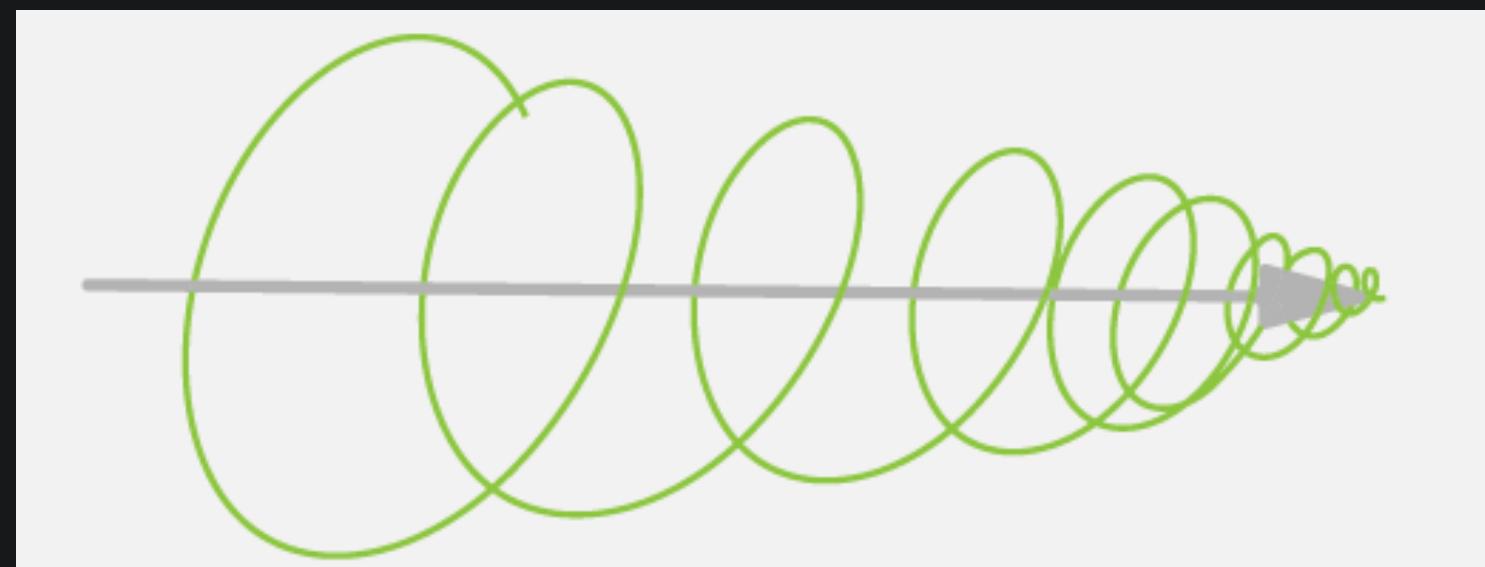


Peer-to-peer Online Systems that Enable People to Evaluate their Ideas

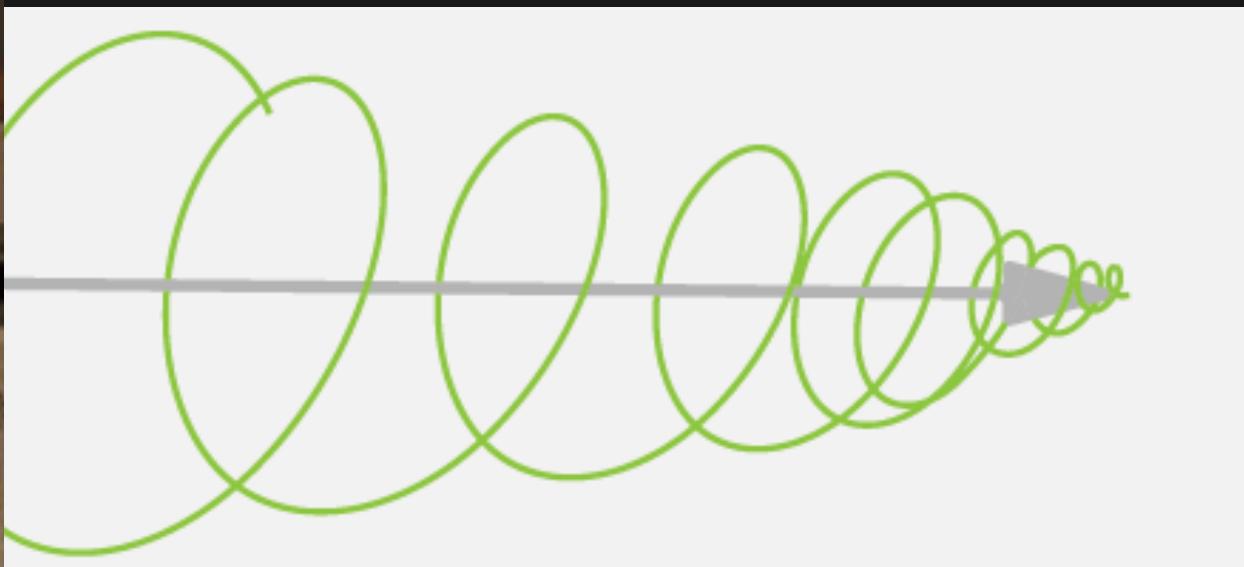
Innovation Lab Workshop
Harvard Business School
Apr 04, 2018

Vineet Pandey
 @vineet1pandey
UC San Diego
The Design Lab

Designing well requires succeeding at Explore and Exploit phases

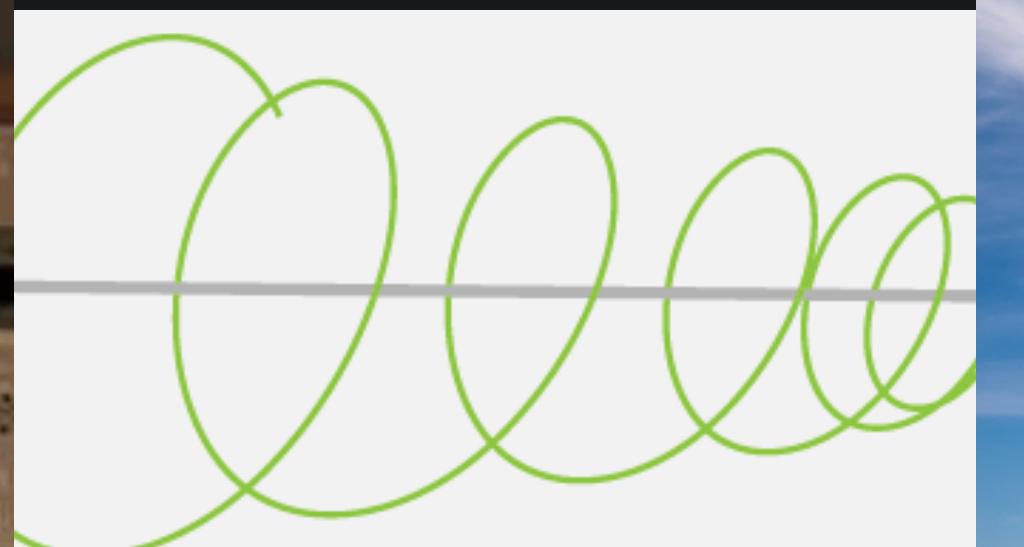


Novices underexplore...



Parallel prototyping leads to better design results, more divergence, and increased self-efficacy.
Steven P Dow et al. 2012. Design Thinking Research.

...Traditionally, lead-users have aced the exploit phase

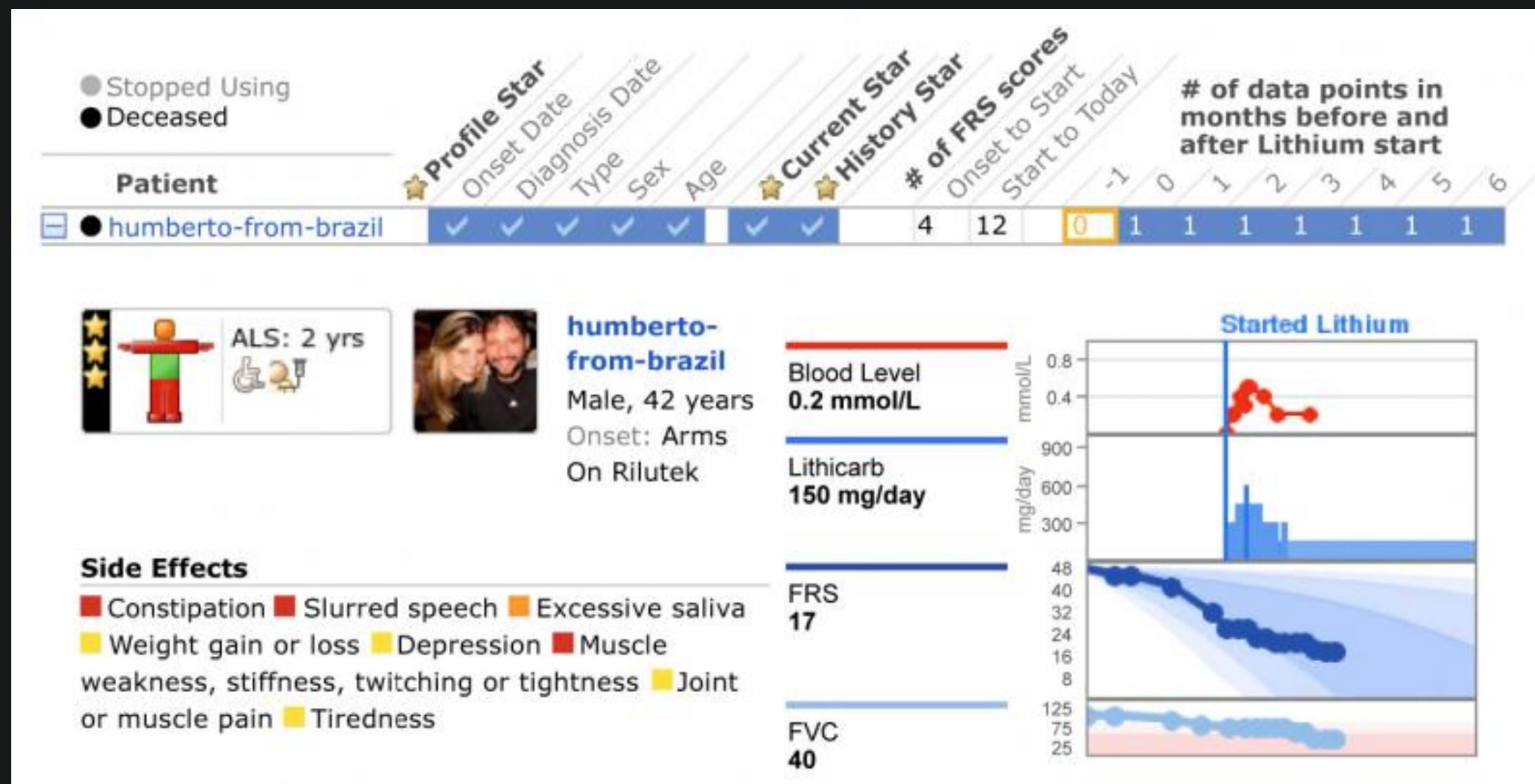


In medical settings, the gap between cause and effect is large

My hunch:

The rate-limiting step in medical innovation is not generating ideas but rather rapidly evaluating them

Sometimes people get it right. Other times, not really...



Tracking study disproved that consuming Lithium improves ALS symptoms

Sham Poo Washes Out

A bacterial pill that tried to duplicate the benefits of a fecal transplant has failed a clinical trial. What does that mean for the microbiome field?

ED YONG | AUG 1, 2016 | SCIENCE

Ill-advised Fecal Transplants can do long-term harm

My work: How can people evaluate their ideas?



The first principle is that you must not fool yourself
and you are the easiest person to fool.

(Richard Feynman)

Understanding the human microbiome requires insights into people's lifestyles

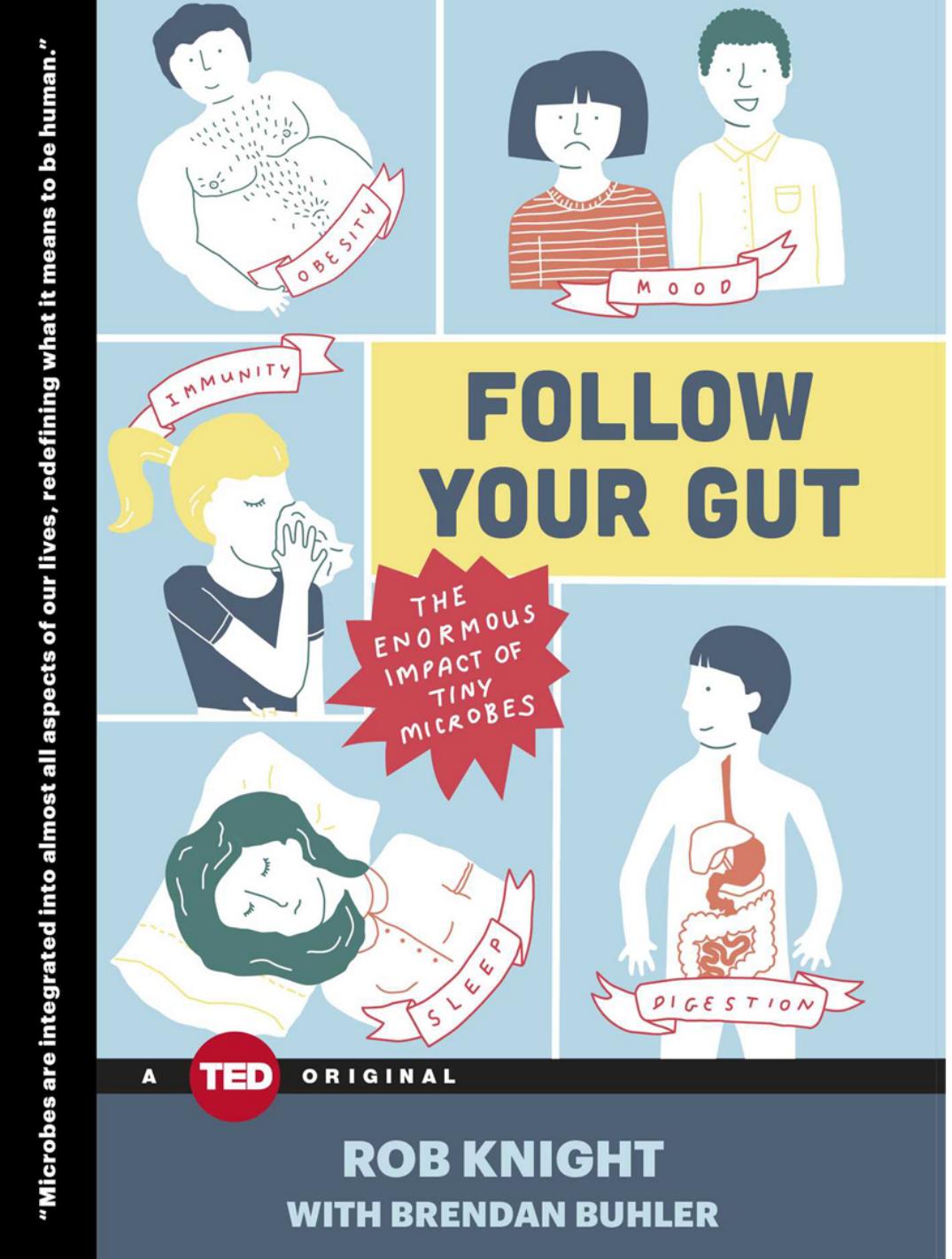
A Baffling Brain Defect Is Linked to Gut Bacteria,

By GINA KOLATA MAY 10, 2017



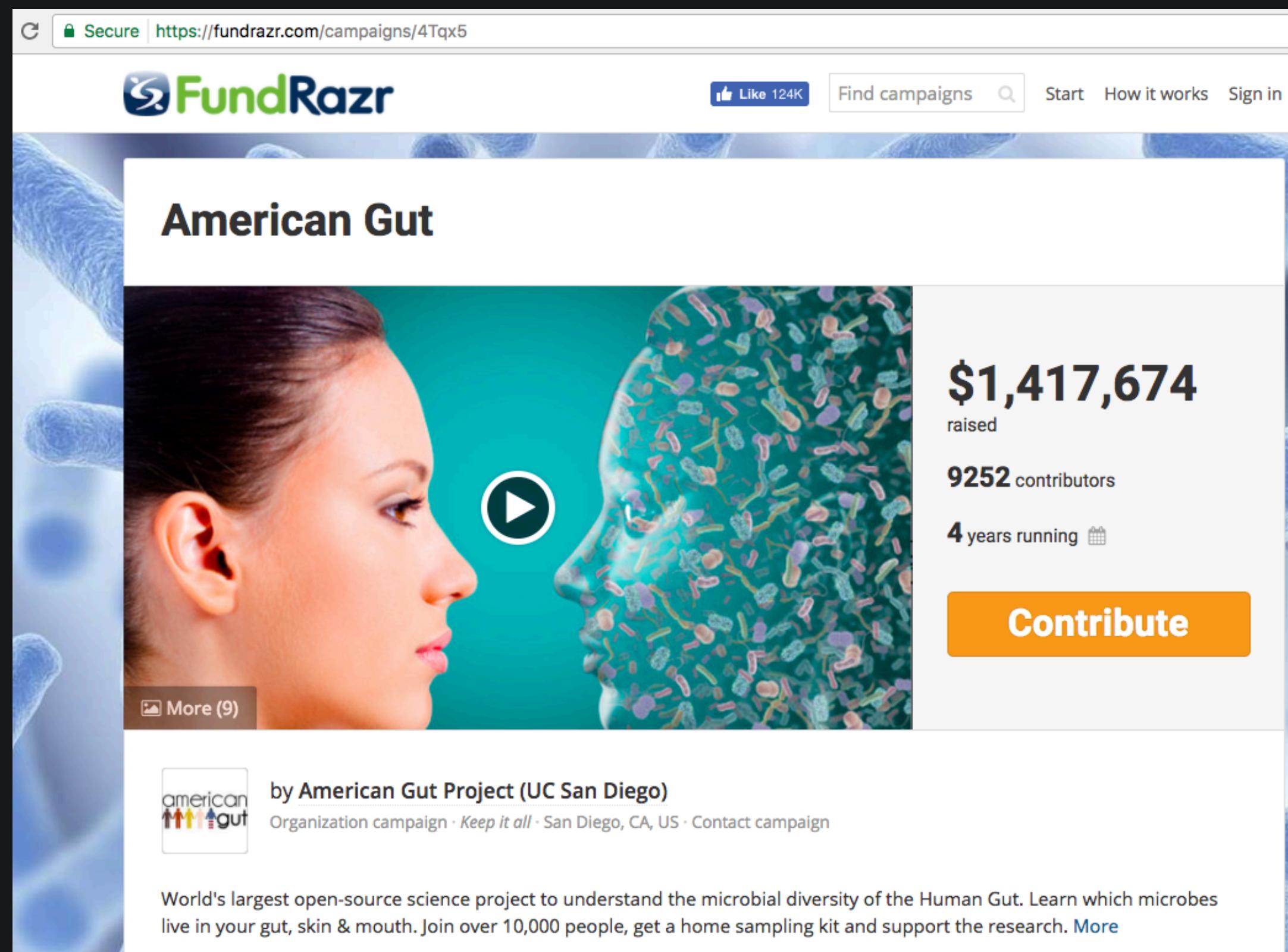
Are Pets the New Probiotic?

By RICHARD SCHIFFMAN JUNE 6, 2017

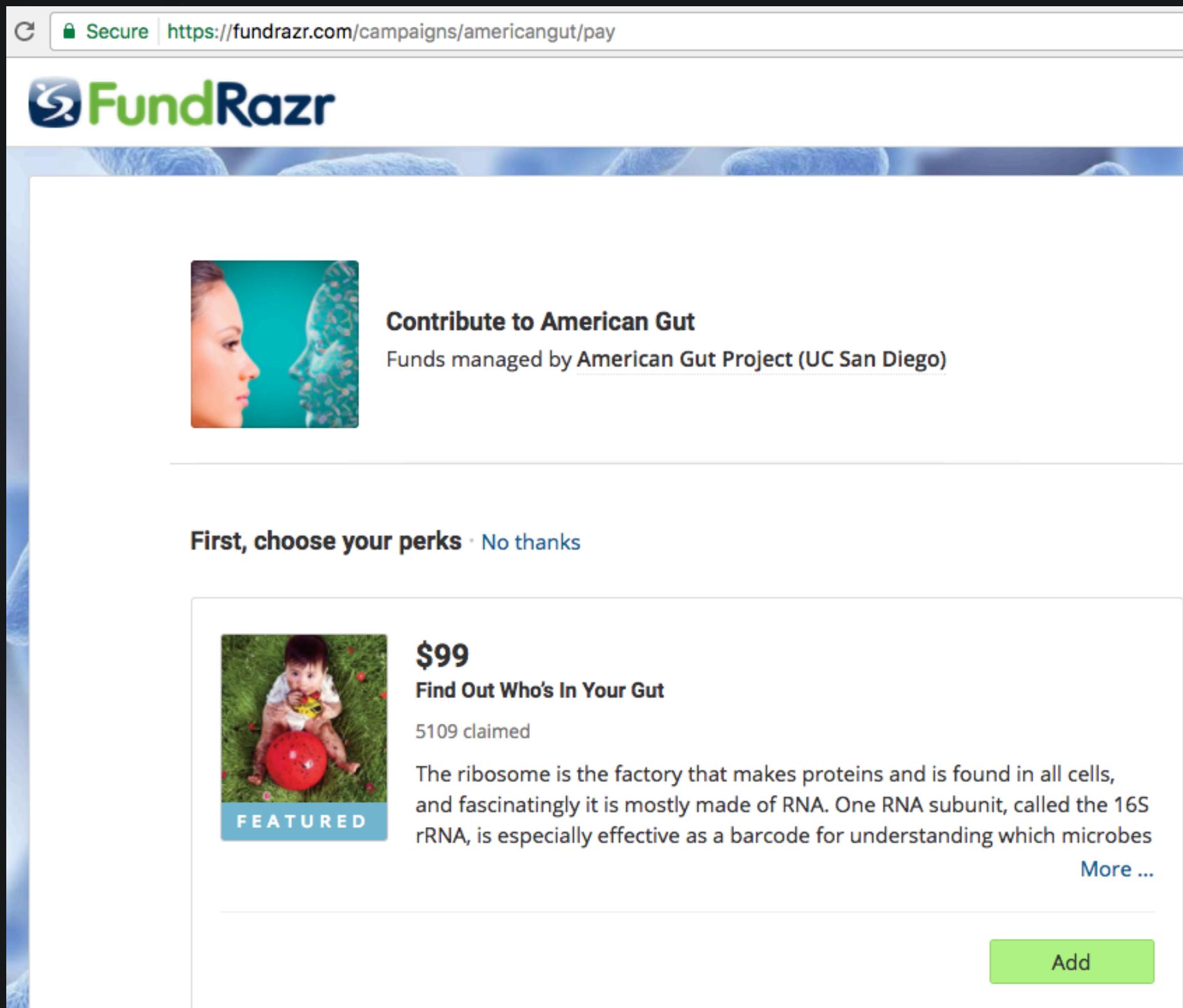


[Flegr et al. 1996] Induction of changes in human behaviour by the parasitic protozoan *Toxoplasma gondii*. Flegr J1, Zitková S, Kodym P, Frynta D. Parasitology 1996.

UC San Diego's American Gut is the world's largest crowd-funded microbiome citizen science project



Step 1: Create an online account and support the project



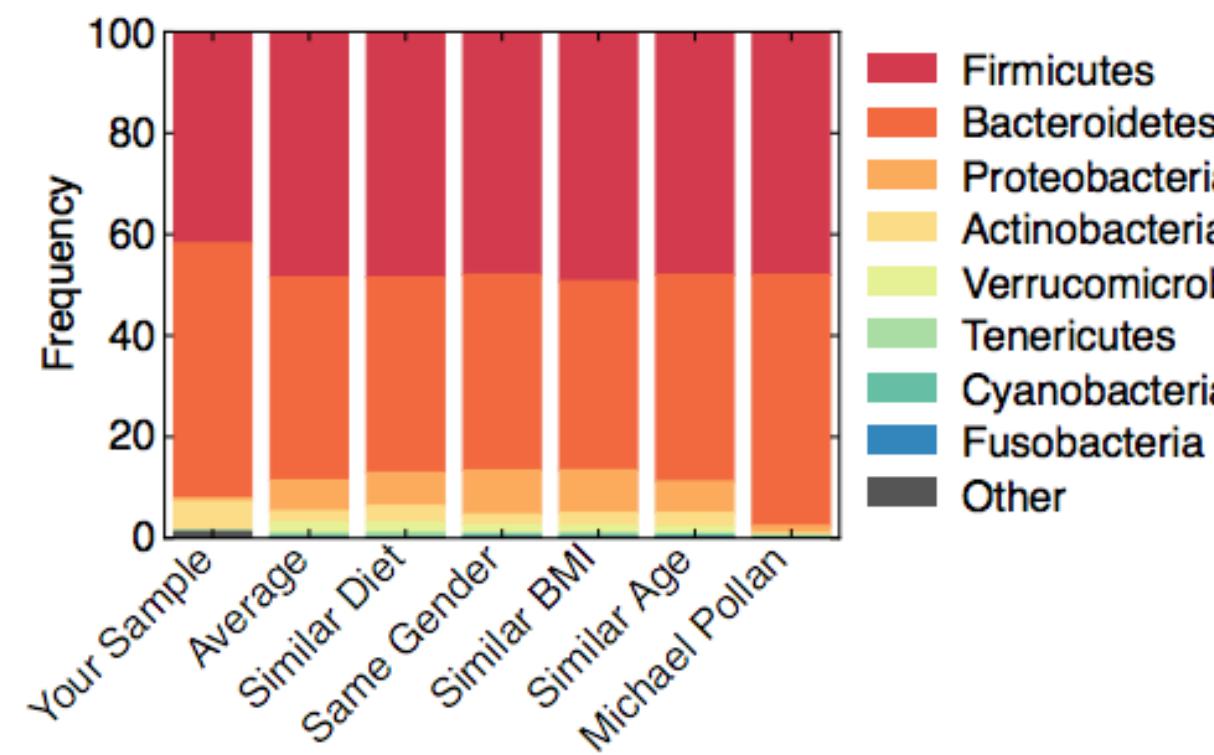
The screenshot shows a FundRazr campaign page for the American Gut Project. At the top, it says "Secure | https://fundrazr.com/campaigns/american gut/pay". The title is "Contribute to American Gut" and it's managed by the "American Gut Project (UC San Diego)". Below this, there's a "First, choose your perks" section. A featured perk is highlighted: "\$99 Find Out Who's In Your Gut" (5109 claimed). The description explains that the ribosome is the factory that makes proteins and is found in all cells, and it's mostly made of RNA. One RNA subunit, called the 16S rRNA, is especially effective as a barcode for understanding which microbes are present. There's a "More ..." link and a green "Add" button at the bottom.

Step 2: Send in your fecal/ oral/skin samples using AGP provided swabs



VINEET PANDEY

What's in your American Gut sample?



Your most abundant microbes:

Taxonomy	Sample
Genus <i>Prevotella</i>	50.1%
Family Lachnospiraceae	12.0%
Family Ruminococcaceae	6.4%
Genus <i>Faecalibacterium</i>	5.8%

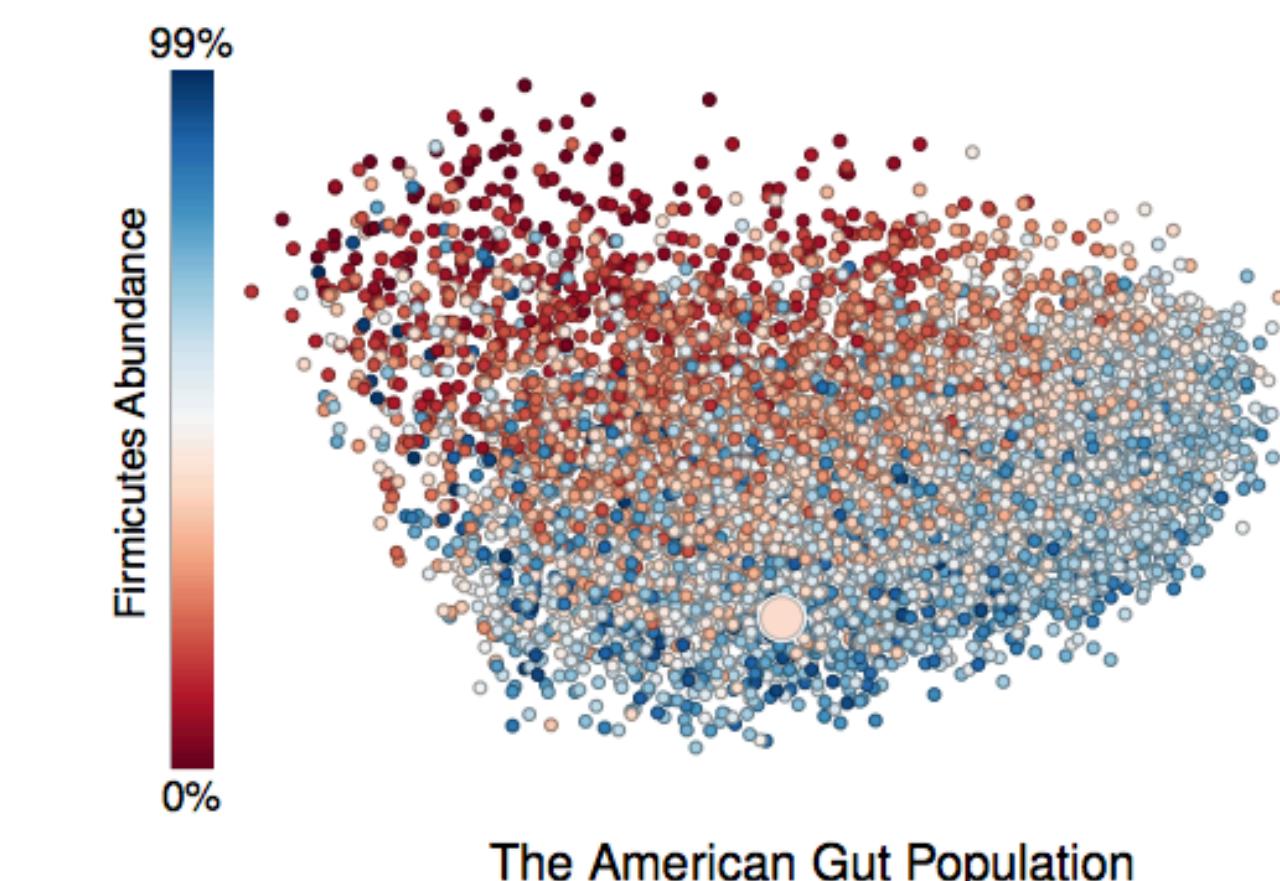
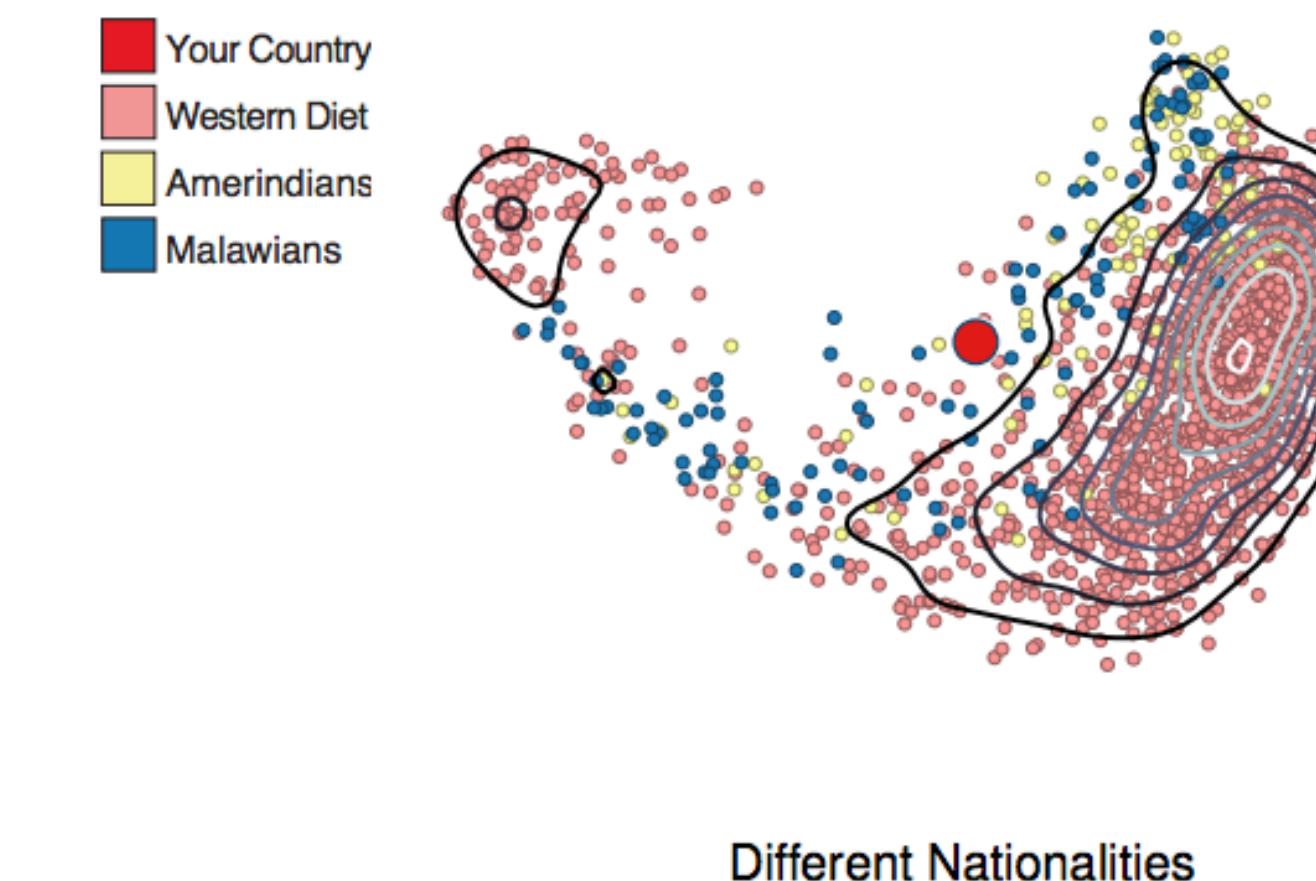
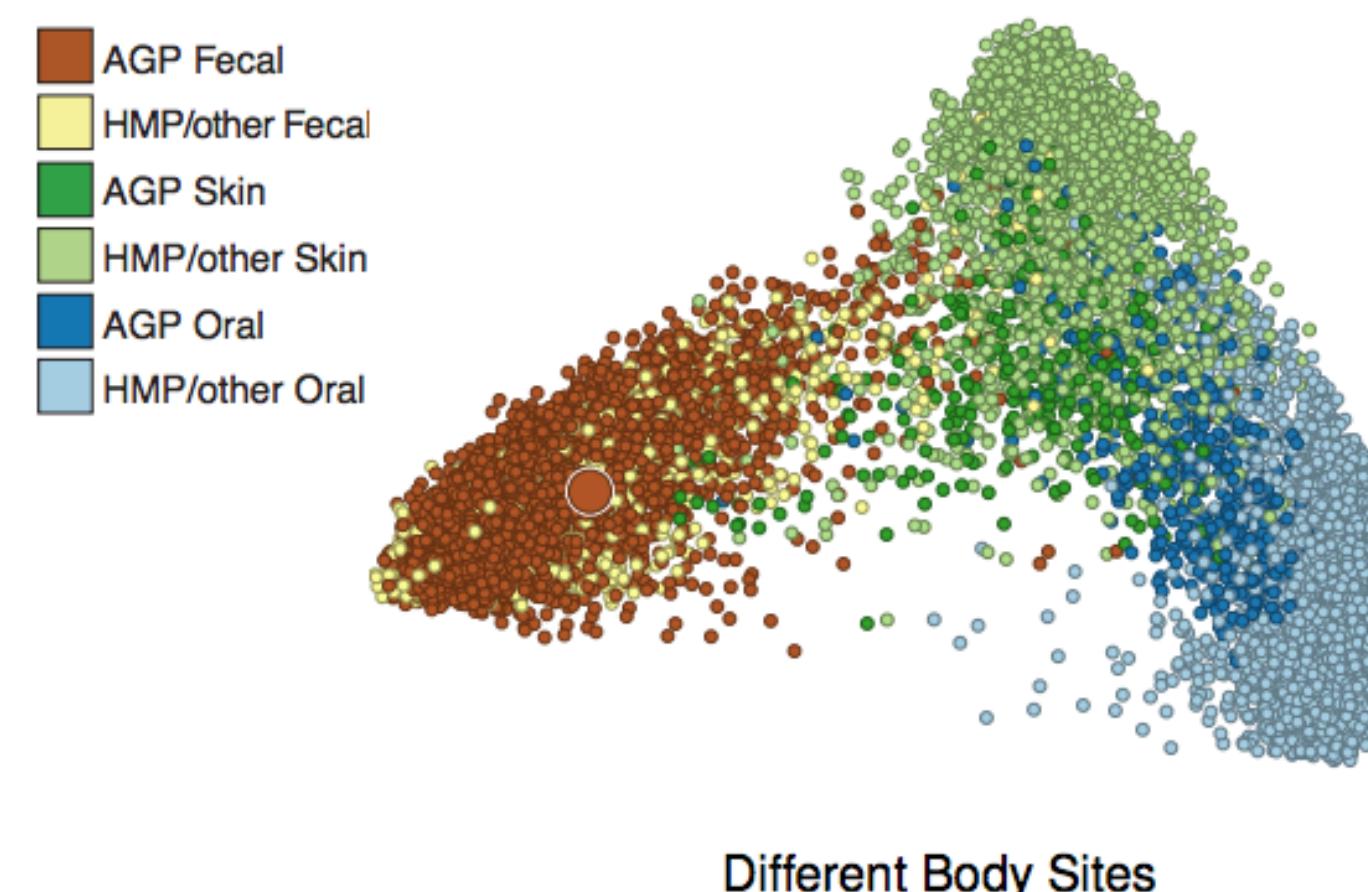
Your most enriched microbes:

Taxonomy	Sample	Population	Fold
Genus <i>Slackia</i>	0.09%	0.01%	9x
Family Victivallaceae	1.04%	0.02%	60x
Family Lachnospiraceae	12.00%	6.98%	2x
cont. Genus <i>Eubacterium</i>	1.02%	0.28%	4x

Your sample contained the following rare taxa: Unclassified Family Microbacteriaceae, Genus *Pseudoclavibacter*.

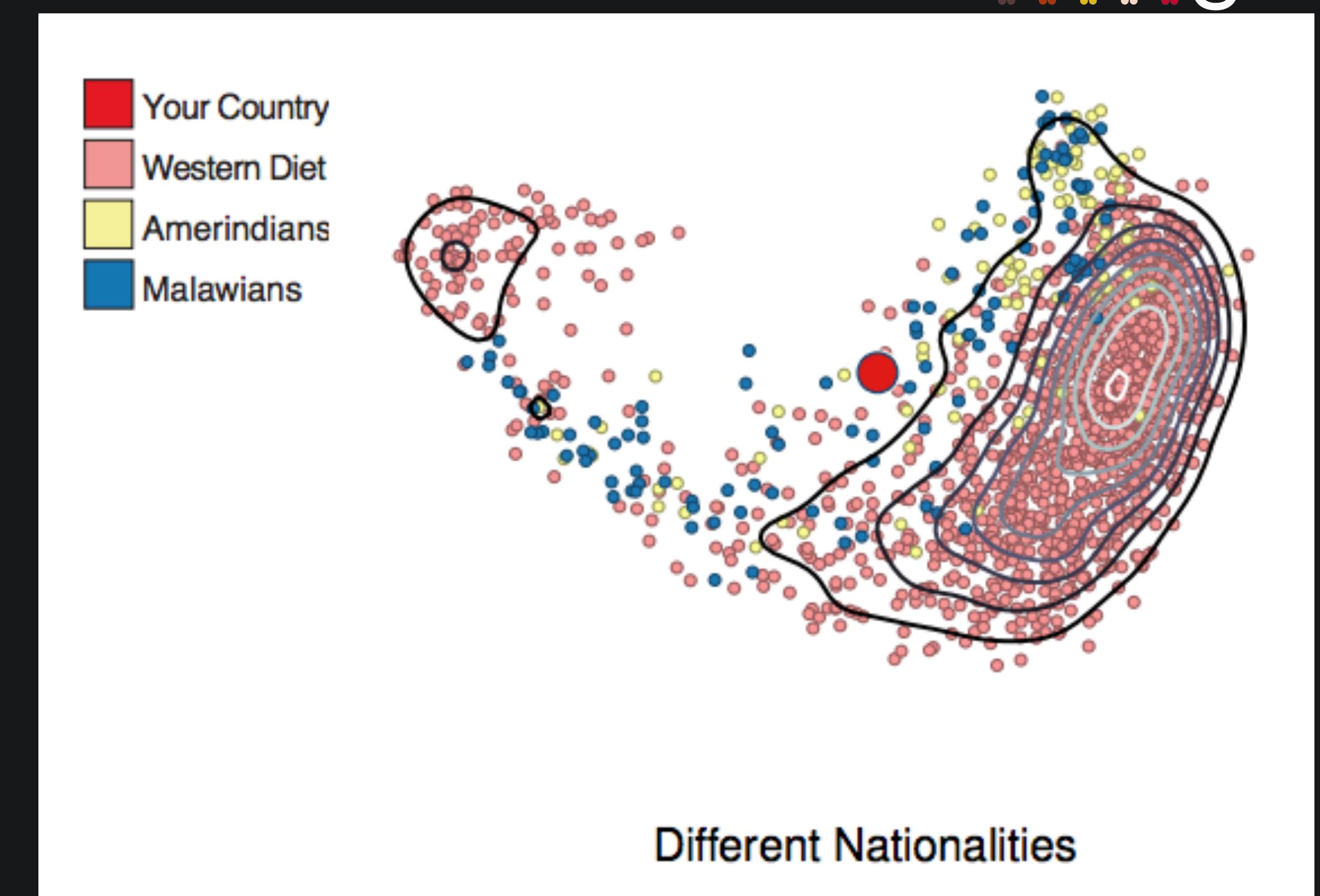
How do your gut microbes compare to others?

● Your sample is here • Others ◉ Unspecified



Experts draw population-level insights using participants' data..

american
gut

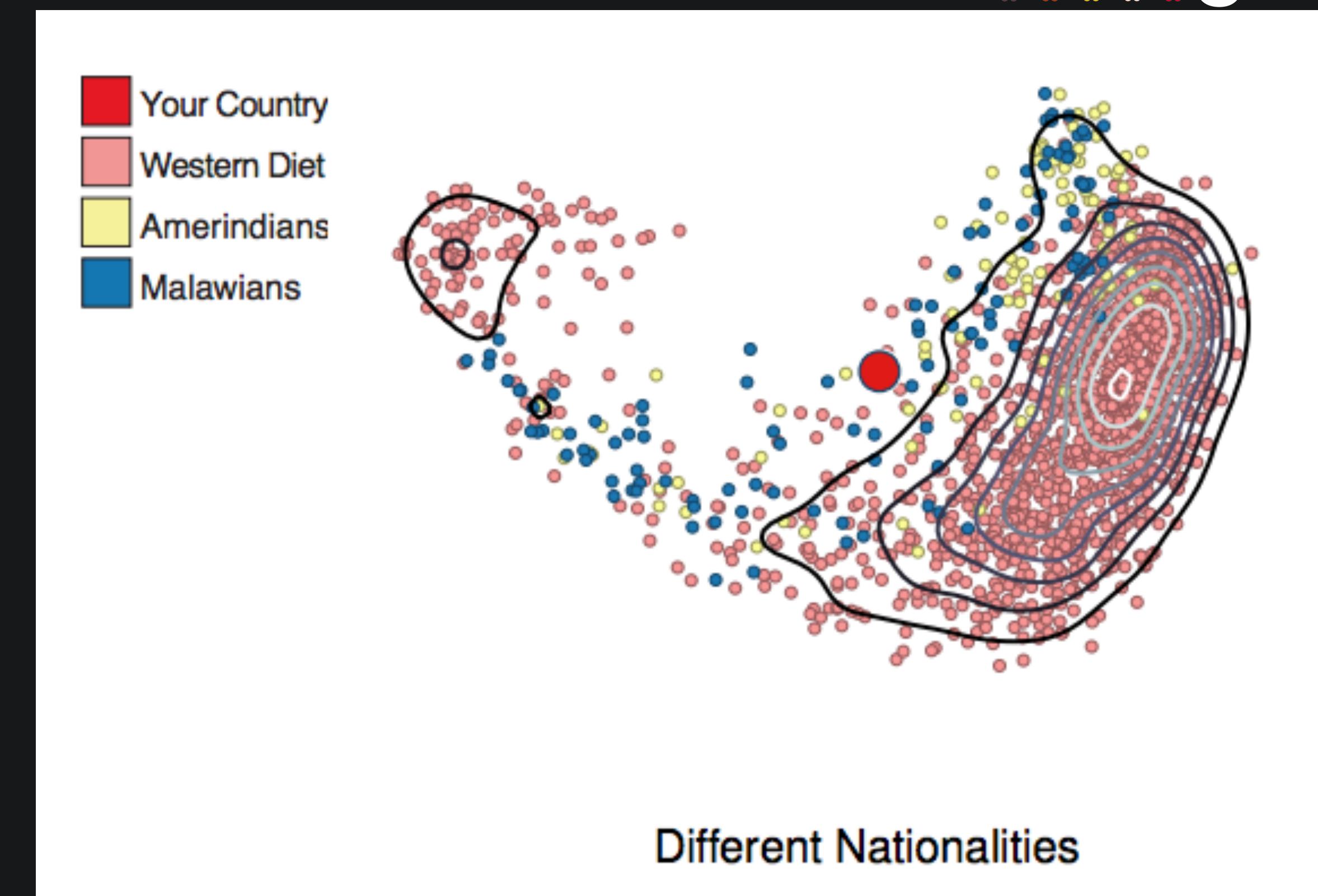


..but participants have intuitions as well

american
gut

Is my data point unique because

1. My diet is vegetarian?
2. I am of Indian descent?
3. I grew up in India?





UC San Diego

Gut Instinct

Collaboratively Creating Scientific Theories

gutinstinct.ucsd.edu

**Open access, open source,
(plans for) publicly available anonymized data**

Learn about the microbiome

Which probiotics do you use?

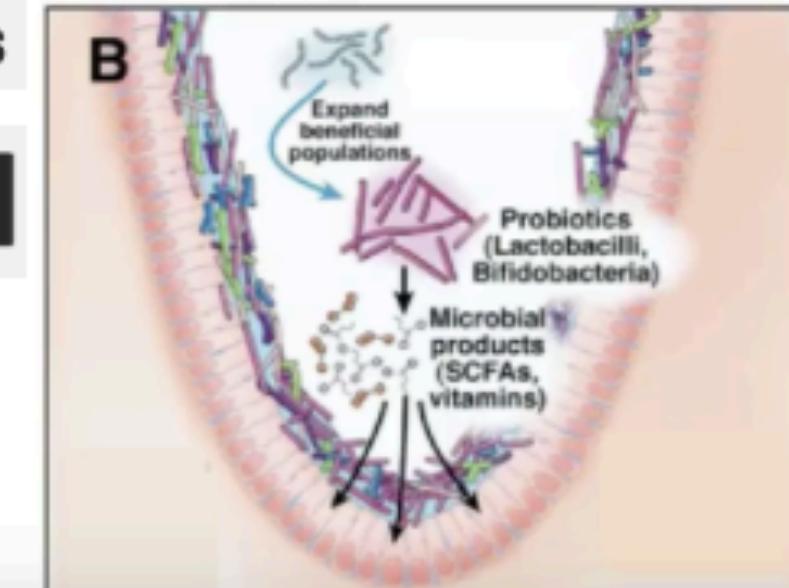
- Probiotic yogurt
- Probiotic Pills
- Home fermented saurkraut

Reflect on lifestyle before
watching a lecture

#probiotics

Video
provided
by
coursera

a



Learn from expert lectures

b

Learn about the microbiome

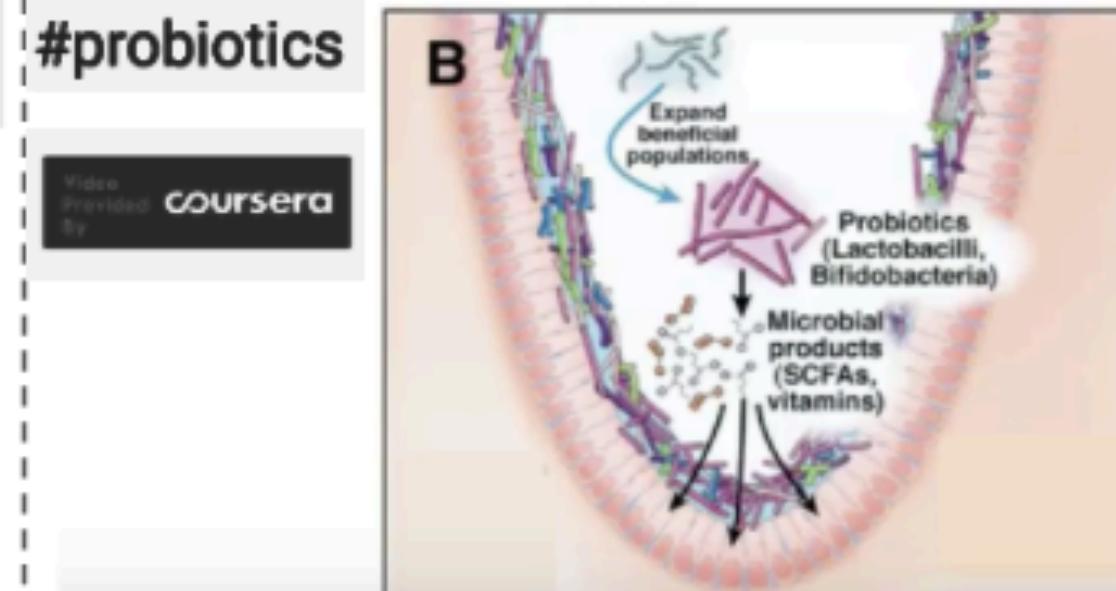
Which probiotics do you use?

- Probiotic yogurt
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#probiotics

Video
provided
by
coursera

a



b

Reflect on lifestyle before
watching a lecture

Receive feedback to learn
about relevant science

Feedback from scientific
material (?)

Updated 24 days ago  Edit

Hi DND, intriguing question! The topic video about gut-brain-axis might provide some basic information about how our microbiome state might be linked - gutinstinct.ucsd.edu/topics Please keep sharing your gut instincts, these are helpful!

Learn from expert lectures

Share links with microbiome
in your questions

Author's mechanism (?)

Flax seeds are very affordable, rich in omega-3 fatty acids and contain good fibre. My gut health improved tremendously after I started consuming them! I am interested to find out whether people really have better bowel movements after they have started consuming flax seeds. Does gut health really improve with flax seeds? Does the effect persist if you stop consuming flax seeds? Research has found that flax seeds alter certain metagenomic species in the gut as well as reduce insulin resistance. Seems to me like flax seeds are a real 'gut

c

Train to frame useful questions

Answerable

Others should be able to answer your question based on their experience.

I wonder how running affects my health?

→ Q1. *How do you feel when you run?*

Identify useful features in practice questions

Learn from expert-created questions

A

Understand what makes a question useful

Have road-trips made you nauseated?

Is this question..

Answerable? (Can others answer it from their personal experience?)

B

Ex 3: How frequently do you go on roadtrips?

- Fortnightly 0 Answer(s) / 0%
- Every month 0 Answer(s) / 0%
- Every 3 months 0 Answer(s) / 0%

Every year 0 Answer(s) / 0%

C

Use checklist while adding a question

Check the criteria

Answerable?

Others should be able to answer your question

D

GutBoard: Ask and Answer Questions

Dive deeper with these follow-up questions!

What type of alcoholic drinks (ex wine, beer, liquor, mixed with sugar) affect your bowel movements?

- wine
- beer
- liquor
- sugary mixed drinks
- Add my option

[Save my choice\(s\)](#)

[Skip](#)

How many drinks does it take to notice a difference in your bowel movements?

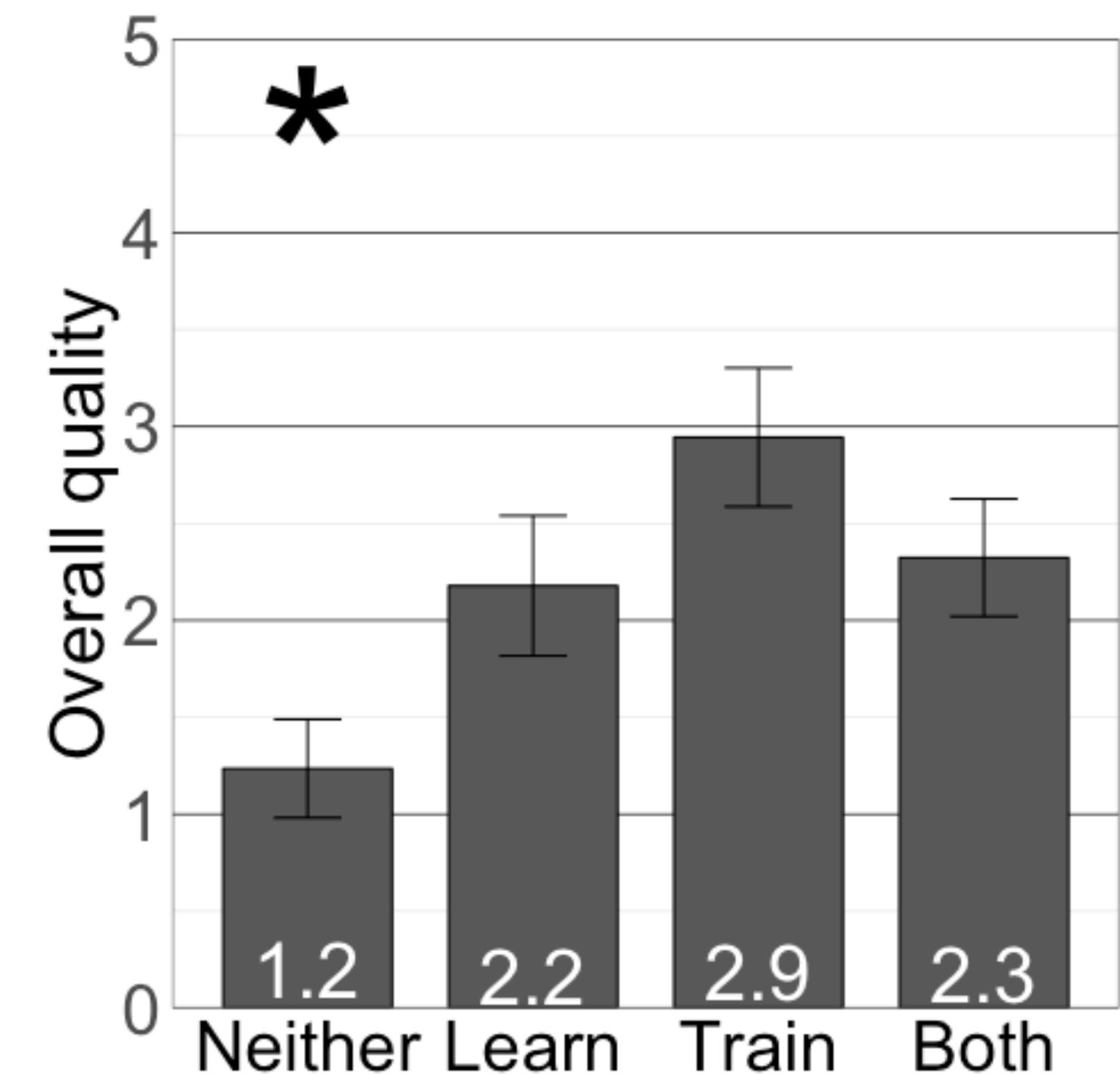
- 1-2
- 3-4
- 5+
- Add my option

Participants create better questions when they have access to training about framing good questions

M=2.54 vs. M=1.66

p< 0.01

**Two-way ANOVA: Learn X Train
Post hoc TukeyHSD for Train**



**400+ hypotheses, 70 considered novel by experts;
Lead users are best with need-intensive problems**

Personal Insights provide Novel Hypotheses

Does consuming probiotics reduce your sugar cravings?

How often do you consume bone broth? Do you have better bowel movements?

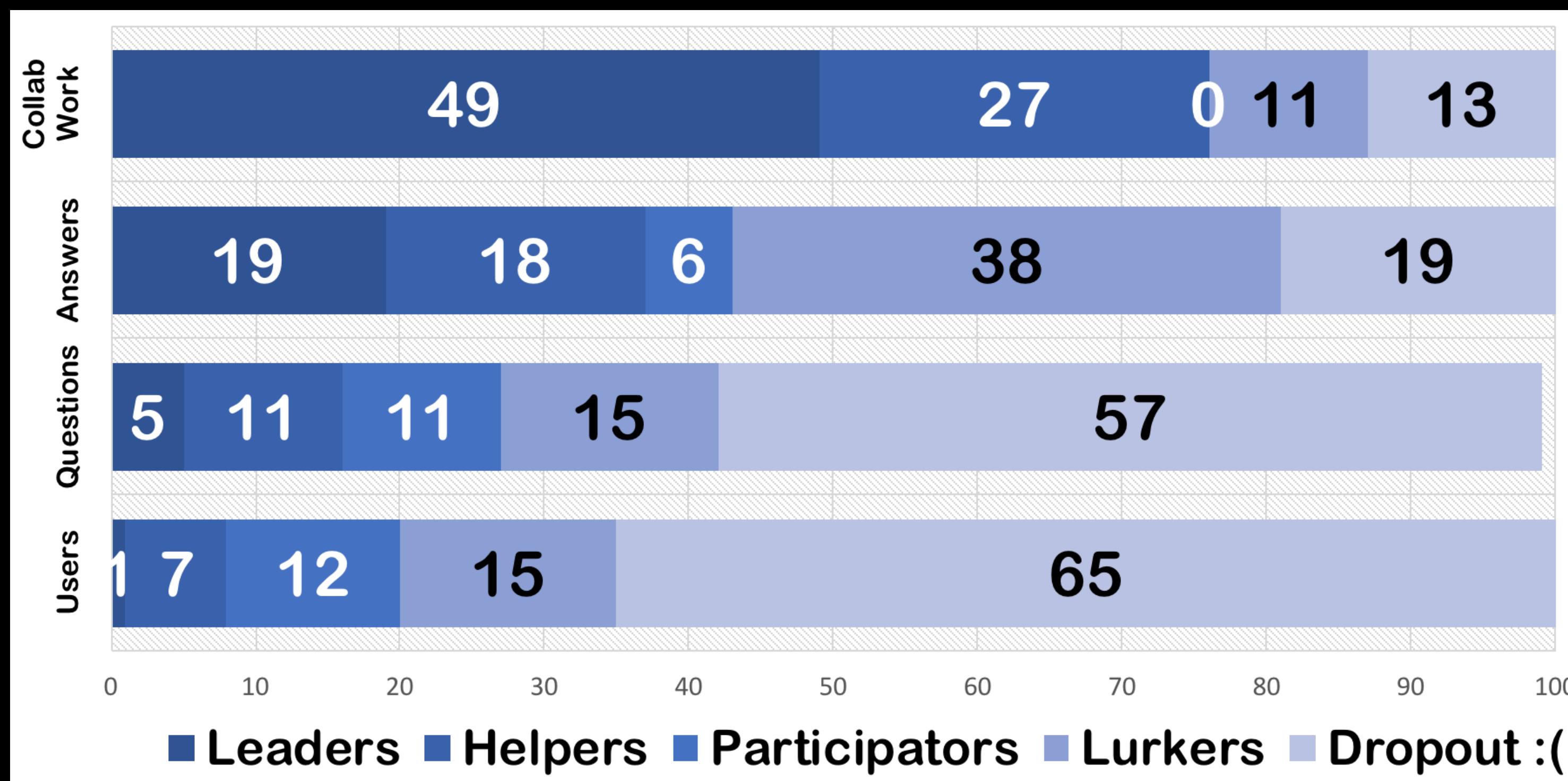
Is yogurt better for your gut at room temperature?

Most Questions contained Known Facts

How often do you consume fermented foods?

Have you ever tried doing intermittent fasting?

Gut Instinct is a *real* social computing system: people take roles and participation needs incentives



..*real* social computing system: Diverse viewpoints, people w/conditions ask more..

'I live in a country, that all the salt contains Flouride 200ppm, although in many places there is high Fluoride in the water. Since in the tropics you drink more water, I am worry of the health consecuences and the effect in the microbiome.'

'Often (not always) when I have eggs for breakfast I feel sleepy or get a churning feeling in the stomach. I have mild IBS and I wonder if anyone else has felt similar effects. If so is there a way to counter this?'

Challenge: Scientists cannot provide direct feedback

8 days ago • Added by: CITIZEN SCIENTISTS [a034]

Could an antibiotic like ciprofloxacin cure an intolerance to gluten and dairy? Seems to have done so for me.

WHat bacteria might be responsible for disrupting the gut's ability to digest gluten and dairy?
 Add my option

[Save my choice\(s\)](#)

 (1 comment) 

4 days ago • Added by: CITIZEN SCIENTISTS [a033]

Is the frequency of Bowel movements related to the gut biome

Is this related to diet? 1 Answer(s) / 100%
 Is it related to age? 0 Answer(s) / 0%
[Add my option](#)

 regularity, diet, 



Dive deeper with these follow-up questions!

If so can it be changed?

If so, can it be changed?
 Add my option

[Save my choice\(s\)](#) [Skip](#)

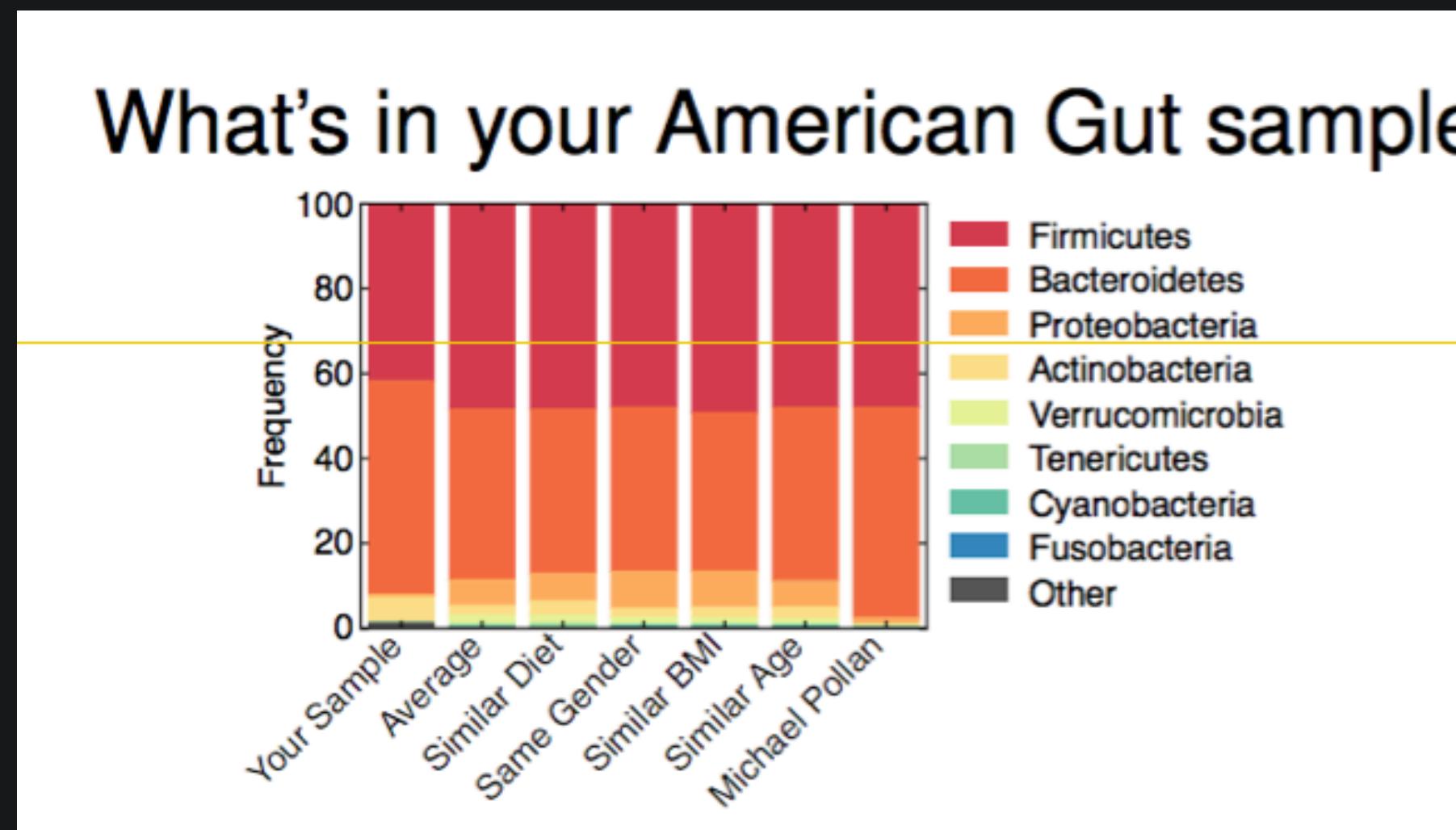
Requires clinical expertise to answer

Requires people to understand limitations of nascent scientific domains

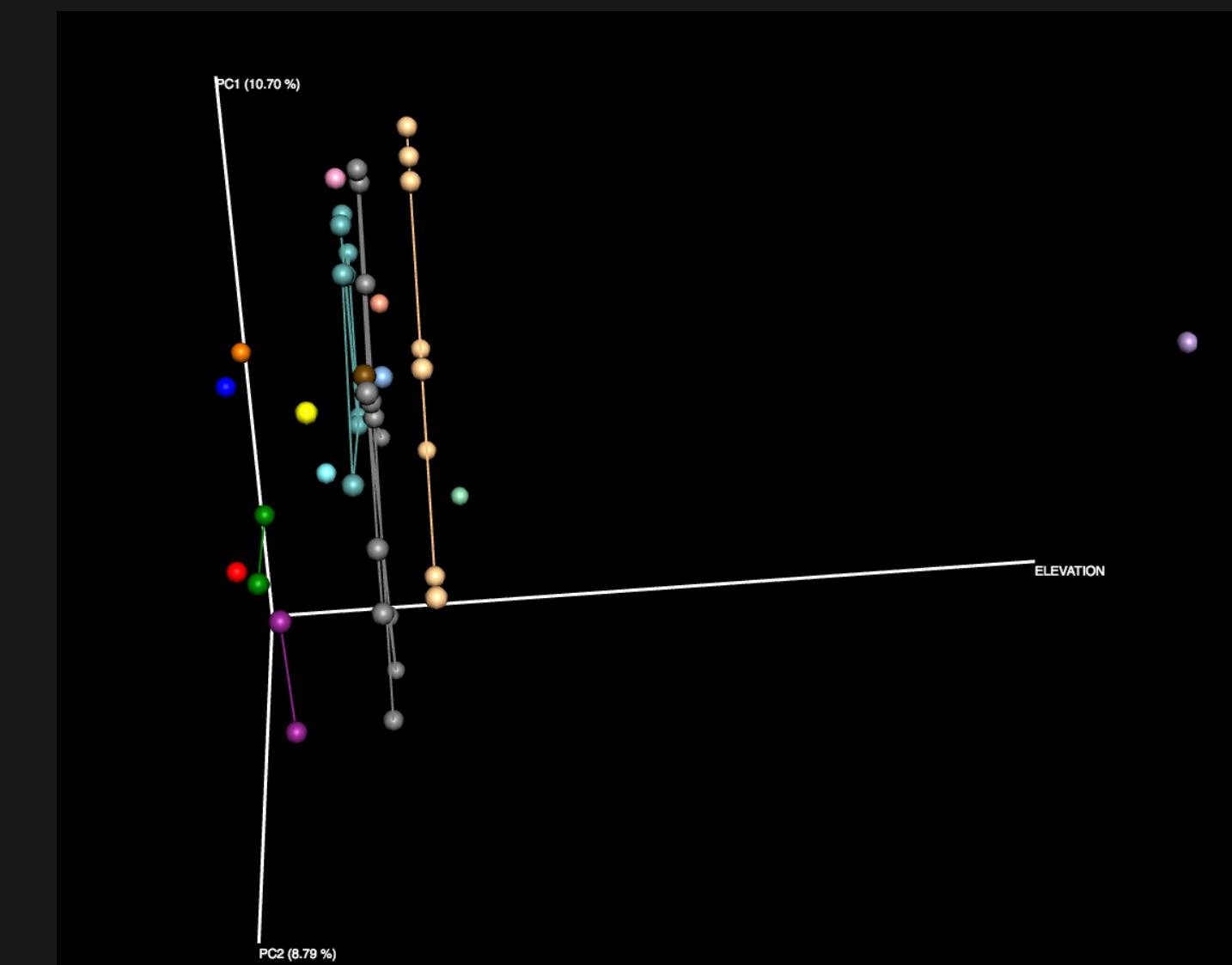
Microbiome science is far from providing prescriptive information

Requires substantial investment of time too!

Challenge: Understanding multivariate microbiome data with crowd-responses is hard

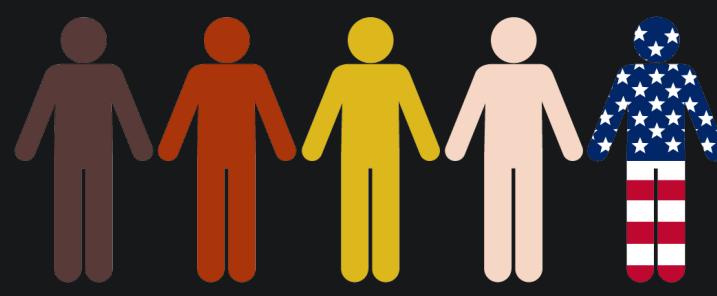


Microbiome data is difficult to interpret



PCoA plots confuse novices;
Forget running analysis

Goal: Roll out 70 novel Gut Instinct
hypotheses to 13,000 american participants!



Can a crowd self-organize to design and run experiments to test these intuitions?

galileo-ucsd.org



Galileo

(LYME)

View All Experiments

Design An Experiment



voah: My Galileo

Provide criteria for your experiment participants

Hypothesis: Vegan diet increases energy levels

Control Condition:

[Wont eat vegan food](#)

No instructions yet

Experiment Condition:

[Will eat vegan food](#)

No instructions yet

Which participants would you select for your experiment?

Exclude a participant from your experiment if they:

Include a participant in your experiment if they:



Learn more from experts!



BACK

NEXT

Hypothesis: Doing yoga for 1 hour every morning decreases stress and anxiety

Cause	Relation	Effect
Doing yoga for 1 hour every morning	decreases	stress and anxiety

Mechanism:

 REVIEW

0 reviews

How is Doing yoga for 1 hour every morning manipulated?

- Participants measure Absence/Presence of Doing yoga for 1 hour every morning
- Reminder sent every day at 8 am with the following message:

"Hello from Galileo! This is your 8:00 am reminder to measure "Doing yoga" today. Was Doing yoga absent or present in your day today? Reply Yes for present, No for absent."

 REVIEW

0 reviews

How is stress and anxiety measured?

- Participants measure Rating of stress and anxiety on a scale of 1 to 5 (1 being low stress and anxiety and 5 being high stress and anxiety)
- Reminder sent every day at 8 pm with the following message:

"Hello from Galileo! This is your 8:00 pm reminder to measure "stress and anxiety" today. How would you rate stress and anxiety today? Please provide your answer on a scale of 1 to 5 (1 means low stress and anxiety, 5 means high stress and anxiety)"

 REVIEW

0 reviews

Control Condition

does not do yoga

- do not perform any exercise in the next 7 days
- continue performing daily activities
- Measure how stress you are at the end of the day around 8pm
- repeat steps for the next 7 days

Experiment Condition

does yoga for 1 hour per day

- do yoga for 1 hour per day before 10am
- go to the same studio with the same teacher
- do not do any other physical exercise
- measure how stress you feel at the end of the night around 8pm
- repeat steps for the next 7 days

Hypothesis: Doing yoga for 1 hour every morning decreases stress and anxiety

Cause	Relation	Effect
Doing yoga for 1 hour every morning	decreases	stress and anxiety

Mechanism:

 REVIEW

0 reviews

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0 reviews

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- go to the same studio with the same teacher
- do not do any other physical exercise
- measure how stress you feel at the end of the night around 8pm
- repeat steps for the next 7 days

Exclusion Criteria

(No participant should meet ANY of the following criteria)

- are under 18 years of age
- are pregnant
- are potentially cognitively impaired
- are a prisoner or incarcerated
- are very over weight
- has a heart condition
- are injured
- someone that can't partake in physical exercise

 REVIEW

0 reviews

Inclusion Criteria

(Every participant must meet EACH of the following criteria)

- can partake in physical exercise

 REVIEW

0 reviews

How does Gut Instinct work towards meeting participants' safety concerns?

Your review of Exclusion Criteria X

provide informed consent?
Yes 0 | No 0

Adherence: Does the Exclusion Criteria exclude participants who might not adhere to the experimental steps for every day of the suggested duration (including providing data)? If not, please add a comment with a suggestion to remove such people from the experiment. E.g. When studying the effects of quitting smoking on the quality of sleep, you might want to avoid long-term smokers who might struggle to quit.
Yes 0 | No 0

Non Profit: Does the Exclusion Criteria exclude participants who might gain from the results of the experiment and the knowledge created? If not, please add a comment with a suggestion to remove such people from the experiment.
Yes 0 | No 0



An amazing ethics training module

Remove an experiment entirely

Community leaders provide defaults and review the experiments



G

Galileo Production



Welcome to your experiment's day 3!
Please remember to follow these instructions:

1. Pick a target bed time that you will try to fall asleep by for the next 7 days
2. Pick a non-caffeinated, non-alcoholic beverage other than water that you will consume in the evenings between 6pm and 8pm for the next 7 days
3. Continue performing your daily activities as usual
4. Abstain from drinking



Text Message



G

Galileo Production



[EXPERIMENT DAY 3]
Hello from Galileo! This is your 9:00 am reminder to measure "people falling asleep no more than 30 minutes past their desired bed time" today.

Did you fall asleep within 30 minutes of your target bed time last night? Reply Yes or No

No

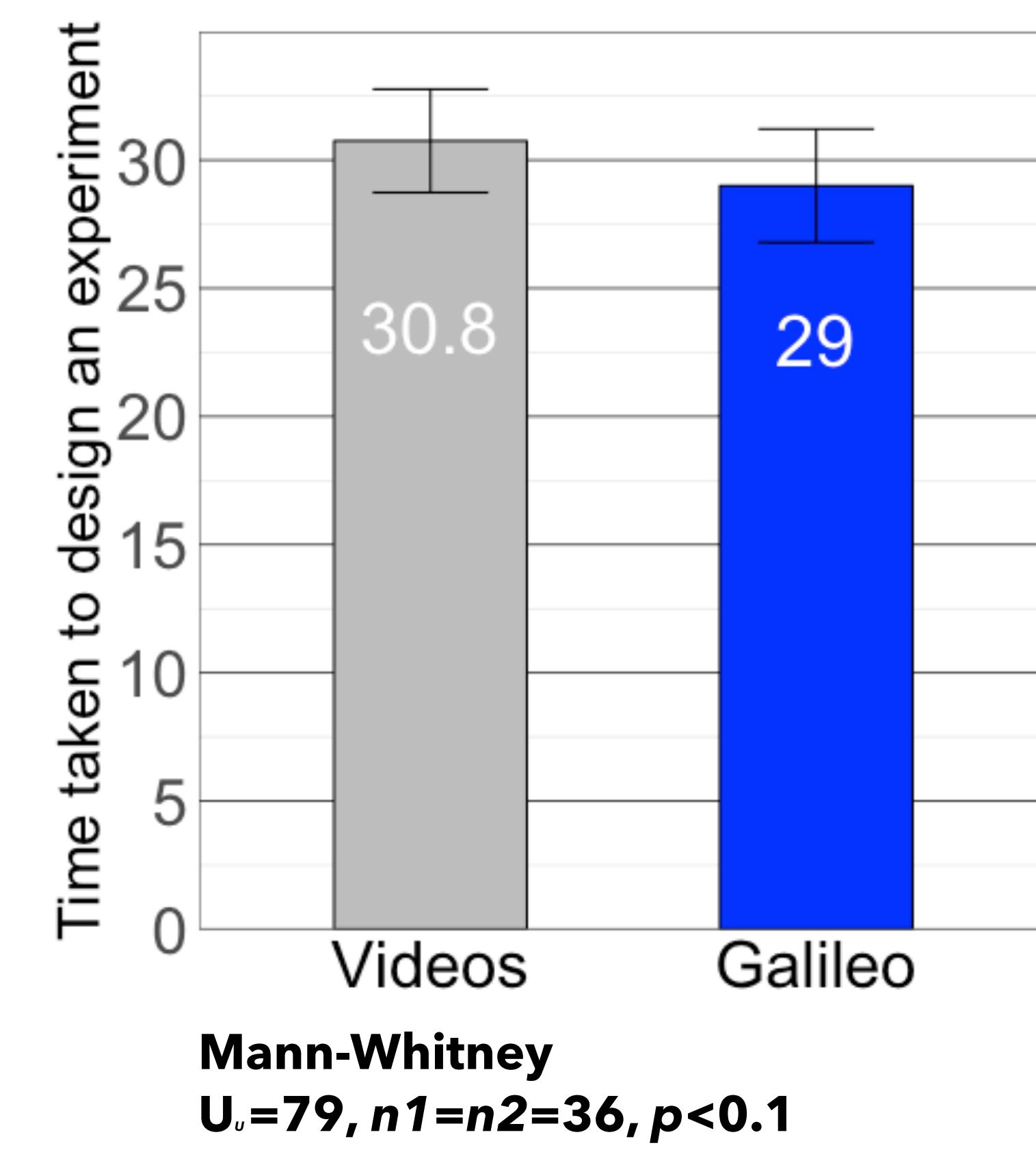
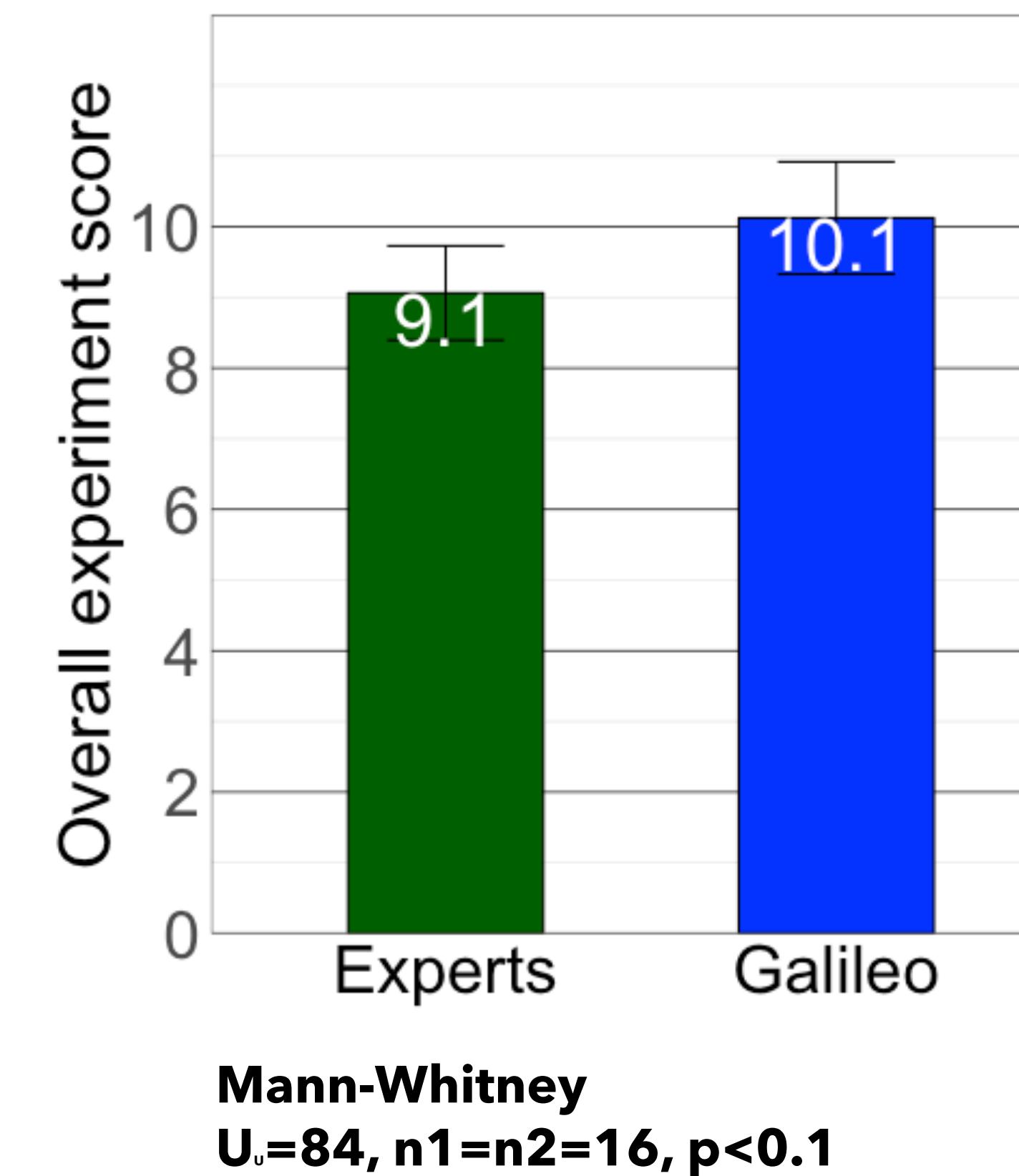
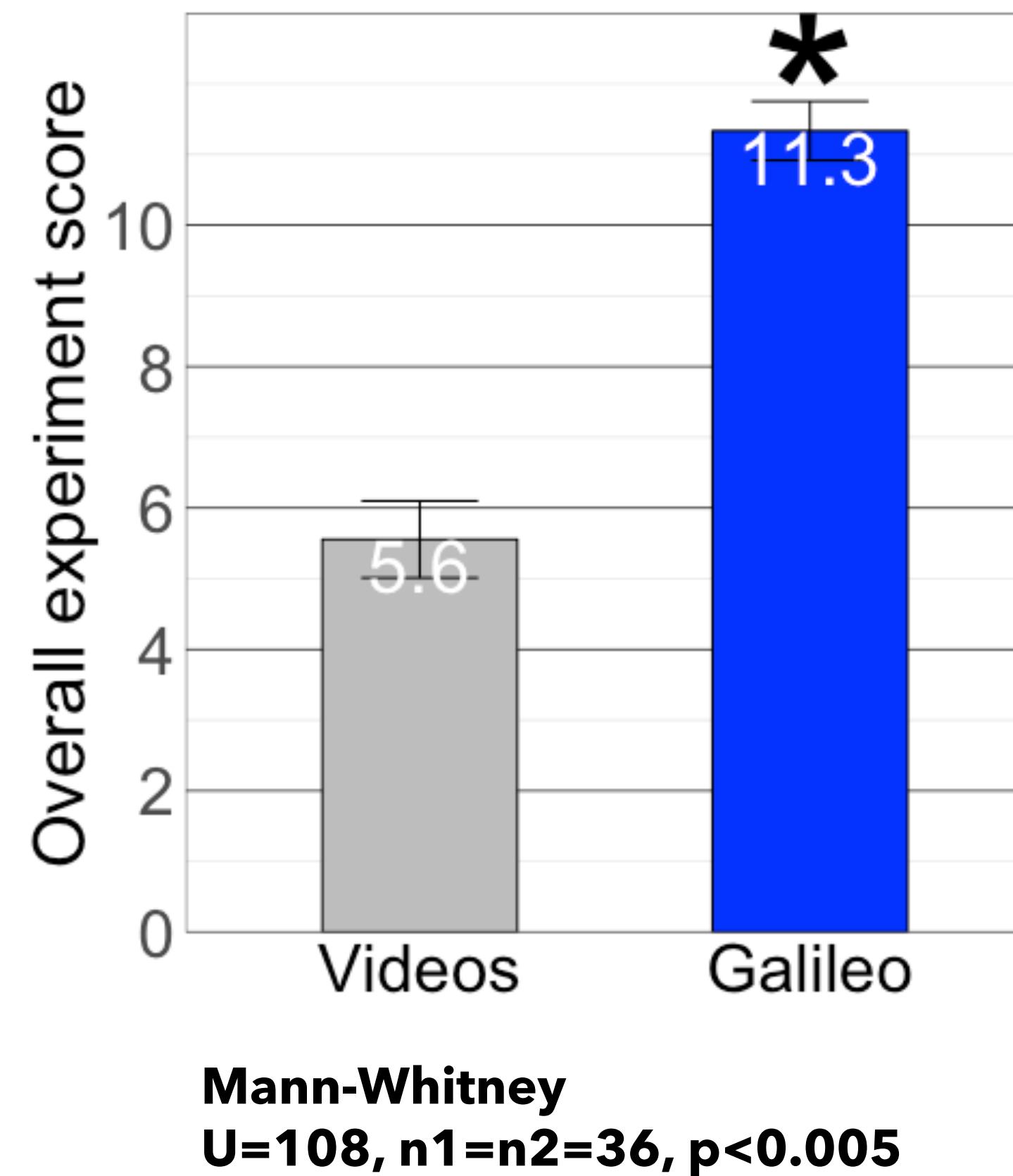
Great work! Your data has been successfully stored in your tracking sheet.



Text Message



In 30 mins, Participants created better experimental designs than those watching online lectures



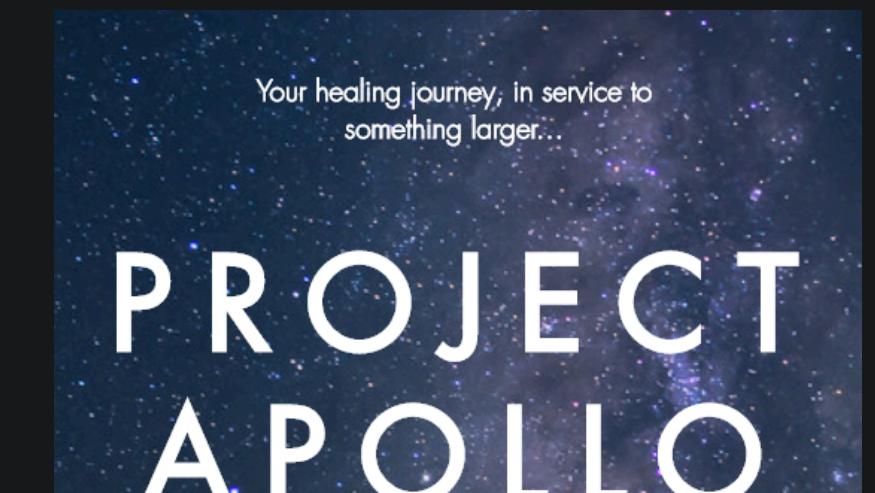
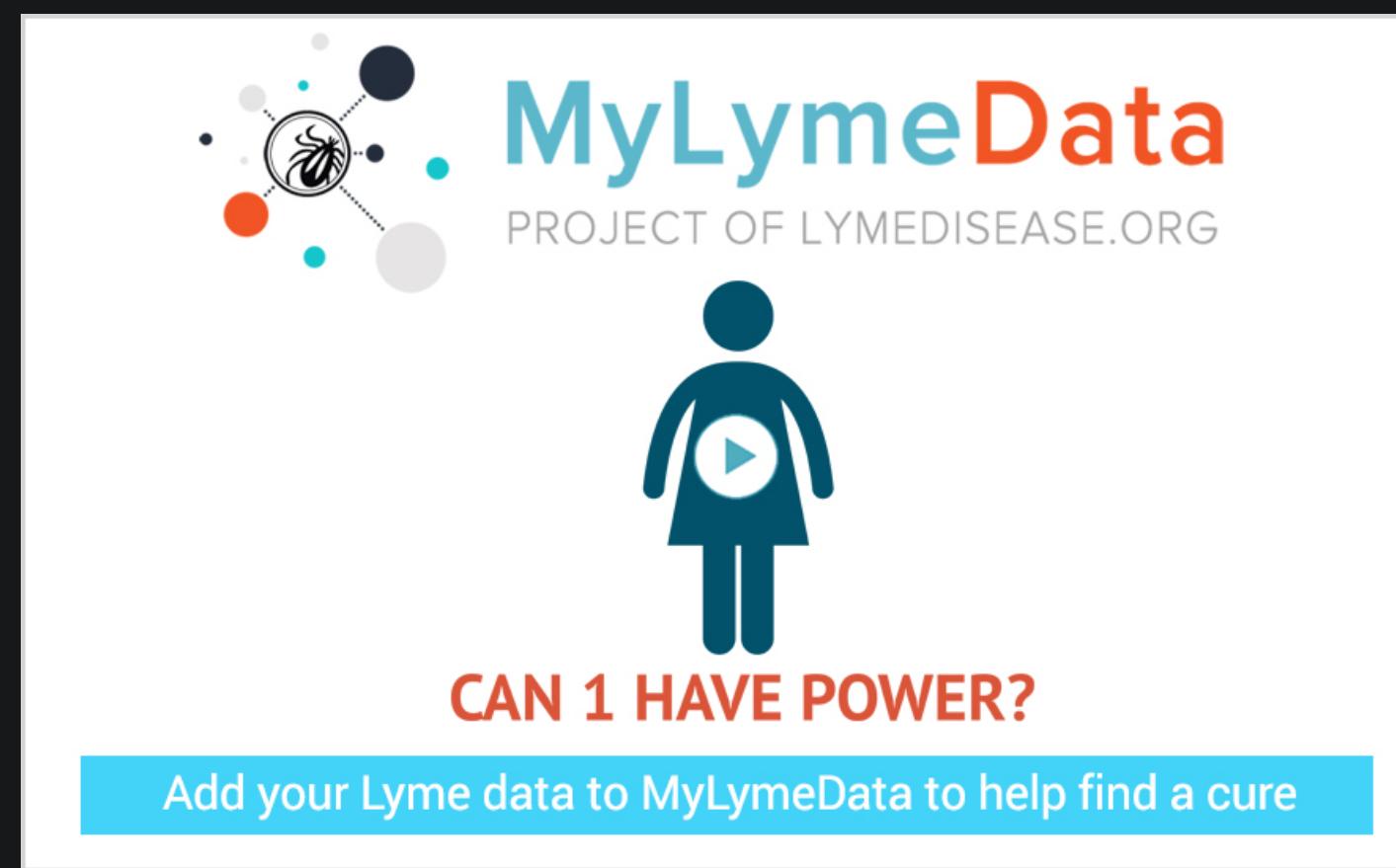
Why do people create better experiments with Gut Instinct?

1. Scaffolds for procedural learning (*how to do X*)
2. Dejargonization
3. Support iterations

Issues unearthed in a Beer-sleep study (N=17)

1. Selection bias
2. Compliance
3. Dropouts

Galileo: Working with specific communities



The challenge in medical innovation: The gap between cause and effect is large

My hunch:

The rate-limiting step in medical innovation is not generating ideas but rather rapidly evaluating them

We need to make evaluation of ideas easier, open, and cheaper by building online systems that build expertise.

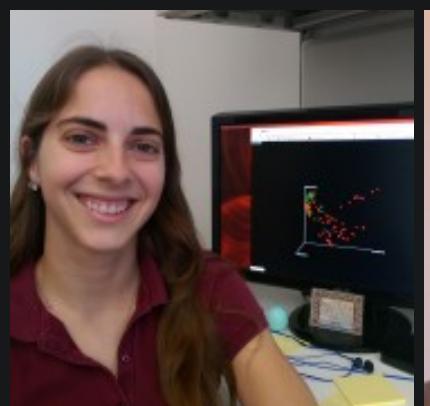
Questions?



Scott



Rob



Embriette



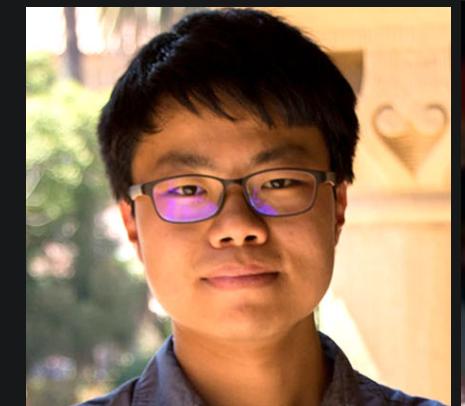
Justine



Tomasz



Daniel



Chen



Tushar

gutinstinct.ucsd.edu

Vineet Pandey
Twitter: **@vineet1pandey**

Galileo: An online learning system for people to design, review, and run experiments. Vineet Pandey, Tushar Koul, Chen Yang, Daniel McDonald, Rob Knight, Scott Klemmer. *In submission.*

Integrating content learning and process training helps people create personally-relevant scientific hypotheses. Vineet Pandey, Justine Debelius, Embriette R Hyde, Tomasz Koscioletk, Rob Knight, Scott Klemmer. *ACM Learning@Scale 2018.*

Gut Instinct: Creating Scientific Theories with Online Learners. Vineet Pandey, Amnon Amir, Justine Debelius, Embriette R Hyde, Tomasz Koscioletk, Rob Knight, Scott Klemmer. *ACM CHI 2017.*

Framing Feedback: Choosing Review Environment Features that Support High Quality Peer Assessment. Catherine M Hicks, Vineet Pandey, C Ailie Fraser, Scott Klemmer. *ACM CHI 2016.*