

Docent: Transforming personal intuitions to scientific hypotheses through content learning and process training

UC San Diego

The Design Lab

Vineet Pandey
Scott Klemmer

 @GutInstinctUCSD



KNIGHT LAB

Justine Debelius
Embriette R. Hyde
Tomasz Kosciolek
Rob Knight

Worldwide, people use online health forums to share insights and look for answers

I've discovered that **finding relief from IBS** is like finding a needle in a haystack. I am still searching. **My faith is what is getting me through each day. I am listing all the things that I have done or tried.** Maybe it will be someones needle in the haystack: **Upper GI, Colonoscopy, Vaginal ultrasound, Gluten and food allergy test, Gallbladder ultrasound, Stomache scoped, Abdominal CT scan, Dicyclomine, Pro-biotics, Colestipol... Gluten Free Diet and Special Carb Diet. Let me know if any of these help you.**

Scientists and people can learn from and help each other

Historical Perspectives

Self-Experimentation and Its Role in Medical Research

Allen B. Weisse, MD

Although experimentation involving human volunteers has attracted intense study, the matter of self-experimentation among medical researchers has received much less attention. Many questions have been answered only in part, or have been left unanswered. How common is this practice? Is it more common among certain nationalities? What have been the predominant medical fields in which self-experimentation has occurred? How dangerous an act has this proved to be? What have been the trends over time? What is the future likely to bring?

*From the available literature, I identified and analyzed 465 documented instances of this practice, performed over the course of the past 2 centuries. Most instances occurred in the United States. The peak of self-experimentation occurred in the first half of the 20th century. Eight deaths were recorded. A number of the investigators enjoyed successful careers, including the receipt of Nobel Prizes. Although self-experimentation by physicians and other biological scientists appears to be in decline, the courage of those involved and the benefits to society cannot be denied. (*Tex Heart Inst J* 2012;39(1):51-4)*

Article

Cell

Noninvasive Deep Brain Stimulation via Temporally Interfering Electric Fields



COMMUNITY DETAILS

 r/tDCS

10.7k
Subscribers

33
Online

A subreddit for discussing the science, technology, construction, and use of noninvasive brain stimulators.

SUBSCRIBE

CREATE POST

People's insights can help scientists discover novel ideas

Scientific research can better inform people's discussions

Allen B Weisse. 2012. Self-experimentation and its role in medical research. From the Texas Heart Institute of St. Luke's Episcopal Hospital, Texas Children's Hospital 39, 1.

https://www.reddit.com/r/tDCS/comments/6epvs8/researchers_invent_new_method_for_noninvasive

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



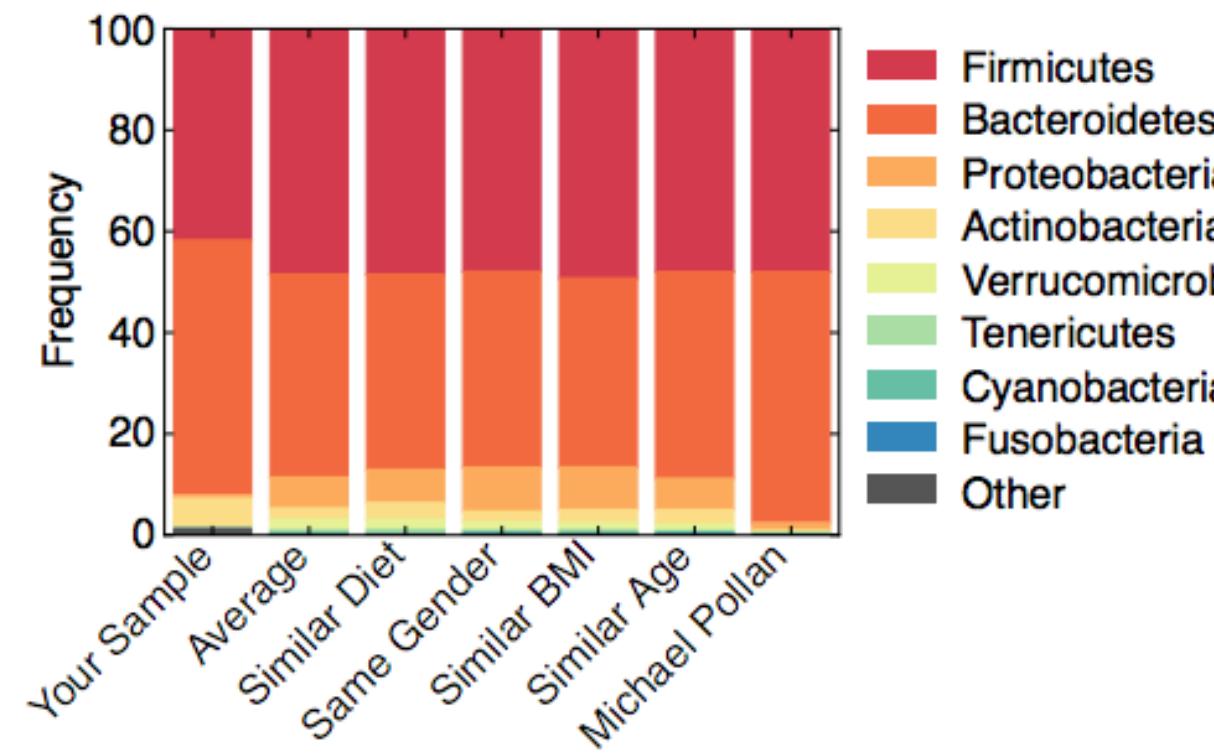
A collage of illustrations and text from a TED talk. On the left, a vertical column of text reads: "Microbes are integrated into almost all aspects of our lives, redefining what it means to be human." Below this is a red starburst containing the text "THE ENORMOUS IMPACT OF TINY MICROBES". At the bottom, it says "A TED ORIGINAL" and "ROB KNIGHT WITH BRENDAN BUHLER". The right side features four panels: 1) A person with a brain-like pattern in their torso, labeled "OBESITY". 2) A man and a woman, labeled "MOOD". 3) A person sleeping, labeled "SLEEP". 4) A person with a visible gut system, labeled "DIGESTION". The overall theme is the significant role of gut microbiota in various human functions.

[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.

YOUR AMERICAN GUT SAMPLE

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% |

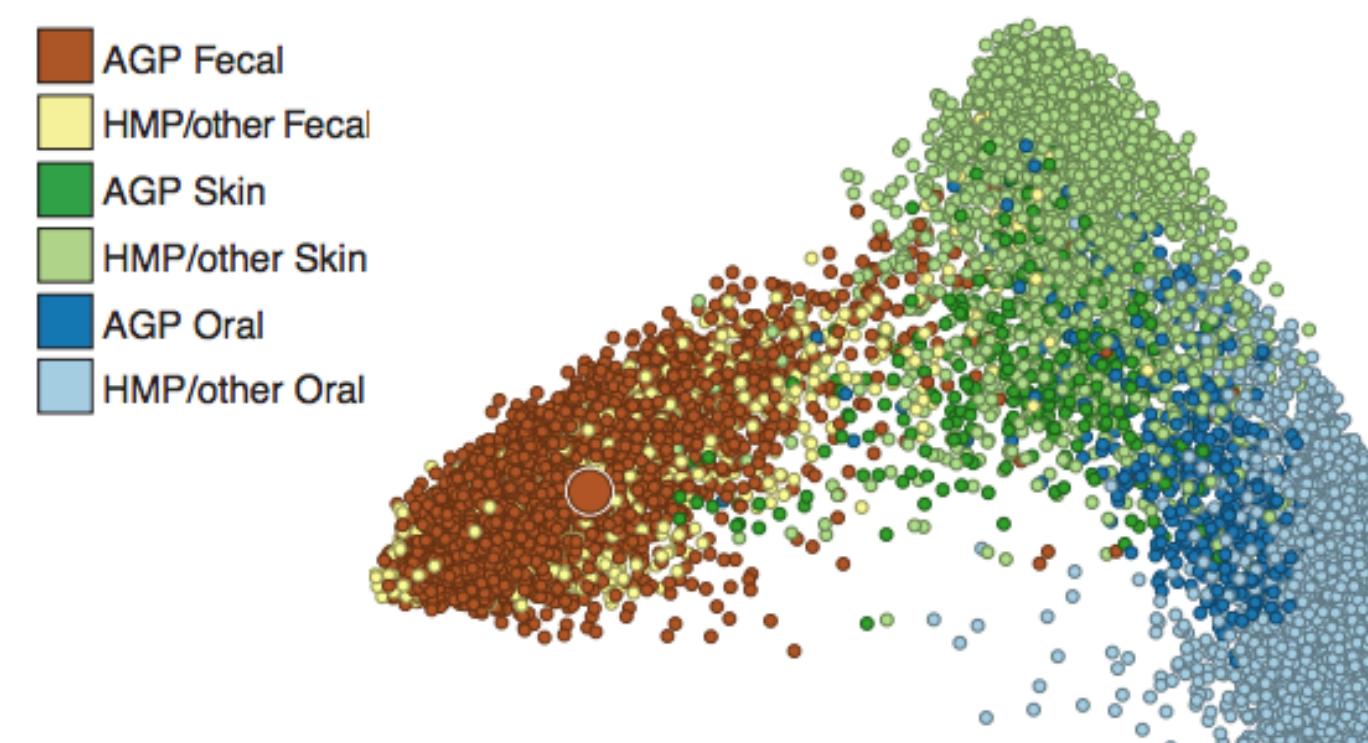
Your most enriched microbes:

| 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 |

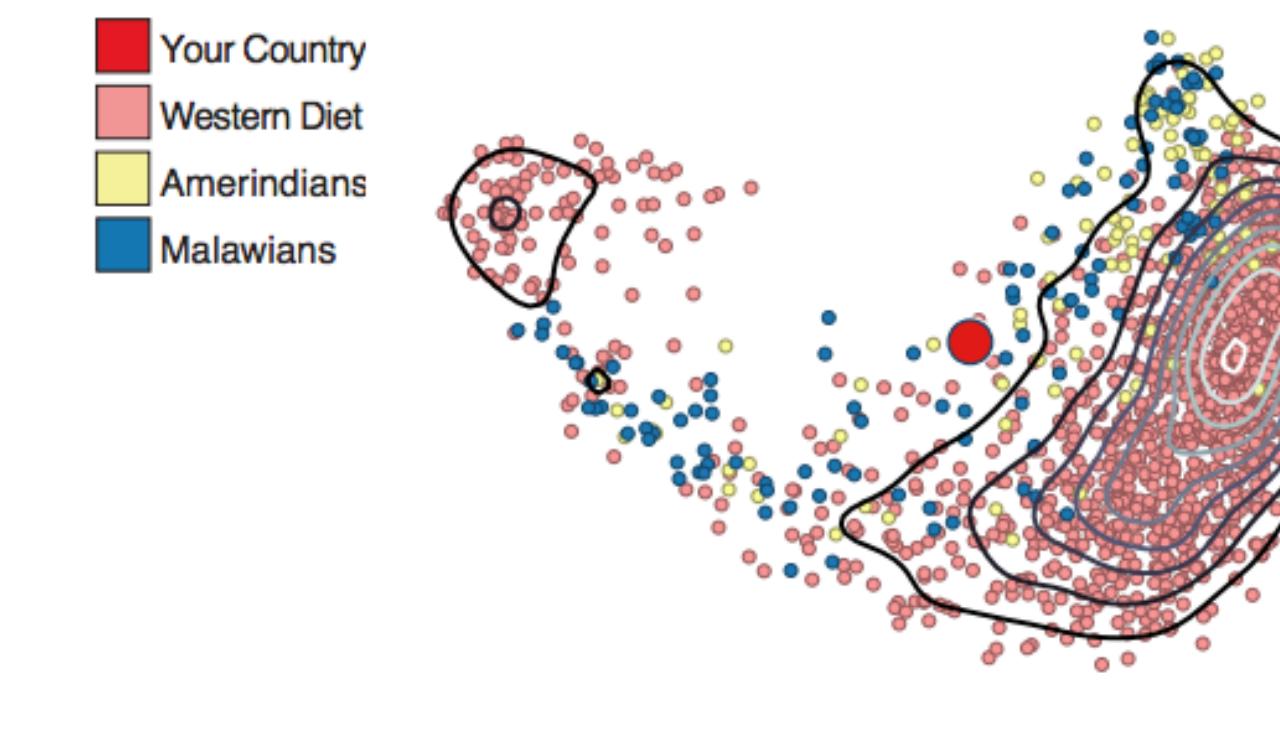
Your sample contained the following rare taxa: Unclassified Family Microbacteriaceae, Genus *Pseudoclavibacter*.

How do your gut microbes compare to others?

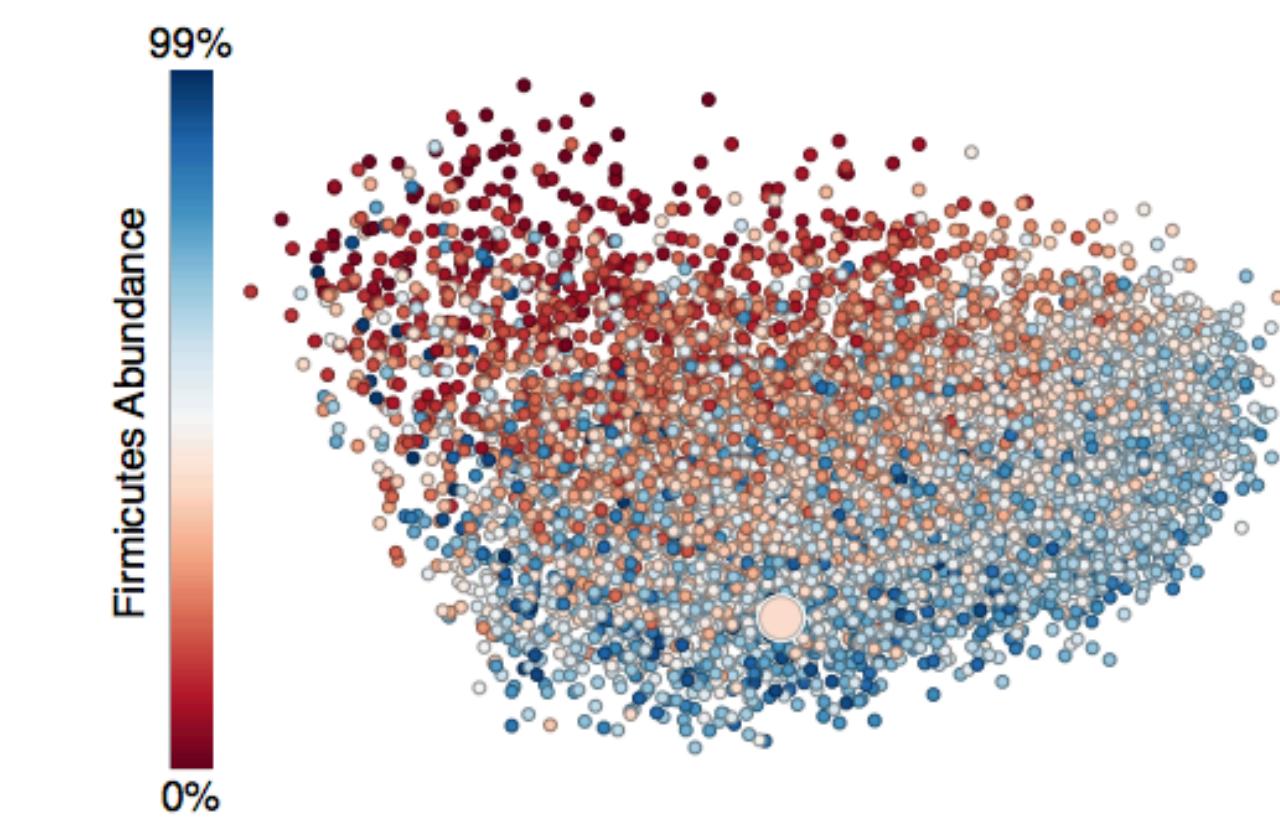
● Your sample is here • Others ◉ Unspecified



Different Body Sites

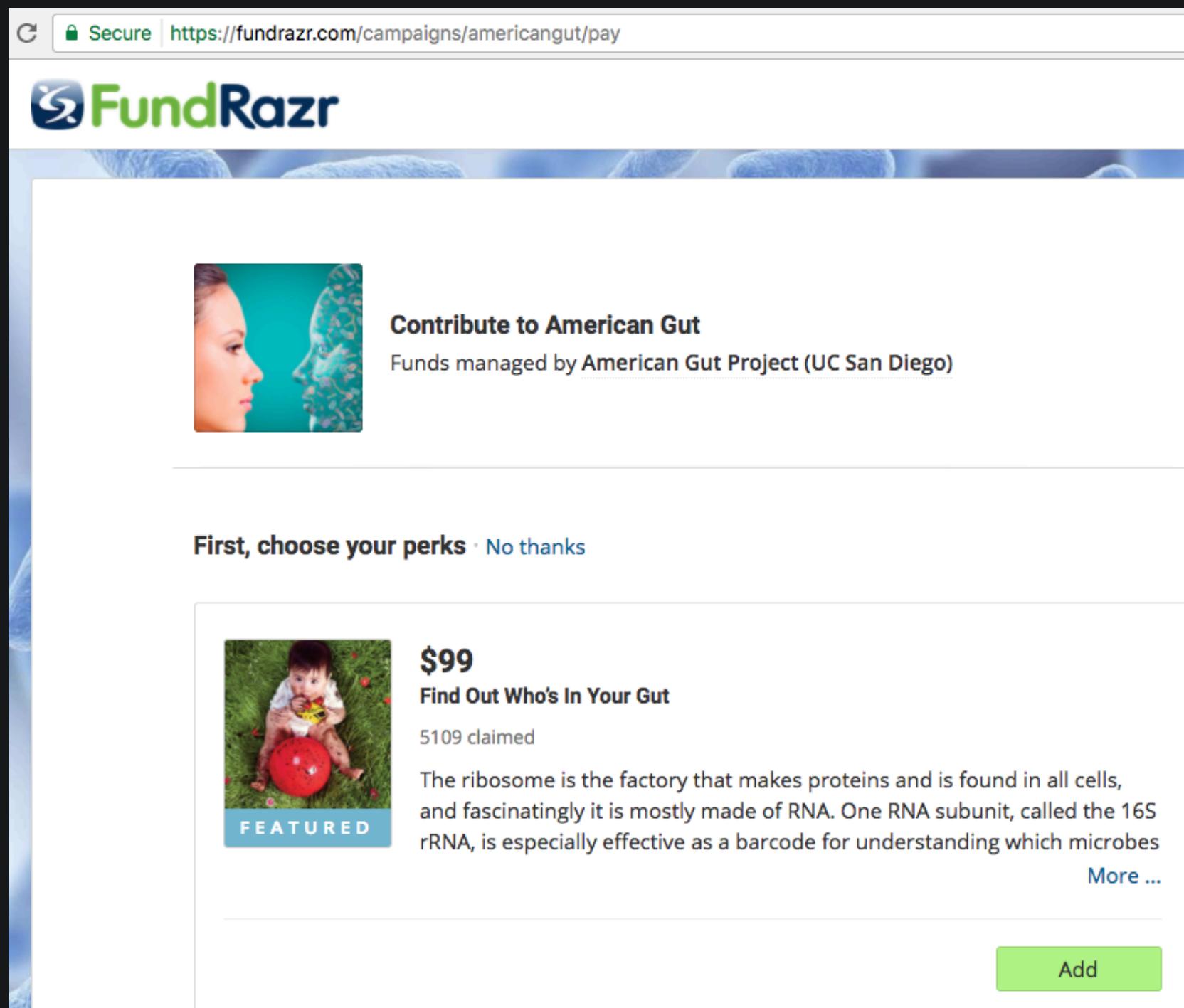


Different Nationalities



The American Gut Population

UC San Diego's American Gut is the world's largest microbiome citizen science 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 main heading is "Contribute to American Gut" with the subtext "Funds managed by American Gut Project (UC San Diego)". Below this, there's a small image of a woman's face and a "No thanks" button. A section titled "First, choose your perks" offers a \$99 perk for "Find Out Who's In Your Gut". This perk includes a description of ribosomes and RNA, and a "More ..." link. A green "Add" button is at the bottom right. The FundRazr logo is in the top left corner.

1: Create an online account and support the project



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

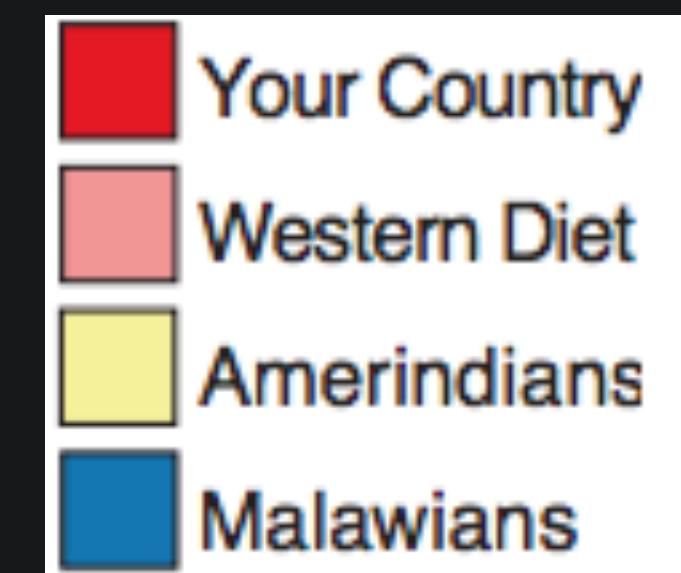
americangut.org

Participants generate hypotheses by looking at the data

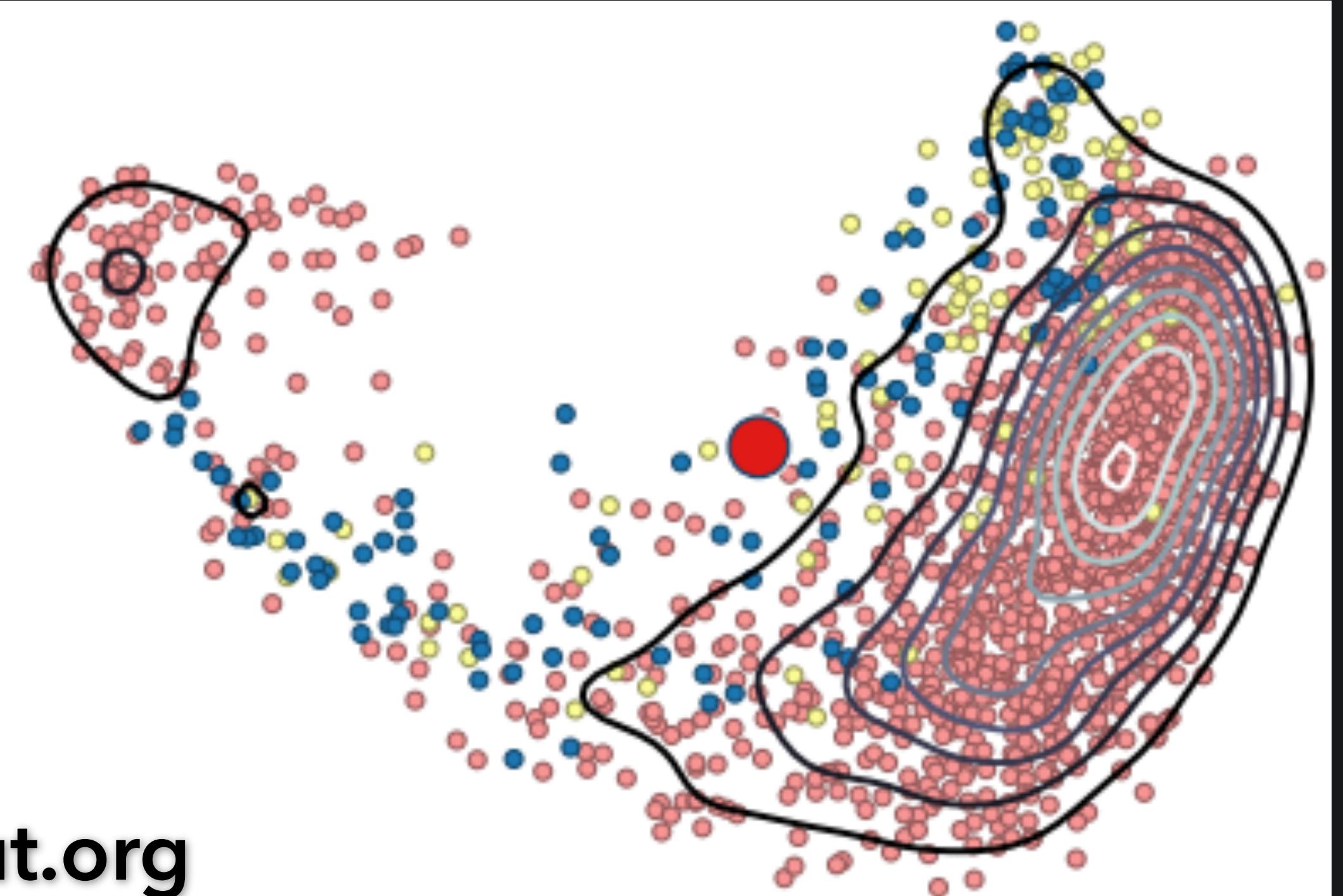


Is my data point unique because

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



americangut.org



Scientists and people can learn from and help each other (microbiome edition)

Antibiotics Weren't Used to Cure These Patients. Fecal Bacteria Were.

In a small study, doctors used so-called fecal transplants to treat a serious gut infection in patients. The transplants, from healthy donors, were as effective as antibiotics.

By Gina Kolata

June 2, 2018



Fecal transplants help improve C. difficile condition

<https://www.nytimes.com/2018/06/02/health/fecal-transplants-bacteria-antibiotics.html>

<http://www.newsweek.com/diy-fecal-transplants-are-dangerous-and-could-transmit-hiv-doctors-warn-810003>

TECH & SCIENCE

DIY FECAL TRANSPLANTS ARE DANGEROUS AND COULD TRANSMIT HIV, DOCTORS WARN

BY MELISSA MATTHEWS ON 2/17/18 AT 8:00 AM

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

Personalized medicine at scale needs insights from people's lived experiences

Scientific domains that are

Nascent

Experts know little

Contextual Huge individual differences

Motivating People care

Genomics
23andMe



Microbiome
American Gut



How might people's situated knowledge supplement ivory-tower science? One instance: Misophonia genetic markers



[23andmeforums.com/discussion/comment/19190#Comment_19190](https://www.23andmeforums.com/discussion/comment/19190#Comment_19190)

I didn't realize I had this until a friend pointed me to this website: misophonia.com/. Turns out my dad has the same condition. We both can not stand, with a sure hatred, when we hear food noises (crunching, chewing, slurping, gulping, etc.)

Does anyone else have this condition? If so, do you find it is exaggerated when you are sleep deprived?

Like Flag

1. Crowds share unique observations

Q chew

Showing 1-1 of 1

Does the sound of other people chewing fill you with rage?

Yes
 No
 I'm not sure

2. Scientists add this to the survey

23andMe Follow

Do you suffer from feelings of rage from hearing other people chew? Misophonia might be in your genes.

We found a genetic marker associated with misophonia on chromosome 5

rs2937573 associated with misophonia

TENM2 gene Brain development

*Findings based on responses from 23andMe research participants.

RETWEETS 36 LIKES 53

3. Scientists unearth novel knowledge

Vision: Enable internet-scale personally-meaningful scientific work by building online learning systems

Domain-specific knowledge improves work quality

- + Summarize current research
- + Focus on novel ideas

Vision: Enable internet-scale personally-meaningful scientific work by building online learning systems

Domain-specific knowledge improves work quality

- + Summarize current research
- + Focus on novel ideas

Diversity and scale improve odds of success

- + Guard against individual shortcomings
- + Mitigate against groupthink

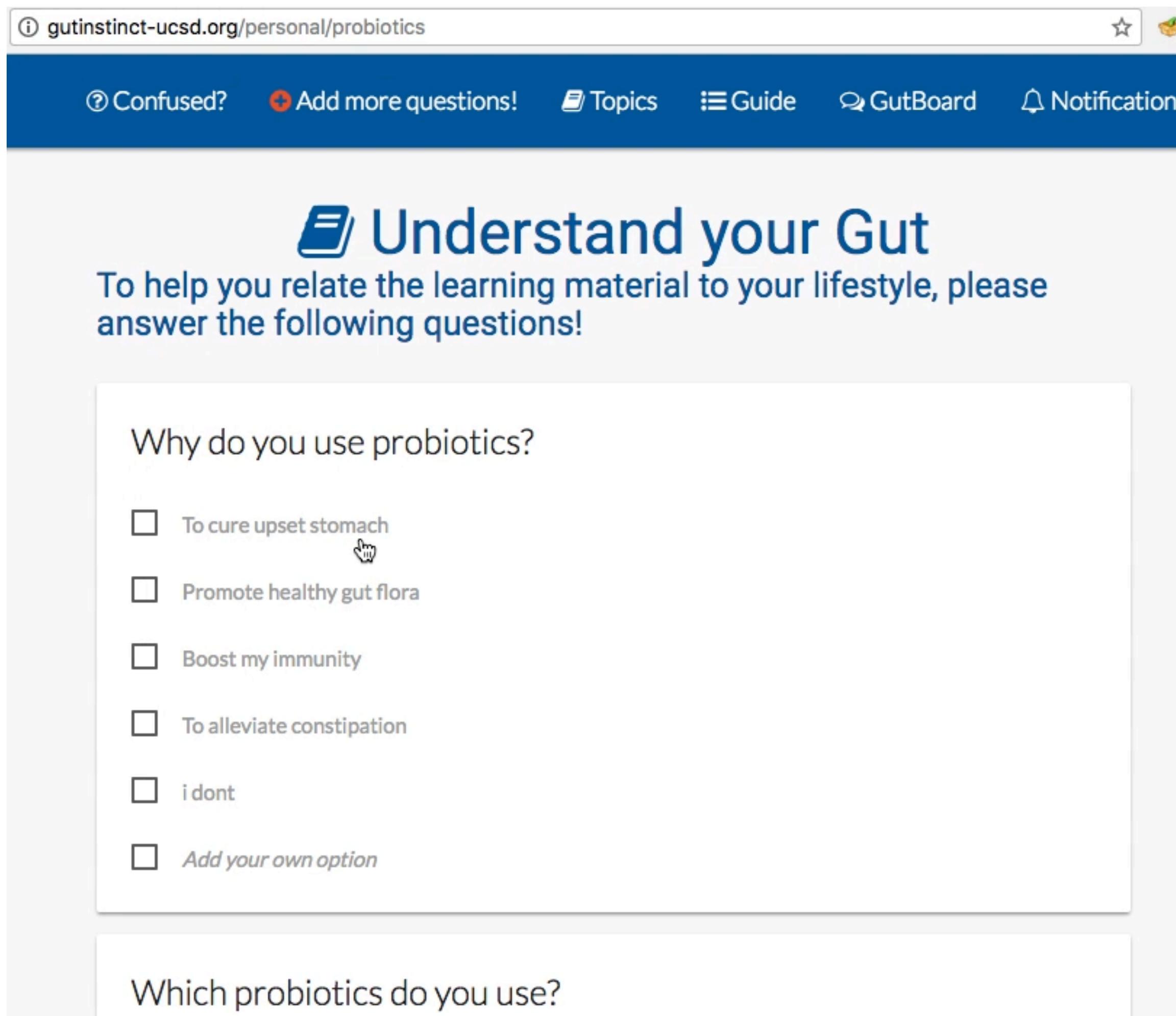
Vision: Enable internet-scale personally-meaningful scientific work by building online learning systems

From intuitions/folk theories.. (*CHI 2017*)

..to hypotheses (**Docent**: *Learn-Train-Ask: L@S 2018*)

..to experiments (**Galileo**: *Self-organized crowd expts*)

Step 1: Learn about probiotics + the microbiome



gutinstinct-ucsd.org/personal/probiotics

Confused? Add more questions! Topics Guide GutBoard Notifications

Understand your Gut

To help you relate the learning material to your lifestyle, please answer the following questions!

Why do you use probiotics?

- To cure upset stomach
- Promote healthy gut flora
- Boost my immunity
- To alleviate constipation
- i dont
- Add your own option

Which probiotics do you use?

Reflect on lifestyle by answering basic questions about probiotics use

Step 1: Learn about probiotics + the microbiome

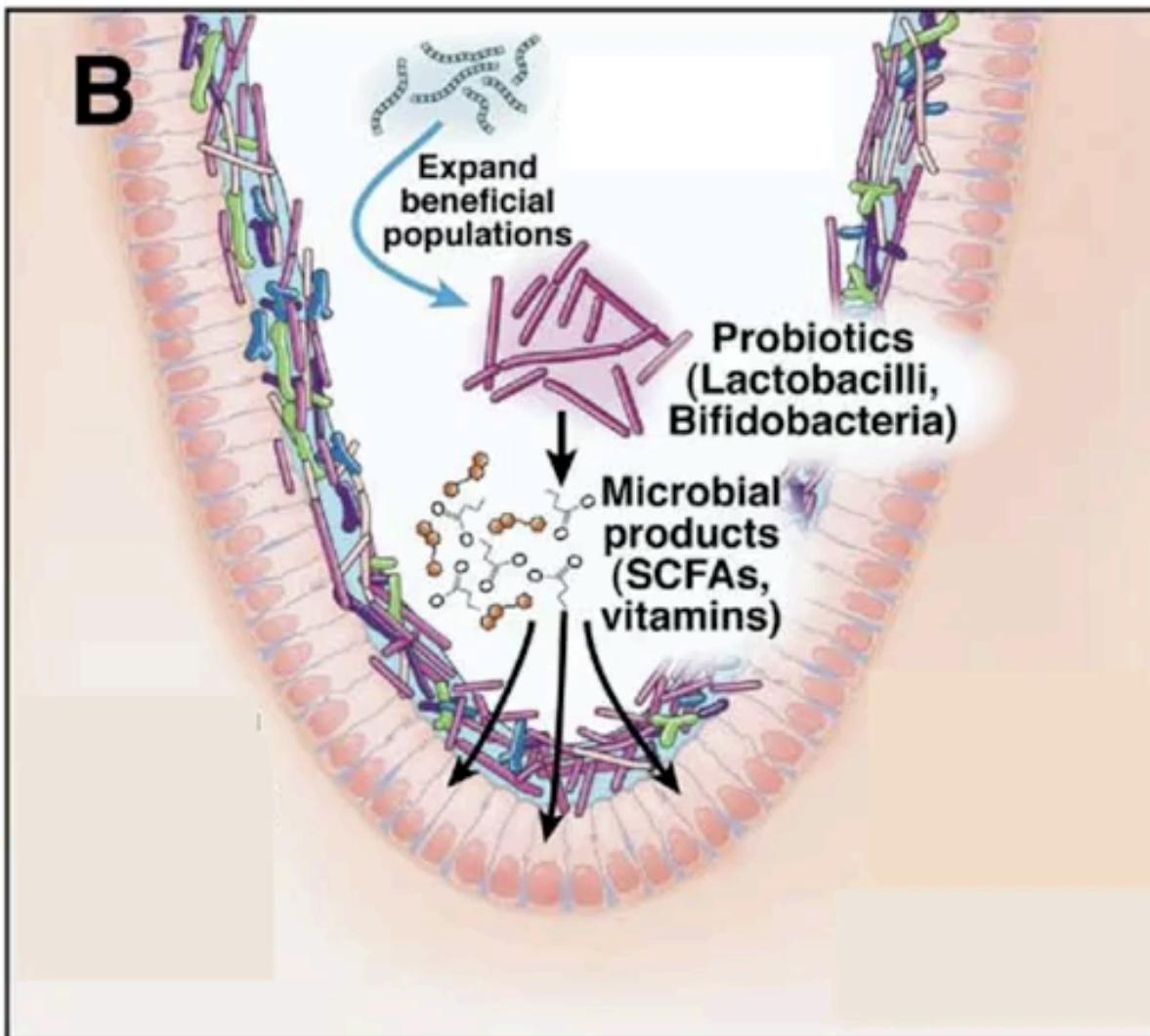
gutinstinct-ucsd.org/t/probiotics

Confused? Add more questions! Topics Guide GutBoard Notifications

Back to Topics

#probiotics

Video
Provided
By coursera



Preidis and Versalovic 2009, Gastroenterology

Watch a 4-minute lecture
that synthesize current
research about probiotics

Step 2: Train to frame useful questions

The screenshot shows the homepage of the 'Follow Your Gut' website. At the top, there's a navigation bar with links for 'Secure', 'Topics', 'Guide', 'GutBoard', and 'Notifications'. Below this is a main heading 'Follow Your Gut' with a blue icon of a notepad and pen. A sub-headline says 'Choose among following topics to understand your gut!'. There are four main topic cards: 'Genetics' (with a DNA helix image), 'Physiology' (with a human torso image), 'Probiotics' (with a blister pack of green capsules image), and 'Introduction' (with a lightbulb icon). Each card has a small 'Learn' button at the bottom.

The screenshot shows a web page titled 'gutinstinct-ucsd.org/guide_question'. The header includes links for 'Confused?', 'Add more questions!', 'Topics', 'Guide', 'GutBoard', and 'Notifications'. Below the header, a banner says 'Learn how to ask expert-like questions'. A section titled 'Step 1: Learn about great questions' contains text: 'A great gut instinct is clear, definite and provocative! How can you convert your vague insights into useful questions for your peers and researchers?'. It also states: 'In the next few steps, the Docent guide will teach you how to create and identify great questions. Pay attention to how these questions evolve!'. A 'Let's begin!' section features a story about a runner asking about health effects, followed by a note about the difficulty of answering such a question. A list of five features of useful questions is provided: 1. Answerable, 2. Definite, 3. A link between a cause and an effect, 4. Operational, 5. Simple. The footer says 'Your ideas and experiences expressed simply!'

Understand what makes a question useful

Step 2: Train to frame useful questions

The screenshot shows the homepage of the 'Follow Your Gut' website. At the top, there's a navigation bar with links for 'Secure', 'Topics', 'Guide', 'GutBoard', and 'Notifications'. Below the header, the title 'Follow Your Gut' is displayed with a blue icon. A sub-header says 'Choose among following topics to understand your gut!'. There are four main topic cards: 'Genetics' (with a DNA helix image), 'Physiology' (with a human body diagram), 'Probiotics' (with a photo of capsules), and 'Introduction' (with a lightbulb icon). Each card has a small 'Learn' button at the bottom.

The screenshot shows a 'Share your Gut Instinct!' page. At the top, there's a navigation bar with links for 'Topics', 'Guide', 'GutBoard', and 'Notifications'. Below the header, the title 'Share your Gut Instinct!' is shown with a question mark icon and a 'Show me examples' link. A large central box contains five numbered steps: 1. Add a top-level question for others to answer: 'Something that you do (a cause)'; 2. Add a follow-up question: 'Something that happens (an effect) due to the cause above'; 3. Add more follow-up questions: 'More effects'; 4. Guess the mechanism for your Gut Instinct; 5. Check the criteria. Each step has a small 'Learn' button at the bottom.

Use the
criteria when
adding a
question

Step 3: Ask questions of people

The screenshot shows a web browser window with the URL <https://hde.gutinstinct-ucsd.org/topics>. The page title is "Follow Your Gut". Below the title, it says "Choose among following topics to understand your gut!". There are four topic cards: "Genetics" (image of DNA), "Physiology" (image of a human skeleton), "Probiotics" (image of green capsules), and "Introduction" (image of a lightbulb).

Learn

18

5. Check the criteria

Make sure that the combination of your top-level and follow-up questions meets the Gut Instinct criteria!

- Answerable?**
Others should be able to answer your question
- Definite?**
A good question includes a clear timeframe
- Links a cause with an effect?**
Your question should attempt to link an activity with a specific result, allowing others to agree/disagree and share their insights
- Operational?**
Your question should avoid ambiguous terms that might be difficult to understand for most people
- Simple?**
A good question is simple to read, to understand, and to answer

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](#)

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

[Skip](#)

Train

Ask

Gut Instinct enables different contribution mechanisms

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](#)

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

by [phenylalanine](#) 14 days ago

0 Upvotes | 0 Downvotes

How much popcorn are you eating? How salty is it? Do you drink enough water with it to stay hydrated? I rarely have issues with constipation/BMs and I've never noticed any food-related changes except if I do something extreme such as eating an entire jar of hot peppers or drinking a jar of pickle juice (just a bad idea. don't do it.)

by [Cangussumicrobiome](#) 18 days ago

0 Upvotes | 0 Downvotes

I believe the problem here is the type or quantity of fiber in popcorn.

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!

Add follow-on questions¹⁹

Discuss questions and responses

Receive scientific feedback

Method

Between-subjects experiment (N=344)

for Learn and Train w/ 2x2 factorial study

H1 Access to learning improves question's content

| | Train | Both | |
|---------|---|---|--|
| Learn | <p>What type of alcoholic drinks (with sugar) affect your bowel movements?</p> <ul style="list-style-type: none"><input type="checkbox"/> wine<input type="checkbox"/> beer<input type="checkbox"/> liquor<input type="checkbox"/> sugary mixed drinks | <p>What type of alcoholic drinks (with sugar) affect your bowel movements?</p> <ul style="list-style-type: none"><input type="checkbox"/> wine<input type="checkbox"/> beer<input type="checkbox"/> liquor<input type="checkbox"/> sugary mixed drinks |  <p>Probiotics</p> <p>YouTube</p> |
| Neither | <p>What type of alcoholic drinks (with sugar) affect your bowel movements?</p> <ul style="list-style-type: none"><input type="checkbox"/> wine<input type="checkbox"/> beer<input type="checkbox"/> liquor<input type="checkbox"/> sugary mixed drinks | <p>What type of alcoholic drinks (with sugar) affect your bowel movements?</p> <ul style="list-style-type: none"><input type="checkbox"/> wine<input type="checkbox"/> beer<input type="checkbox"/> liquor<input type="checkbox"/> sugary mixed drinks |  <p>Probiotics</p> <p>YouTube</p> |

H2 Just-in-time training improves question's structure

Measures

Question quality coded by blind, independent raters with microbiome expertise (max 5 points)



coursera Explore Q. What do you want to learn?

University of Colorado Boulder UC San Diego

Gut Check: Exploring Your Microbiome

★★★★★ 4.7 521 ratings • 168 reviews



Microbiome - Reddit
https://www.reddit.com/r/Microbiome/ ▾
Microbiome - an "ecological community of commensal, symbiotic and pathogenic microorganisms" found in and on all multicellular organisms studied to date ...

r/HumanMicrobiome HumanMicrobiome subscribeunsubscribe2,906 ...

How long does it take for your ... How long it takes for your microbiome to reflect the foods ...

Content

Insightful: Does the question & discussion link to existing knowledge of the microbiome?
Novel: Is there a chance the world will learn something?

Structure

Answerable: Is it a question about the participant?
Specific: Does it ask about only one topic?

Creativity

Is it reasonably interesting/ creative?

Measures

Question quality coded by blind, independent raters with microbiome expertise (max 5 points)

High-Quality

Have you ever eaten raw pumpkin seeds to eliminate parasites?
(Content: 1, Structure: 2, Creativity: 1)

Medium-quality

Do you get constipated when stressed? (Content: 0.5, Structure: 2, Creativity: 0.5)

Low-quality

Does day of the week influence good vs. bad microbiota? (Content: 0, Structure: 1, Creativity: 0)

Content

Insightful: Does the question & discussion link to existing knowledge of the microbiome?
Novel: Is there a chance the world will learn something?

Structure

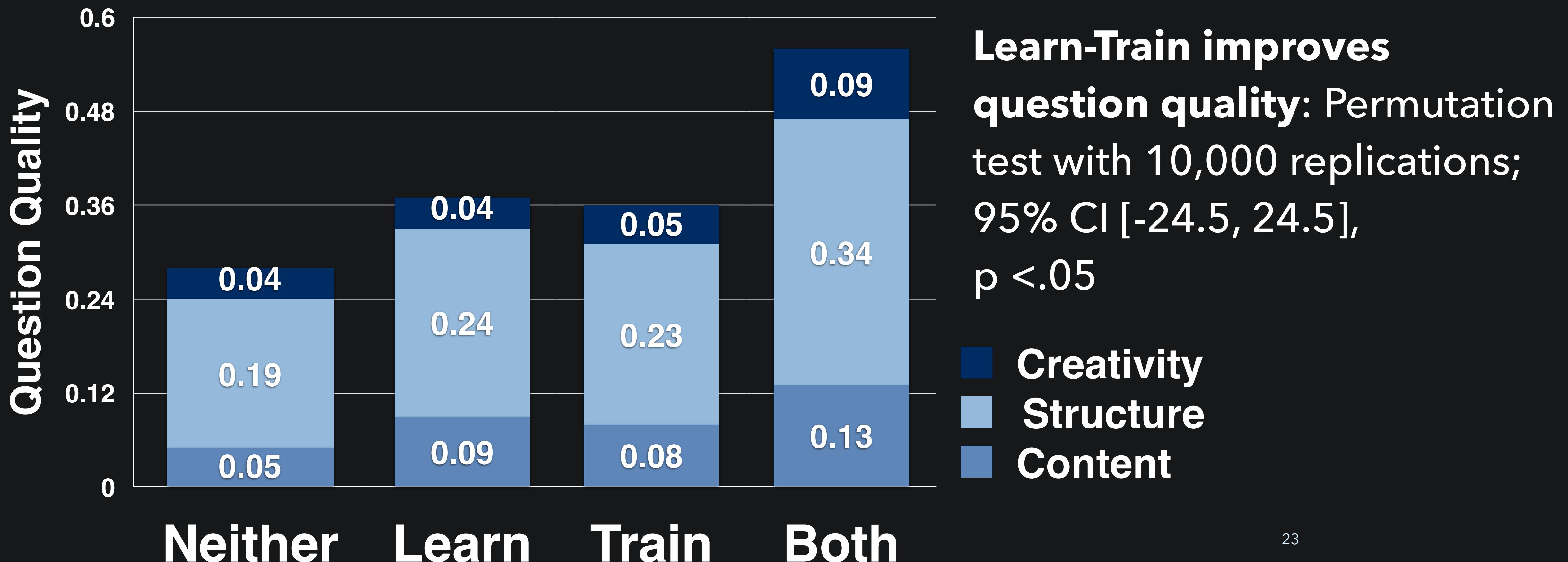
Answerable: Is it a question about the participant?
Specific: Does it ask about only one topic?

Creativity

Is it reasonably interesting/ creative?

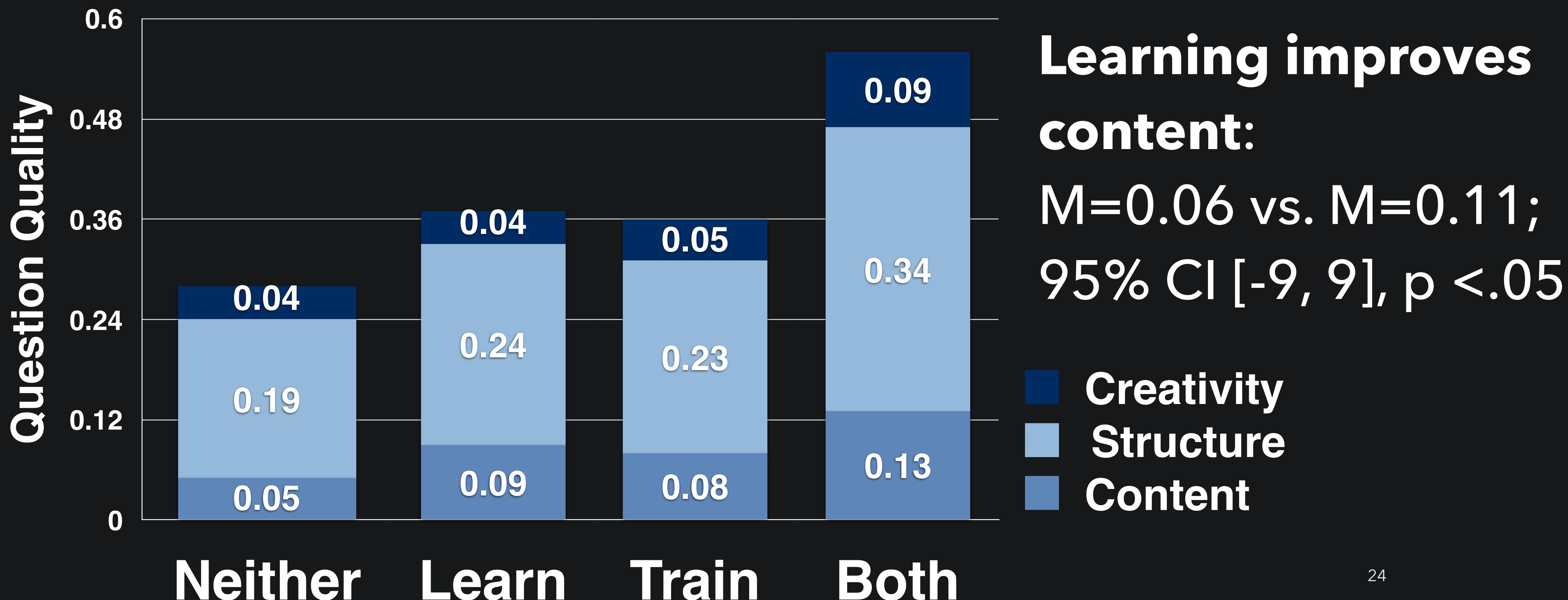
Results

The combined Learn-Train condition produces better questions ($N=344$)



Results

The combined Learn-Train condition produces better questions ($N=344$)



Results

The combined Learn-Train condition produces better questions ($N=344$)



Results

The combined Learn-Train condition produces better questions (N=344)



Why did Learning and Training help?

- Content learning engaged people
 - more time -> more questions
 - more ideas -> more questions
- Tight integration of training with question asking
 - reminder of the goal (focus on one topic + answerable)
 - makes it easy to edit in-place

399 hypotheses, 75 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?

Common themes



Diversity in roles: technical interventions are scalable, social interventions are powerful

Role and Actions

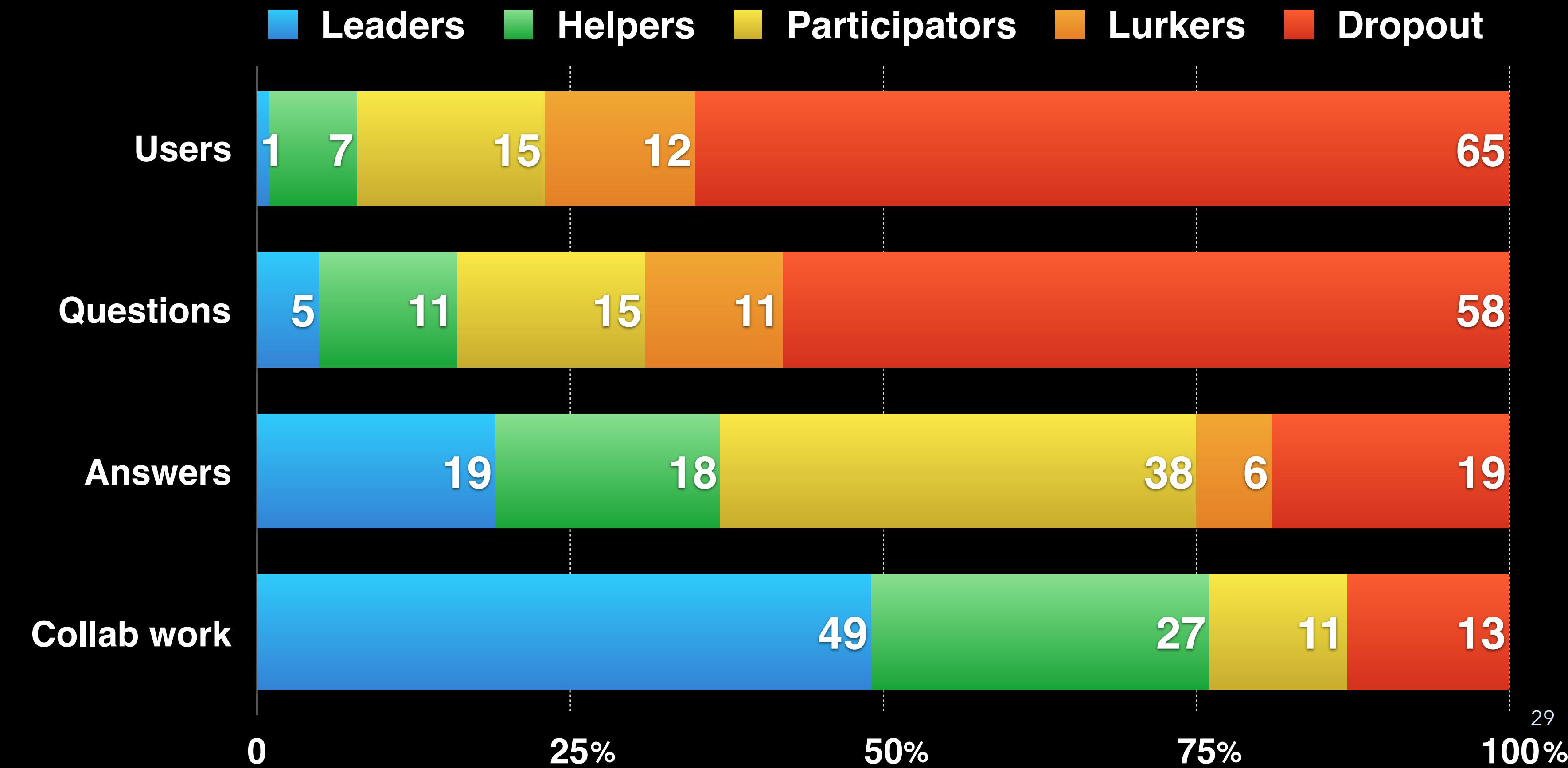
Leader: Add questions, answer & edit others' questions, add follow-ups, discuss

Helper: Add & answer questions, add follow-ups

Participant: Answer questions

Lurker: Add questions but no collaborative work

Dropout: Add a question; never return

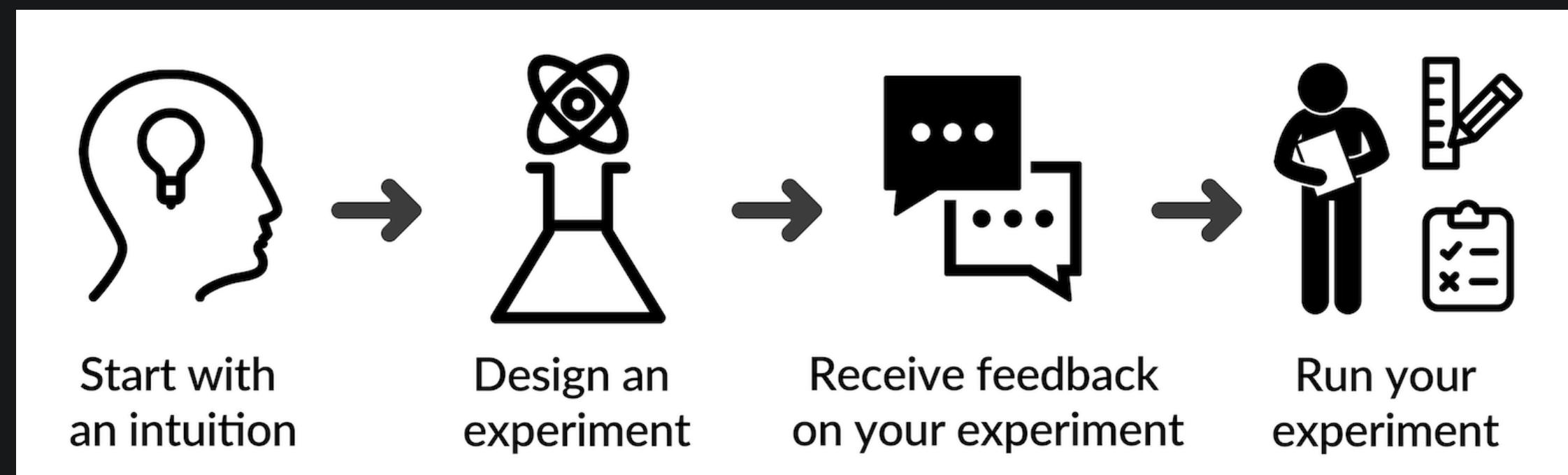


Vision: Enable internet-scale personally-meaningful scientific work by building online learning systems

From intuitions/folk theories.. (*CHI 2017*)

..to hypotheses (**Docent**: *Learn-Train-Ask: L@S 2018*)

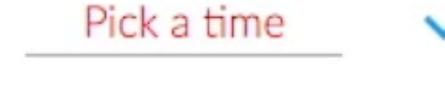
..to experiments (**Galileo**: *Self-organized crowd expts*)



Gut Instinct now supports community designed-review-run experiments to test intuitions!

Hypothesis: Drinking lassi decreases bloatedness 

All participants will provide data about the cause (**Drinking lassi**) and the effect (**bloatedness**) every day for the duration of the experiment. At what **daily fixed time** should people receive an automated text message reminder?

Send all participants a reminder to provide **Absence/Presence** of **Drinking lassi** at 

Send all participants a reminder to provide **Rating** of **bloatedness** at 

BACK

Step 2. Provide experimental steps for your participants

Example

Add steps for the Control group : Participants don't drink lassi

- ✖ DO NOT consume any caffeinated drink throughout the day 
- ✖ Continue performing your daily activities as usual 
- ✖ Measure effect: in the evening, write down how bloated you feel on a scale c 
- ✖ Send your measurements to Gut Instinct through sms 
- ✖ Repeat steps for the next 7 days 

ADD STEPS FOR THE EXPERIMENTAL GROUP

Gut Instinct now supports community designed-review-run experiments to test intuitions!

Experiment Design Summary

Hypothesis: Drinking lassi decreases bloatedness 

| Cause | Relation | Effect |
|----------------|-----------|-------------|
| Drinking lassi | decreases | bloatedness |

Mechanism:

How is Drinking lassi manipulated? 

- Participants measure Absence/Presence of Drinking lassi
- Reminder sent every day at 8 pm with

How is bloatedness measured? 

- Participants measure Rating of bloatedness on a scale of 1 to 5 (1 being no bloatedness and 5 being

Experiment Status



What you've achieved so far:

- ✓ Designed your experiment
- ✓ Your experiment is now open for review

What's next:

To move ahead, you need to get at least 2 people to **review** your experiment!

Anyone with an internet access can review your experiment design in **5 mins!**

How might we crystallize intuitions to create personally-meaningful scientific knowledge?

System



gutinstinct.ucsd.edu

Technique

Learn-Train-Ask

Key Result

Integrating conceptual learning with task-specific training improves question quality