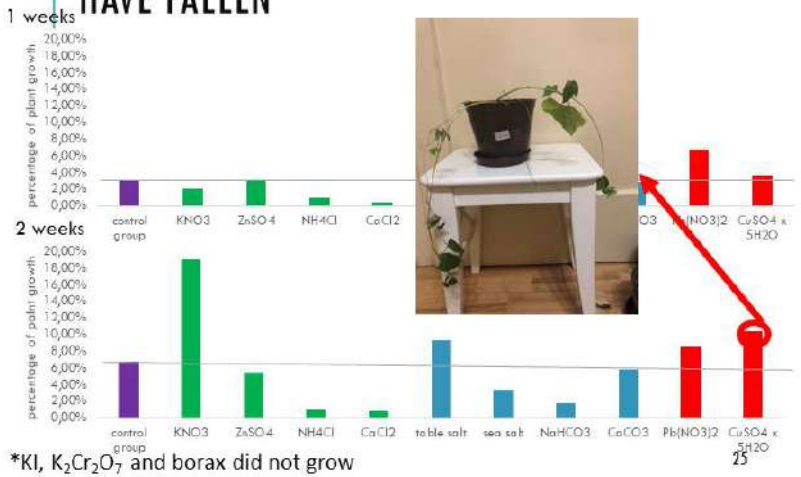
THIRD EXPERIMENT→AFTER COTYLEDONS HAVE FALLEN



*KI, $K_2Cr_2O_7$ and borax did not grow

24

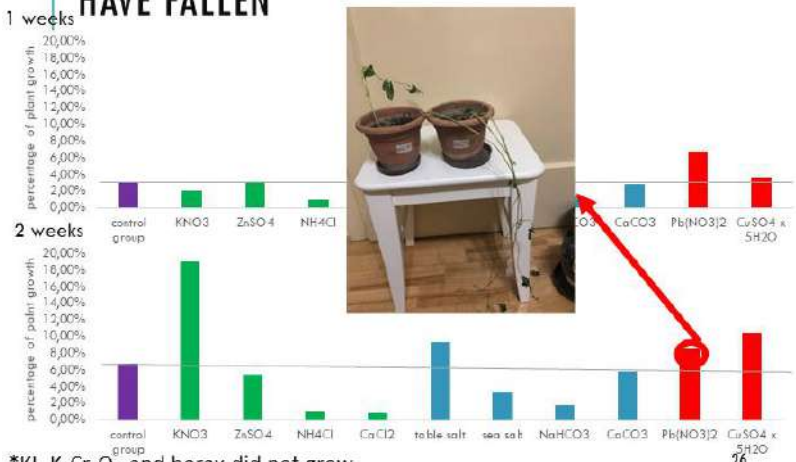
THIRD EXPERIMENT→AFTER COTYLEDONS HAVE FALLEN



*KI, $K_2Cr_2O_7$ and borax did not grow

25

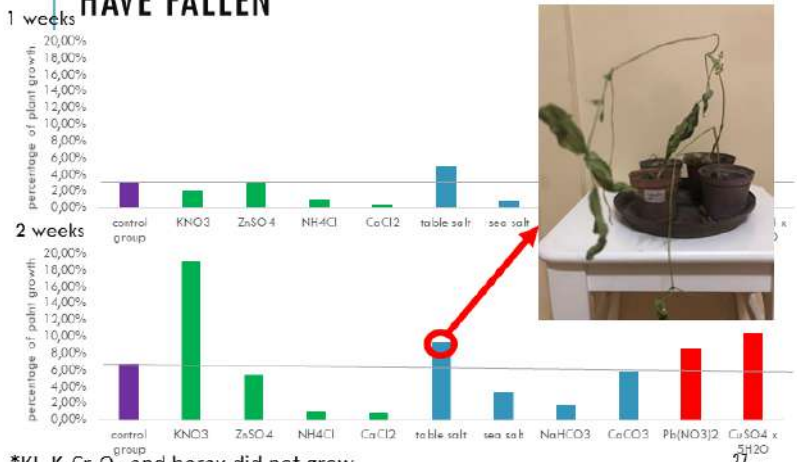
THIRD EXPERIMENT → AFTER COTYLEDONS HAVE FALLEN



*KI, $K_2Cr_2O_7$ and borax did not grow

26

THIRD EXPERIMENT → AFTER COTYLEDONS HAVE FALLEN



*KI, $K_2Cr_2O_7$ and borax did not grow

27

CONCLUSIONS

Watered with salt solutions	Positive effect	No effect	Negative effect
from seeding	KNO_3 ✓	table salt ✓	$Pb(NO_3)_2$ ✓
after first leaves appeared	$ZnSO_4$ ✓	sea salt ✓	borax ✓
	NH_4Cl ✗	$NaHCO_3$ ✓	$K_2Cr_2O_7$ ✓
after cotyledons fallen	$CaCl_2$ ✗	$CaCO_3$ ✗	KI ✓
			$CuSO_4x5H_2O$ ✗

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[1] Benyovsky Šoštarić, K. *Zeleni kvadrat.* Profil, Zagreb, 2010.

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[6] https://www.azom.com/article.aspx?ArticleID=2588

[7] https://homeguides.sfgate.com/fertilize-plants-sea-salt-39373.html

[8] https://pubchem.ncbi.nlm.nih.gov/compound/Calcium_dichloride#section=Density

[9] https://pubchem.ncbi.nlm.nih.gov/compound/Copper_II__sulfate_pentahydrate

[10] https://pubchem.ncbi.nlm.nih.gov/compound/potassium_dichromate

29

THANK YOU!

Team Croatia
Reporter: Magdalena Žokalj

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KNO_3

- fertilizer
- NO_3^- → N → proteins and chlorophyl, photosynthesis
- K^+ → water and nutrient transportation, protein and starch synthesis photosynthesis
- imeddiately aveliable N from NO_3^-

31

$ZNSO_4$

- fertilizer
- Zn^{2+} → enzymes and poteins, hormone production
- SO_4^{2-} → S → amino acids, chlorophyll

32

NH_4CL

- fertilizer
- NH_4^+ → N → proteins and chlorophyl, photosynthesis
- Cl^- → photosynthesis, osmotic adjustment, suppression of plant disease

33

$CACL_2$

- fertilizer
- Ca^{2+} → cell walls
- Cl^- → photosynthesis, osmotic adjustment, suppression of plant disease

34

$NAHCO_3$

- treatmnet for fungal diseases

37

PROBLEM 4. SUNFLOWER SPIRALS

Team Croatia
Reporter: Dora Špoler

PROBLEM 4. SUNFLOWER SPIRALS

Patterns of seeds in the head of a **sunflower** have a very specific **geometric structure.** How can one **describe and explain** such a structure? What **other plants** demonstrate similar geometric patterns in their leaves or seeds?

2

OUTLINE

Theoretical introduction
- Geometry of sunflower spirals
- Dynamics and Biochemistry
- Other plants and sequences

Experiment
- Experimental setup

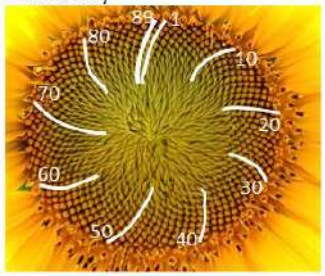
Results
- Occurrence of other types

3

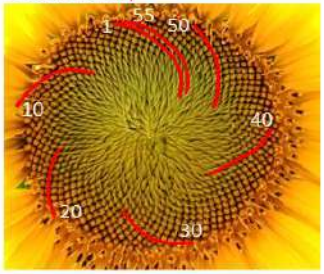
GEOMETRY OF SUNFLOWER SPIRALS

Number of spirals clockwise and anti-clockwise – **parastichy pair** = two successive **fibonacci numbers**

First family



Second family



Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

4

FIBONACCI SEQUENCE

F(0)=0 F(1)=1

F(n) = F(n-1) + F(n-2) for n > 1

Successive pairs

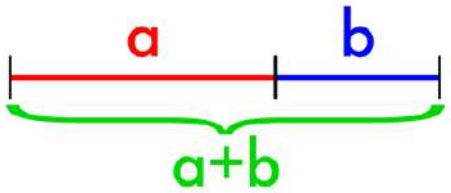
0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144…

$$\frac{F(n)}{F(n-1)} \approx 1.61803398\ldots = \textbf{\textit{the golden ratio}}$$

Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

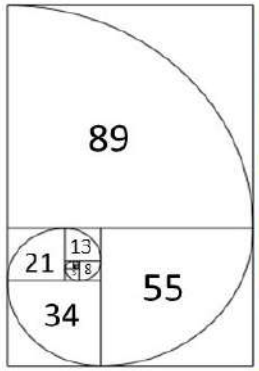
5

FIBONACCI SEQUENCE

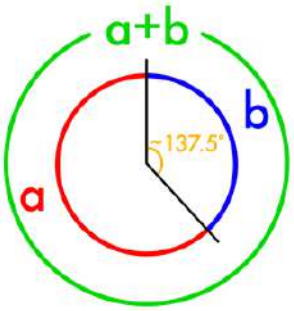


$$\frac{F(n)}{F(n-1)} \approx 1.61803398\ldots = \textit{the golden ratio}$$

FIBONACCI SPIRAL



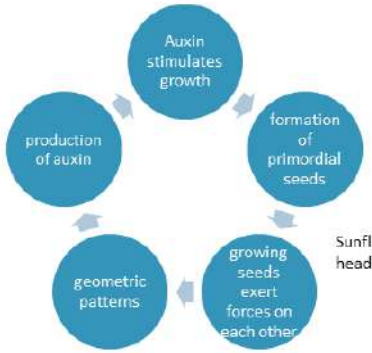
THE GOLDEN ANGLE



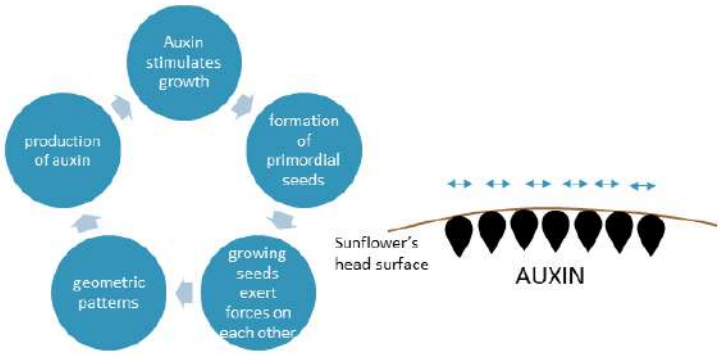
φ = 137.5° - the golden angle

Each seed rotates for golden angle - maximum filled space

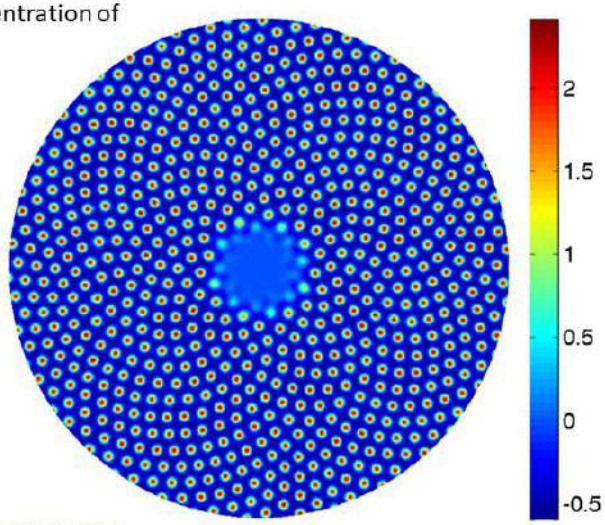
DYNAMICS AND BIOCHEMISTRY



DYNAMICS AND BIOCHEMISTRY

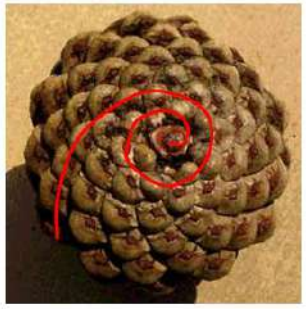


Concentration of auxin



OTHER PLANTS WITH FIBONACCI SEQUENCE

Pinecone



Succulents

OTHER PLANTS WITH FIBONACCI SEQUENCE

Daisy familiy

OTHER NUMBERS WHICH APPEAR IN SUNFLOWER SPIRALS

- **Double Fibonacci** – 2,4,6,10,16,26,42,68,110,…
- **Lucas** – 1,3,4,7,11,18,29,47,76,123…
  - $L_n = L_{n-1} + L_{n-2}$ for n>1
    $L_0 = 1 \quad L_1 = 3$
- **F4** – 1,4,5,9,14,23,37,60,97,….

Fibonacci subtypes

- **Fibonacci-1** - 12,20,33,54,88,143
- **Fibonacci+1** - 14,22,35,56,90,145

Non-fibonacci structure

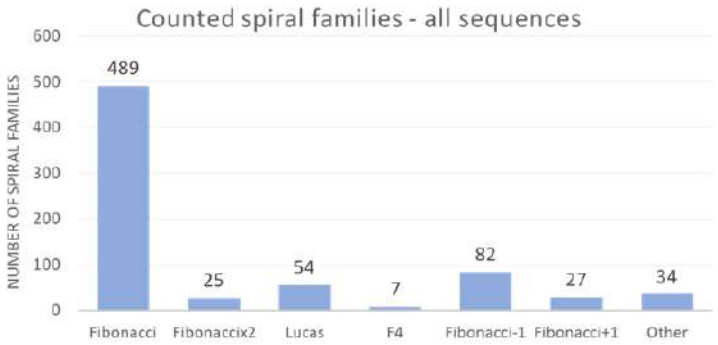
HYPOTHESES

1. Most of the spiral families will have **fibonacci structure**
2. The **fibonacci** sequence will be **the most represented** among spirals with fibonacci structure
3. There will be **more** spiral families with **Fibonacci-1** sequence than **Fibonacci+1** sequence

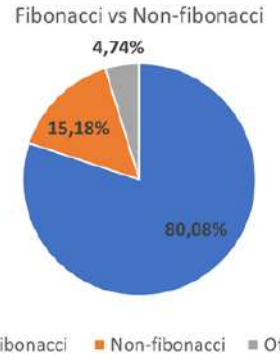
EXPERIMENTAL SETUP

- 359 photographs of sunflowers → 718 spiral families
- Manual counting families of spirals in each direction

RESULTS

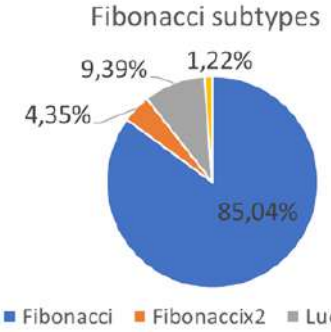


H1:MOST OF THE SPIRAL FAMILIES WILL HAVE FIBONACCI STRUCTURE ✓



Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

H2:THE FIBONACCI SEQUENCE WILL BE THE MOST REPRESENTED AMONG SPIRALS WITH FIBONACCI STRUCTURE ✓



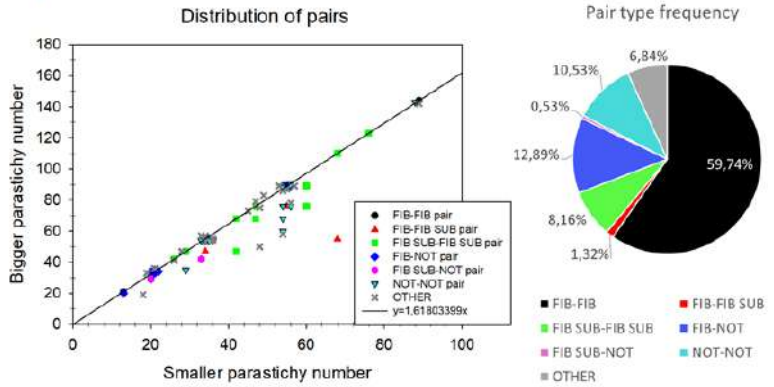
Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

H3:THERE WILL BE MORE SPIRAL FAMILIES WITH FIBONACCI-1 SEQUENCE THAN FIBONACCI+1 SEQUENCE ✓

NUMBER TIPE	NUMBER OF SPIRAL FAMILIES
FIBONACCI-1	82
FIBONACCI+1	27

Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

PAIR DISTRIBUTION



Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

CONCLUSION

- Fibonacci sequence – the most common type
- Subtypes of fibonacci sequence
- 80% of spiral families had type of fibonacci sequence out of which about 15% were subtypes of fibonacci sequence **– H1,H2** ✓
- Approximately fibonacci (one spiral less or more)
- One spiral less than fibonacci sequence appears more often **– H3** ✓

LITERATURE

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http://s15858.pcdn.co/wp-content/uploads/sites/default/files/images/http-inlinethumb59.webshots.com-42298-256177879010510160OS600x600Q85.jpg
https://www.google.hr/search?biw=1536&bih=706&tbm=isch&sa=1&ei=ITHXZaiebFrgT9hbiVYCA&q=sunflower+heads&oq=sunflower+heads&gs_l=img.3..0i19l2j0i5i30i19l2j0j8i30i19l2.39656.665946..666679...0.0..0.134.1887.0j15.....3....1..gws-wiz-img.....0..0i67j0.h6UQuFC6Msk
http://www.missmaggie.org/mission4_parts/spe/teaching/imgs/pinecone.jpg

22

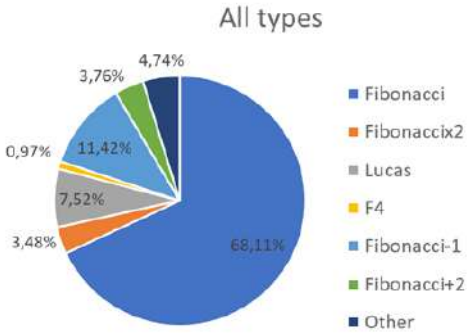
Theory – geometry → Theory – biology → Other plants and seq → Experiment → Results

23

THANK YOU!

Team Croatia
Reporter: Dora Špoler

ADDITIONAL SLIDES



25

PREVIOUS STUDIES

There have been only two large empirical studies of spirals in the capitulum, or head, of the sunflower: Weisse [15] and Schoute [16], which together counted 459 heads; Schoute found numbers from the main Fibonacci sequence 82% of the time and Weise 95%. The original motivation of this study was to add a third replication to these two historical studies of a widely discussed phenomenon.

26

GOLDEN RATIO

Formulas:

$$\varphi = 1 + \frac{1}{1 + \frac{1}{1 + \frac{1}{\varphi}}} \qquad \varphi = 1 + \frac{1}{\varphi}$$

$$\frac{a+b}{a} = \frac{a}{b} \equiv \varphi \qquad \varphi = \frac{1+\sqrt{5}}{2} = 1.6180339887$$

27

GOLDEN ANGLE

A primordium, the nascent leaf, forms at the least crowded part of the shoot meristem. The golden angle between successive leaves is the blind result of this jostling. Since three golden arcs add up to slightly more than enough to wrap a circle, this guarantees that no two leaves ever follow the same radial line from center to edge. The generative spiral is a consequence of the same process that produces the clockwise and counter-clockwise spirals that emerge in densely packed plant structures, such as *Protea* flower disks or pinecone scales.

28

FIBONACCI SEQUENCE IN TREES

- Fibonacci fraction – number of spiral rotations around a branch/number of branches that takes to do certain amount of rotation
- Uniqe for each tree type

Oak tree 2/5

Beech tree 1/3

30

THE GOLDEN RATIO

two quantities are in the **golden ratio** if their ratio is the same as the ratio of their sum to the larger of the two quantities

$$\frac{a+b}{a} = \frac{a}{b} \equiv \varphi\,.$$

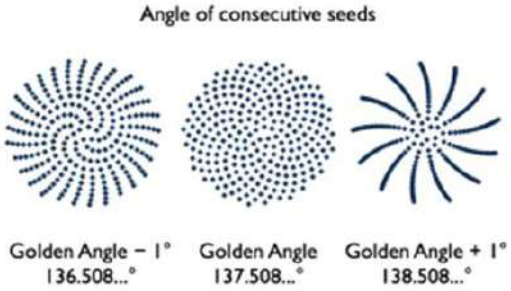
$$\varphi = \frac{1+\sqrt{5}}{2} = 1.6180339887$$

31

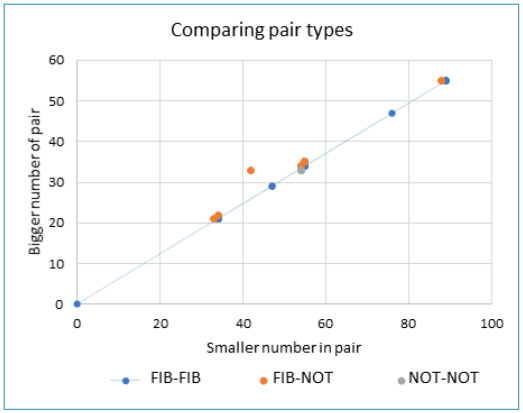
MULTIPLE FIBOANCCI

In some cases, the numbers appear to be multiples of Fibonacci numbers because the spirals consist of whorls.

32



33



- Results are not sparse, they are close to fibonacci sequence

FIB-FIB – both numbers in pair are a type of fibonacci numbers

FIB-NOT – one number in pair is type of fibonacci numbers, the other is not

NOT-NOT – neither one number in pair is type of fibonacci number

Line connects fibonacci nubers (not subtypes)

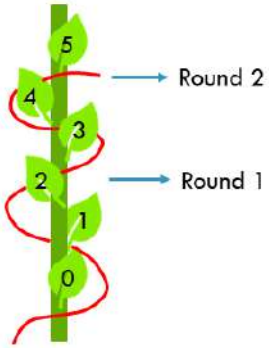
34

PHYLLOTAXIS

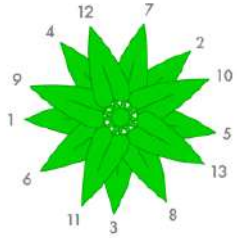
- The regular arrangement of lateral organs (leaves, petals)
- divergence angles between the organs
- the most common - 137.5° the golden angle

http://algorithmicbotany.org/papers/abop/abop-ch4.pdf

OTHER PLANTS WITH FIBONACCI SEQUENCE



Fibonacci fraction
2/5

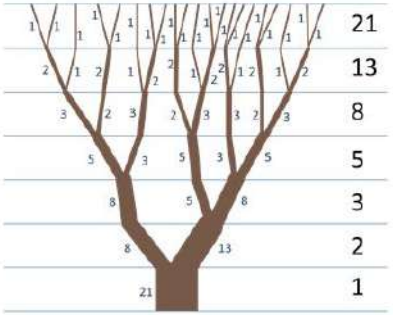


OTHER PLANTS WITH FIBONACCI SEQUENCE

Fern fiddlehead

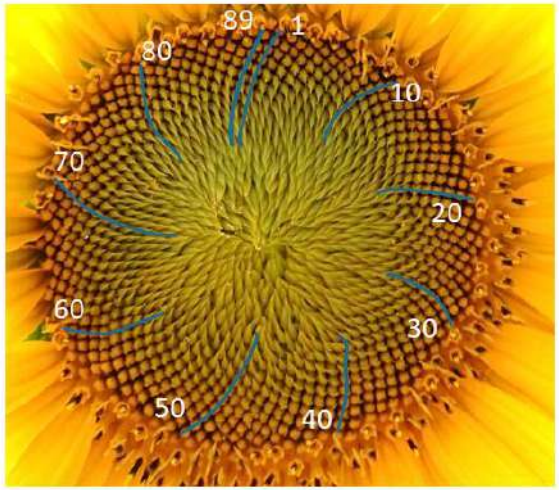
Calla lilie

OTHER PLANTS WITH FIBONACCI SEQUENCE



sneezewort

First spiral family



Theory – geometry | Theory – biology | Other plants and seq | Experiment | Results

39

6. SOUNDPROOFING

Team Croatia

Reporter: Marko Drozdek

6. SOUNDPROOFING

"It is sometimes necessary to **reduce unwanted noise** in a **closed space**.

Test **various methods** to **soundproof** your room."

2

OUTLINE

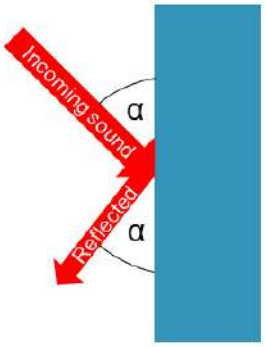
Theoretical introduction
- Absorption
- Reflection
- Frequency and intensity

Experiment
- Methods and measurements

Results
- Isolation outside of box
- Isolation inside of box
- Isolation with obstacles on walls

3

REFLECTION

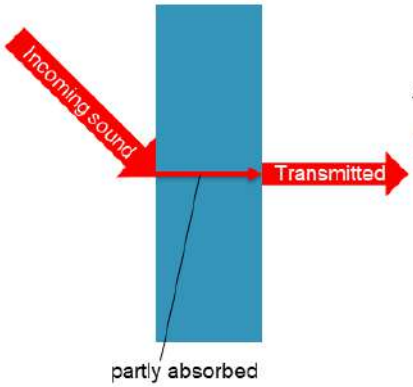


Reflection → sound measured inside

- Same angle
- Surface smoothness

4

ABSORPTION



Absorption → sound measured outside

- Heat
- Air

5

FREQUENCY AND INTENSITY

Frequency

$$f = \frac{n}{t}$$

n: number of rolls

t: time (seconds)

Hertz (Hz)

Human hearing

Intensity

$$I = \frac{P}{A}$$

P: power (watts)

A: area (m^2)

Watt per square meter (W/m^2)

Deci-Bel (dB)

6

HYPOTHESIS

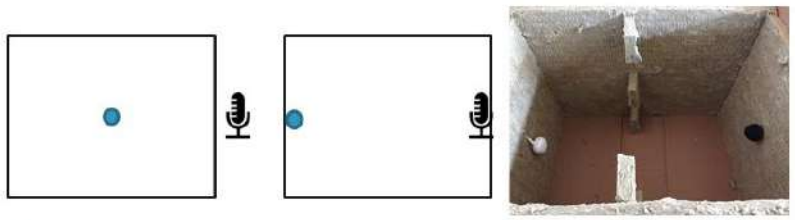
- **Loudest** sound **outside** of the box → **lowest frequency**
- **Inside** of the box with **styrofoam** → **loudest sound**
- **More obstacles** on the walls → **less sound** in the box
- **Best absorption** of sound → **rockwool**

7

METHODS AND MEASUREMENTS

- 3 isolating materials
- 3 frequencies
- 5 intensities

- Sound outside of box
- Sound inside of box
- Sound with obstacles on walls

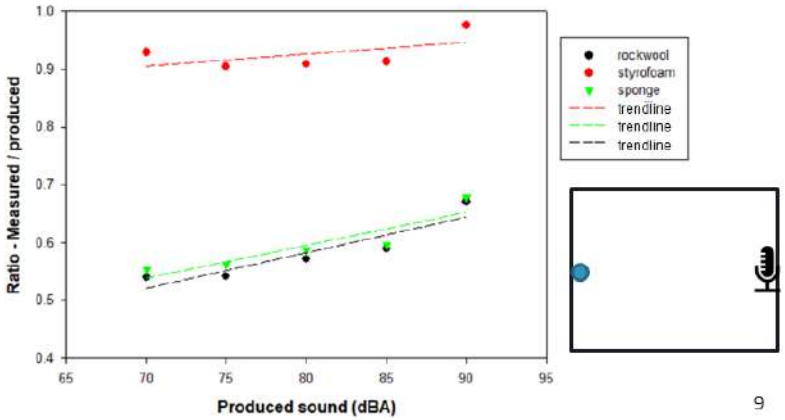


speaker

sound level meter

8

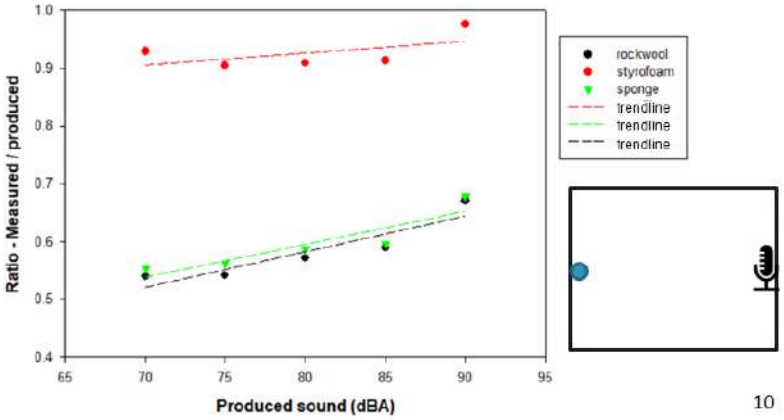
RESULTS- SOUND INSIDE OF BOX- 1000 Hz



9

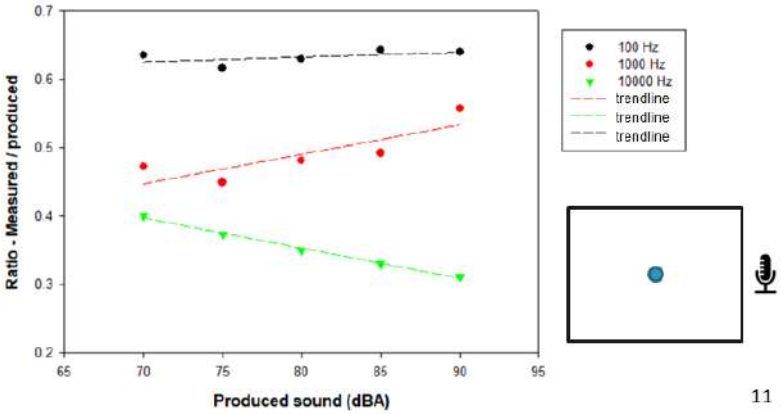
Inside of the box with styrofoam → loudest sound

Best absorption of sound → rockwool



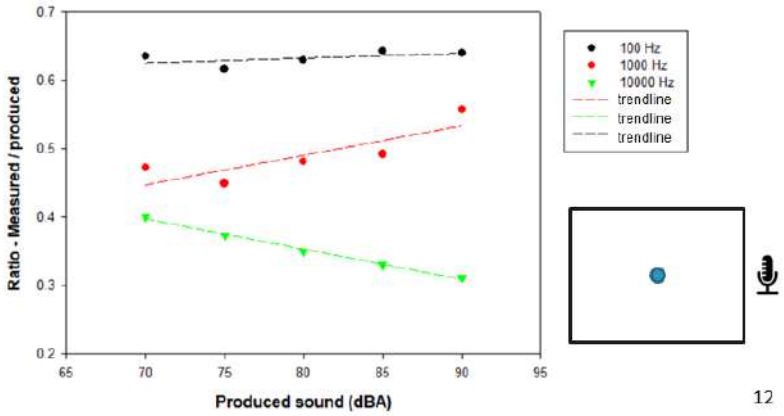
10

RESULTS- SOUND OUTSIDE OF THE BOX- ROCKWOOL



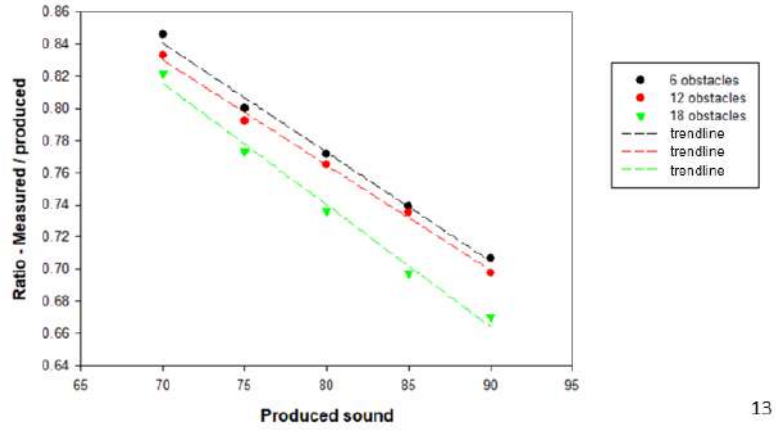
11

Loudest sound outside of the box → lowest frequency



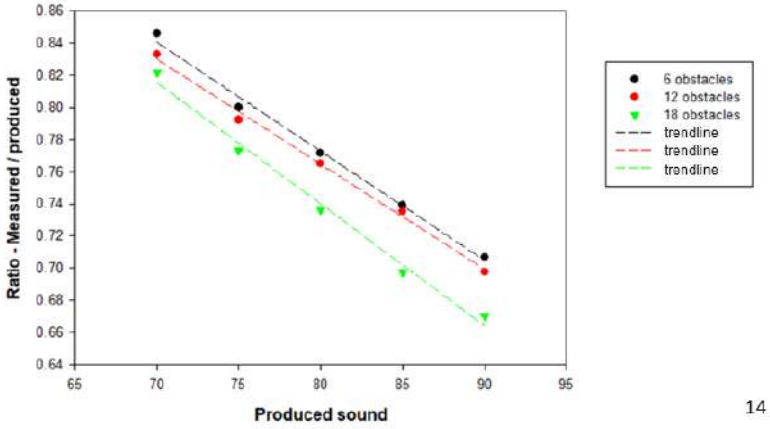
12

RESULTS- OBSTACLES ON THE WALLS



13

✓ More obstacles on the walls → less sound in the box



14

CONCLUSIONS

- ✓ Loudest sound outside of the box → lowest frequency
- ✓ Inside of the box with styrofoam → loudest sound
- ✓ More obstacles on the walls → less sound in the box
- ✓ Best absorption of sound → rockwool

15

LITERATURE

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- Mozaik knjiga: Znanost- velika ilustrirana enciklopedija
- Predrevac: Zvučna rezonancija
- Knezović: Mjerenje buke na odjelu za fiziku
- Petošić, Grubeša, Suhanek: Osnove akustike, buka okoliša te mjere za zaštitu od buke u otvorenom izatvorenom prostoru
- Drvo znanja: Zvuk I akustika
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16

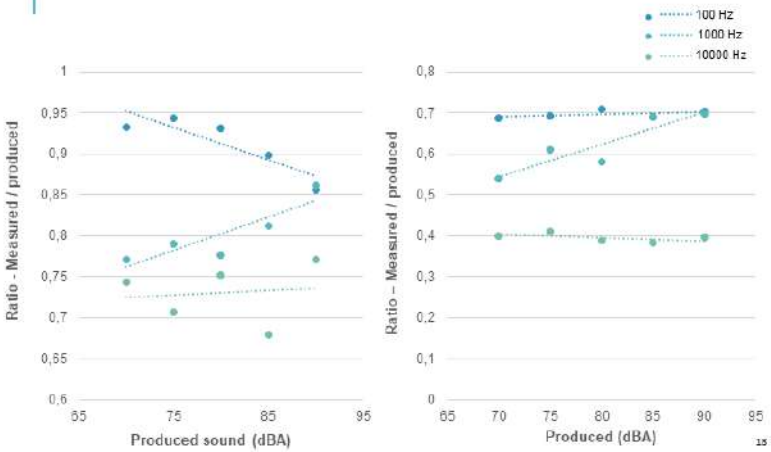
THANK YOU!

Team Croatia
Reporter: Marko Drozdek

IYNT 2019 MINSK

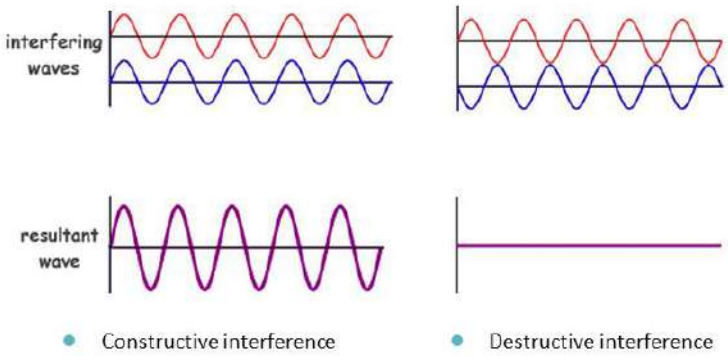
8

MEASUREMENTS- NO ISOLATION



18

SOUND INTERFERENCE



- Constructive interference
- Destructive interference

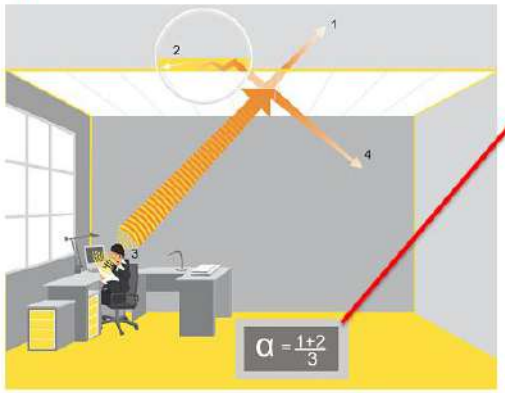
19

APPARATUS

- Speaker- Genius SP-i160 Specs- 2 watts, 80-23 000 Hz, 4 Ω
- Sound level meter- Tenmars TM 101

20

SOUND ABSORPTION COEFFICIENT



$$\alpha = \frac{1+2}{3}$$

1- transmitted sound

2- absorbed sound

3- produced sound

4- reflected sound

21

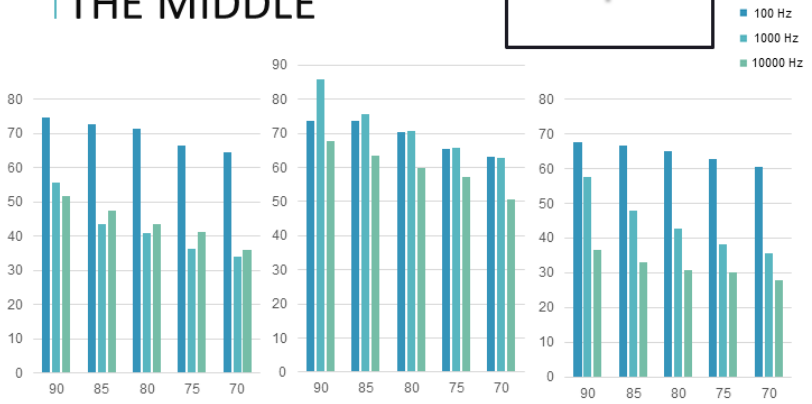
DECIBELS

$$\beta = (10\ \text{dB}) \log \frac{I}{I_0}$$

β = sound intensity, in decibels (dB)
I = sound intensity (W/m^2)
I_0 = reference sound intensity ($I_0 = 10^{-12}\ W/m^2$)

22

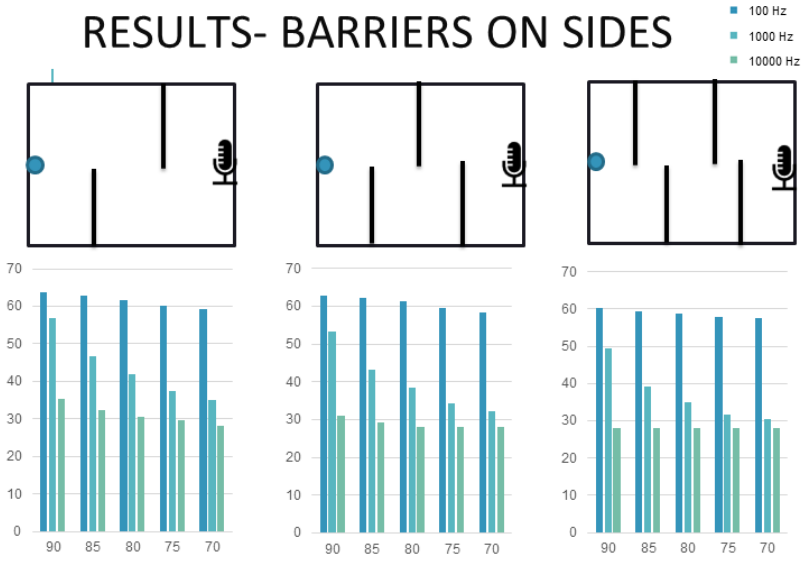
RESULTS- BARRIER IN THE MIDDLE



SPONGE STYROFOAM ROCKWOOL

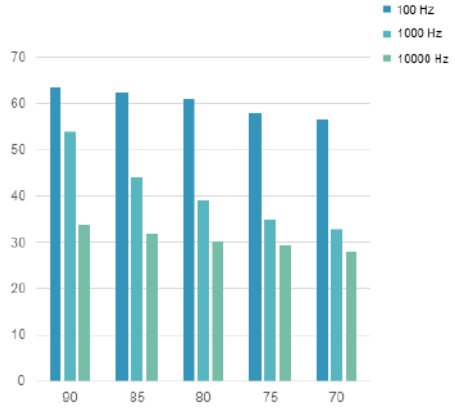
23

RESULTS- BARRIERS ON SIDES



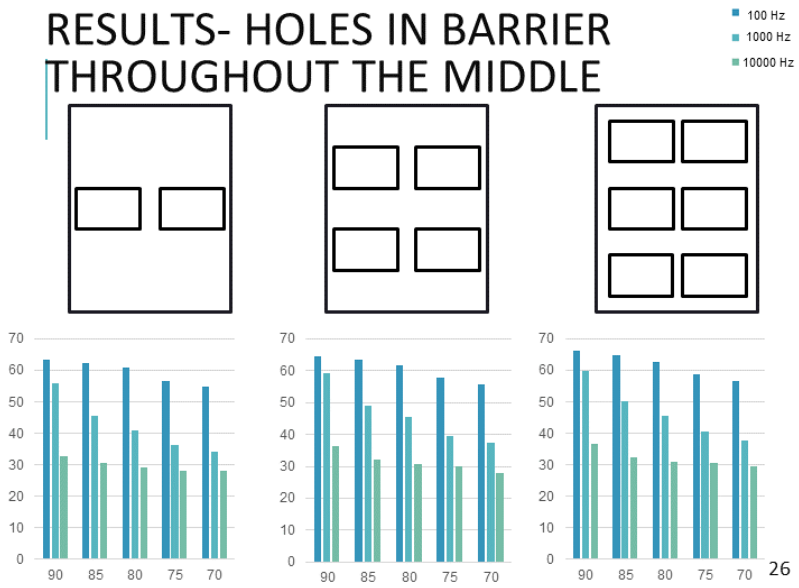
24

RESULTS- BARRIER THROUGHOUT THE MIDDLE



25

RESULTS- HOLES IN BARRIER THROUGHOUT THE MIDDLE



26

7.BURNING GLASS

Team Croatia
Reporter: Marita Machata

BURNING GLASS

- Propose and test **various methods** to start a **fire** with a **magnifying glass.**

Experiment

- Diameter of the lens
- Distance of the object from the magnifying glass
- Material

Theory → Experiment → Results

2

WHY IS IT POSSIBLE TO START A FIRE WITH A MAGNIFYING GLASS?

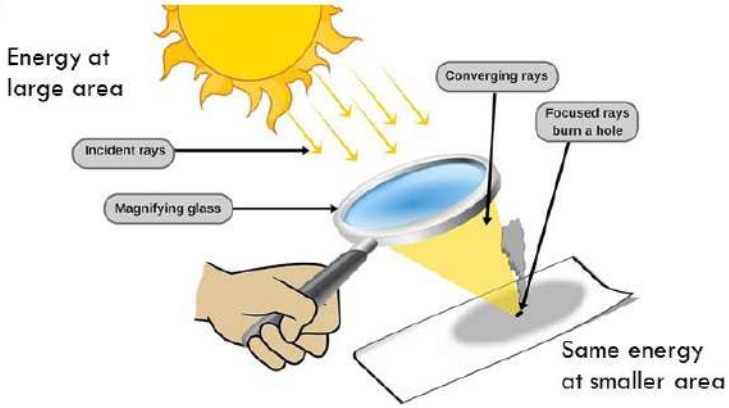


Image 1: Lighting a fire with magnifying glass

3

H2:MAGNIFYING GLASS WITH A LARGER LENS WILL START A FIRE IN A SHORTER AMOUNT OF TIME

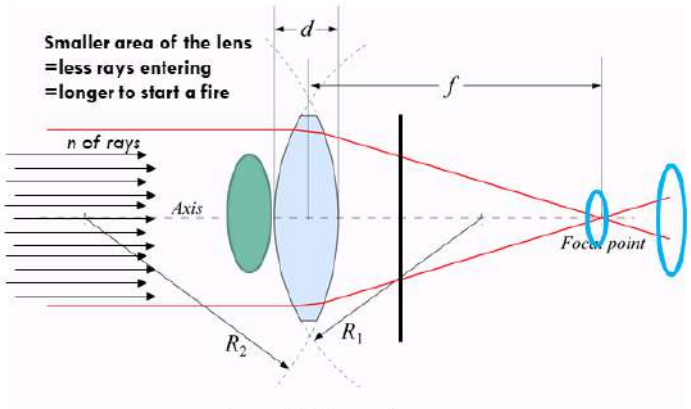


Image 2: Convex lens

4

H3: BURNING OF PAPER DEPENDS ON THE PAPER TEXTURE AND MATERIAL

Wood shavings will ignite **slower** than newspaper but **faster** than printing paper.

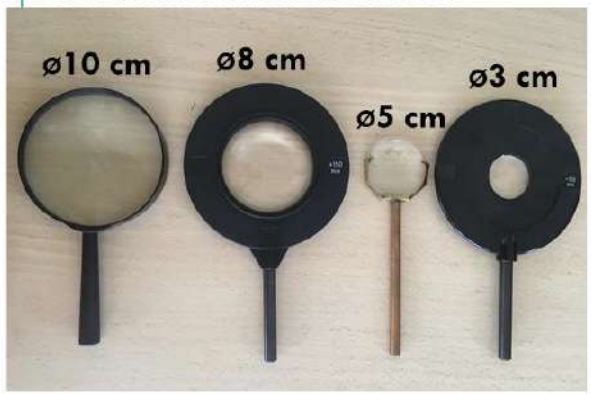
5

H3: BURNING OF PAPER DEPENDS ON THE PAPER TEXTURE AND MATERIAL

- **Newspaper**
- made of recycled, low-in-water material and the thinest from all the materials
  → **more flamable than wood shavings and printing paper**
- **Printing paper**
- made by draining cellulose fibres from a suspension in water
  → **less flamable than newspaper and wood shavings**
- **Wood shavings**
- significantly thicker than newspaper
  → **less flamable than newspaper**

6

EXPERIMENTAL SETUP



- measuring tape
- Ruler
- Sun intensity measuring device
- stopwatch
- materials for burning

Theory | Experiment | Results

7

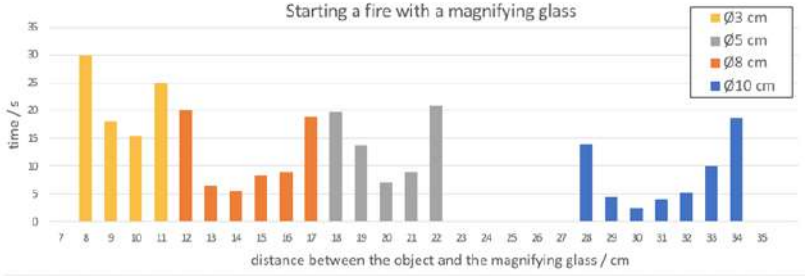
EXPERIMENT LAYOUT

- Lay flat a piece of paper or material
- Right angle of the magnifying glass depending on the posititon of the sun
  - Incident rays have to be perpendicular to the lens
- Measure the distance between the magnifying glass and the object
- Start the timer and position the lens between the Sun and the paper
- Stop the timer when a hole is burned
  - Hole = Ø0.5 cm

Theory | Experiment | Results

8

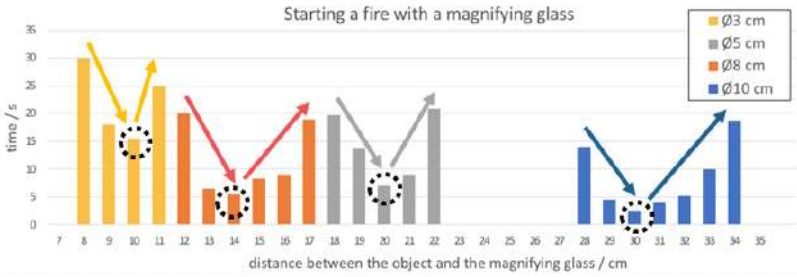
RESULTS



- **The closer** the object to the **focal point**
  → **object ignites faster**
- **The** focal distance
  → **object ignites the fastest**

9

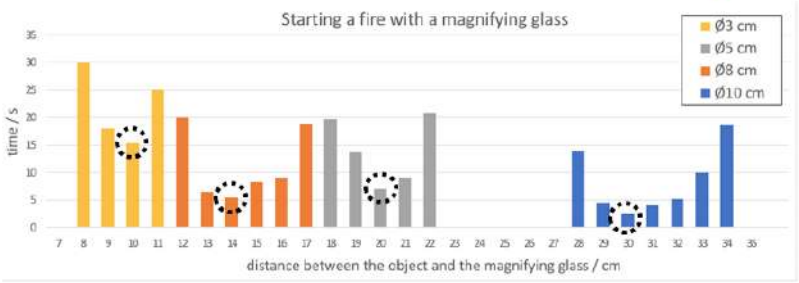
H1: IT WILL BE THE EASIEST TO START A FIRE WHEN THE MAGNIFYING GLASS IS AT THE FOCAL DISTANCE FROM THE OBJECT.



- **The closer** the object to the **focal point**
  - → **object ignites faster**
- **The** focal distance
  - → **object ignites the fastest**

10

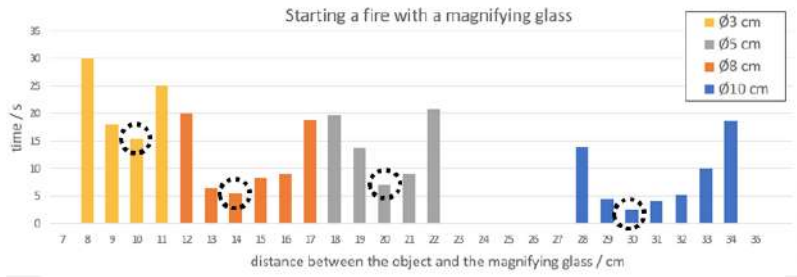
H2: MAGNIFYING GLASS WITH A LARGER LENS WILL START A FIRE IN A SHORTER AMOUNT OF TIME



- Minimum time for starting a fire
  - Ø3 cm→ 15,5 s
  - Ø5 cm→ 7 s
  - Ø8 cm→ 5,4 s
  - Ø10 cm→2,4 s

11

H2: MAGNIFYING GLASS WITH A LARGER LENS WILL START A FIRE IN A SHORTER AMOUNT OF TIME

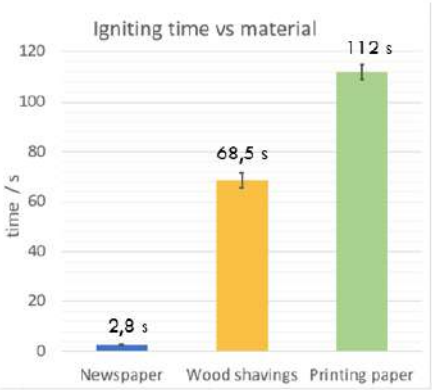


larger area of the lens

- → **the fire can be started further away from the focal point**
  - Ø3 cm→ fire could hardly be started 2 cm away from the focal point
  - Ø10cm→ 2 cm away the fire could still be started in about 5 s

→ with more rays entering, they don't have to be concentrated on such a small area to be able to start a fire

H3: WOOD SHAVINGS WILL IGNITE SLOWER THAN NEWSPAPER BUT FASTER THAN PRINTING PAPER



3 tests with same conditions

- Ø10 cm lens
- distance: 30 cm (focal distance)
- 109100– 109900 lux (bright sunlight)

- Avg. time needed for igniting:
  - Newspaper → 2,8 s
  - Wood shavings → 68,5 s
  - Printing paper → 112 s
    → **as expected**

13

CONCLUSION

H1: It will be **the easiest** to start a fire when the magnifying glass is at the **focal distance** from the object. ✓

H2:Magnifying glass with a **larger lens** will start a fire in a **shorter** amount of **time** ✓

H3: Burning of paper depends on the **paper texture** and **material** (Wood shavings will ignite **slower** than newspaper but **faster** than printing paper.) ✓

Theory | Experiment | Results

LITERATURE

- https://goneoutdoors.com/magnifying-glass-start-fire-4578543.html
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- http://www.simplescience.info/science/magnifyingglass

THANK YOU!

Team Croatia
Reporter: Marita Machata

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HYPOTHESES

H1: It will be **the easiest** to start a fire when the magnifying glass is at the **focal distance** from the object.

H2:Magnifying glass with a **larger lens** will start a fire in a **shorter** amount of **time**

H3: Burning of paper depends on the **paper texture** and **material** (Wood shavings will ignite **slower** than newspaper but **faster** than printing paper)

Theory | Experiment | Results

H2:MAGNIFYING GLASS WITH A LARGER LENS WILL START A FIRE IN A SHORTER AMOUNT OF TIME

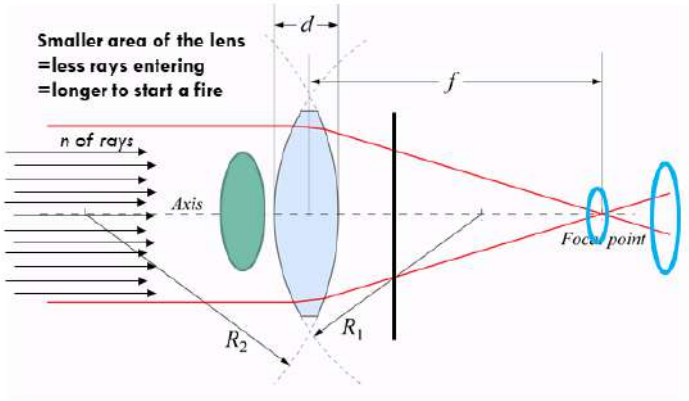


Image 1: Lighting a fire with magnifying glass

18

8. SMELLS

Team Croatia
Reporter: Marko Drozdek

8. SMELLS

Smells spread through the air, however it would take **some time** before a human nose is able to detect the smell. Study different aspects of **odor diffusion** and **sensation of odor** by humans.

2

OUTLINE

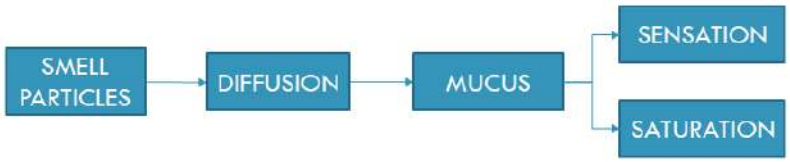
Theoretical introduction
- Sense of smell

Experiment
- Methods and measurements

Results
- Dependence of temperature
- Dependence of distance

3

SENSE OF SMELL



4

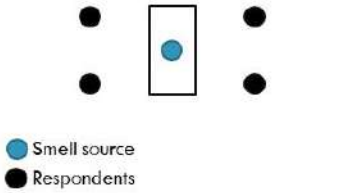
HYPOTHESIS

- Longer distance ⟹ more time for sensation
- Higher temperature ⟹ shorter sensation time

5

METHODS AND MESUREMENTS

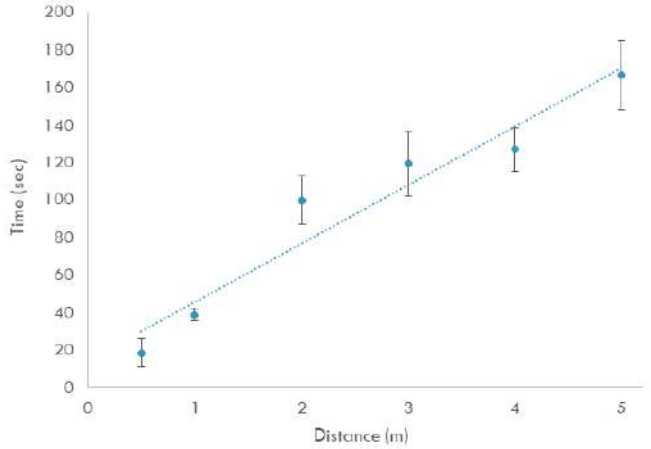
- 8 respondents
- Distance → smell source and respondents
- Solution temperature
- Time → stopwatches



6

RESULTS- DIFFERENT DISTANCES

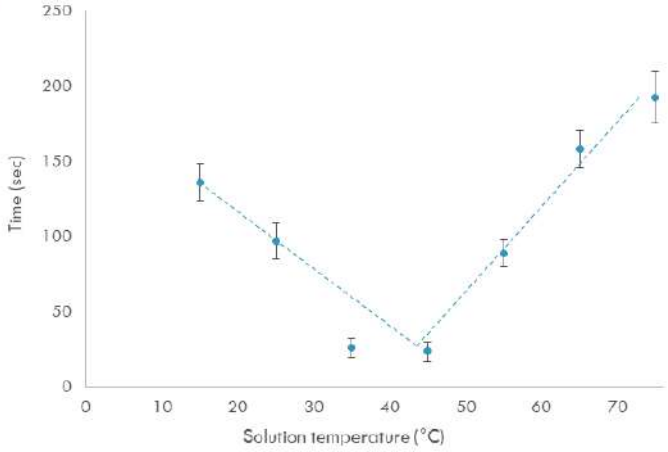
✓ Longer distance → more time for sensation



7

RESULTS- DIFFERENT SOLUTION TEMPERTURES

✗ Higher temperature → shorter sensation time



8

CONCLUSIONS

✓ Longer distance → more time for sensation

✗ Higher temperature → shorter sensation time

9

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THANK YOU!

Team Croatia
Reporter: Marko Drozdek

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9. FADING IN SUNLIGHT

Team Croatia
Reporter: Rea Pešušić

9. FADING IN SUNLIGHT

Printed pages **fade** in **direct sunlight,** especially if **certain types** of ink and paper are used. Propose **quantitative parameters** to study the prolonged exposure of ink and paper to sunlight.

2

OUTLINE

Theoretical introduction
- Sunlight
- Ink/Paper
- RGB values

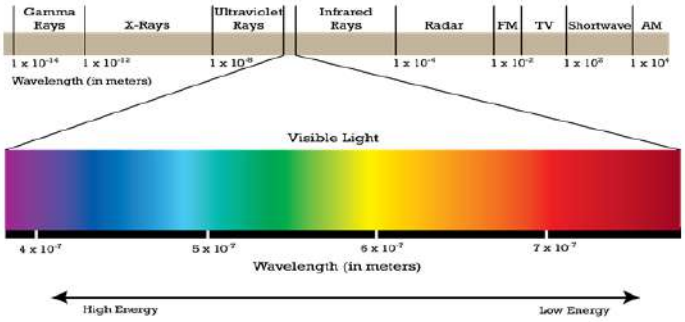
Experiment
- Hypotheses
- Experimental setup

Results
- White paper
- Receipt

3

SUNLIGHT

- The light spectrum is made up of many different wavelengths, out of which we can only see a small sliver



4

INK

- Ink is made from pigments/dyes and solvents
- Polymers are often added in to give the ink its desired look and texture, as well as to prevent clotting
- The exact chemical formula of ink is not known

5

PAPER

- Paper composes of celulose ($C_6H_{10}O_5$) and bleach (H_2O_2)
- Celulose is protected by lignin ($C_9H_{10}O_2$), which gives the paper a yellow tint
- The exact chemical formula of paper is not known

6

RGB VALUES

- red, green and blue receptors
- all colours come from the mix

BLACK

0 — 255

0 — 255

0 — 255

WHITE

7

HYPOTHESES

- H1: marker will fade away the last
- H2: write-erase pen will fade away first
- H3: the receipt will fade away quicker than the printed paper

8

EXPERIMENTAL SETUP

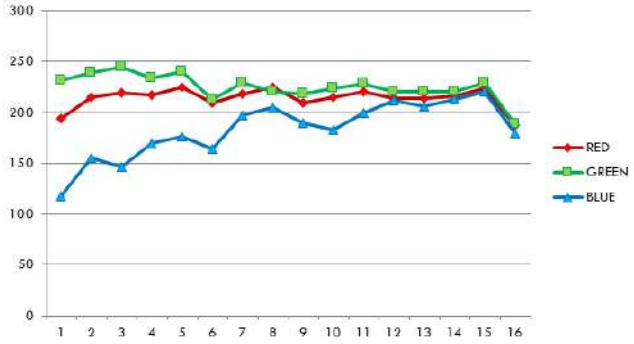
- a paper – printed
  - – marker → 16 days
  - – write-erase pen
- a receipt from a store → 13 days
- measured RGB values in ImageJ
- receipt – 197, 197, 205
- white paper - 174, 175, 179

9

PRINTED PAGES

10

MARKER



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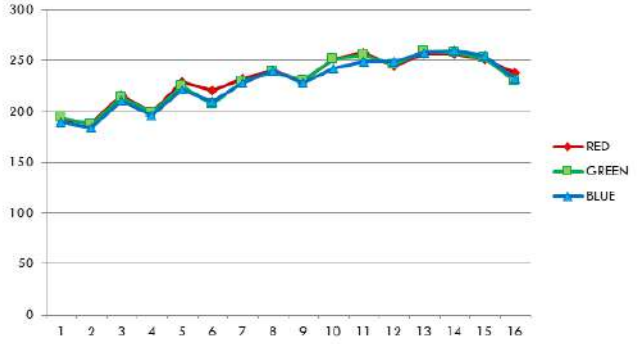
WRITE-ERASE PEN

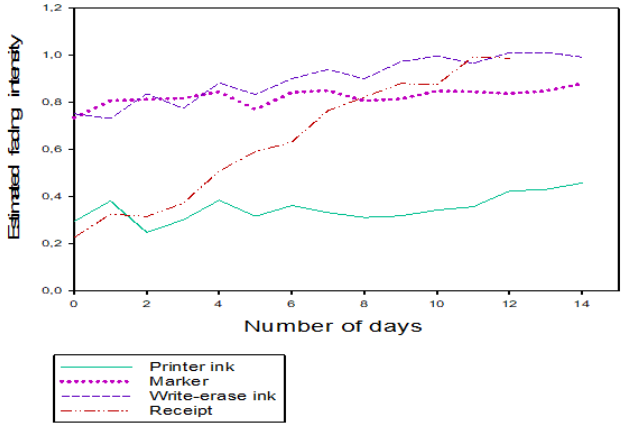


12

RECEIPT

13

INK FADE INTENSITY



14

CONCLUSION

- H1: marker will fade away the last ✗
- H2: write-erase pen will fade away first ✗
- H3: the receipt will fade away quicker than the printed paper ✓

- Possible factors: quality of ink/paper
  colour of ink
  printed/written
  position of the Sun

15

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16

THANK YOU!

Team Croatia
Reporter: Rea Pešušić

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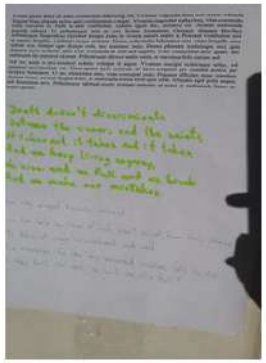


16

19

10. ELASTIC BONES

Team Croatia

Reporter: Magdalena Žokalj

10. ELASTIC BONES

Chicken bones kept in **acidic conditions** for a few days become **elastic.** Perform such an experiment in **controlled conditions** and investigate **what components of bones** are responsible for their **mechanical properties.**

2

DEMONSTRATION OF THE PHENOMENOM

3

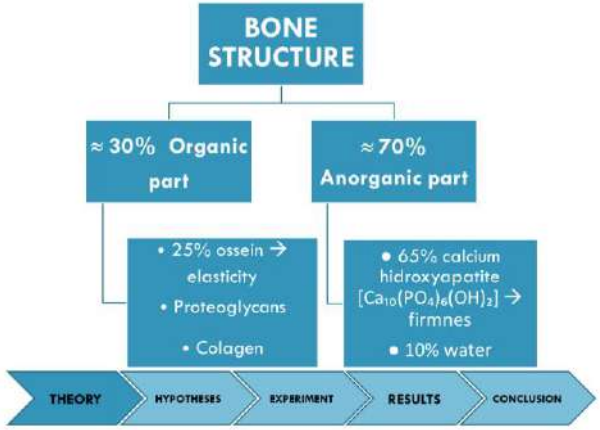
OUTLINE

Theoretical introduction
- Bone structure
- Young's modulus
- Chemical reaction

Experiment
- Method 1-streching
- Method 2-bending

Results
- Results - streching
- Results - bending

4



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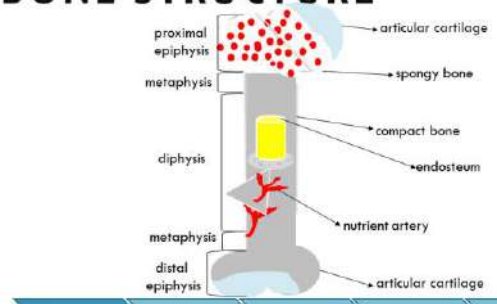
BONE STRUCTURE



THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

6

CHEMICAL REACTION

- **stronger acid takes weaker acid's place in its solution**

a) ACETIC ACID (VINEGAR ACID) (pH=2)

$Ca_{10}(PO_4)_6(OH)_2(s) + 20\ CH_3COOH(aq) \rightarrow 10\ Ca(CH_3COO)_2(aq) + 6\ H_3PO_4(aq) + 2\ H_2O(l)$

b) SULFURIC ACID (pH=1)

$Ca_{10}(PO_4)_6(OH)_2(s) + 10\ H_2SO_4(aq) \rightarrow 10\ CaSO_4(aq) + 6\ H_3PO_4(aq) + 2\ H_2O(l)$

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

7

YOUNG'S MODULUS

- measures the stiffness of an object
- streching, bending, compression → transformations of solid objects

$$E = \frac{F/A_0}{\Delta L/L_0} \quad \left[Pa = \frac{N/m^2}{m/m}\right]$$

E → Young's modulus
F → force
A_0 → area
ΔL → extention
L_0 → initial lenght

Table 1. Critical tension of the bone (MPa)

STRETCHING	BENDING	COMPRESSION
83,00	27,50	100,00

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

8

HYPOTHESES

1. The **bones** which were put in **acid** for a while will be **more elastic** than **fresh bones.**
2. The **bones** which were put in **sulfuric acid** for 60 hours will be **more elastic** than the **bones** put in **acetic acid**.
3. It will take **less force** for the **bone** to **snap** using the **bending** method than when the **stretching** method is used.
4. The **leg bone** will **break** when a **smaller force** is applied than the force needed to break the **bone of the thigh**.

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

9

EXPERIMENT

Table 2. Experimental design

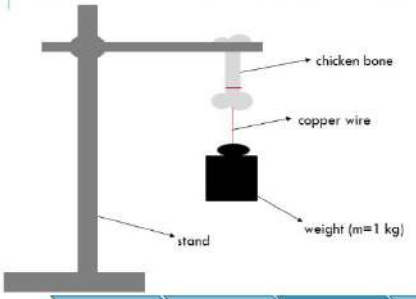
	Stretch	Bend
Control group	8 legs, 8 thighs	8 legs, 8 thighs
CH_3COOH	8 legs ,8 thighs	8 legs ,8 thighs
H_2SO_4	8 legs,8 thighs	8 legs,8 thighs

- elasticity of control group and bones kept in **9% acid** for **60 hours** measured using **bending** and **stretching** methods

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

10

METHOD 1-STRETCHING

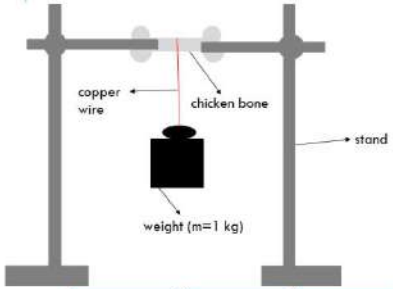


Picture 1: Stretching method

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

11

METHOD 2-BENDING

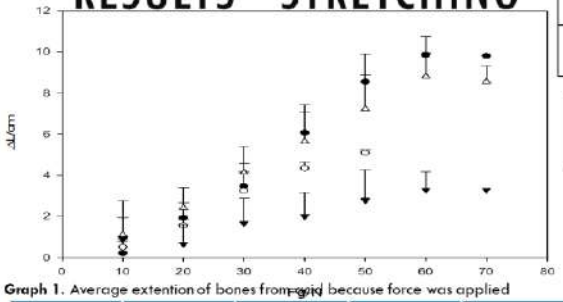


Picture 2: Bending method

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

12

RESULTS - STRETCHING

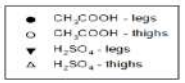


Graph 1. Average extention of bones from acid because force was applied

HYPOTHESYS 2 ✖

HYPOTHESYS 3 ✖

HYPOTHESYS 4 ✖

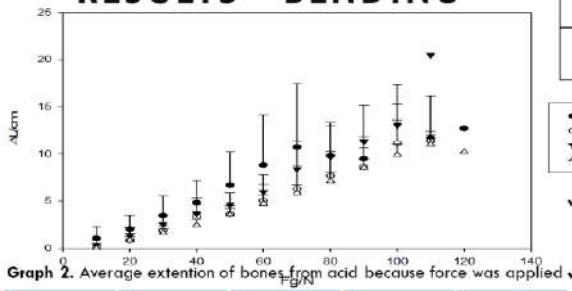


- ✓ **CH_3COOH legs, H_2SO_4 legs and thighs → the same force needed for bones to snap**
- ✓ **CH_3COOH legs → largest extention**

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

13

RESULTS - BENDING



Graph 2. Average extention of bones from acid because force was applied

HYPOTHESYS 2 ✖

HYPOTHESYS 3 ✖

HYPOTHESYS 4 ✖

✓ CH_3COOH legs and H_2SO_4 thigs → the greatest force needed for bones to snap

✓ H_2SO_4 legs → largest extention

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

14

CONCLUSION

1. The bones which were put in acid for a while will be more elastic than fresh bones. ✓
2. The bones which were put in sulfuric acid for 60 hours will be more elastic than the bones put in acetic acid. ✖
3. It will take less force for the bone to snap using the bending method than when the stretching method is used. ✖
4. The leg bone will break when a smaller force is applied than the force needed to break the bone of the thigh. ✖

THEORY | HYPOTHESES | EXPERIMENT | RESULTS | CONCLUSION

15

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16

THANK YOU FOR YOUR ATTENTION!!!

Team Croatia

Reporter: Magdalena Žokalj

17

ADDITIONAL SLIDES

Team Croatia
Reporter: Magdalena Žokalj

18

RESULTS - STRETCHING

Table 2. Young's module of bones when stretched

	F/N	A/m²	L_0/m	ΔL/m	E/Pa
CH_3COOH-legs	53,70	0,000072	0,11	0,0087	58 988,64
CH_3COOH-thighs	45,00	0,000078	0,08	0,0043	31 009,62
H_2SO_4-legs	60,60	0,000065	0,11	0,0038	32 206,99
H_2SO_4-thighs	58,80	0,000070	0,08	0,0086	90 300,00

19

RESULTS - BENDING

Table 3. Young's module of bones when bent

	F/N	A/m²	L_0/m	ΔL/m	E/Pa
CH_3COOH-legs	99,70	0,000060	0,11	0,1357	2 049 892,42
CH_3COOH-thighs	96,30	0,000093	0,08	0,1148	1 485 919,36
H_2SO_4-legs	94,70	0,000077	0,11	0,1141	1 275 710,34
H_2SO_4-thighs	102,50	0,000084	0,08	0,0803	1 224 813,99

20

11. YEAST

Team Croatia
Reporter: Marita Machata

1. YEAST

- **Investigate the rate of the multiplication of yeast at different temperatures**
  - 4 temperatures → 12 hours

Theory | Experiment | Results

THEORETICAL SLIDE

- Yeasts → single-celled fungi
- The presence of food (sugar) enables them to grow and multiply by **budding**

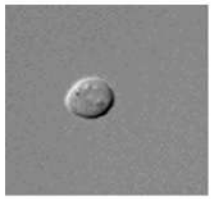


Image 1: Budding of yeast cells

SUGAR + OXYGEN → CO2 + WATER + ENERGY TO GROW

Expected to grow at different rates and speeds at different temperatures→experiment

Theory | Experiment | Results

DEPENDANCE OF POPULATION ON TIME

- rate at which the number of individuals in a population increases in a given time period

- $\boldsymbol{P(t)}$= population count after time $\boldsymbol{t}$
- $\boldsymbol{t}$ = time
- $\boldsymbol{r}$ = growth rate coefficient
- $\boldsymbol{K}$ = maximum population

$$\boldsymbol{P(t) = \frac{K}{1 + Ae^{-rt}}}$$

Edge cases
- $t = 0,\ P = P_0$
- $t \gg 0, P(t) \approx K$

Theory | Experiment | Results

HYPOTHESES

H1: Number of cells **will increase** over time

H2: Yeasts will multiply the most over the **first 6 hours.**

H3: Yeast cell counts over time will be consistent with the following **population model**:

$$\boldsymbol{P(t) = \frac{K}{1 + Ae^{-rt}}}$$

H4: Yeasts will **start to multiply** quicker and at larger rates at **higher temperatures**

H5: The largest multiplication rate at the investigated temperature range will be at **30 °C**

Theory | Experiment | Results

PREPARING THE YEAST MIXTURE

- ratios
  - **5 g** of sugar (white granulated)
  - **50 ml** of water (temperature of the multiplicating environment)
  - **0.05 g** of yeast

Theory | Experiment | Results

MIXING AND MEASURING

- Measuring **every 2 h** over the time of 12 h – **7 times**
  - (immediately after mixing, +2 h, +4h, +6 h, +8 h, +10 h, +12 h)
  - mixing every two hours, taking 1mL ***3(triplicates)***
- **Freezing** it emediately to **stop** the multiplication process
  - Repeat two hours later

Theory | Experiment | Results

MIXING AND MEASURING

Image 2: Prepared 1mL containers for freezing the yeast cells

COUNTING CELLS

- **Hemocytometer**
  - A miscroscope slide, similar to a regular glass slide
  - engraved lines that create chambers that **fit the exact amount of liquid**
  - possible to count the number of cells in a **specific volume of fluid**

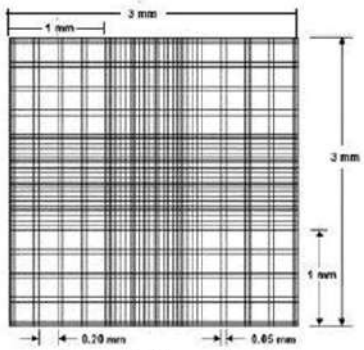
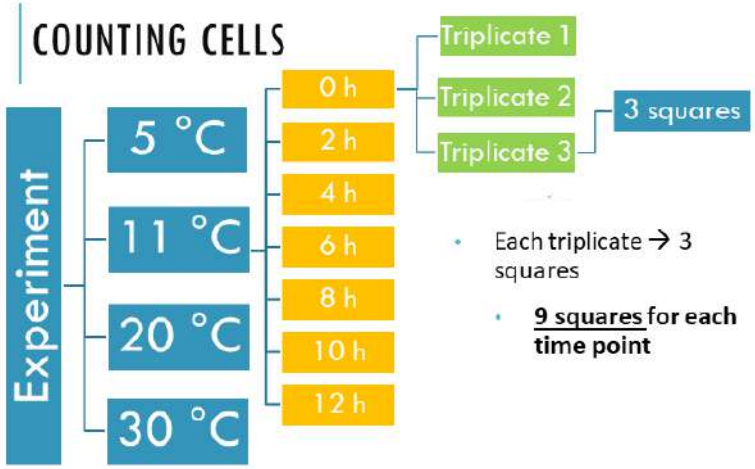


Image 3: Hemocytometer

Theory | Experiment | Results

COUNTING CELLS



- Each triplicate → 3 squares
  - **9 squares for each time point**

COUNTING CELLS

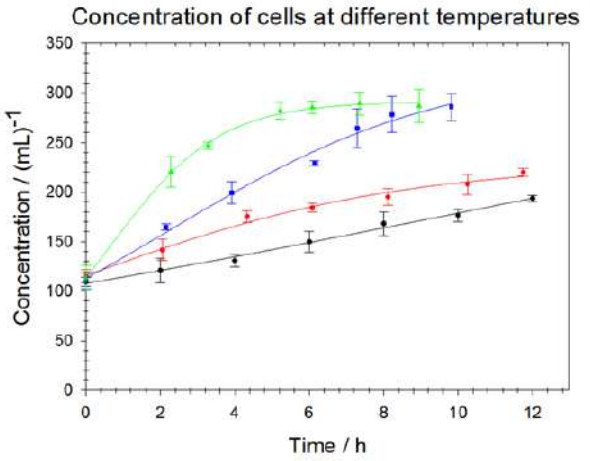
- After counting cells in a specific square, I can calculate the **concentration of yeast cells**
  - N=number of cells in one square
  - V=volume of liquid in one square
    - **V=0,004 mm3**

$$C = \frac{N}{V}$$

- By multiplying the number by **250 000**→concentration of cells in **1 mL**
  - **0,004 mm3 x 250 000 = 1000 mm3 = 1 cm3 = 1 mL**

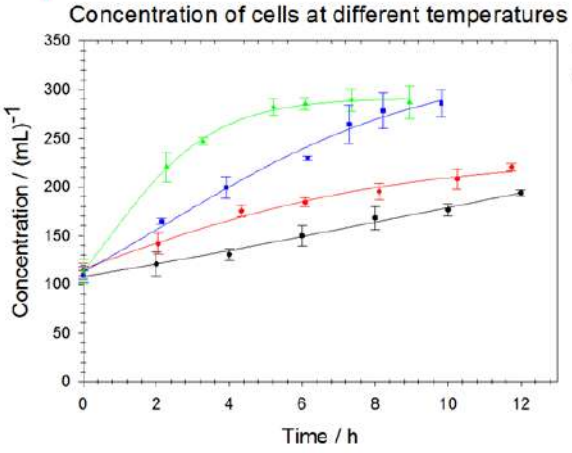
Theory | Experiment | Results

H1: NUMBER OF CELLS WILL INCREASE OVER TIME



- number of cells **increased by 88 - 152%** their original count

H2: YEASTS WILL MULTIPLY THE MOST OVER THE FIRST 6 HOURS



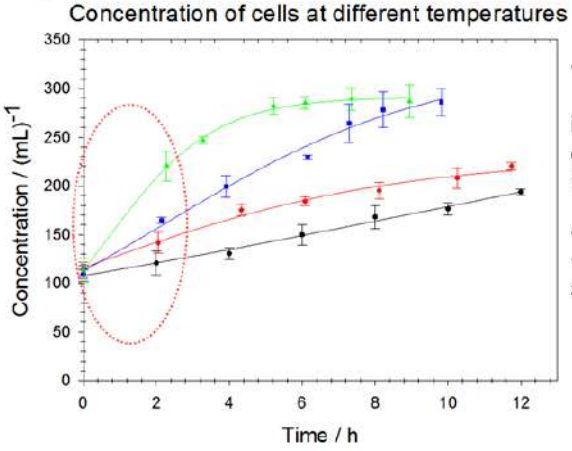
- of the maximum achievable population
  - 5 °C – **41,8%**
  - 11 °C – **80,4%**
  - 20 °C – **70,5%**
  - 30 °C – **98%**
    - → **first 6 h**
  - Hypothesis confirmed for temperatures higher then **11 °C**

H3: YEAST CELL COUNTS OVER TIME WILL BE CONSISTENT WITH THE FOLLOWING POPULATION MODEL: $P(t) = \frac{K}{1+Ae^{-rt}}$ ✓

- Correlation factor between the results and the population model:
  - 5 °C – **0,9961**
  - 11 °C – **0,9946**
  - 20 °C – **0,995**
  - 30 °C – **0,9993**
  - →

14

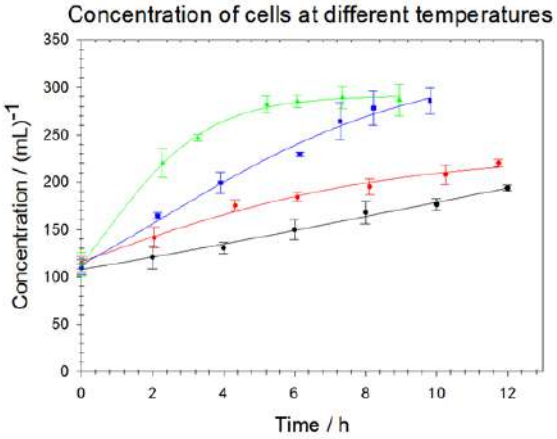
H4: YEASTS WILL START TO MULTIPLY QUICKER AND AT LARGER RATES AT HIGHER TEMPERATURES ✓



- **Low temperatures** → multiplication is slower and more distributed over the 12 hrs
- **Higher temperatures** →growth starts faster and then stagnates

15

H5: THE LARGEST MULTIPLICATION RATE AT THE INVESTIGATED TEMPERATURE RANGE WILL BE AT 30 °C ✓



- number of cells **increased the most** at 30 °C
  - 20 °C – 10h →close
- At 30 °C multiplication happened the fastest

→**MOST OPTIMAL FOR USAGE**

16

CONCLUSION

H1: Number of cells **will increase over time** ✓

H2: Over the **first 6 h** of multypling, the muliplication rate will be the largest ✓

H3: Yeasts will **start to multiply** quicker and at larger rates at **higher temperatures** ✓

H4: The largest multiplication rate at the investigated temperature range will be at **30 °C** ✓

Theory → Experiment → Results

17

THANK YOU!

Team Croatia
Reporter: Marita Machata

IYNT 2019 MINSK

THEORETICAL SLIDE

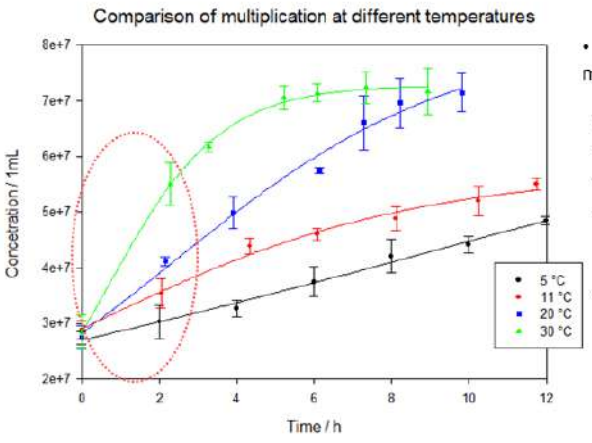
- **Saccharomyces cerevisiae** - species of yeast I used in my expiriment
- **dehydrated instant** version - dissolves faster and activates quicker
- **granulated** yeast-easier to weigh

Image 4: Yeast cells under the microscope

Image 5: Instant yeast

20

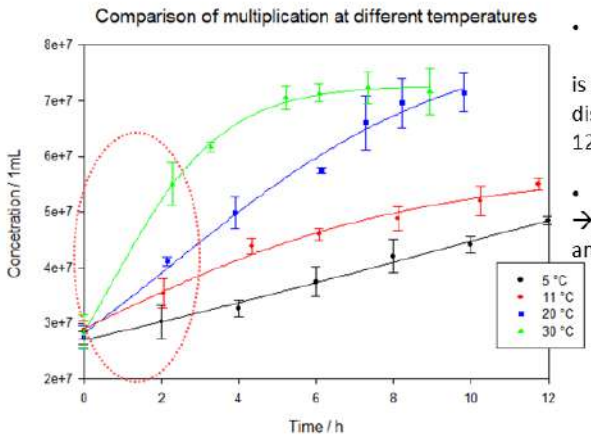
H2: YEASTS WILL MULTIPLY THE MOST OVER THE FIRST 6 HOURS



- of the all together multiplication process
  - 5 °C – 77%
  - 11 °C – 80%
  - 20 °C – 85%
  - 30 °C – 98%
  - → **first 6 h**
- only **2-23%** of the process in the **last 6 hours**

21

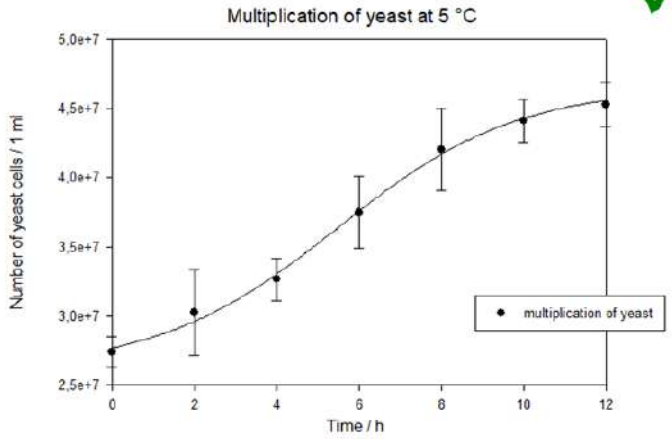
H3: YEASTS WILL START TO MULTIPLY QUICKER AND AT LARGER RATES AT HIGHER TEMPERATURES



- **Low temperatures** → multiplication is slower and more distributed over the 12 hrs
- **Higher temperatures** →growth starts faster and then stagnates

22

H1: NUMBER OF CELLS WILL INCREASE OVER TIME ✓



- number of cells **increased by 88%** their original count

TEMPERATURE CONTROL

- 5 °C – fridge
- 11, 20, 30 °C – water pump

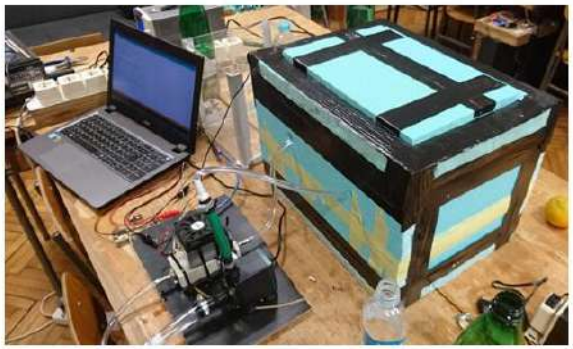


Image 6: Teperature control setup

12. MOON

Team Croatia
Reporter: Rea Pešušić

12. MOON

The **apparent size** of the Moon **perceived** by **an observer** depends on **multiple factors**. Investigate these factors and their role.

2

OUTLINE

Theoretical introduction
- Moon
- Moon illusion

Experiment
- Experimental setup
- Age; male:female ratio

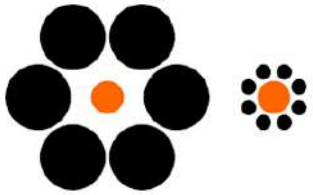
Results
- A vs. B group
- Realistic group

3

4

MOON ILLUSION

Ebbinghaus illusion



- Different theories across centuries
- Most recent ones: Ebbinghaus illusion — NOT plausible
  Ponzo illusion — NOT plausible
  Convergence micropsia — plausible
  Ventral/dorsal — plausible

Ponzo illusion

5

HYPOTHESES

H1: the Moon will appear bigger near the horizon

H2: the Moon will appear bigger on the light than on the dark background

H3: most participants will not be able to see the Moon illusion

H4: more people will be able to see the illusion on the realistic images

H5: at the train tracks (Ponzo illusion), the upper Moon will appear bigger

H6: the Moon will be appear bigger when there is an actual horizon

6

EXPERIMENT

- Made a Google form with a Moon image on different backgrounds

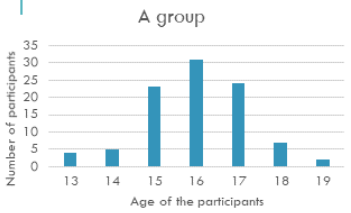
Artifical	Realistic
Dark vs. light blue	Blue vs. orange
Up/down without horizon	City horizon (b-b)
Up/down with horizon	Beach horizon (b-o)
Train tracks	Train tracks

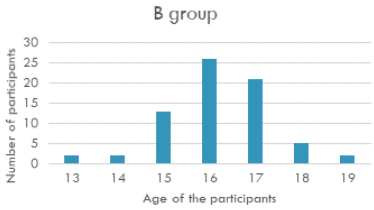
7

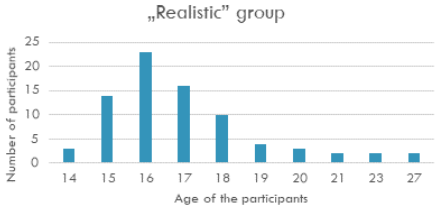
A group	B group	C group
Light - dark	Dark - light	Realistic
96 participants	71 participant	79 participants

8

AGE







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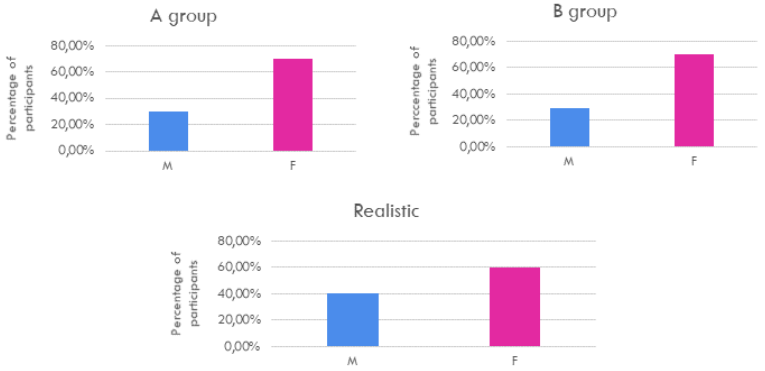
MALE:FEMALE RATIO



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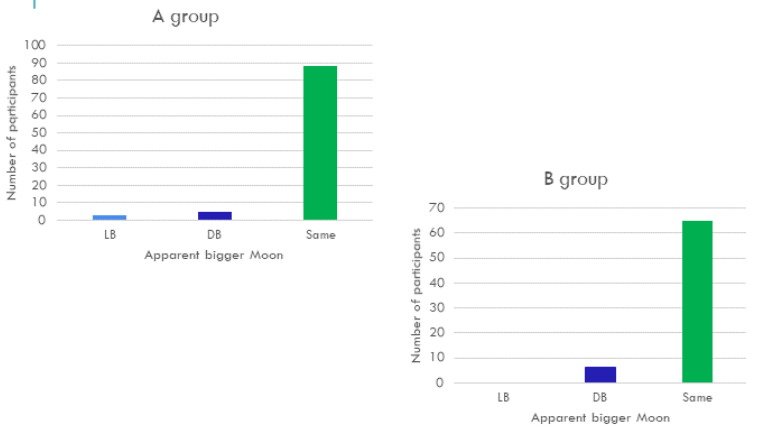
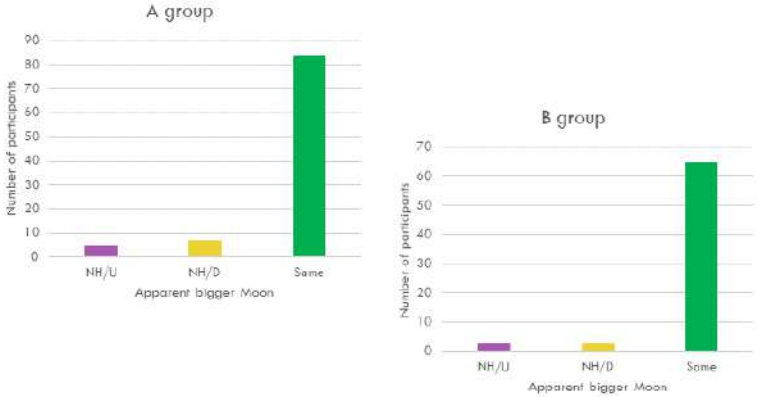
LIGHT VS DARK BACKGROUND



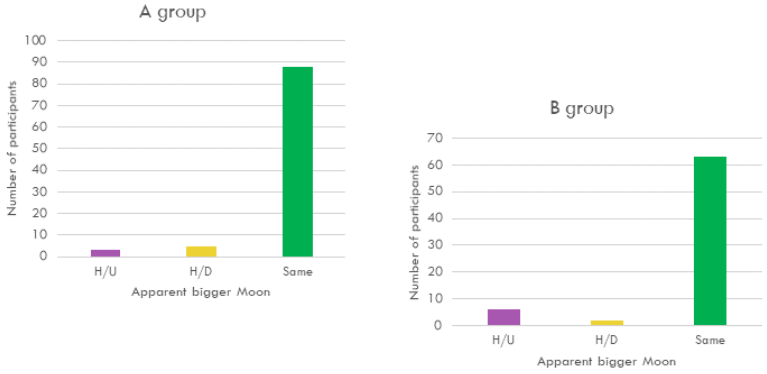
11

UP/DOWN WITHOUT HORIZON



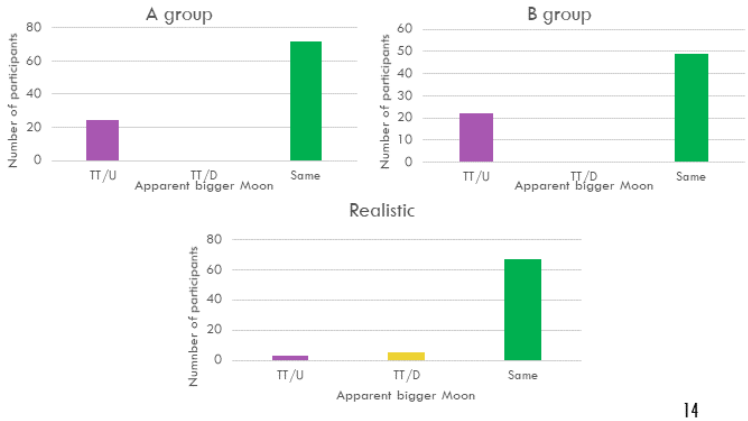
12

UP/DOWN WITH HORIZONT



13

TRAIN TRACKS (PONZO ILLUSION)



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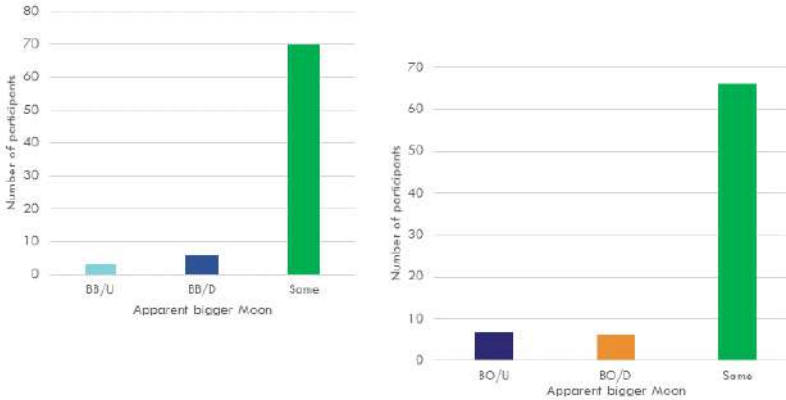
REALISTIC MOON B/B VS B/O



15

CONCLUSION

- Even though the Moon illusion does exist, in a simulation (screen) it's hard to achieve
- More tests are required, in the natural enviroment

16

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17

THANK YOU!

Team Croatia
Reporter: Rea Pešušić

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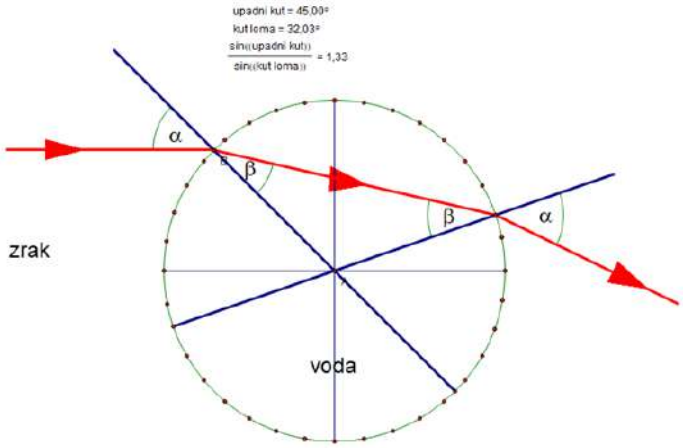
3. EFFECT OF THE SHAPE OF THE MOON'S ORBIT

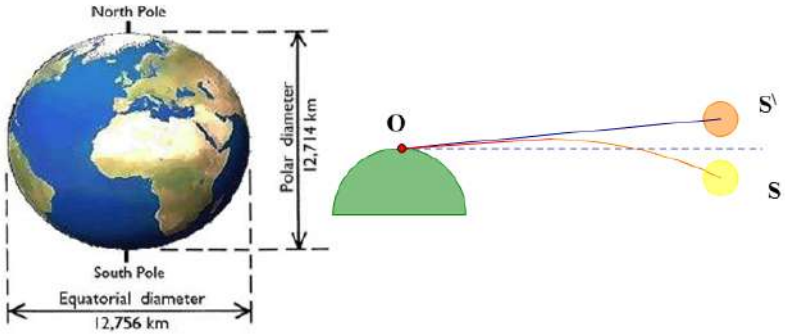
* bigger at the perigee for 13.97%

20



21

4. THE EFFECT OF THE GEOGRAPHIC POSITION



22

INVENT YOURSELF
PROBLEM 13. BAKING BREAD

Team Croatia
Reporter: Marko Drozdek

INVENT YOURSELF PROBLEM 13. BAKING BREAD

Distinctly different types of bread are produced by varying **methods of baking, proportions of ingredients,** and **types of flour.** We studied how the **type of flour, duration of baking** and **baking temperature** affect the bread properties and optimal baking time.

2

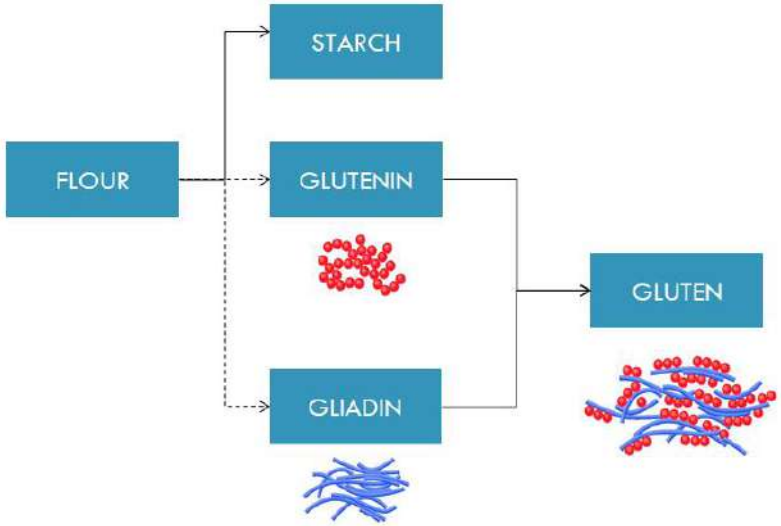
OUTLINE

Theoretical introduction
- Flour
- Water and yeast

Experiment
- Ingredients for bread
- Hypothesis
- Process of bread making
- Parameters and measurements

Results
- Dependence of time
- Dependence of temperature
- Dependence of rising before baking

3



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YEAST = FUNGUS

- fermentation

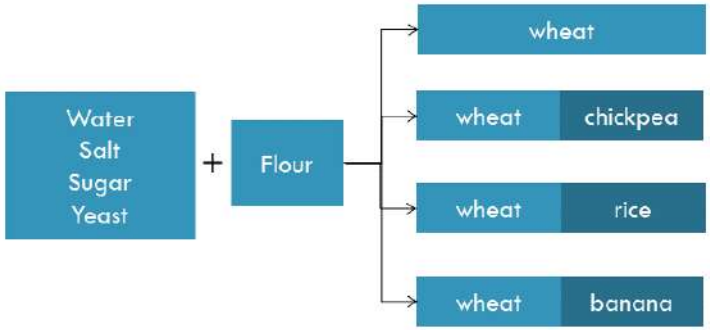
$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$

GLUCOSE — ETHANOL — CARBON DIOXIDE

WATER
- -Fills starch
- -Dissolving sugar → yeast
- -Bread rising

5

INGREDIENTS FOR BREAD



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HYPOTHESIS

1. Bread of wheat flour ⟹ the biggest volume
2. Longer baking time ⟹ smaller mass of baked bread.
3. Higher temperature of baking ⟹ smaller mass of baked bread
4. Longer rising before baking ⟹ bigger volume

7

PROCESS OF BREAD MAKING

1. Dough kneading
2. Dough rising
3. Baking

8

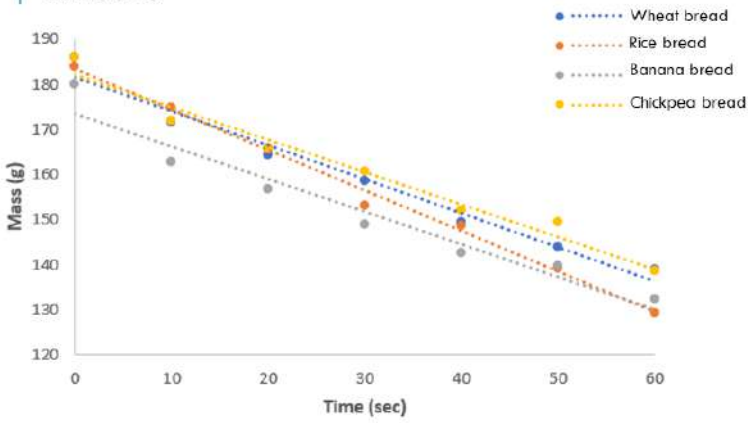
PARAMETERS AND MEASUREMENTS

- Baking time
- Baking temperature
- Rising before baking

- Mass- scale
- Volume- vacuuming, water displacement

9

RESULTS- DIFFERENT BAKING TIMES- MASSES



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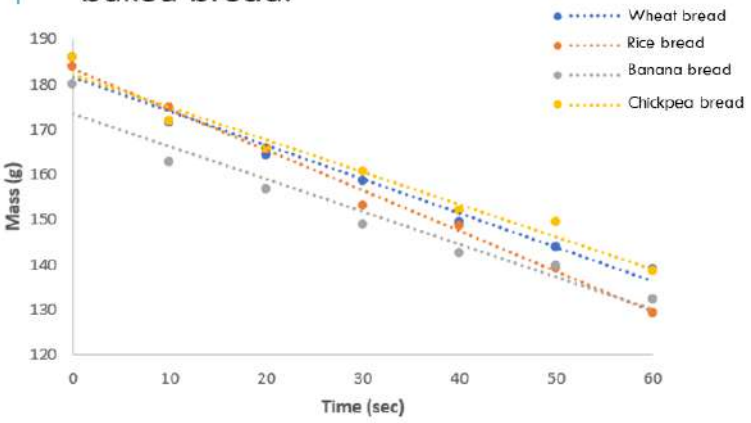
✓ 2. Longer baking time ⟹ smaller mass of baked bread.



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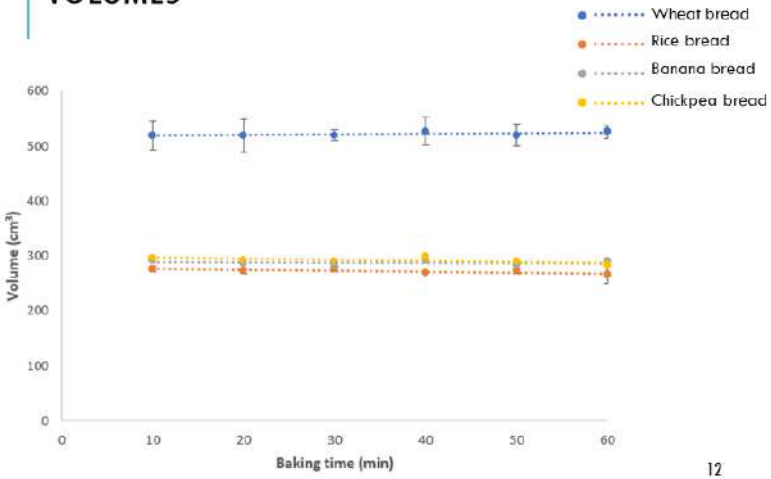
RESULTS- DIFFERENT BAKING TIMES- VOLUMES



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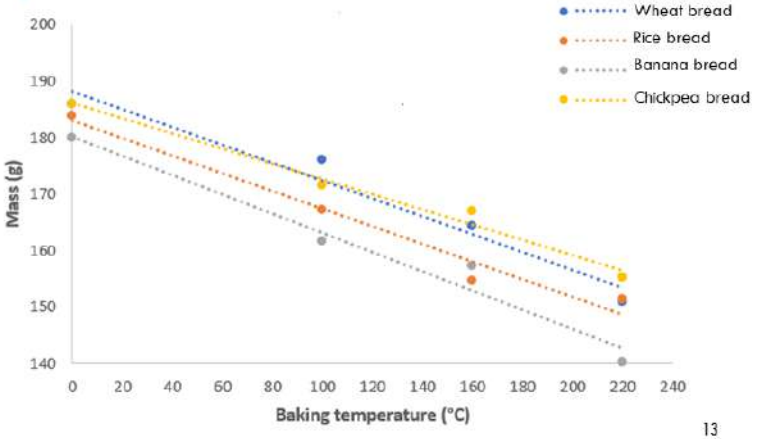
RESULTS- DIFFERENT TEMPERATURES- MASSES



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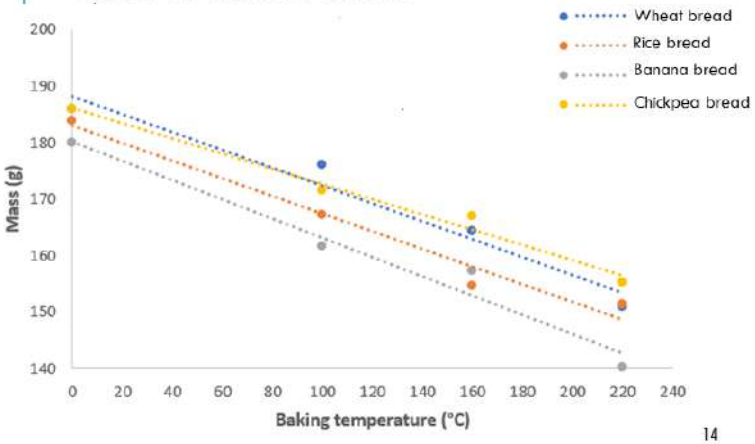
3. Higher temperature of baking ⟹ smaller mass of baked bread



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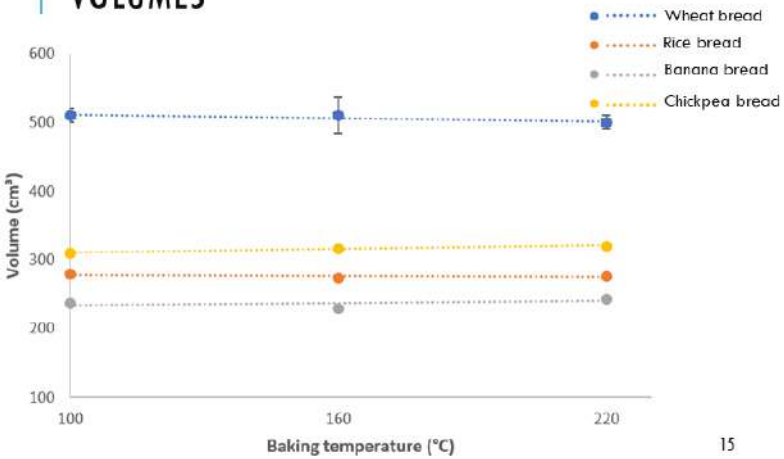
RESULTS- DIFFERENT TEMPERATURES- VOLUMES



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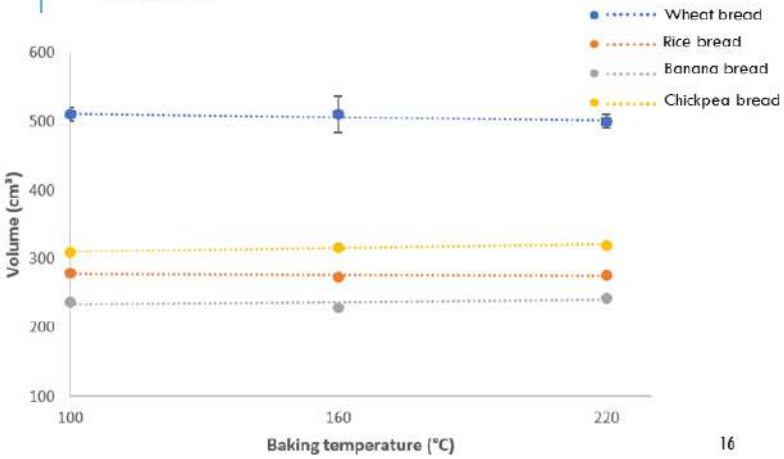
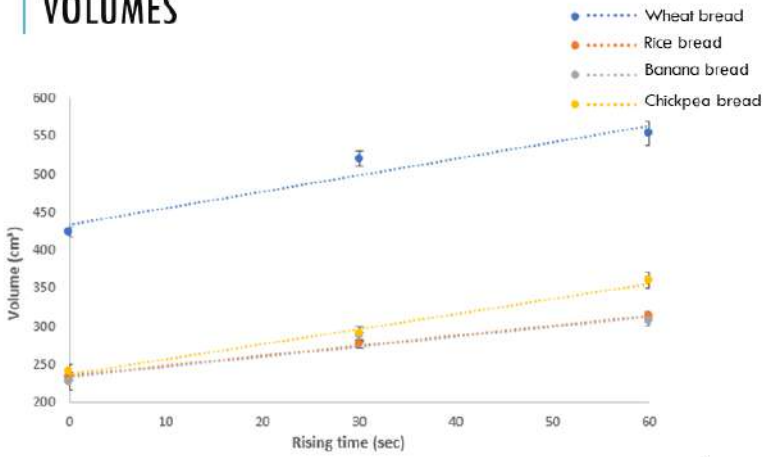
1. Bread of wheat flour ⟹ the biggest volume



16

RESULTS- DIFFERENT RISING TIMES- VOLUMES



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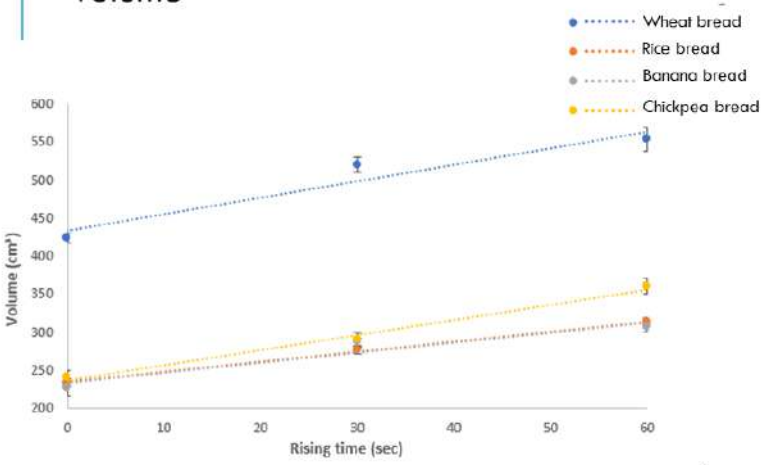
✓4. Longer rising before baking ⟹ bigger volume



18

CONCLUSIONS

✓1. Bread of wheat flour ⟹ the biggest volume

✓2. Longer baking time ⟹ smaller mass of baked bread.

✓3. Higher temperature of baking ⟹ smaller mass of baked bread

✓4. Longer rising before baking ⟹ bigger volume

19

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20

THANK YOU!

Team Croatia
Reporter: Marko Drozdek

IYNT 2019 MINSK

RESULTS- DIFFERENT TIMES

22

RESULTS- DIFFERENT BAKING TEMPERATURES

23

14. EYE MOVEMENTS

Team Croatia
Reporter: Rea Pešušić

14. EYE MOVEMENTS

Human eyes are in constant **involuntary** and **voluntary motion** when exposed to **visual stimuli**. Eye motion depends on **colour** and **movement patterns**.

Investigate how these affect the **psychological** and **physiological state** of participants

2

OUTLINE

Theoretical introduction
- Eye movements
- Colour mood affect
- Hypotheses

Experiment
- Experimental setup
- Example of videos

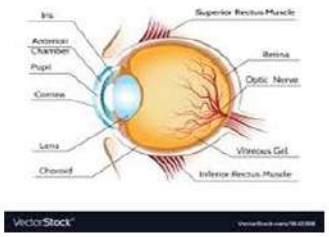
Results
- Stress level changes
- Pulse change

3

EYE MOVEMENTS

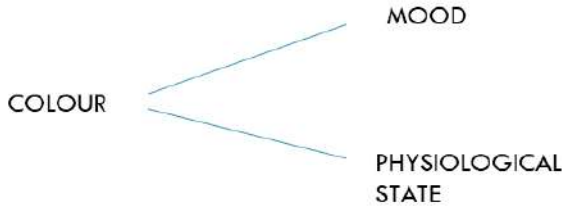
- Eyes – paired sight organs
- Stimulus – optic nerve – brain
- Beta movement
- Involuntary movements

EYE ANATOMY



4

COLOUR MOOD AFFECT



Blue and green – relaxing
Red, yellow, orange – stressing
Achromatic colours – little to no effect

5

HYPOTHESES

- H1: Colour changes/movement
  - Slow/methodic – relaxing
  - Flashes/sudden - stressing
- H2: Colours
  - Blue/green – relaxing
  - Red/yellow/orange - stressing
- H3: Achromatic colours
  - No effect

6

EXPERIMENTAL SETUP

FIRST GROUP	SECOND GROUP	CONTROL GROUP
Blue/green slow transition	Red/orange/yellow flashes	-
Achromatic transitions	Achromatic transitions	Achromatic transitions
Storm video	Sunset timelapse	Bird flight

Three groups of nine people

7

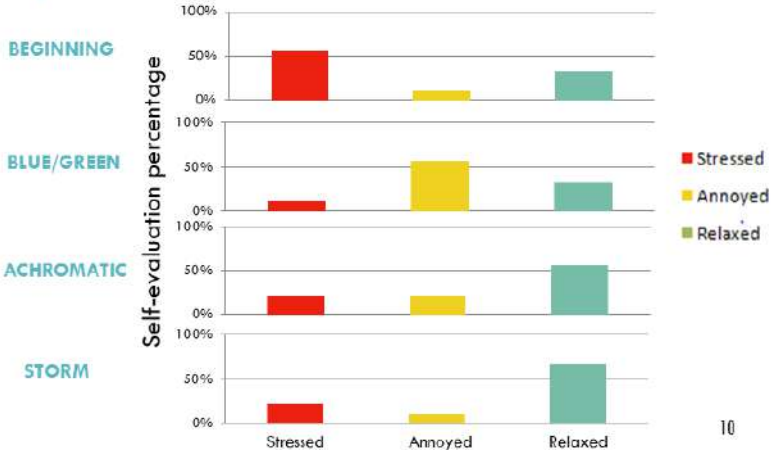
EXPERIMENT SLIDES

- Measured pulse changes manually before and after a video
- Self - evaluation changes of stress levels

8

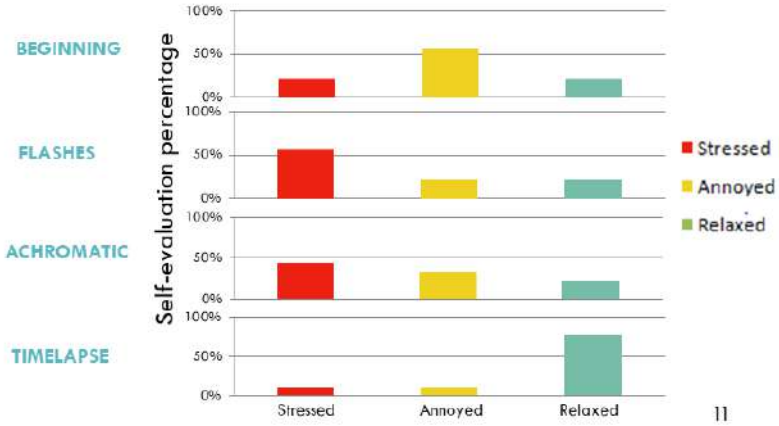
9

STRESS LEVELS CHANGES – GROUP 1



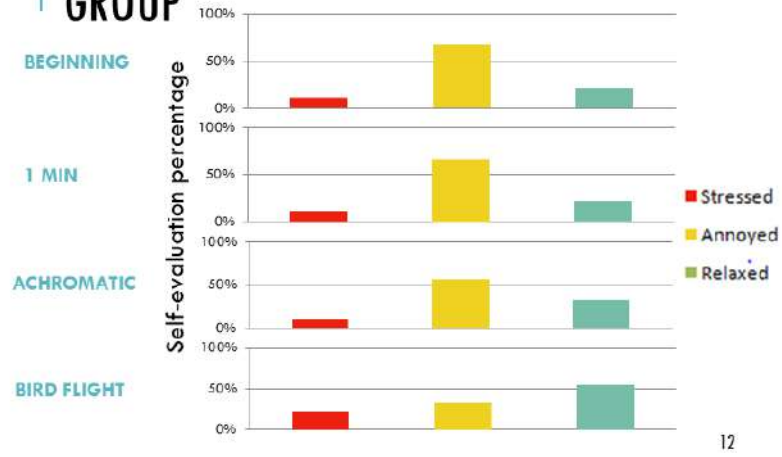
10

STRESS LEVEL CHANGES – GROUP 2



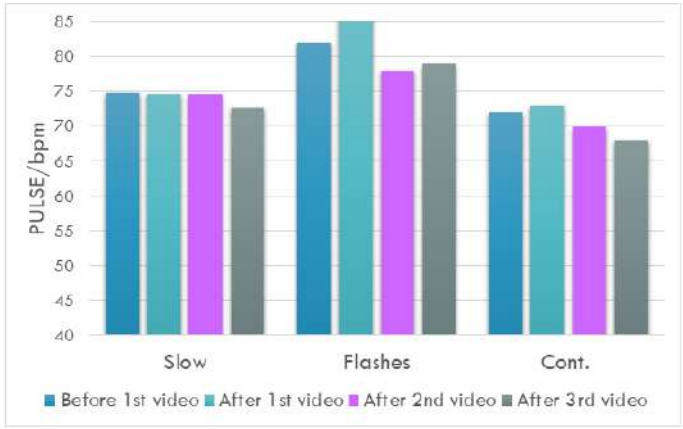
11

STRESS LEVEL CHANGES – CONTROL GROUP



12

PULSE CHANGES



13

CONCLUSION

- H1: Slow/methodic movements – pos. effect
  Flashes/sudden movements – neg. effect ✓
- H2: Blue/green – pos. effect
  Red/yellow/orange – neg. effect ✓
- H3: achromatic colours – no effect ✗

14

LITERATURE

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Bastić, Begić, Novoselić, Popović: Biologija 8, Alfa, 2014.
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https://journals.sagepub.com/doi/full/10.1177/2158244014525423

15

THANK YOU!

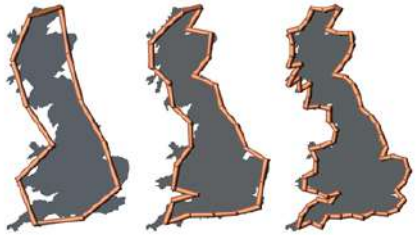
Team Croatia
Reporter: Rea Pešušić

15. INVENT YOURSELF: FRACTALS

Team Croatia
Reporter: Dora Špoler

15. INVENT YOURSELF: FRACTALS

Coastline doesn't have a well-defined length because it depends on the scale of the measurement. Measure the **fractal dimension of coastlines** and investigate how relevant **parameters** affect the coastline fractal dimension.



2

DEMONSTRATION OF THE PHENOMENON

3

OUTLINE

Theoretical introduction
- Fractals
- Fractal dimension

Experiment
- Experimental setup
- Box counting method
- Correlation method

Results
- Hypotheses

4

FRACTALS

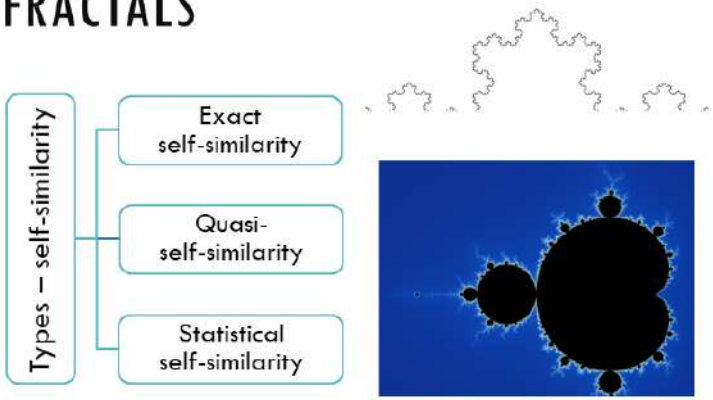
- Same **level of detail** regardless on resolution
- Infinite lenght
- Approximately fractals

FEATURES
- fine structure - small scales
- irregular
- Self-similarity
- Recursive definition

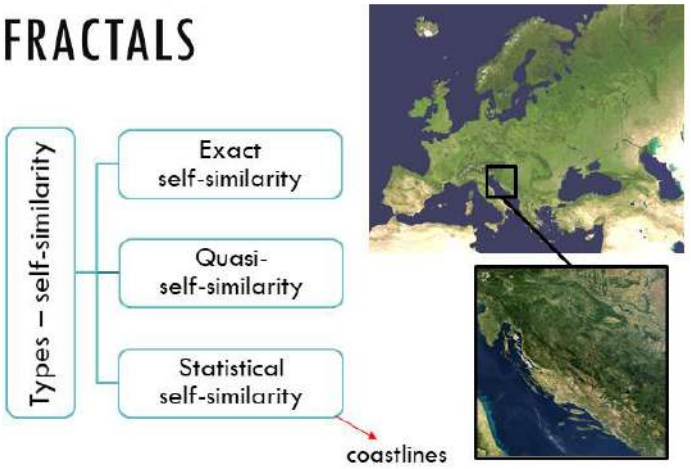
Theory - fractals | Experiment | Methods | Results

5

FRACTALS

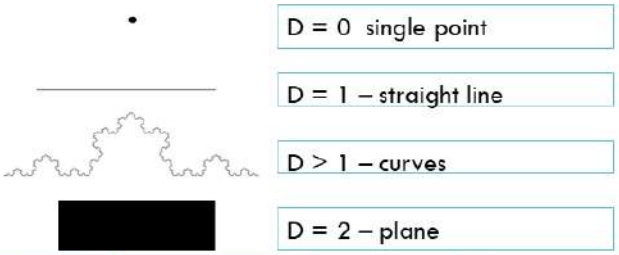


FRACTALS



FRACTAL DIMENSION

- Ratio providing a statistical index of **complexity**
- Measure of the **space-filling capacity**



PARAMETERS

- Fractal counting method
- Image resolution
- Island area
- Geographical position
- Coastline lenght

EXPERIMENTAL SETUP

- openstreetmaps → coastlines
- Fractalyse – programme for calculating fractal dimension
  - Box-counting dimension
  - Correlation dimension

Theory - fractals | Experiment | Methods | Results

BOX-COUNTING METHOD

box counting dimension

$$d_B = \log_x \left(\frac{y}{10^c} \right)$$

the number of boxes (squares) with positive signals (n(r))

side length (r) of the corresponding box (square)

corresponds to the point of origin on the *Y*-axis

Theory - fractals | Experiment | Methods | Results

CORRELATION METHOD

Correlation dimension

$$d_C = \log_n \frac{m - c}{a}$$

mean number of occupied pixels per window

size of the analysis window (number of pixels)

corresponds to the point of origin on the *m*-axis

Theory - fractals | Experiment | Methods | Results

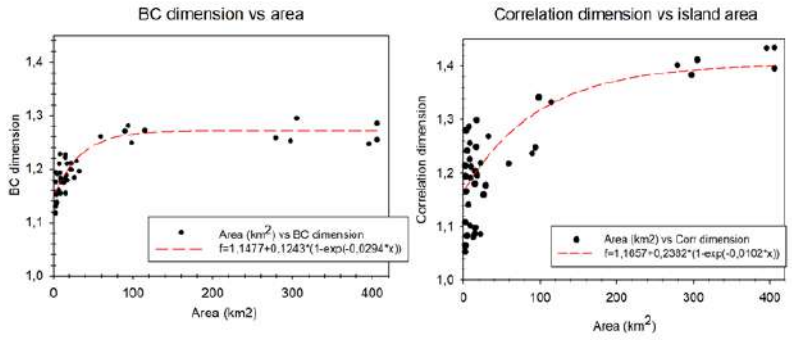
HYPOTHESES

1. All coastlines will have fractal dimension between 1 and 2
2. Island area will not affect fractal dimension
3. Fractal dimension will decrease with resolution of the image
4. Fractal dimension will decrease in direction of south

Theory - fractals | Experiment | Methods | Results

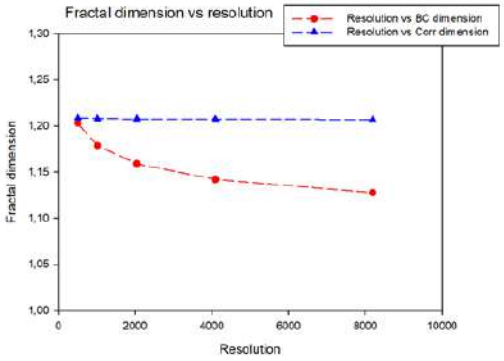
H1: ALL COASTLINES WILL HAVE FRACTAL DIMENSION BETWEEN 1 AND 2 ✓

H2: ISLAND AREA WILL NOT AFFECT FRACTAL DIMENSION ✗



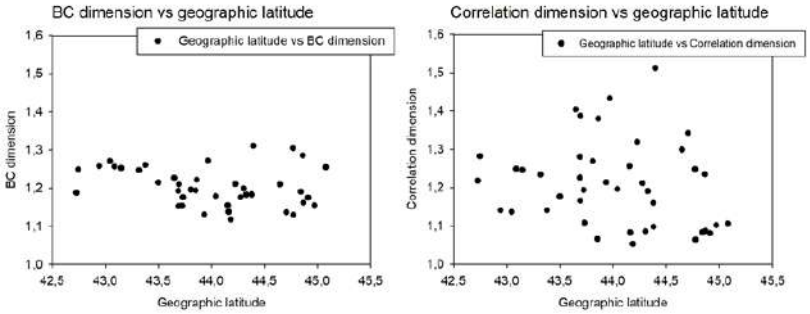
Theory - fractals | Experiment | Methods | Results

H3: FRACTAL DIMENSION WILL DECREASE WITH RESOLUTION OF THE IMAGE ✓/✗



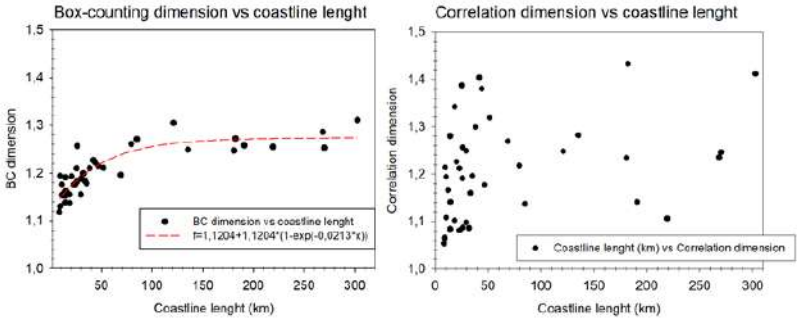
Theory - fractals | Experiment | Methods | Results

H4: FRACTAL DIMENSION WILL DECREASE IN DIRECTION OF SOUTH ✗



Theory - fractals | Experiment | Methods | Results

DEPENDANCE ON COASTLINE LENGHT



Theory - fractals | Experiment | Methods | Results

CONCLUSION

- Coastline has fractal dimension between 1 and 2 – H1 ✓
- Fractal dimension increases with increasing area of an island – H2 ✗
- Fractal dimension decreases with decreasing resolution of an image – H3 ✗
- Fractal dimension doesn't depend on geographic latitude – H4 ✗

11

LITERATURE

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https://web.archive.org/web/20100211165343/http://atlas.nrcan.gc.ca/site/english/learningresources/facts/coastline.html/ (5.2.2019.)
http://li.mit.edu/Stuff/CNSE/Paper/Mandelbrot67Science.pdf (5.2.2019.)
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http://www.uvm.edu/pdodds/files/papers/others/everything/larry015-EoE.pdf (6.3.2019.)*
https://books.google.com/books?id=0R2LkE3N7-oC (6.3.2019.)
http://math.bu.edu/DYSYS/chaos-game/node6.html (6.3.2019.)*

12

THANK YOU!

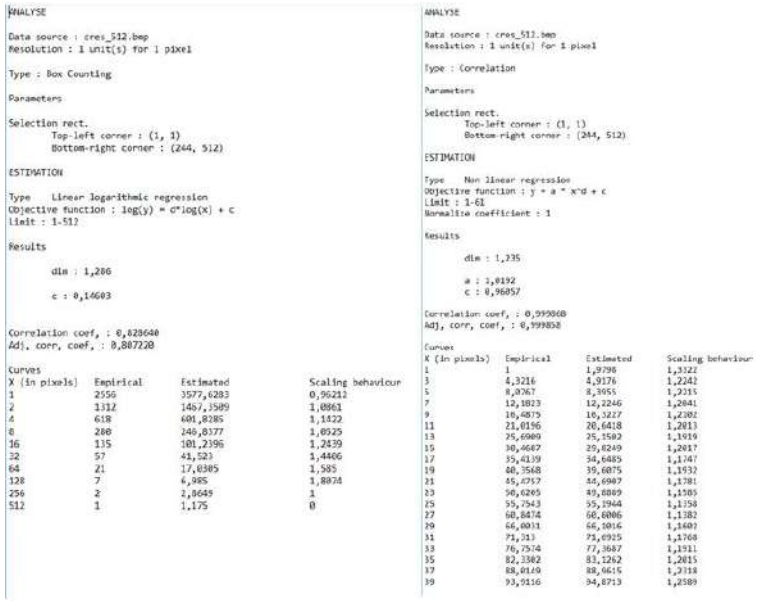
Team Croatia
Reporter: Dora Špoler

IYNT 2019 MINSK

SOFTWARE LINKS

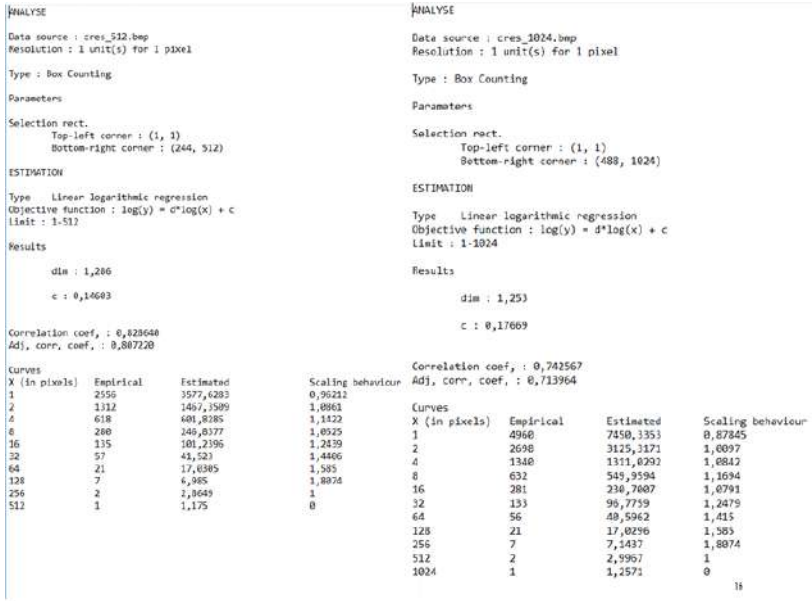
- *Fractalyse - developped by the research team "Mobilities, city and transport" of the research centre ThéMA*
  - *http://www.fractalyse.org/en-home.html*
- openstreetmaps: - *http://openstreetmapdata.com/data/coastlines?fbclid=IwAR39LNlp3jQZrxL6DPw9Tp4bKyKfLIrU7RxJcx1R4gUbhwcoQT6eykAbtJk*

14



```
ANALYSE

Data source : cres_512.bmp
Resolution : 1 unit(s) for 1 pixel

Type : Box Counting

Parameters

Selection rect.
        Top-left corner : (1, 1)
        Bottom-right corner : (244, 512)

ESTIMATION

Type    Linear logarithmic regression
Objective function : log(y) = d*log(x) + c
Limit : 1-512

Results

        dim : 1,286

        c : 0,14603

Correlation coef, : 0,828640
Adj, corr, coef, : 0,807220

Curves
X (in pixels)   Empirical       Estimated       Scaling behaviour
1               2556            3577,6283       0,96212
2               1312            1467,3589       1,0861
4               618             601,8285        1,1422
8               280             246,8377        1,0525
16              135             101,2396        1,2439
32              57              41,523          1,4406
64              21              17,0305         1,585
128             7               6,985           1,8074
256             2               2,8649          1
512             1               1,175           0
```

```
ANALYSE

Data source : cres_512.bmp
Resolution : 1 unit(s) for 1 pixel

Type : Correlation

Parameters

Selection rect.
        Top-left corner : (1, 1)
        Bottom-right corner : (244, 512)

ESTIMATION

Type    Non linear regression
Objective function : y = a * x^d + c
Limit : 1-61
Normalize coefficient : 1

Results

        dim : 1,235

        a : 1,0192
        c : 0,96057

Correlation coef, : 0,999868
Adj, corr, coef, : 0,999858

Curves
X (in pixels)   Empirical       Estimated       Scaling behaviour
1               1               1,9796          1,3122
3               4,3216          4,9176          1,2242
5               8,0767          8,3955          1,2215
7               12,1823         12,2246         1,2041
9               16,4875         16,5227         1,2302
11              21,0196         20,6418         1,2013
13              25,6909         25,1502         1,1919
15              30,4667         29,6249         1,2017
17              35,4139         34,6485         1,1747
19              40,3568         39,6875         1,1932
21              45,4717         44,6947         1,1781
23              50,6265         49,8869         1,1585
25              55,7543         55,1944         1,1358
27              60,8474         60,6006         1,1382
29              66,0011         66,1016         1,1603
31              71,213          71,6925         1,1768
33              76,7574         77,3687         1,1911
35              82,3382         83,1262         1,2015
37              88,0149         88,0615         1,2118
39              93,9116         94,8713         1,2589
```

```
ANALYSE

Data source : cres_512.bmp
Resolution : 1 unit(s) for 1 pixel

Type : Box Counting

Parameters

Selection rect.
        Top-left corner : (1, 1)
        Bottom-right corner : (244, 512)

ESTIMATION

Type    Linear logarithmic regression
Objective function : log(y) = d*log(x) + c
Limit : 1-512

Results

        dim : 1,286

        c : 0,14603

Correlation coef, : 0,828640
Adj, corr, coef, : 0,807220

Curves
X (in pixels)   Empirical       Estimated       Scaling behaviour
1               2556            3577,6283       0,96212
2               1312            1467,3589       1,0861
4               618             601,8285        1,1422
8               280             246,8377        1,0525
16              135             101,2396        1,2439
32              57              41,523          1,4406
64              21              17,0305         1,585
128             7               6,985           1,8074
256             2               2,8649          1
512             1               1,175           0
```

```
ANALYSE

Data source : cres_1024.bmp
Resolution : 1 unit(s) for 1 pixel

Type : Box Counting

Parameters

Selection rect.
        Top-left corner : (1, 1)
        Bottom-right corner : (488, 1024)

ESTIMATION

Type    Linear logarithmic regression
Objective function : log(y) = d*log(x) + c
Limit : 1-1024

Results

        dim : 1,253

        c : 0,17669

Correlation coef, : 0,742567
Adj, corr, coef, : 0,713964

Curves
X (in pixels)   Empirical       Estimated       Scaling behaviour
1               4960            7450,3353       0,87845
2               2698            3125,3171       1,0097
4               1340            1311,0292       1,0842
8               632             549,9594        1,1694
16              281             230,7007        1,0791
32              133             96,7759         1,2479
64              56              40,5962         1,415
128             21              17,0296         1,585
256             7               7,1437          1,8074
512             2               2,9967          1
1024            1               1,2571          0
```


Formula for calculating box-counting dimension and dilation dimension

$$\log(y) = d * \log(x) + c \qquad d \sim \frac{1}{x^2} \qquad d \sim y^2$$

$$d = \log_x y - c \log_x 10$$

Y axis - the number of boxes (squares) with positive signals (n(r))
X axis - side length (r) of the corresponding box (square)
d – box counting dimension
Parameter c of the estimated function corresponds to the point of origin on the Y-axis

FORMULA CORRELATION METHOD

$$y = a * x^d + c$$

X-axis = size of the analysis window (number of pixels)

Y-axis = mean number of occupied pixels per window

Parameter c of the estimated function corresponds to the point of origin on the Y-axis

d = correlation dimension

Fractal properties include self-similarity or affinity, scale symmetry, scale independence or invariance, heterogeneity, complexity, and infinite length or detail. ‘Self-similar’ here has two meanings. One can understand ‘similar’ as a loose everyday synonym of ‘analogous’. But there is also the strict textbook sense of ‘contracting similarity’. It expresses that each part is a linear geometric reduction of the whole, with the same reduction ratios in all directions. Random fractals are self-similar only in a statistical sense; to describe them it is more appropriate to use the term ‘scale invariance’ than self-similarity

19

16. INVENT YOURSELF: SHORT-TERM MEMORY

Team Croatia
Reporter: Dora Špoler

16. INVENT YOURSELF: SHORT-TERM MEMORY

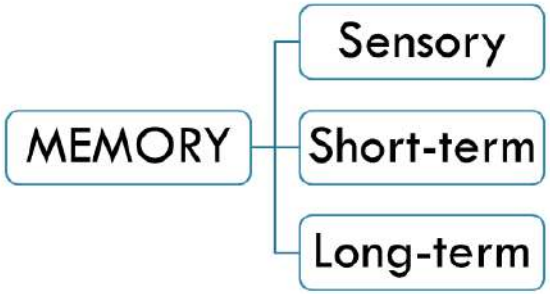
What is the **capacity and duration** of human **short-term memory**?

Investigate the effect of **music** on short-term memory and the difference between memorising **abstract** and **concrete words.**

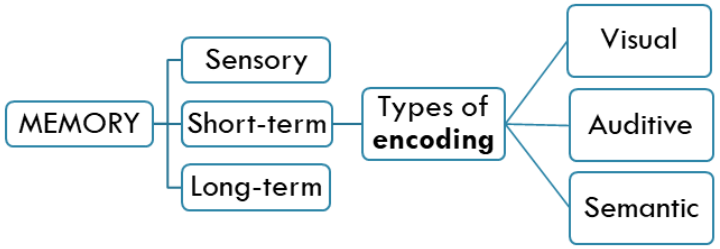
OUTLINE

- **Theoretical introduction**
  - Human memory
- **Study 1**
  - Experimental setup
  - Results
- **Study 2**
  - Experimental setup
  - Results

HUMAN MEMORY



HUMAN MEMORY



PARAMETER SUMMARY

STUDY 1

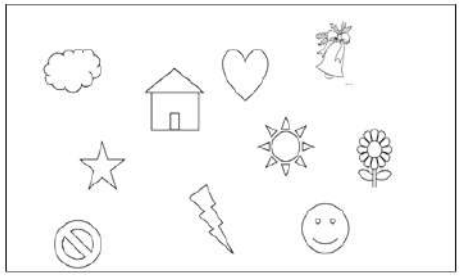
- Decay over time
- Gender
- Stress
- visual vs auditive

STUDY 2

- rock vs classical music
- age groups
- word placement on a list
- abstract vs concrete words

EXPERIMENTAL SETUP – STUDY 1

VISUAL



10 SYMBOLS – 1,5 seconds

AUDITIVE

10 WORDS

EXPERIMENTAL SETUP – STUDY 1

GENDER: M F

I HAVE A TEST TODAY: YES NO

WRITE ALL SYMBOLS/WORDS YOU REMEMBER:

Questionnaire

- 0 min
- 30 min
- 60 min
- 90 min

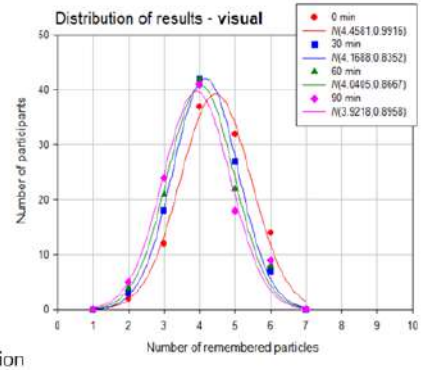
HYPOTHESES – STUDY 1

N = Number of remembered particles

1. N **decreases over time**
2. N is **bigger in auditive** research than in visual
3. N **doesn't depend on gender**
4. N is **smaller** if participant is **under stress**

[1]Dorene M. Rentz„Sex differences in episodic memory in early midlife: impact of reproductive aging

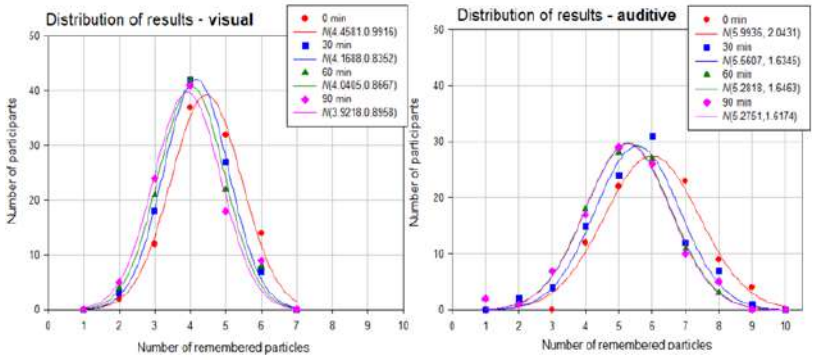
H1:N DECREASES OVER TIME



- 97 participants
- Normal distribution

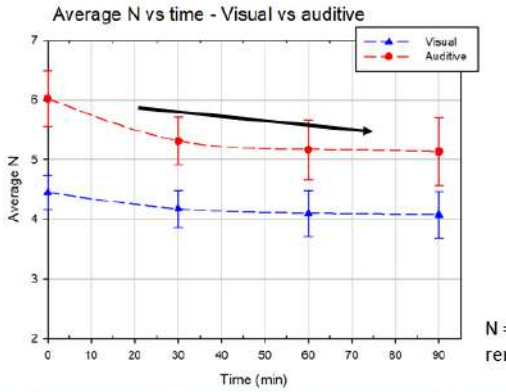
11

H1:N DECREASES OVER TIME



12

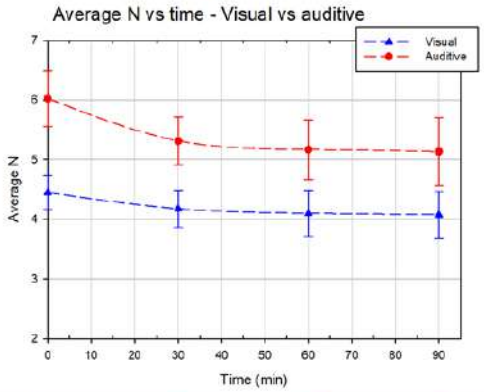
H1:N DECREASES OVER TIME ✓



N = number of remembered particles

13

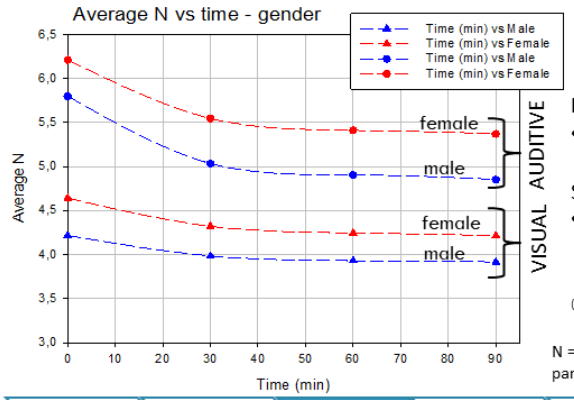
H2: N IS <u>BIGGER IN AUDITIVE</u> RESEARCH THAN IN VISUAL ✓



N = number of remembered particles

14

H3: N DOESN'T DEPEND ON GENDER OF PARTICIPANT ✗



44 male, 53 female

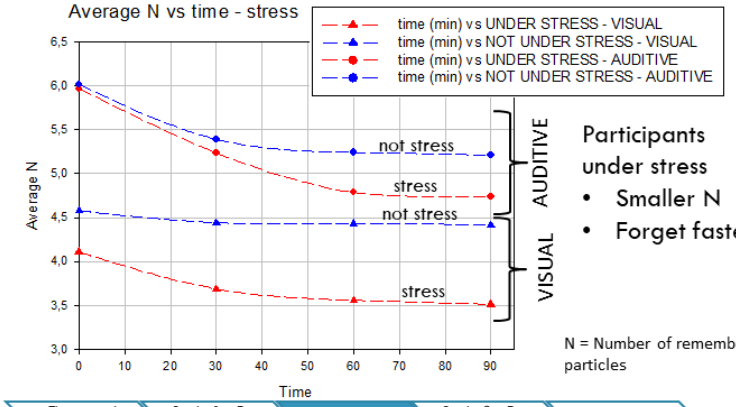
Female participants
- **higher average N**

Statistical test
- two-way repeated measures **ANOVA**

(M. Rentz 2016)

N = number of remembered particles

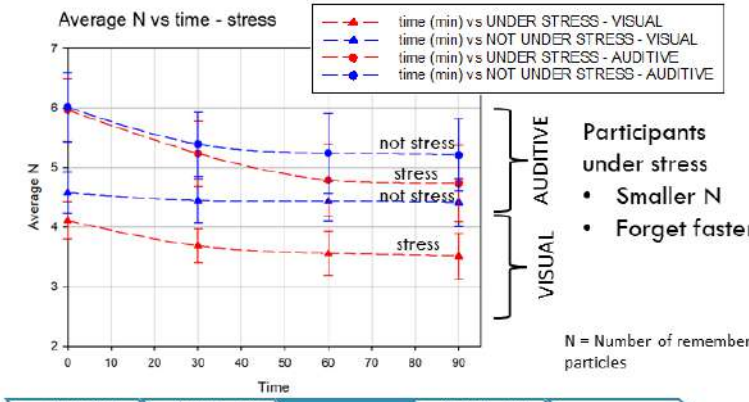
H4: N IS SMALLER IF PARTICIPANT IS UNDER STRESS ✓



Participants under stress
- Smaller N
- Forget faster

N = Number of remembered particles

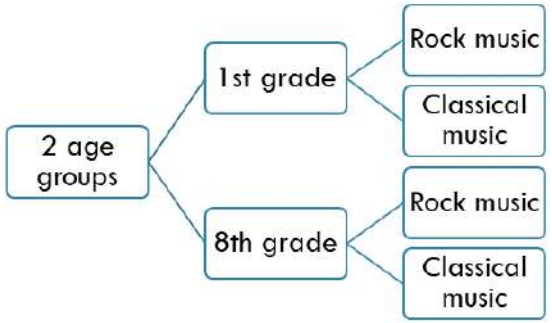
H4: N IS SMALLER IF PARTICIPANT IS UNDER STRESS ✓



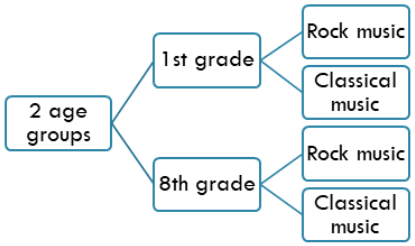
Participants under stress
- Smaller N
- Forget faster

N = Number of remembered particles

EXPERIMENTAL SETUP – STUDY 2



EXPERIMENTAL SETUP – STUDY 2

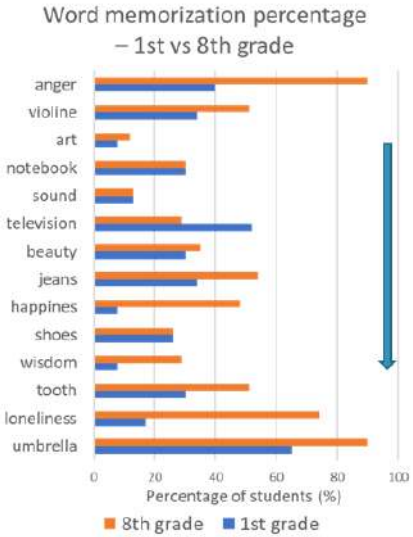


Audio-tape of 14 words

- One concrete – one abstract word

HYPOTHESES –STUDY 2

5. First word - one of the most frequently memorized words - **primacy effect**
6. Last word - one of the most frequently memorized words - **recency effect**
7. **Concrete words** – memorized more frequently than **abstract words**
8. **Older students** will memorize more words
9. Students listening to **classical music** will memorize more words than students listening to **rock music**



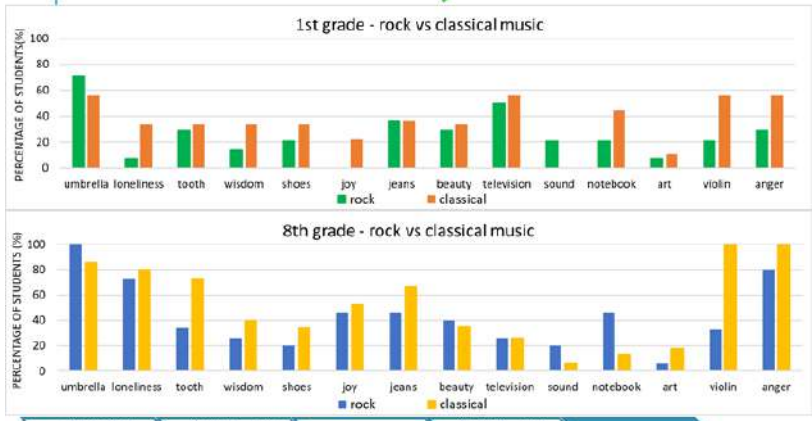
H5: **FIRST** WORD – ONE OF THE MOST FREQUENTLY MEMORIZED ✓

H6: **LAST** WORD – ONE OF THE MOST FREQUENTLY MEMORIZED ✓

H7: **CONCRETE** WORDS – MORE FREQUENTLY MEMORIZED THAN ABSTRACT ✓

H8: **OLDER STUDENTS** WILL MEMORIZE MORE WORDS ✓

H9: STUDENTS LISTENING TO CLASSICAL MUSIC WILL MEMORIZE MORE WORDS THAN STUDENTS LISTENING TO ROCK MUSIC ✓



CONCLUSION

- Number of remembered particles **decreases over time** – H1 ✓
- We remember **auditive** informations **better** – H2 ✓
- **Female** participants remembered **more particles** than male participants – H3 ✗
- We **remember less** and **forget faster** when we are **under stress** – H4 ✓
- **Primacy** and **recency** effect is present in memorising – H5 ✓
- **Concrete** words are **easier** to remember than abstract words – H7 ✓
- **Young adults** are **better** at memorising than children – H8 ✓
- **Classical** music is **better** for memory than rock music – H9 ✓

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THANK YOU!

Team Croatia
Reporter: Dora Špoler

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ADDITIONAL SLIDES

- Formula for standard deviation:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{X})^2}{n}}$$,where arithmetic mean of results is $\overline{X} - x_1, x_2, \ldots x_n$

- Formula for coefficient of variation in percentages

$$V = \frac{\sigma}{\overline{X}} \cdot 100$$

V (%)	Variability
0 – 10	Very weak
10 – 30	Relatively weak
30 – 50	Moderate
50 – 70	Relatively strong
Veći od 70	Very strong

- **Median** – central value (results have to be lined by value)

  Position of median: $C = \frac{n+1}{2}$ n – number of measurments

- **Mode** or dominant value D – the most common value, value with biggest frequency

- **Arithmetic mean** – average value (sum of all number devided by count of those numbers)

27

DEVIATION AND VARIABILITY

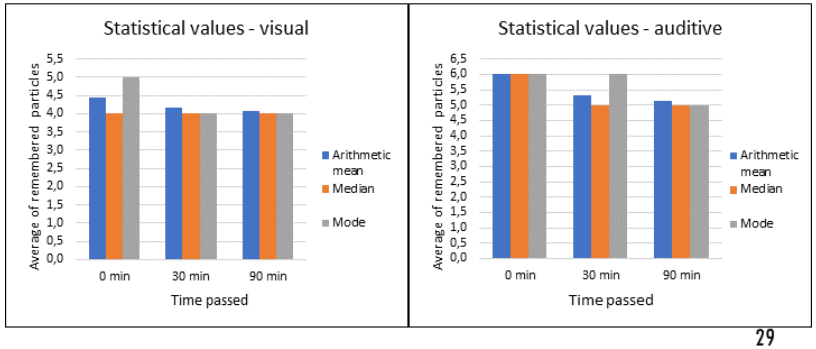
- Standard deviation is very close to aritmethic middle of results
- Variability is relatively weak
- The results are well grouped around the arithmetic middle and there was no major scattering of results

	V (0 min)	V (30 min)	V (90 min)
Visual research	21,39%	22,02%	25,28%
Auditive research	22,64%	27,5%	29,27%

28

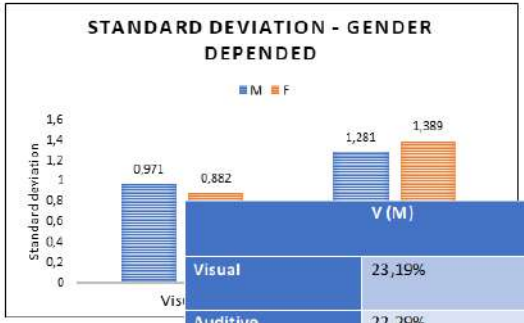
COMPARATION OF STATISTICAL VALUES

- Average N:
  - Visual: 4-5
  - Auditive: 5-6



29

DEVIATION AND VARIABILITY – GENDER DEPENDED



	V (M)	V (F)
Visual	23,19%	18,9%
Auditive	22,29%	22,18%

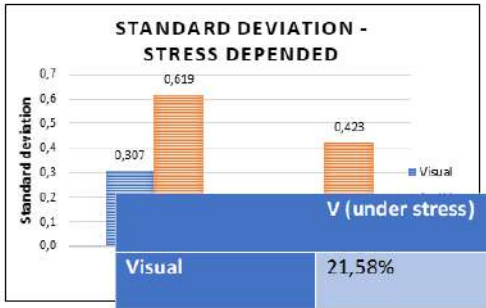
30

HYPOTHESIS 3: N IS SMALLER IF PARTICIPANT IS UNDER STRESS

	VISUAL INTERROGATION	AUDITIVE INTERROGATION
Number of participants under stress	45	59
Number of participants who were not under stress	52	38

31

DEVIATION AND VARIABILITY – STRESS DEPENDED



	V (under stress)	V (not under stress)
Visual	21,58%	19,84%
Auditive	22,08%	23,4%

32

LITERATURE

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33

LISTS OF WORDS

STUDY 1:

bicycle, fireman, bed, science, chocolate, collage, family, rain, hammer, grass

STUDY 2:

umbrella, loneliness, tooth, wisdom, shoes, joy, jeans, beauty, television, sound, notebook, art, violin, anger

34

STATISTICAL TEST

- Conducted in R

ProvoÃ□enje ANOVA testa

```
anovaVizualno = aov(Odgovor ~ Spol * Vrijeme, data = shapedData)
summary(anovaVizualno)

NAs introduced by coercion

             Df Sum Sq Mean Sq F value   Pr(>F)
Spol          1  12,56  12,558  13,803 0,000244 ***
Vrijeme       2   7,12   3,560   3,913 0,021063 *
Spol:Vrijeme  2   0,18   0,091   0,101 0,904399
Residuals   285 259,30   0,910
---

             Df Sum Sq Mean Sq F value   Pr(>F)
Spol          1   19.9  19.933   9.672  0.00206 **
Vrijeme       2   43.1  21.567  10.465 4.11e-05 ***
Spol:Vrijeme  2    0.3   0.172   0.083  0.92007
Residuals   285  587.3   2.061
---
```

35

25. PAPER AIRPLANES

Team Croatia
Reporter: Andrej Todić

25. PAPER AIRPLANES

- Costruct a **paper airplane** using an **A4 paper sheet**. Investigate the **conditions** ensuring the **longest distance** of its flight.
- Investigating the **effects of throwing angle** and **wing span of the airplane** and suggested **the ideal** conditions.

2

OUTLINE

Theoretical introduction
- Forces that affect the flight

Experiment
- Experient plan
- Experimental setup

Results
- Wing span effect
- Angle effect
- Ideal condition

3

FORCES THAT AFFECT THE FLIGHT

- Air moves over and under the wings – upward lift force
- Air pushing back – drag force
- Gravity
- Weight – didnt change the weight so that doesnt differenciate the results

4

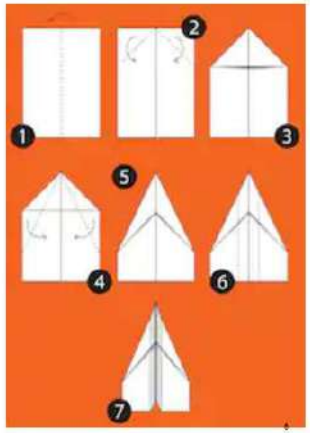
EFFECTS ON THE FLIGHT

- Angle of throwing the airplane
- With **smaller angle - bigger force**

5

MAKING OUR PAPER AIRPLANE

- We chose a techique in which we **didnt have to change the paper format** in order to **change the size of an airplane.**



HYPOTHESES

1. Airplanes with the **same wing size** will have roughly the **same results.**
2. Airplanes with **bigger wing span** will fly a longer distance
   - ❑ Area of contact with the air is larger
3. Two times the **size of an angle,** the **flight will be** 2 times **shorter.**

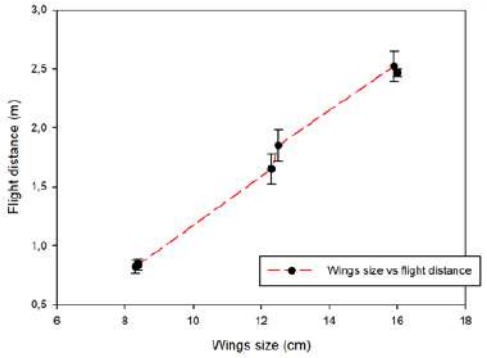
EXPERIMENT PLAN

- Parameters:
  - Wingspan → 16 cm, 12,5 cm, 8,5 cm
  - Angle of the throw → 30° and 60°
  - Weight **wasn't** changed – A4 paper
- Repeatings
  - **Two** planes for each span
  - each plane thrown **three** times
- Measured the distance that the plane flew

EXPERIMENTAL SETUP

- A4 paper
- Ruler
- Angle measuring tool
- Measuring tape

EFFECTS OF WING SIZE ON FLIGHT DISTANCE



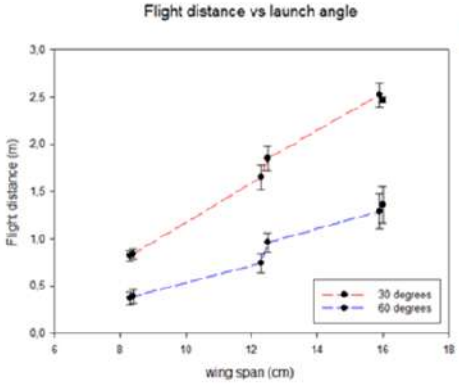
- Wingspan
  - 8.4 – avg. 82 cm
  - 12.4 – avg. 175 cm
  - 15.9 – avg. 249 cm

H1: Airplanes with the **same wing size** will have roughly the **same results** ✓

H2: Airplanes with **bigger wing span** will fly a longer distance ✓

10

EFFECTS OF LAUNCHING ANGLE ON FLIGHT DISTANCE



- angle

For **60** degrees the flight was on average **44-56% shorter**

H3: Two times the **size of an angle**, the **flight will be** 2 times **shorter.** ✓

11

CONCLUSION

- Repeatings showed similar results
- Larger wingspan - bigger distance
- Larger angle- shorter flight

- Things that might have ALSO affected the results – air flow (people walking, breeze, etc), human error (arms tiring, not always having the same grip), running out of time (rushing, bigger chances of error)

12

CONCLUSION

- For a longer flight
  - Larger wingspan for as smaller mass
  - Smaller angle of throwing – larger force

13

LITERATURE

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https://www.cheapflights.com/news/science-of-flight-paper-airplanes

THANK YOU!

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14

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