

Creating Scientific Theories with Online Learners

Thesis Proposal
June 14, 2017

Vineet Pandey
 @vineet1pandey
UC San Diego
The Design Lab

People design, build and track to better understand and improve their health



OpenAPS - In the News.
<https://openaps.org/in-the-news/>

Already, people...
design, build and track to better
understand and improve their health



Dana Lewis - Created DIY Pancreas

A screenshot of the patientslikeme website. At the top, there is a navigation bar with tabs: Patients (selected), Conditions (highlighted with a blue asterisk icon), Treatments, Symptoms, and Research. Below the navigation bar is a search bar with the placeholder text "Look up a condition". The main content area features the title "ALS (Amyotrophic Lateral Sclerosis)". Below the title is a call-to-action box with the text "We're all in this for good. By sharing your stories and data, you will:" followed by a bulleted list: "• help each other live better and uncover the best ways to manage your health today" and "• help researchers shorten the path to new treatments tomorrow".

Ran a study to test a research paper result

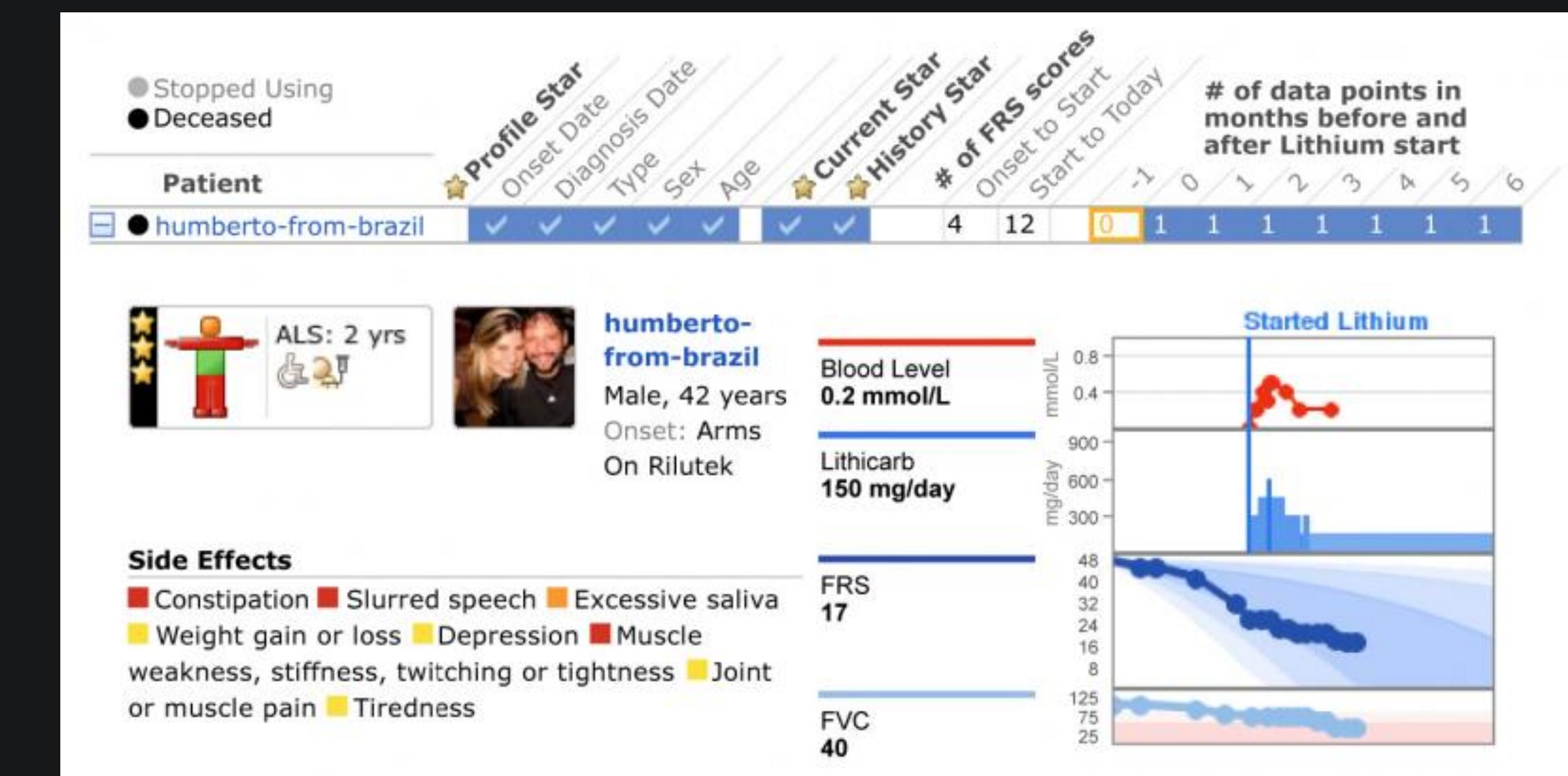
Already, people... write software, try novel hardware and create tracking workflows



Pebble watch with constant glucose monitoring

Nightscout on HealthLine <http://www.healthline.com/diabetesmine/first-impressions-of-a-nightscout-newbie>

Your data doing good: The Lithium study from PatientsLikeMe. <https://vimeo.com/149413987>



Collaboratively-created tracking sheets

Already, people... produce DIY Manuals, reference designs, wikis, even scientific papers

OpenAPS Design Details

Medical device communication

OpenAPS periodically (i.e. every 5 minutes) reads new data from the CGM as it becomes available. It also periodically (every few minutes) queries the insulin pump for current settings and recent activity, such as current (scheduled or temporary) and maximum basal rates, recent boluses, IOB (if available), ISF, DIA, carb ratio, BG target/range, etc. If that query is successful, OpenAPS updates its bolus wizard calculations (detailed below) and determines whether any action is required (canceling or issuing a temporary basal).

If action is required, OpenAPS issues the appropriate insulin dosing command to the pump, confirms that it was received and acknowledged by the pump, and then performs another query for recent activity to make sure any new temporary basal successfully took effect.

Algorithms

Basic overnight operation (oref0)

OpenAPS community

Reference design with algorithmic details

computational
BIOLOGY

ANALYSIS

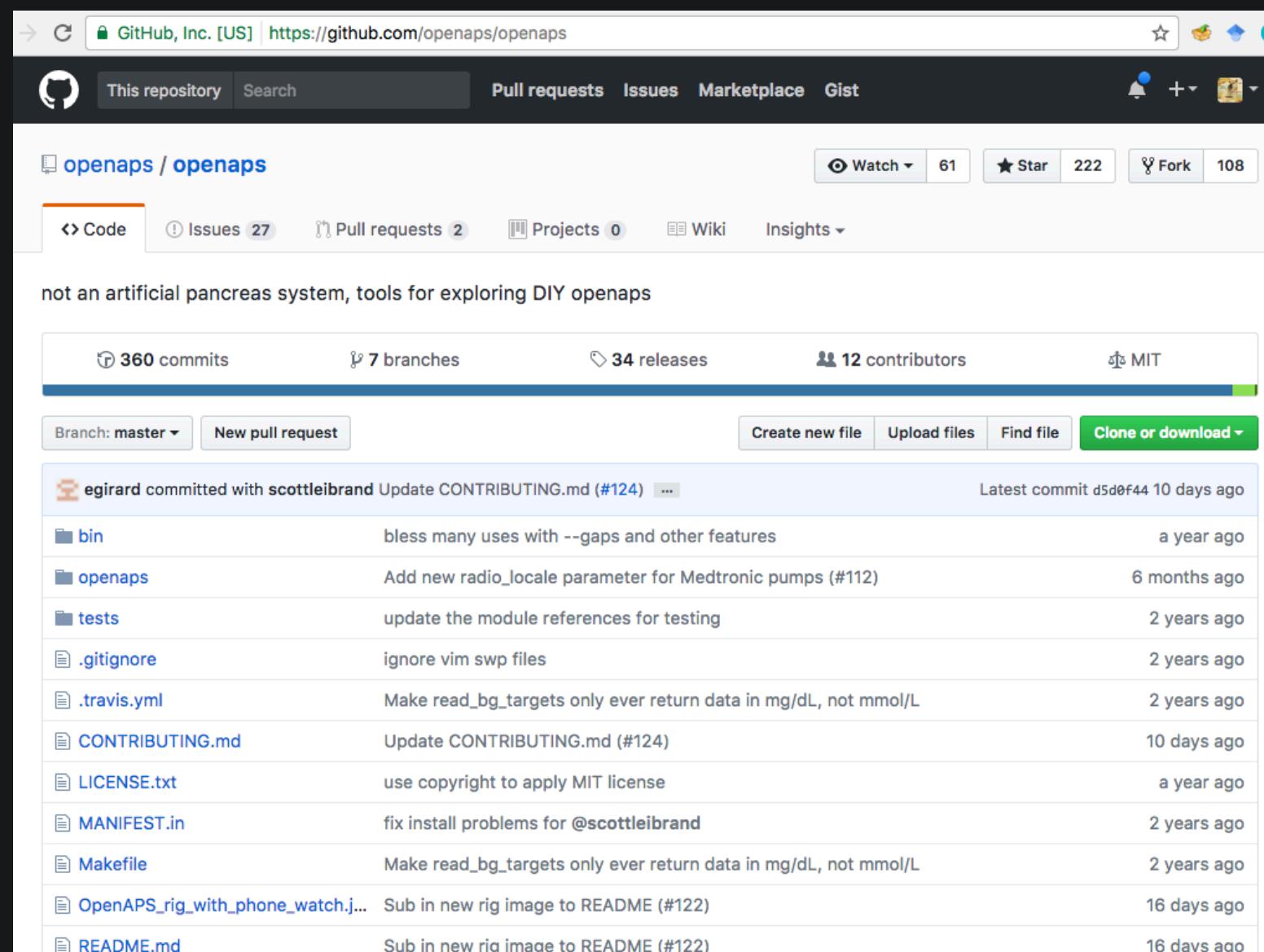
Accelerated clinical discovery using self-reported patient data collected online and a patient-matching algorithm

Paul Wicks, Timothy E Vaughan, Michael P Massagli & James Heywood

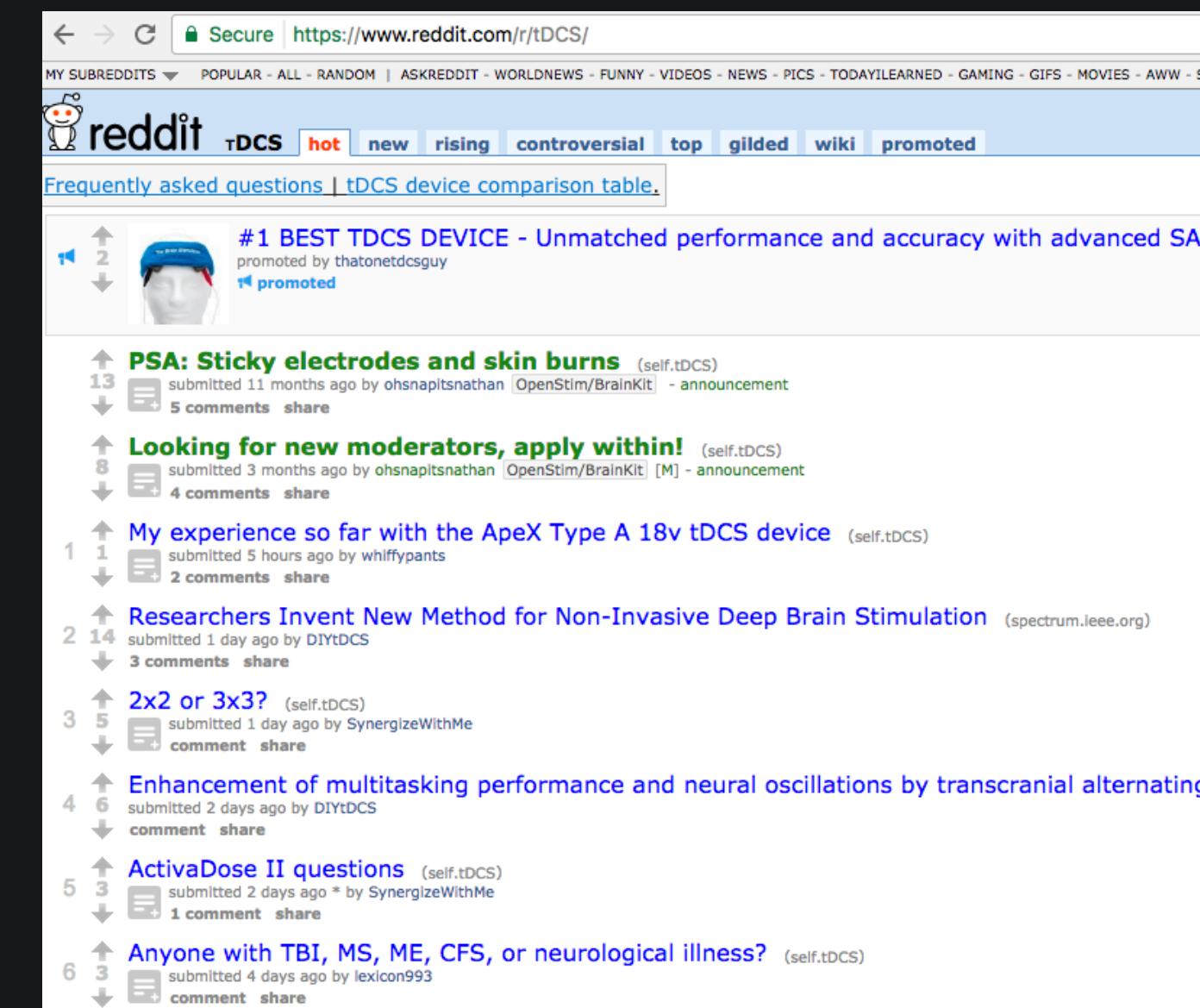
ALS community

Ran a study to test a research paper finding

Already, people... collaborate using online platforms to share software, manuals and personal insights



GitHub to share code
github.com/openaps



Reddit to share insights
[reddit.com/r/tDCS/](https://www.reddit.com/r/tDCS/)



Social engagement
fb.com/groups/658084947665356/

Already, people... draw ideas from current research by reading and discussing papers

Lithium delays progression of amyotrophic lateral sclerosis

Francesco Fornai*†‡, Patrizia Longone§, Luisa Cafaro†, Olga Kastsiuchenka*, Michela Ferrucci*, Maria Laura Manca†, Gloria Lazzeri*, Alida Spalloni§, Natascia Bellio¶, Paola Lenzi*, Nicola Modugno†, Gabriele Siciliano†, Ciro Isidoro†, Luigi Murri†, Stefano Ruggieri†, and Antonio Paparelli*

*Department of Human Morphology and Applied Biology, and †Department of Neuroscience, Clinical Neurology, University of Pisa 56100 Pisa, Italy; §Istituto Neurologico Mediterraneo, Istituto Di Ricovero e Cura a Carattere Scientifico Neuromed, 86077 Pozzilli (IS), Italy; ¶Molecular Neurobiology Unit, Santa Lucia Foundation, 00179 Rome, Italy; and ‡Department of Medical Sciences, University of Novara, 28100 Novara, Italy

Edited by Thomas C. Südhof, University of Texas Southwestern Medical Center, Dallas, TX, and approved December 21, 2007 (received for review August 24, 2007)

Letter to the Editor

Real-World Use of Open Source Artificial Pancreas Systems

Dana Lewis¹, Scott Leibrand¹, and the #OpenAPS Community

Keywords

artificial pancreas, APS, OpenAPS, #WeAreNotWaiting, closed loop, DIY diabetes technology

Journal of Diabetes Science and Technology
2016, Vol. 10(6) 1411
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DOI: 10.1177/1932296816665635
dts.sagepub.com


Researchers Invent New Method for Non-Invasive Deep Brain Stimulation (spectrum.ieee.org)

14 submitted 3 days ago by DIYtDCS

3 comments share

all 3 comments

sorted by: best ▾

[-] DIYtDCS [S] 3 points 3 days ago

And their research paper: [Noninvasive Deep Brain Stimulation via Temporally Interfering Electric Fields](#)

[permalink](#) [embed](#)

[-] malo5tak 2 points 3 days ago

Tldr

Neurons typically don't respond to high frequency electric signals. But they do respond to low frequency signals. Boyden and Grossman hypothesized that if they sent to a deep brain target two high frequency signals that differed by a small amount, the signals would pass through the more superficial tissues of the brain. When these signals interfered with each other at the target, they would create a field with an amplitude that oscillates at a frequency equal to the small difference between the two high frequency signals. That electrical wave would be low enough to engage neurons.



EXPERIENCE
NEW HORIZONS
IN DIABETES

SAN DIEGO, CA
JUNE 9-13, 2017

[American Diabetes Association - 77th Scientific Sessions Home](#)

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[Itinerary](#)

Session LB-01 - Late Breaking Poster Session

127-LB / 127 - Automatic Estimation of Basals, ISF, and Carb Ratio for Sensor-Augmented Pump and Hybrid Closed-Loop Therapy

June 11, 2017, 12:00 - 1:00 PM

Hall B

Authors

DANA M. LEWIS, SCOTT LEIBRAND, Seattle, WA

Disclosures

D.M. Lewis: None. S. Leibrand: None.

*“Part of what distinguishes **science** from cognition more broadly is the **cultural accumulation of tools and knowledge** that can support information gain in ways that go well beyond **naive exploration.**”*

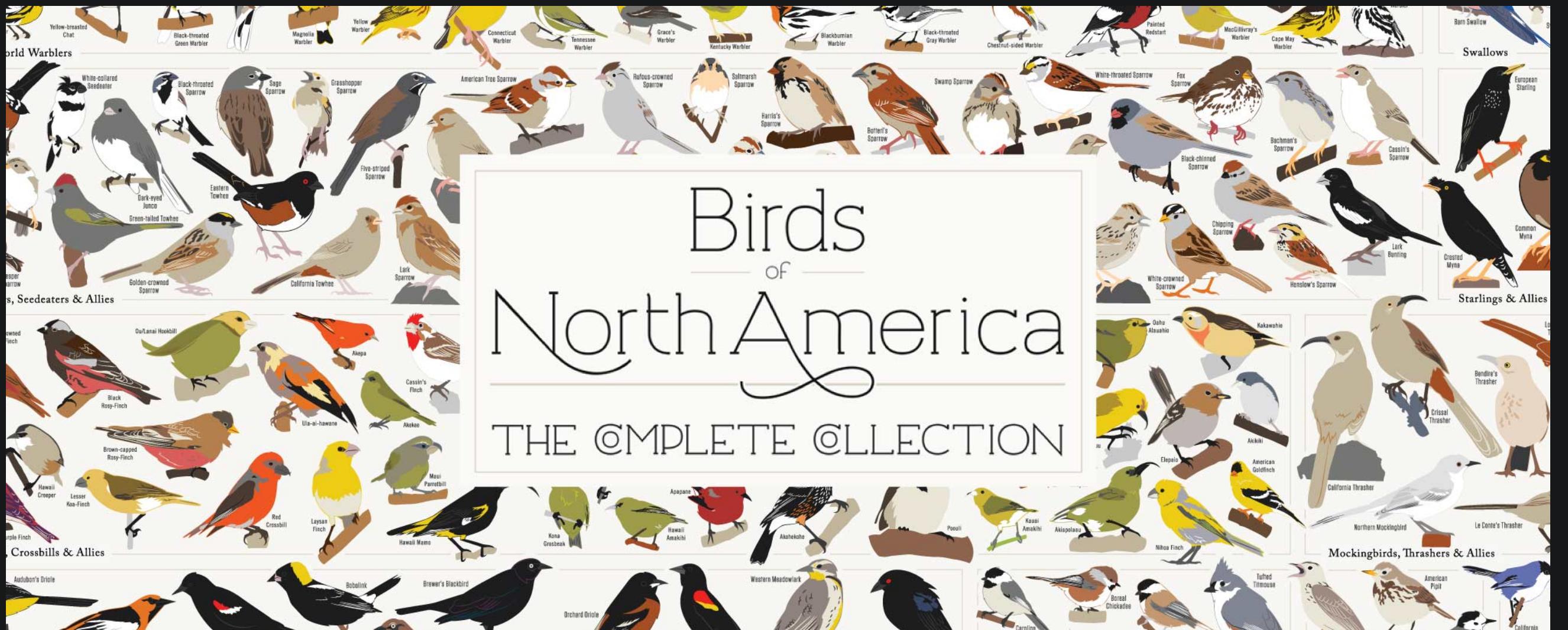
Problem

People develop intuitions of cause and effect that *might or might not be correct and exist in scientific literature*

Opportunity

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

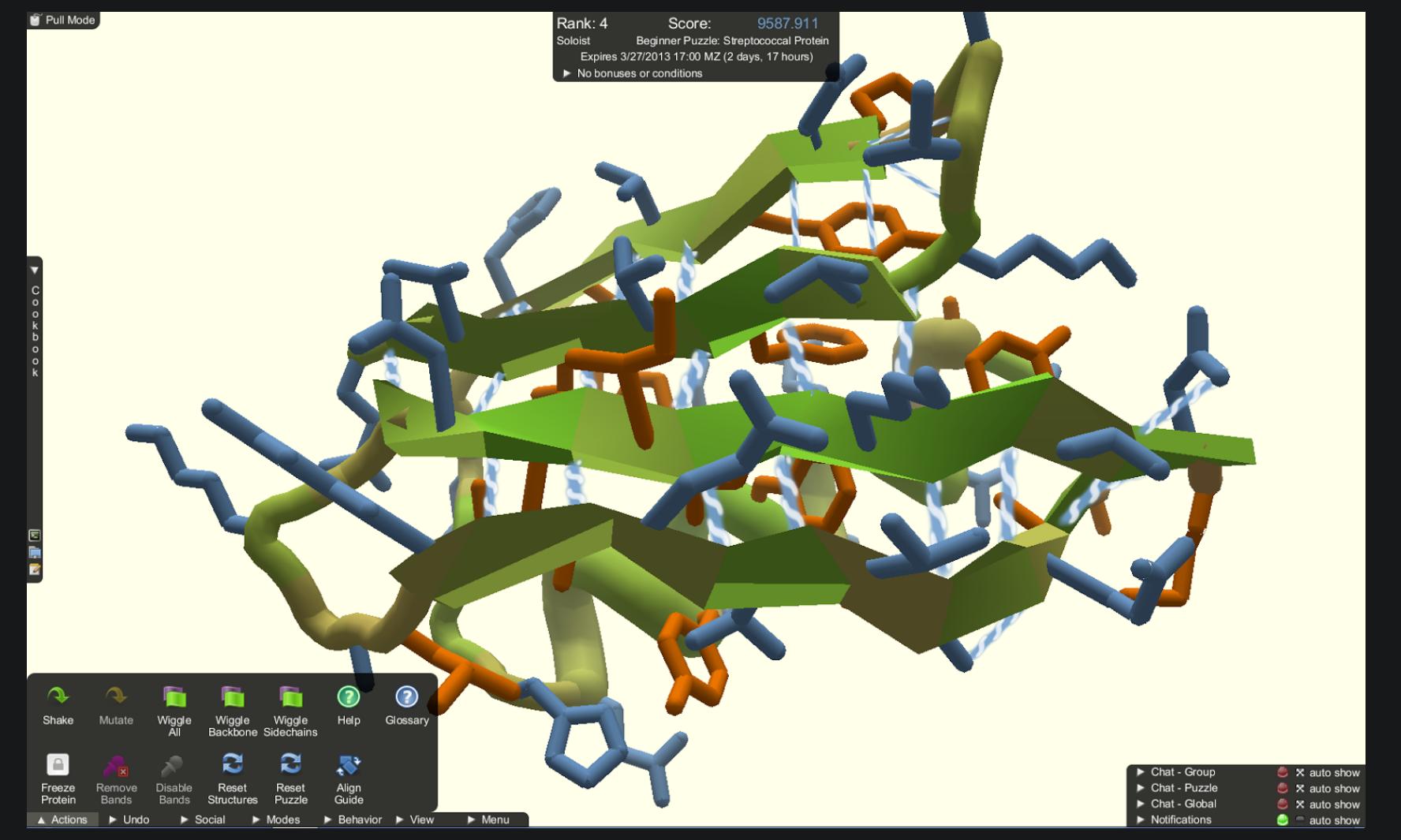
Citizens have successfully solved expert-defined problems as sensors or algorithms



Tracking bird migration

eBird

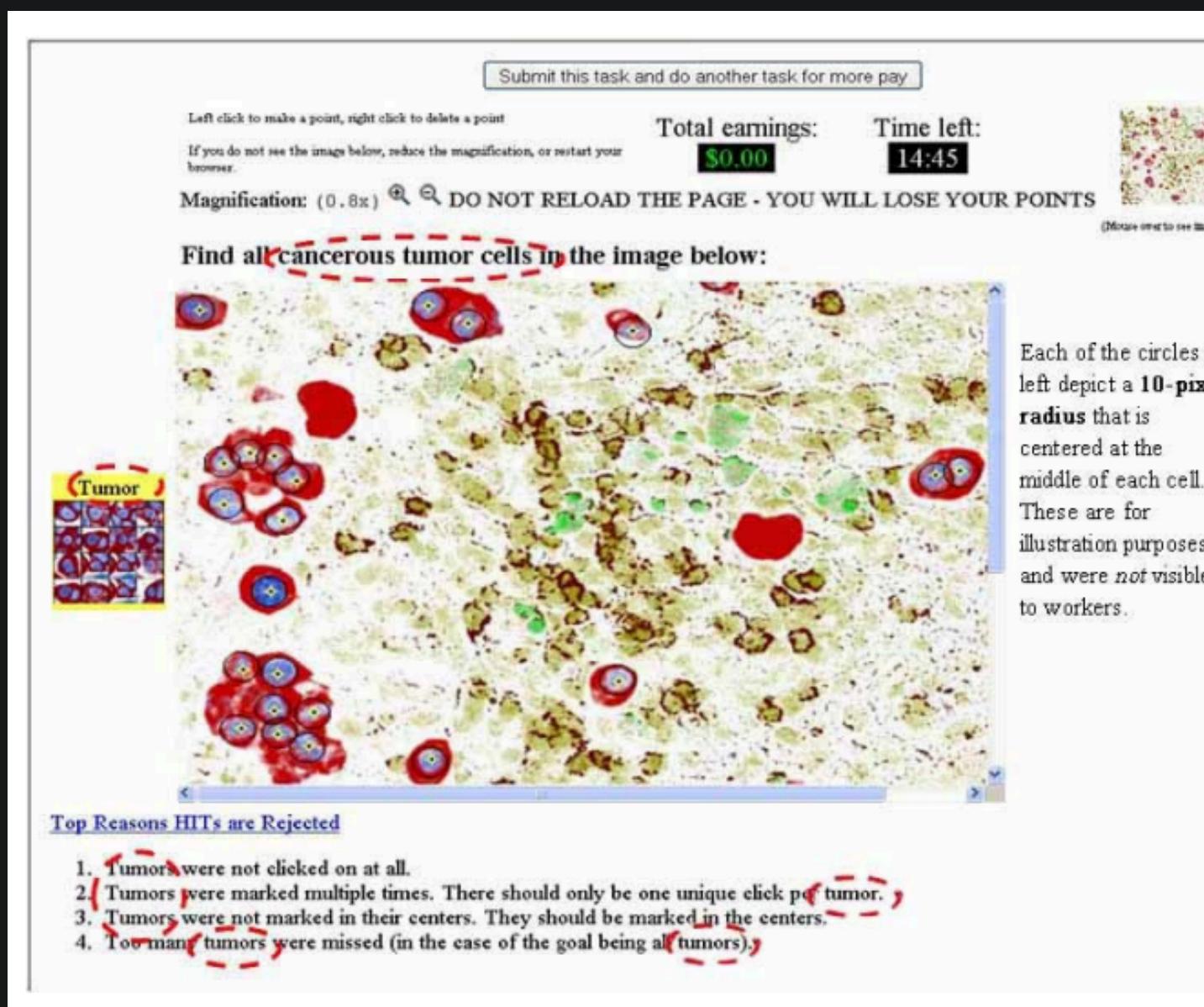
eBird: A citizen-based bird observation network in the biological sciences. Brian L. Sullivan *, Christopher L. Wood, Marshall J. Iliff, Rick E. Bonney, Daniel Fink, Steve Kelling. 12
Predicting protein structures with a multiplayer online game. Seth Cooper, Firas Khatib, Adrien Treuille. Nature 2010.



Folding proteins

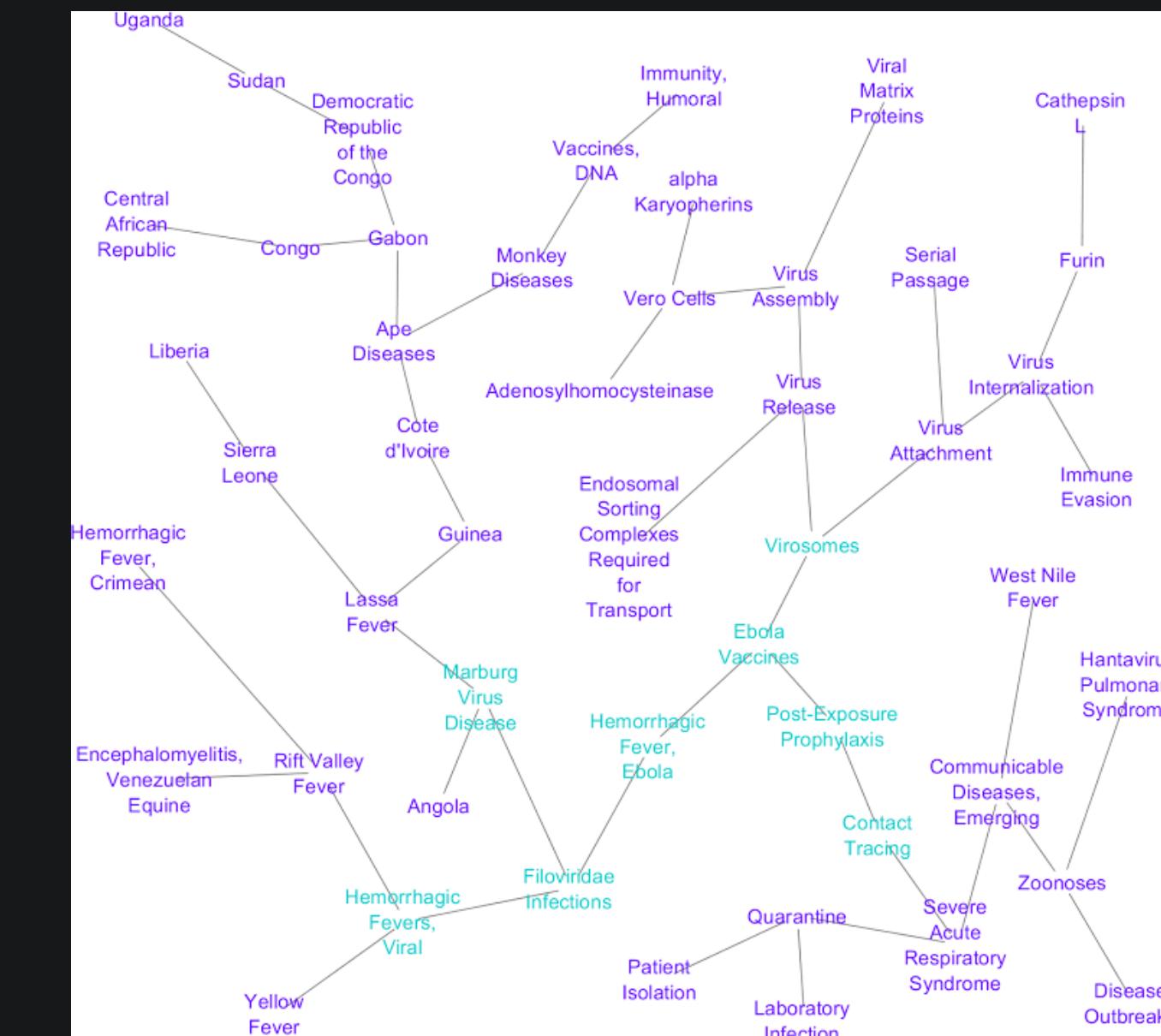
Foldit

Communities' motivation can be focused to specific tasks



Identifying Cancerous tumors

[Chandler et al. 2010]



Identifying concept relationships

Mark2Cure [Tsueng et al. 2009]

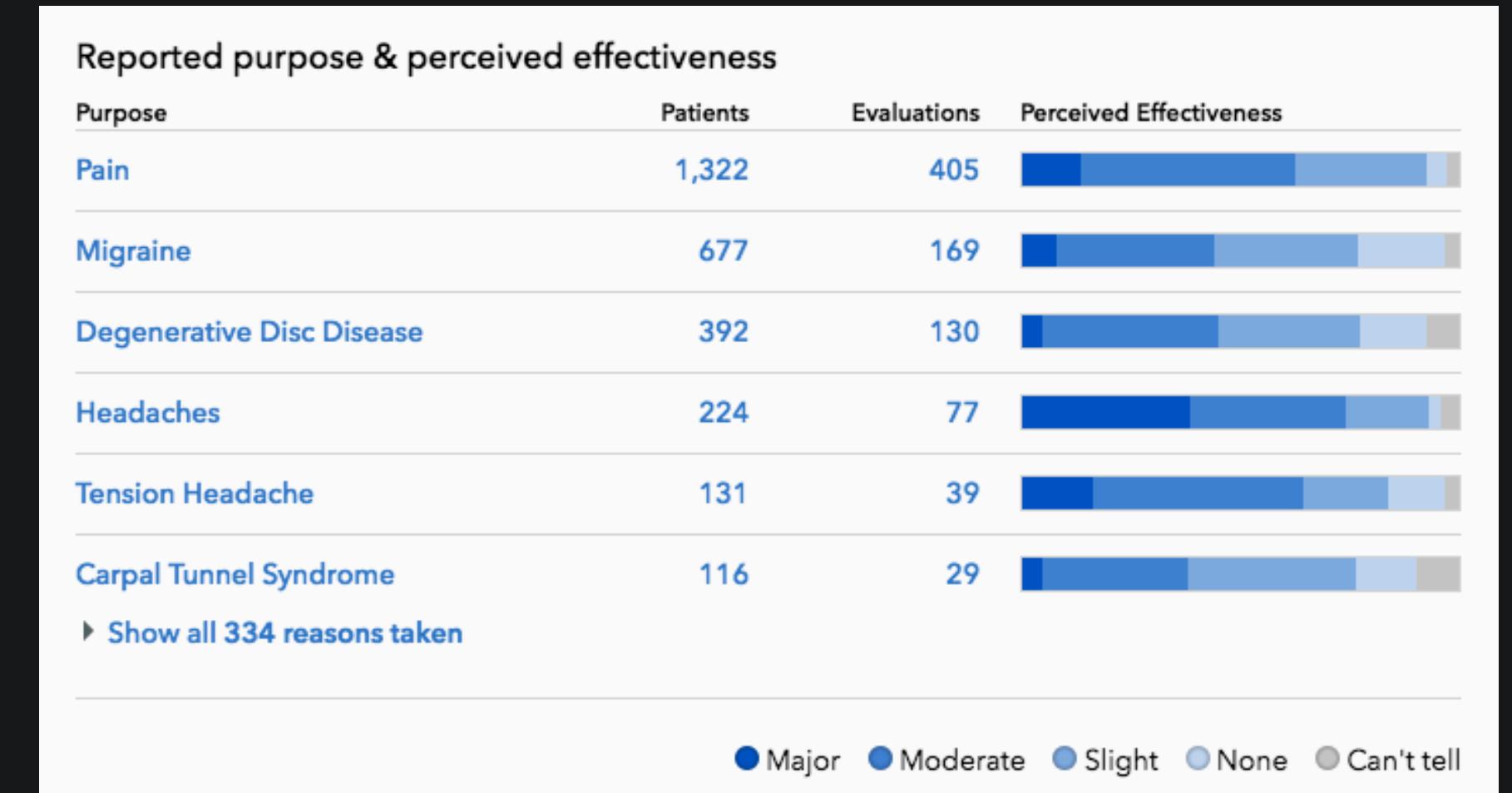
Powerful ideas emerge when people combine personal data with insights



Genomics
23andme



Microbiome
American Gut



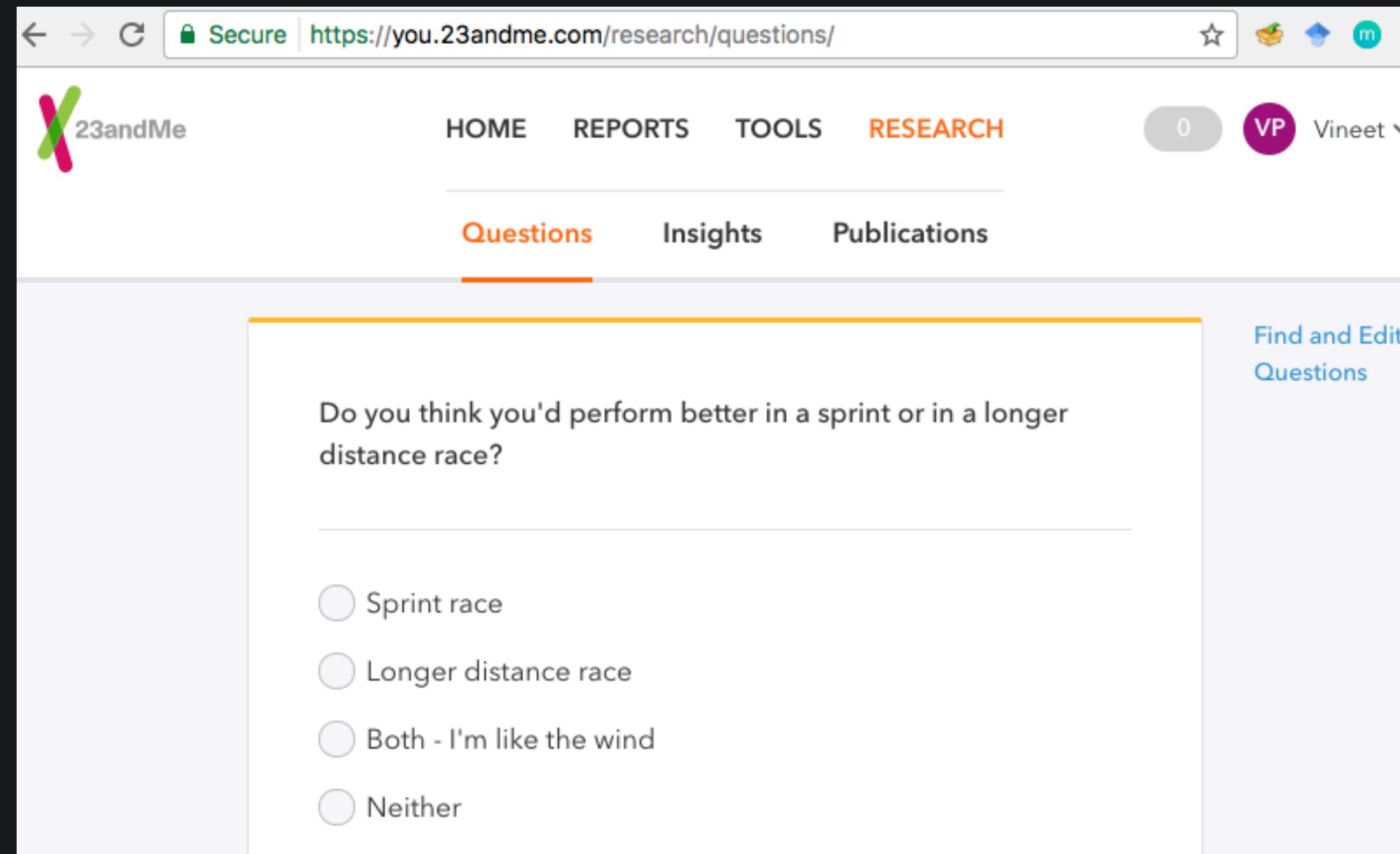
Medicine effects
Patientslikeme



THE PRECISION MEDICINE INITIATIVE



Scientists' questions identify some correlations but miss contextual insights



The screenshot shows a web browser window for the 23andMe website at <https://you.23andme.com/research/questions/>. The page is titled "RESEARCH" and has tabs for "Questions", "Insights", and "Publications". The "Questions" tab is selected. A question is displayed: "Do you think you'd perform better in a sprint or in a longer distance race?". Below the question are four radio button options: "Sprint race", "Longer distance race", "Both - I'm like the wind", and "Neither". On the right side of the page, there is a sidebar with a "Find and Edit Questions" link.

My real answer: "I don't know, but I think running daily improves my sleep quality"

How might people's situated knowledge supplement ivory tower science?

Secure | https://www.23andmeforums.com/discussion/comment/19190#Comment_19190

Following 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.)

Discussions Categories

Categories General

Reports Ancestry Health

• 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

How might people's situated knowledge supplement ivory tower science?

C Secure | https://www.23andmeforums.com/discussion/comment/19190#Comment_19190

Following
Discussions
Categories

Categories
General

Reports
Ancestry

Health

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

Like Flag

Q chew

Showing 1-1 of 1

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

Yes

No

I'm not sure

1. Crowds share unique observations

2. Scientists add this to the survey

How might people's situated knowledge supplement ivory tower science?

Secure | https://www.23andmeforums.com/discussion/comment/19190#Comment_19190

Following Discussions Categories

Categories General Reports Ancestry Health

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

Q chew

Showing 1-1 of 1

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

Yes
 No
 I'm not sure

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

11:02 AM - 2 Sep 2016

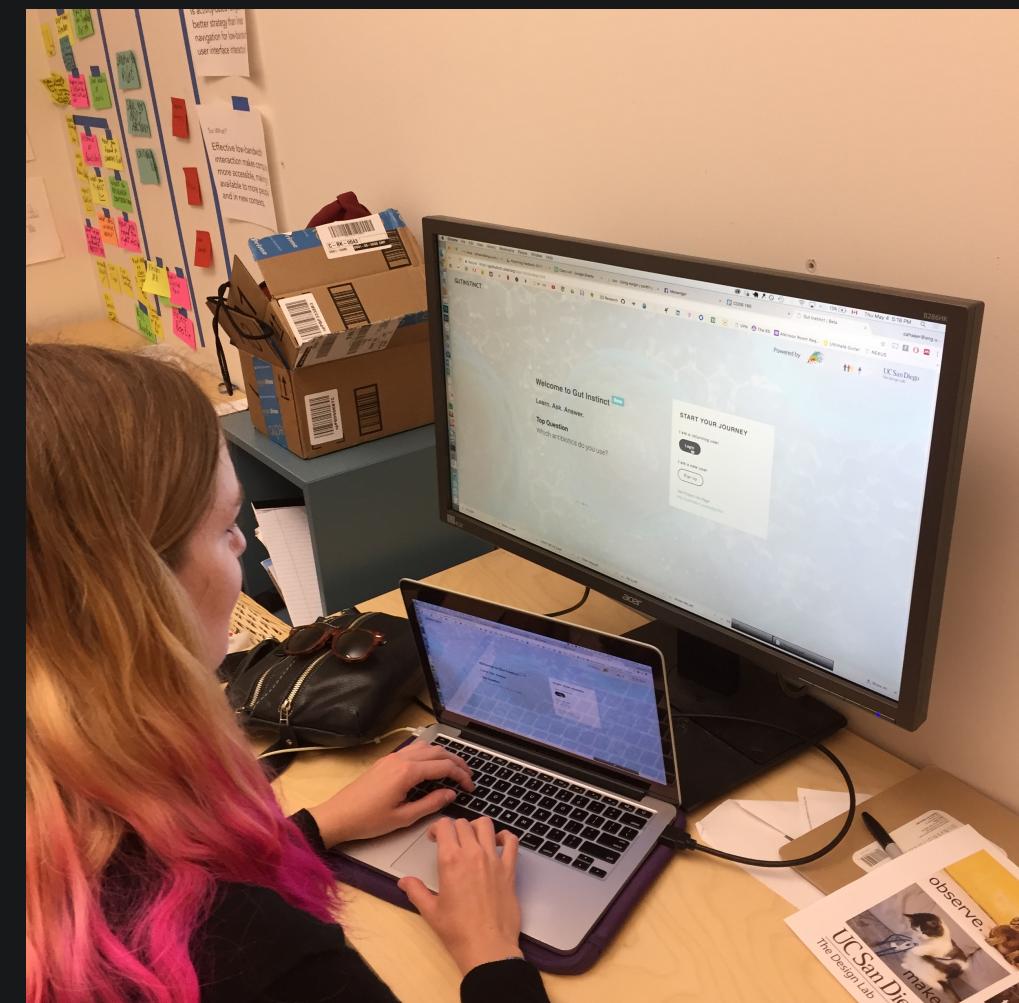
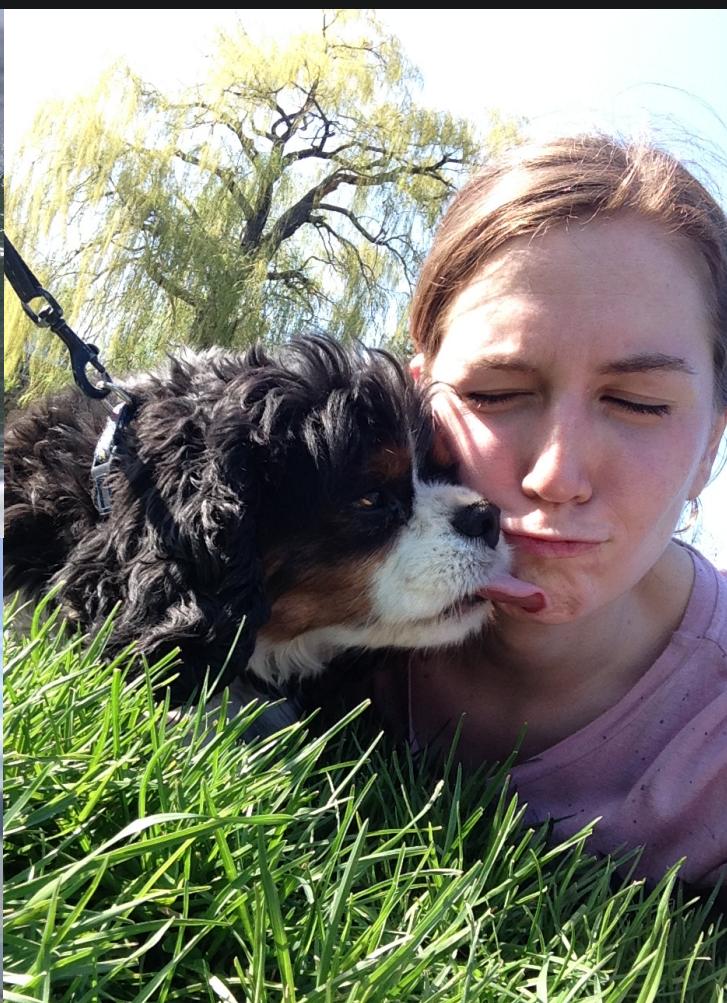
1. Crowds share unique observations

2. Scientists add this to the survey

3. Scientists unearth novel knowledge

Can people create scientific knowledge for themselves and the world@large?

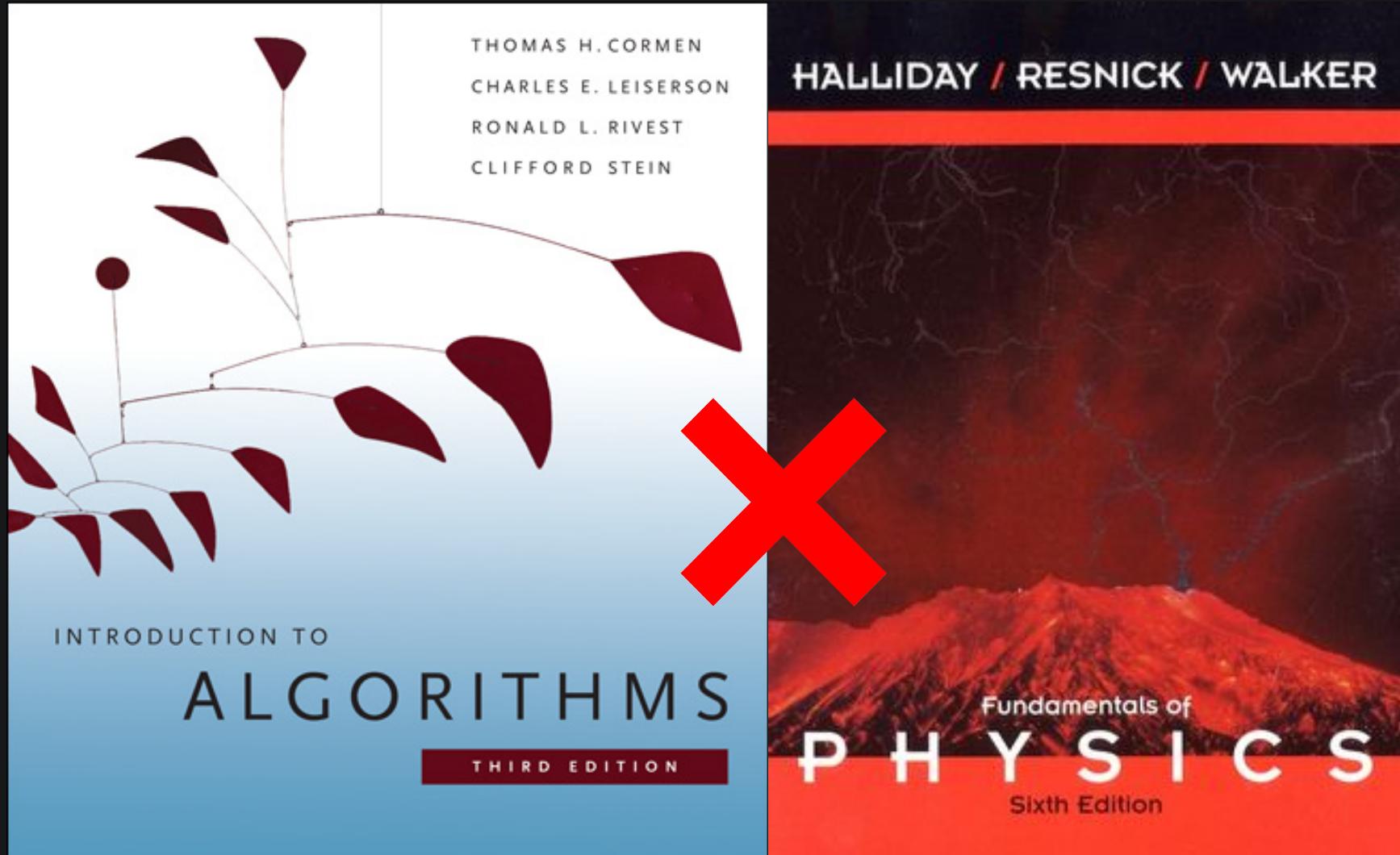
Create scientific theories based on lifestyle



Use scientific knowledge to identify lifestyle choices

Contributing to science while learning
about it is difficult

Contributing to science while learning about it is difficult

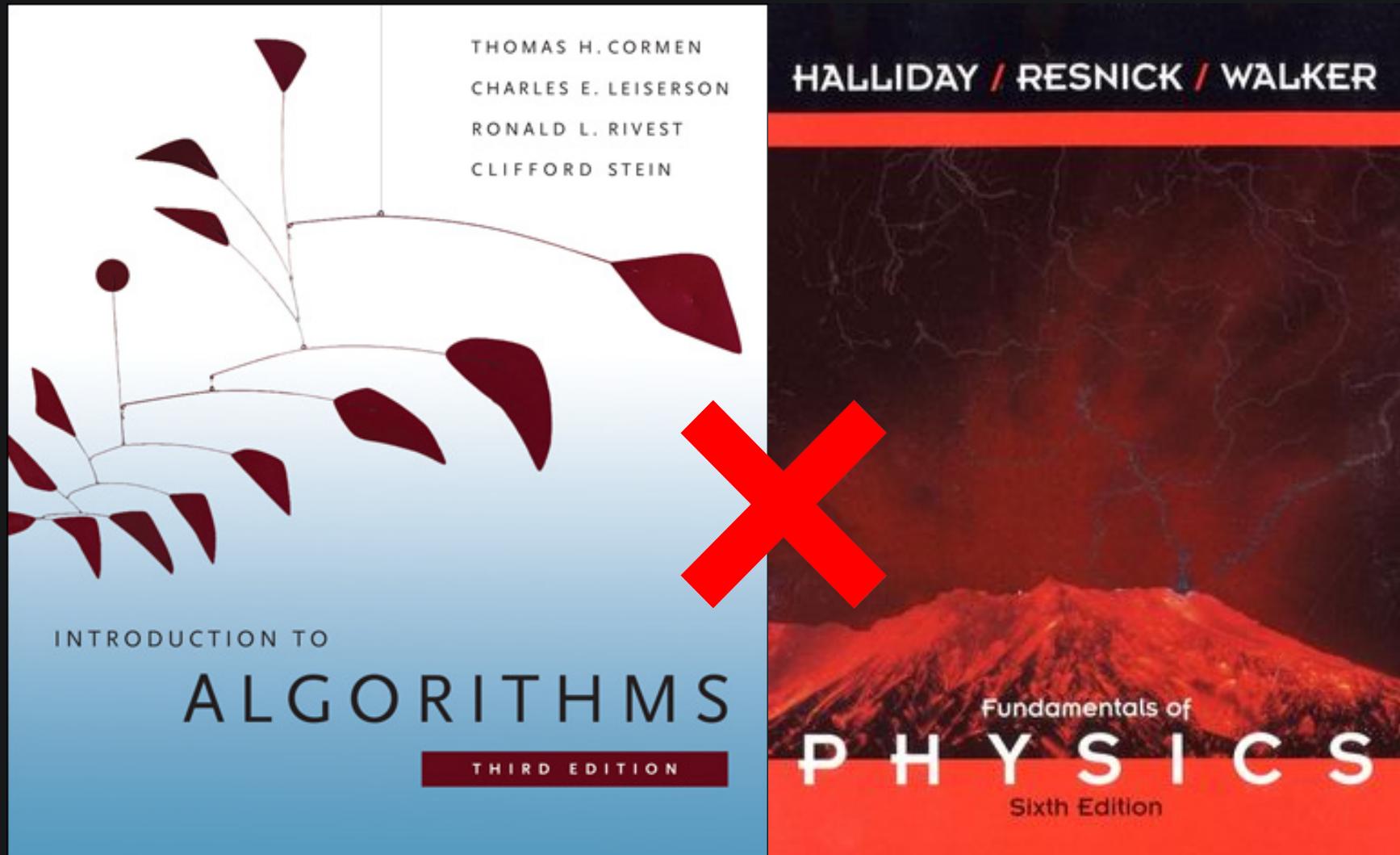


Limited learning material



Novices do not perform as well as experts on creative tasks

Contributing to science while learning about it is difficult



Limited learning material

Curate research findings



Novices do not perform as well as experts on creative tasks

On-task scaffolding

Thesis

Integrating conceptual learning with task-specific scaffolding
enables personally meaningful & useful scientific work

Three systems and corresponding studies will evaluate this thesis

From intuition..

..to questions (**Gut Instinct**: Learn-Ask-Answer)

..to hypotheses (**Docent**: Learn-Train-Ask)

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

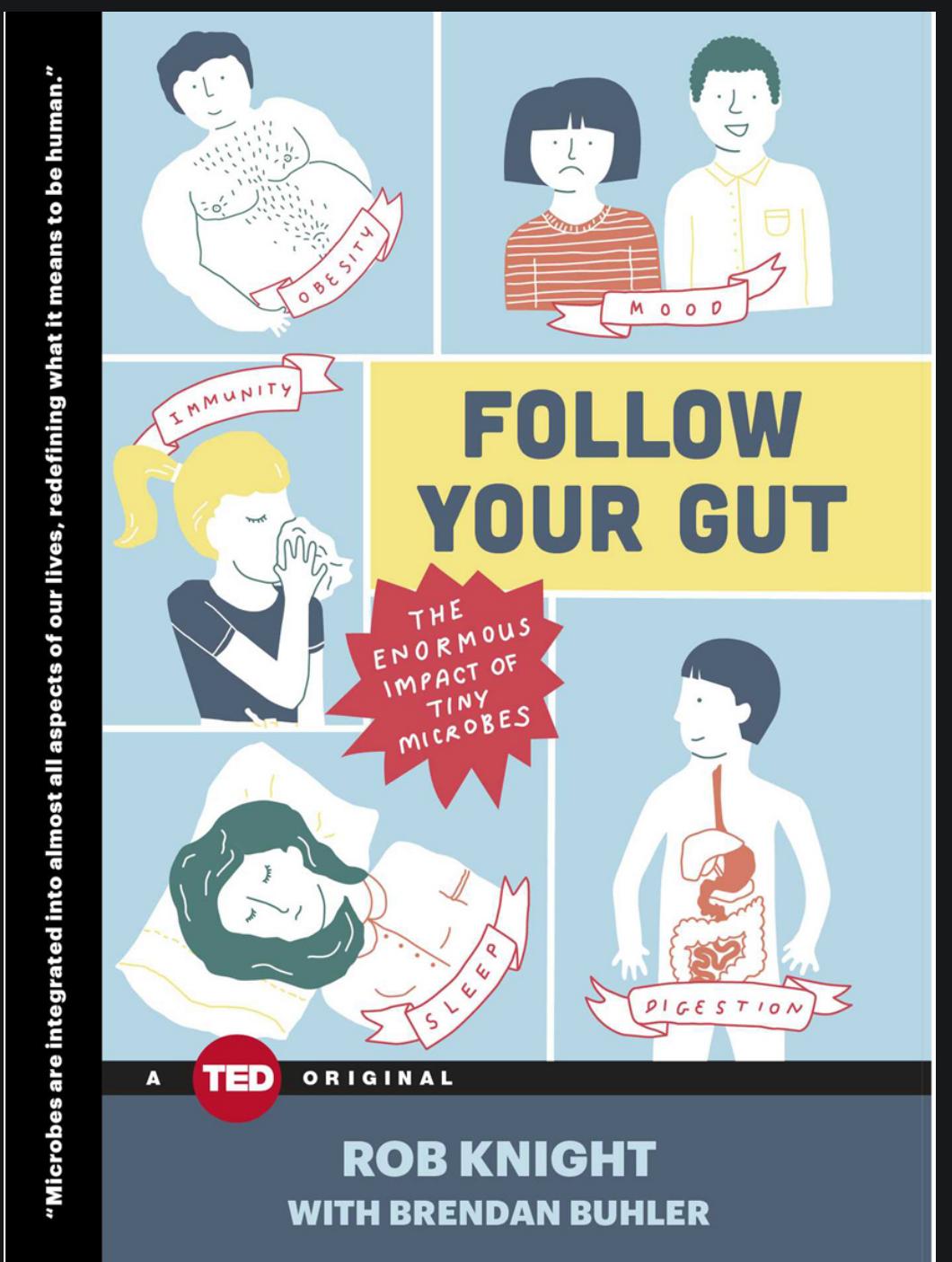
For bonus points: people improve their learning

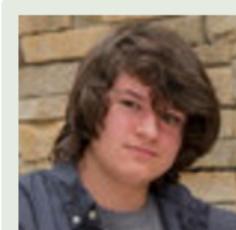
People learn - not necessarily better or worse..

Understanding the human microbiome requires insights into people's lifestyles

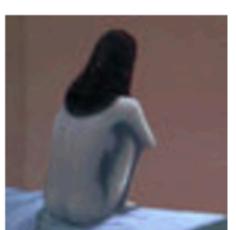
- Microbiome = Collection of all microbes and their genes in our body
- Extremely personal; shows drastic effects on health

Men infected with *Toxoplasma gondii* tend to be rule-breakers, while infected women are more sociable [Flegr et al. 1996]





[A Baffling Brain Defect Is Linked to Gut Bacteria, Scientists Say](#)



VOICES
A Suicide Therapist's Secret Past

PAID POST: TROPICANA
Why Making Orange Juice Is Not as Easy as You Think



PHYS ED
Noisy Knees? Arthritis May Be in Your Future



Why Everything We Know About Salt May Be Wrong

A Baffling Brain Defect Is Linked to Gut Bacteria, Scientists Say

By GINA KOLATA MAY 10, 2017



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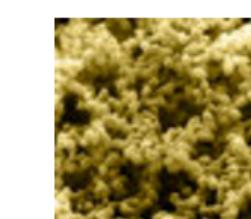
THE NEW HEALTH CARE
Exciting Microbe Research? Temper That Giddy Feeling in Your Gut MARCH 6, 2017



Say Hello to the 100 Trillion Bacteria That Make Up Your Microbiome MAY 15, 2013



Scientists Urge National Initiative on Microbiomes OCT. 28, 2015



TAKE A NUMBER
40 Trillion Bacteria on and in Us? Fewer Than We Thought. FEB. 15, 2016



TIES
Holding On to My Pets, as Alzheimer's Takes My Memories



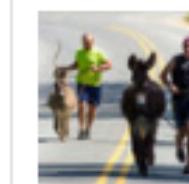
Does Your Pet Need an Eye Doctor?



When a Pet Dies, Helping Children Through the 'Worst Day of Their Lives'



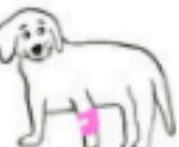
The Vegan Dog



RUNNING WITH SHERMAN
Running With the Herd



PAID POST: PROM PERU
How a New Generation of Chefs is Changing the Future of Food



Pet In Work

WELL | FAMILY

Are Pets the New Probiotic?

By RICHARD SCHIFFMAN JUNE 6, 2017

[f](#) [t](#) [p](#) [e](#) [r](#) [b](#) | [l](#) 45



Epidemiological studies show that children who grow up in households with dogs have a lower risk for developing autoimmune illnesses like asthma and allergies. Debra Bardowicks/Getty Images

Scientists are paying increasing attention to the "indoor microbiome," the billions of bacteria, viruses and fungi that we share our homes and offices with. But not all those micro-organisms are bad for us, experts note. And exposure to a rich array of indoor germs may actually be salutary, helping stave off a variety of illnesses.

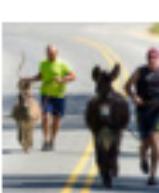
RELATED COVERAGE



[The Vegan Dog](#) JUNE 6, 2017



[The Empathetic Dog](#) JUNE 4, 2017



[RUNNING WITH SHERMAN
Running With the Herd](#) JUNE 5, 2017

Pets

[Holding On to My Pets, as Alzheimer's Takes My Memories](#) JUN 9

[The Lonely Pets Quiz](#) JUN 8

[Better Health Through the 'Lassie Effect'](#) JUN 8

[When a Pet Dies, Helping Children Through the 'Worst Day of Their Lives'](#) JUN 8

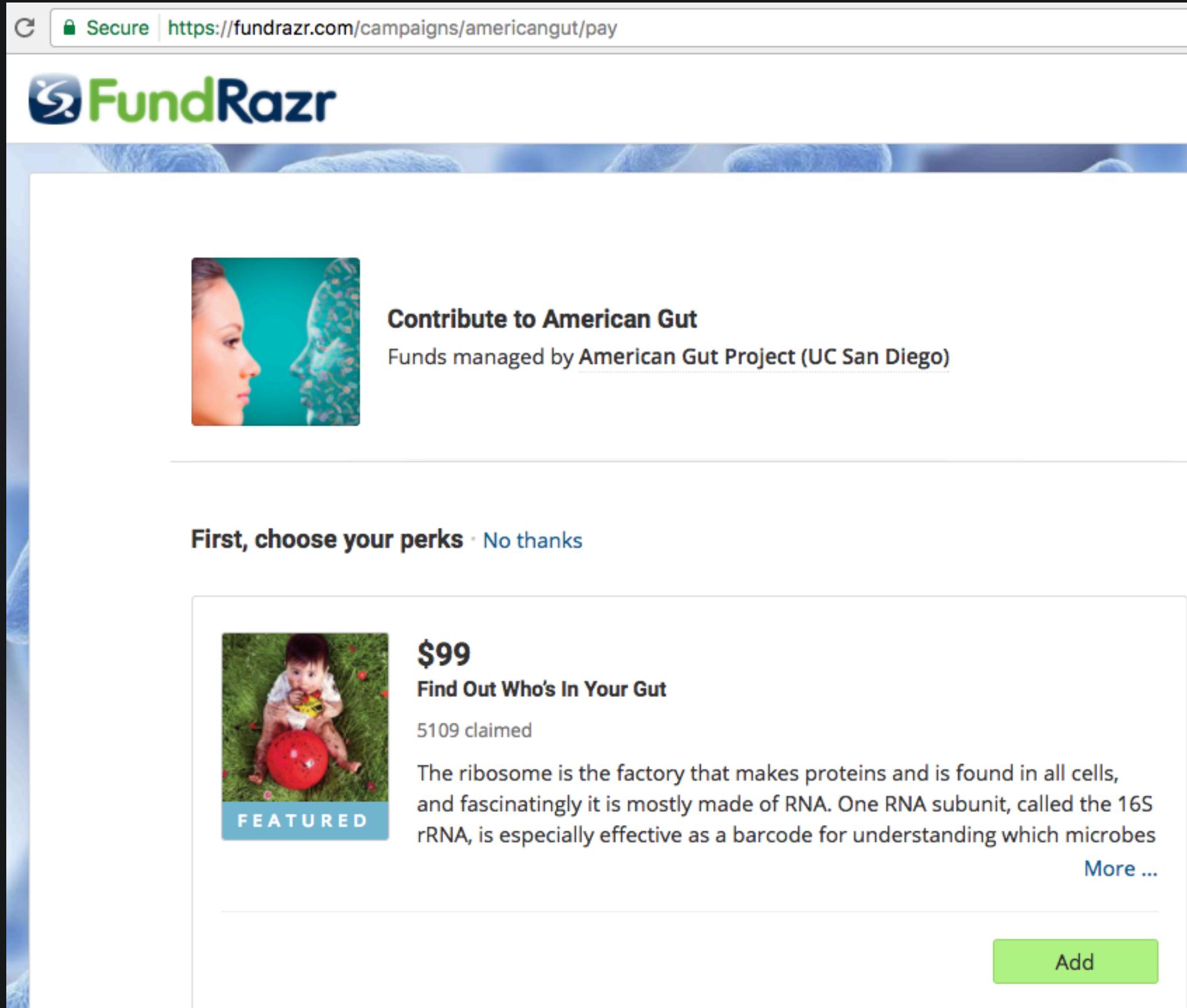
[How Worried Should Cat Owners Be About Toxoplasmosis?](#) JUN 8

[See More »](#)

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



Step 1: Create an online account and support the project



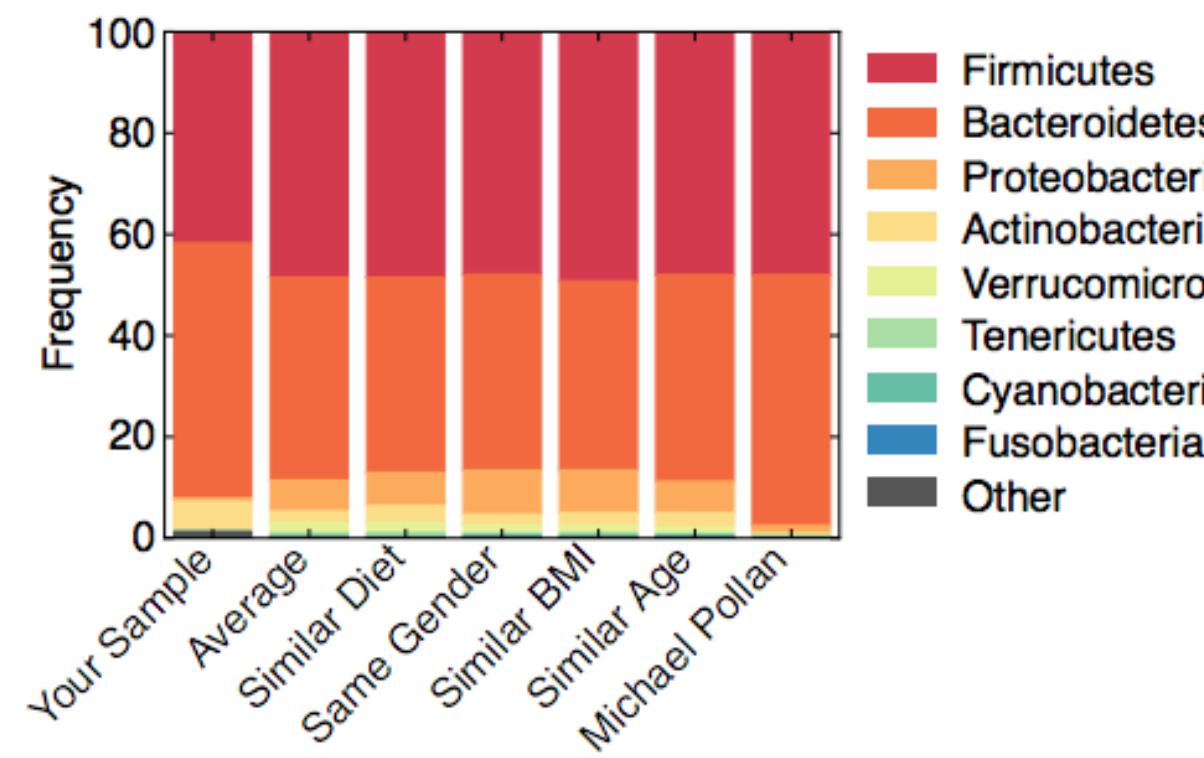
The screenshot shows a FundRazr campaign page for the American Gut Project. At the top, it says "Secure | https://fundrazr.com/campaigns/american gut/pay". The title is "Contribute to American Gut" and it's managed by the "American Gut Project (UC San Diego)". Below this, there's a "First, choose your 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%

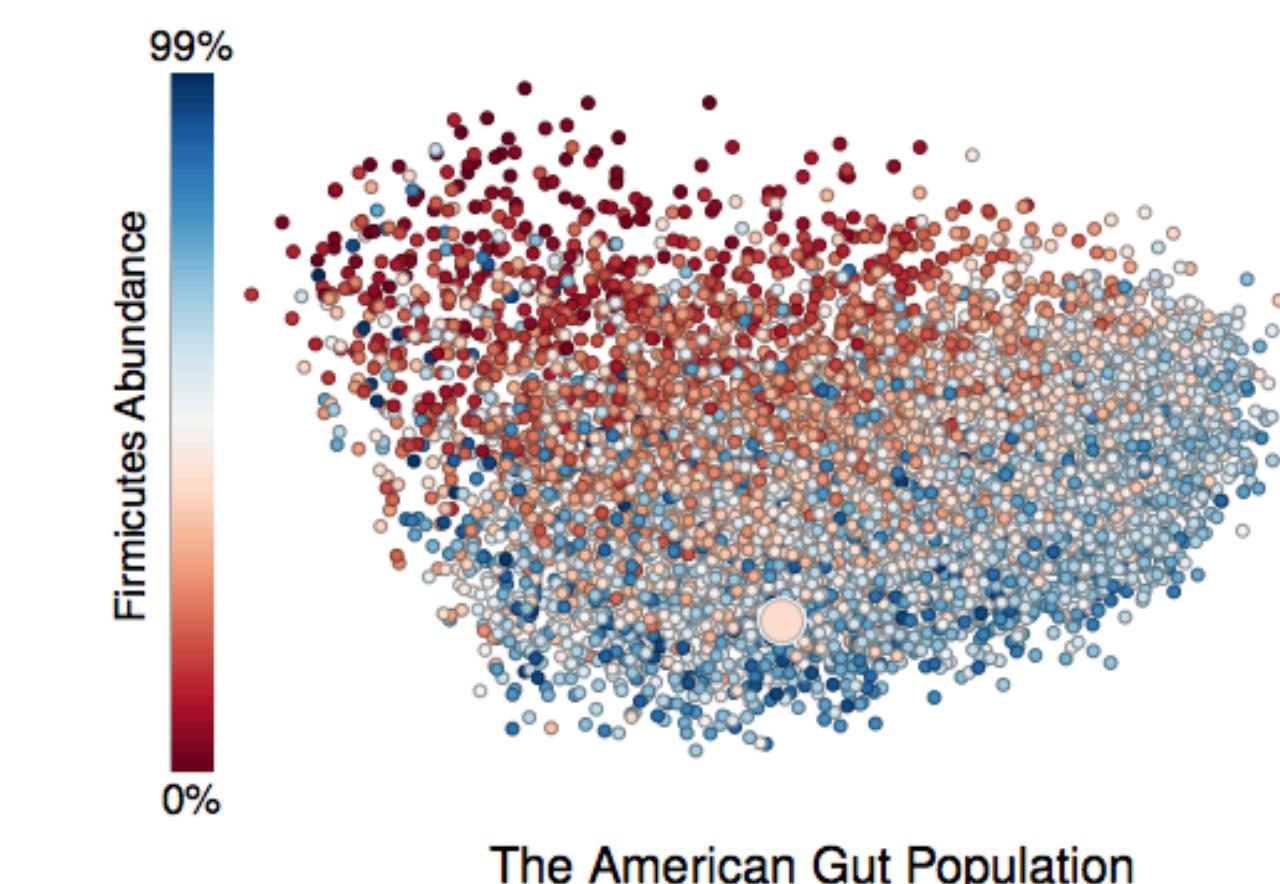
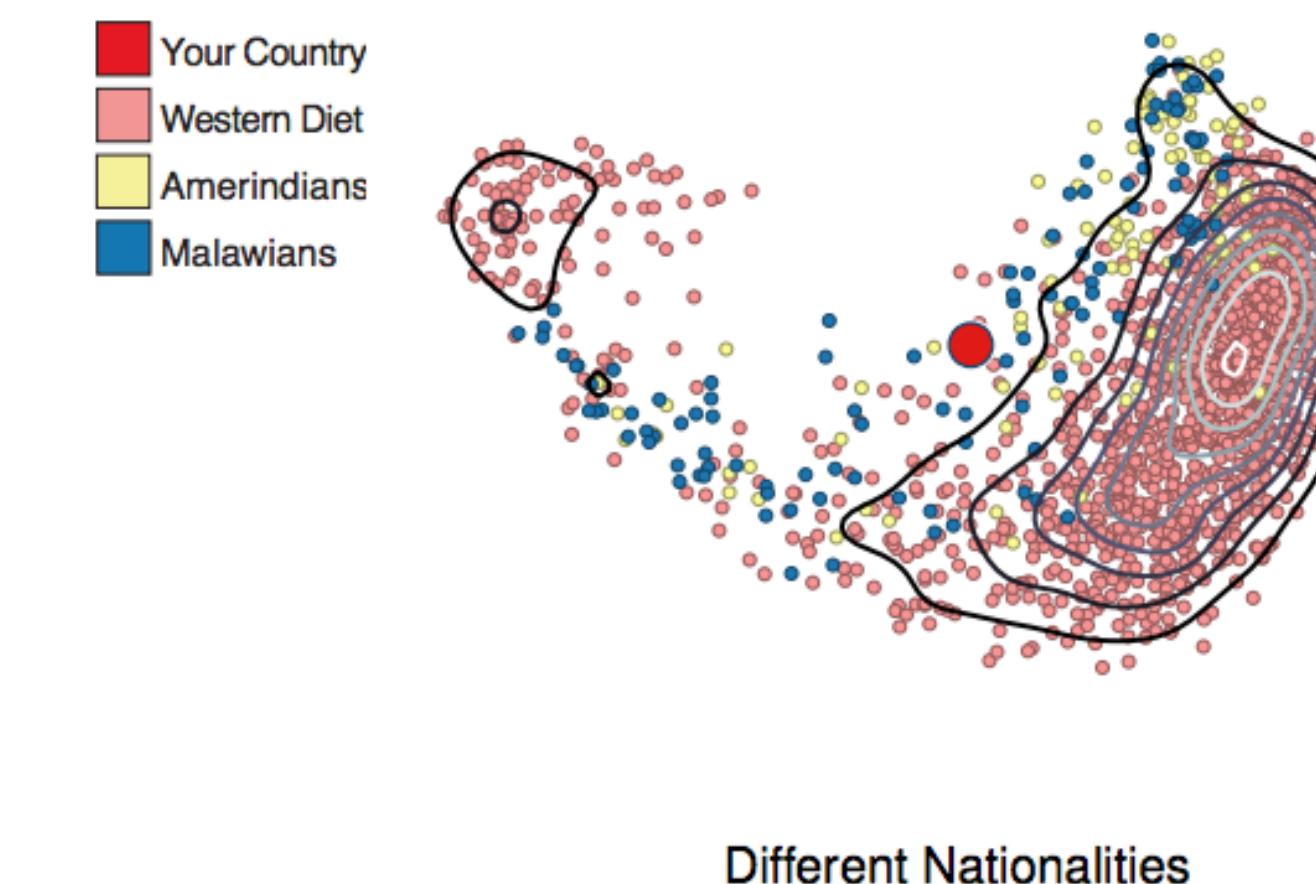
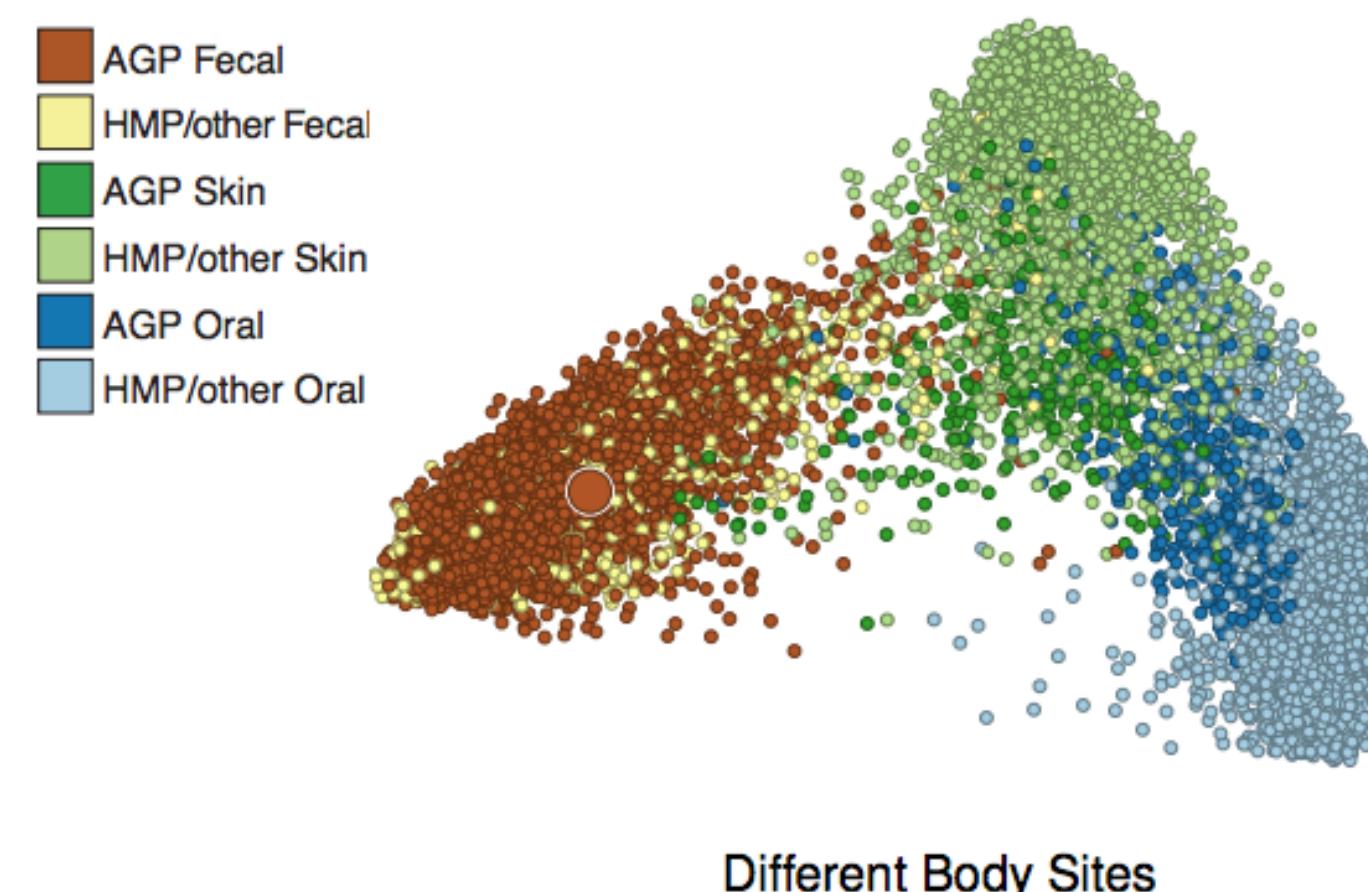
Your most enriched microbes:

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*.

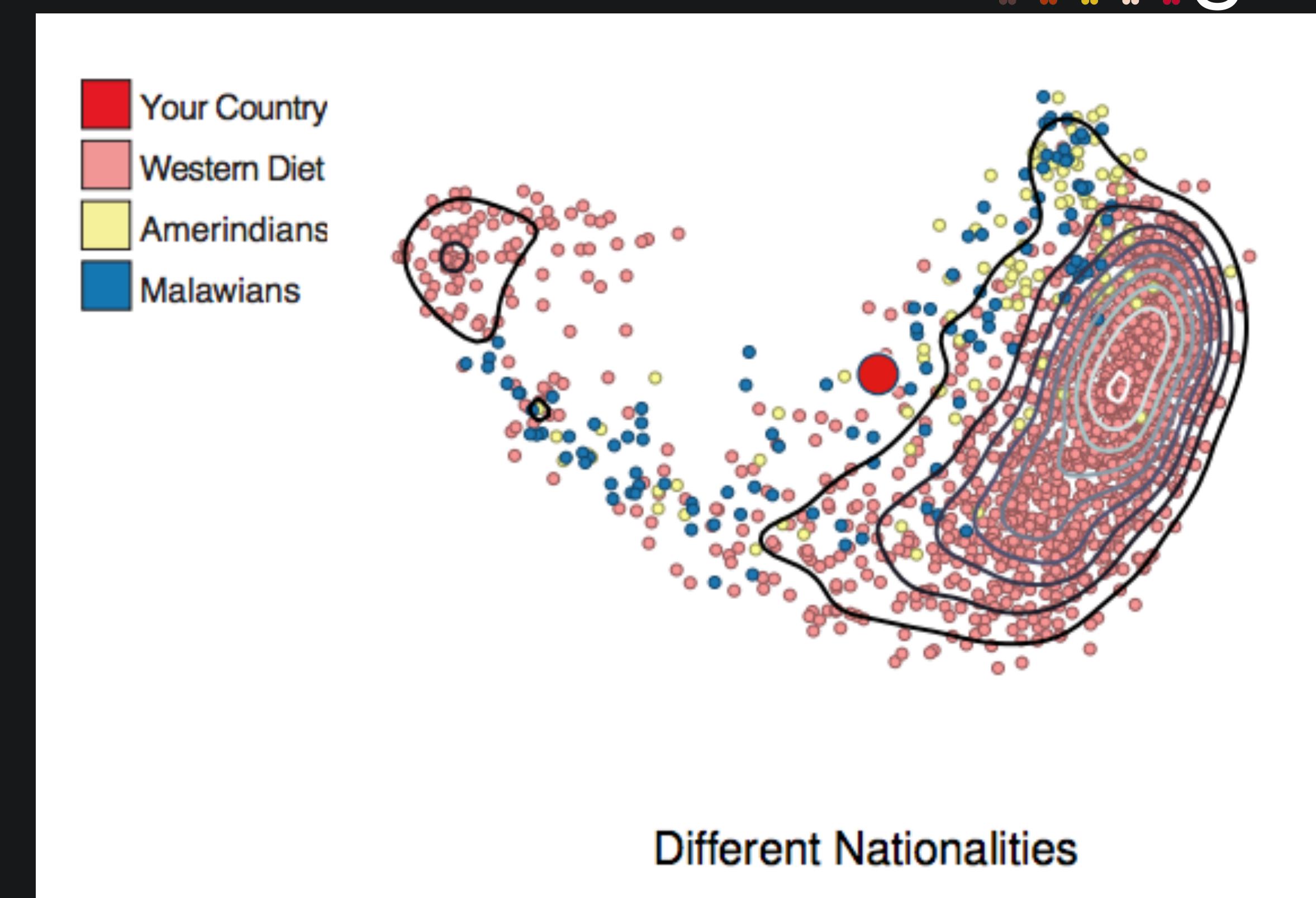
How do your gut microbes compare to others?

● Your sample is here • Others ◉ Unspecified



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

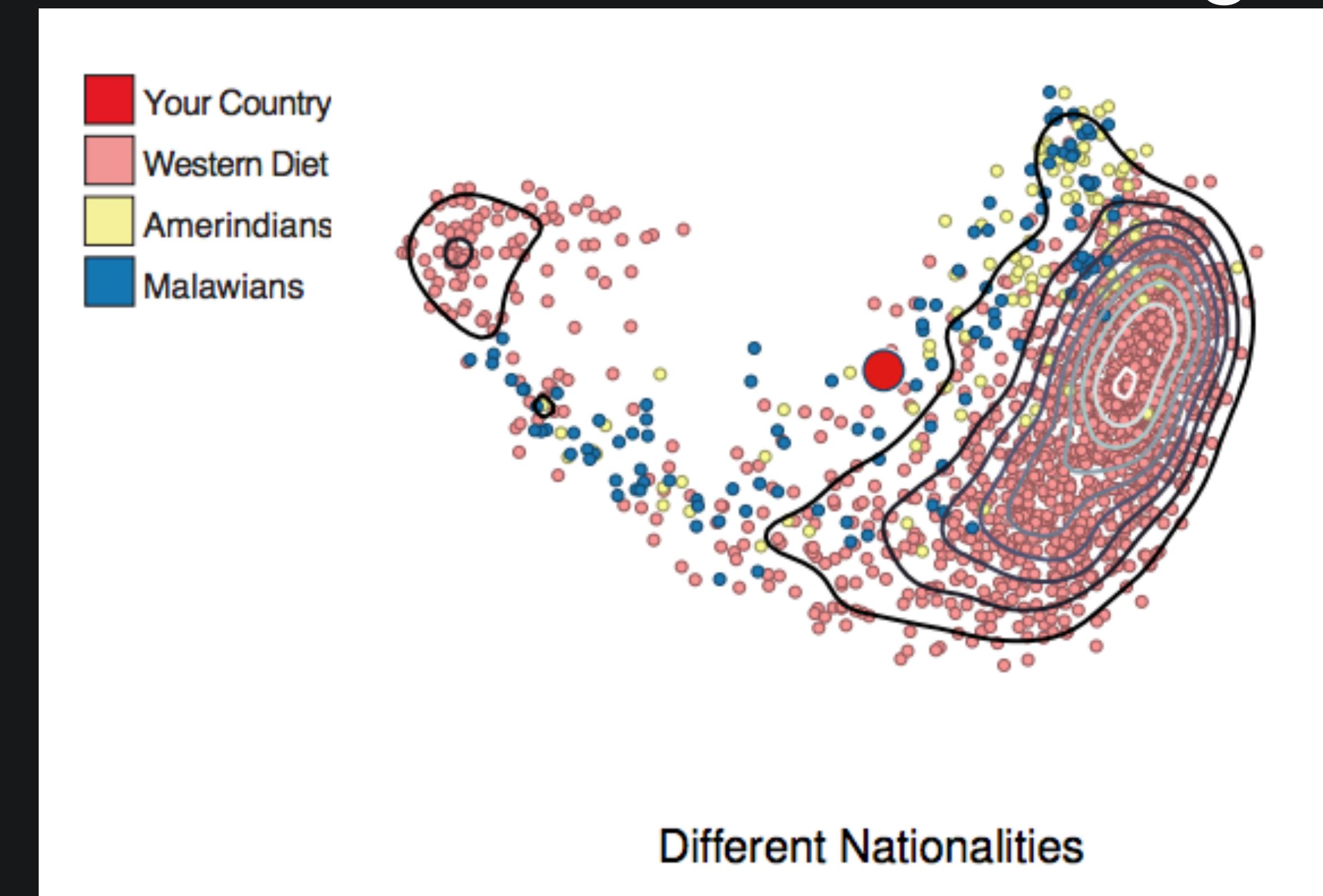
american
gut



..but participants have intuitions as well

american
gut

- Is my data point unique b/c
1. I am of Indian descent?
 2. My diet is predominantly vegetarian?
 3. I grew up in India?

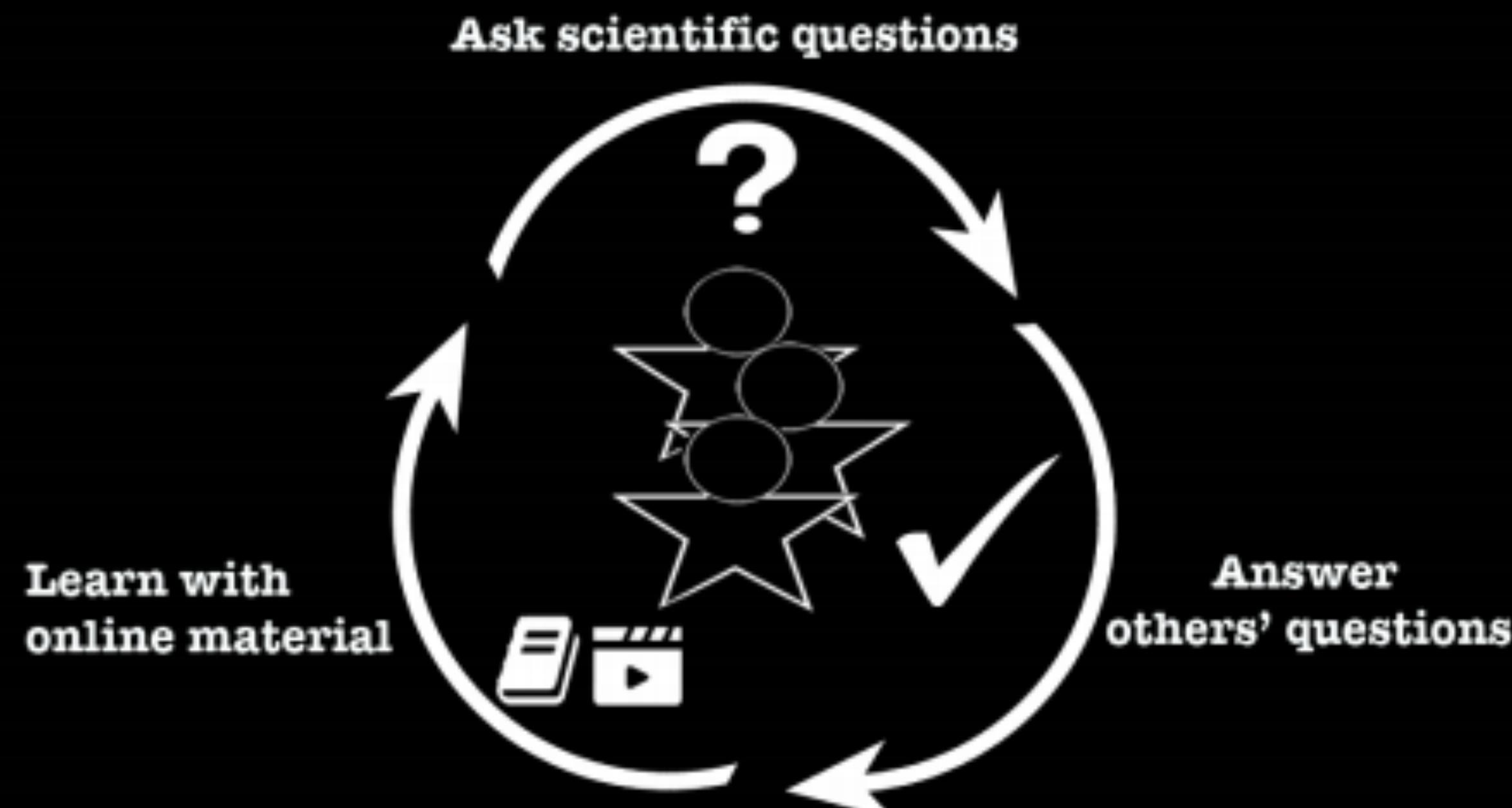


From intuition..

..to questions (*Gut Instinct: Learn-Ask-Answer*)

..to hypotheses (*Docent: Learn-Train-Ask*)

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



Gut Instinct integrates scientific learning and question asking



gutinstinct.ucsd.edu

Existence Proof: 10 of 29 participants' *questions matched* *researchers' questions* *(we think this is good)*

Do you drink soylent regularly?
Do you eat red meat so often?
Do you use the treadmill at the gym?
Do you take any meal replacements such as protein powders?
Do you smoke?
Do you poop regularly?
Were you not breast fed as a child?
Are you regular got drunk?
Do you exercise regularly or have enough physical activities?
Do you sleep at least 7-8 hours a night?
Have you quit smoking in the past?
Do you eat hot (spicy) food often?
Did you ever switch from a meat based diet to a vegan diet or vice versa?
Do you eat meals while working?
Do you eat raw meat?
Do you smoke weed ?
Do you just eat 1-2 meals a day ?
Do you eat probiotic yogurt?
Do you think you have a belly?
Do you eat probiotic yogurt?
Do you have really bad smelling poop?
Do you eat blueberries regularly?
Do you drink coffee?
Do you often feel fatigued?
Are you a morning person ?
Do you follow a sleep cycle?
Do you use antibacterial soap?
Do you wash your hands everytime you use the bathroom?
Do you follow a specific diet?

Gut Instinct

Have you wondered how your diet, exercise, and other habits affect your gut (and life)? Scientists wonder about it, too!

With Gut Instinct, you can don your labcoat and help scientists understand human gut while having fun!

Learn about current science of the gut microbiome, discuss your ideas with other citizen scientists, and collaborate on popular questions.
Share your Gut Instinct!

There are **30** citizen scientists contributing to Gut Instinct

Sign Up

STRAIGHT FROM THE GUT

Popular Questions!

There are no questions available :(

Gut Instinct as of Sep 5, 2016

Have you wondered how your diet, exercise, and other habits affect your gut (and life)? Scientists wonder about it, too!

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STRAIGHT FROM THE GUT

Popular Questions!

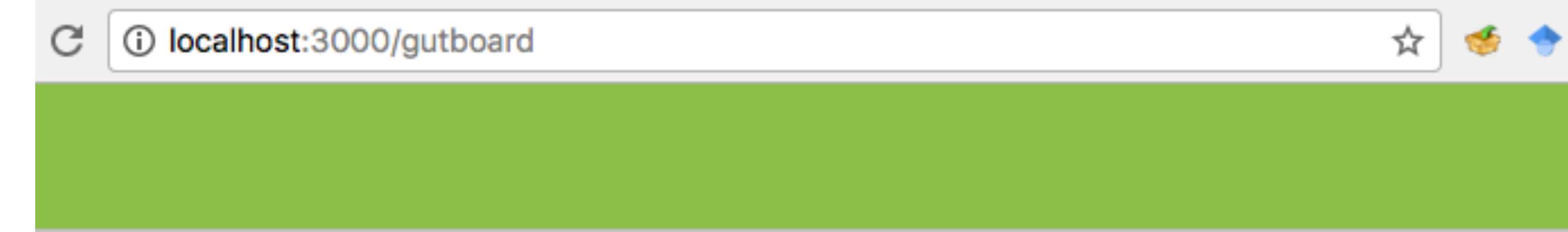
There are no questions available :(

vineet

.....

Sign Up

Step 1: Answer participants' questions



STRAIGHT FROM THE GUT
How do your Gut Instincts compare to others?

QUESTIONS
(To see all questions, click [here](#))

UNANSWERED! (8)	DISCUSSED (0)	ANSWERED (0)	WRITTEN (0)
-----------------	---------------	--------------	-------------

2 minutes ago • ADDED BY: RESEARCHERS

1. Do you use antibiotics?

antibiotics

[Tweet](#)

[YES](#) [NO](#) [Discuss \(1 comment\)](#)

2 minutes ago • ADDED BY: RESEARCHERS

1. Do you eat fermented foods?

fermented foods

[Tweet](#)

[YES](#) [NO](#) [Discuss \(0 comments\)](#)

Step 1a: Answer follow-up questions

7 minutes ago • ADDED BY: RESEARCHERS

1. Do you drink alcohol?

alcohol diet

 Tweet

 YES  NO  Discuss (1 comment)

1.0e+2% said "Yes" and 0.0% said "No"

2. If so, what kind of food do you eat the next morning?

Type your answer here

 SUBMIT  SKIP

Step 2: Ask questions

Add your question here!

"Yes/No" Question

sample: Do you eat probiotic yogurt?

Follow-up Question (if answer is "yes")

sample: If so, what brand do you eat?

Tags

sample: #diet #probiotics

Start Discussion

Start your discussion here.

SUBMIT **CLEAR**

Think of interesting and whacky questions, but also how they might relate to the gut.
What's your gut feeling?

Remember, you're a scientist. What was crazy idea once, is now accepted theory, esp for gut microbiome

Think about how this question affects you or even people around you: your friends, family. E.g. drinking too much one night can give you a bad headache next morning (duh!)

Step 3:

Learn about the scientific domain

FOLLOW YOUR GUT!

Choose among following topics to explore your gut!



genetics

[CLICK HERE TO LEARN MORE](#)



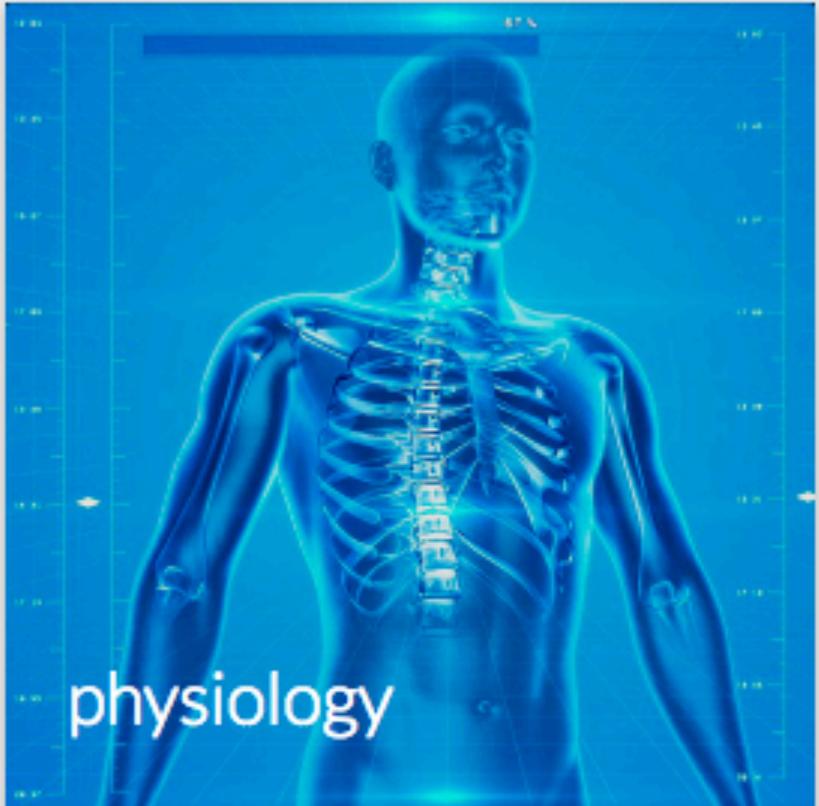
probiotics

[CLICK HERE TO LEARN MORE](#)



diet

[CLICK HERE TO LEARN MORE](#)



physiology

[CLICK HERE TO LEARN MORE](#)

Step 3:

Learn about the scientific domain

JOURNAL OF VERBAL LEARNING AND VERBAL BEHAVIOR 18, 357–364 (1979)

To Ask a Question, One Must Know Enough to Know What is Not Known

NAOMI MIYAKE AND DONALD A. NORMAN

University of California, San Diego

FOLLOW YOUR GUT!

Choose among following topics to explore your gut!

The screenshot shows a web page with a green header bar. Below it, the text "FOLLOW YOUR GUT!" is displayed in large capital letters, followed by the instruction "Choose among following topics to explore your gut!". There are four rectangular cards, each containing an image and text. The first card on the left has a blue DNA helix image and the word "genetics". The second card on the right has an image of various colorful capsules and the word "probiotics". The third card at the bottom left has an image of fresh fruits and vegetables like apples, carrots, and a glass of milk, with the word "diet". The fourth card at the bottom right has an image of a human skeleton and the word "physiology". Each card has an orange "CLICK HERE TO LEARN MORE" button at the bottom.

genetics

CLICK HERE TO LEARN MORE

probiotics

CLICK HERE TO LEARN MORE

diet

CLICK HERE TO LEARN MORE

physiology

CLICK HERE TO LEARN MORE

Step 3a:

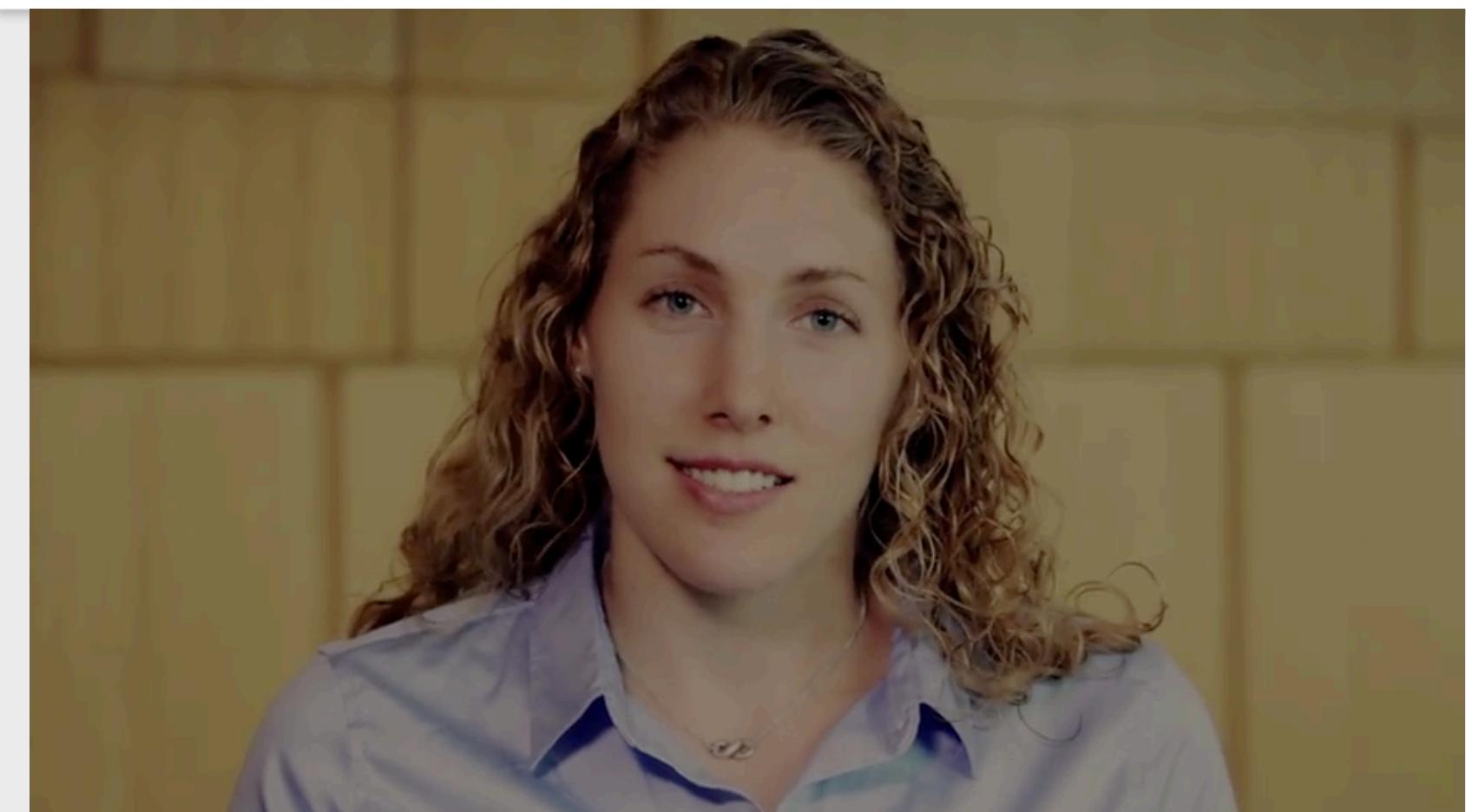
Learn about a specific topic, say *antibiotics*

① localhost:3000/t/antibiotics

◀ Back to Topics

#antibiotics

#antibiotics is one of many topics. You can explore more topics from the main [topics page](#).



▶ 0:00 / 2:27

Sorry. #antibiotics cannot be investigated at the moment :(Please try other [topics](#).

Science says:

Gut Instinct does not have the scientific data curated about #antibiotics

You can learn more about #antibiotics through this Google Scholar [link](#)

Hypotheses for Dual-objective online learning systems

H1 Learning improves quality of work on relevant problems.

H2 Working on relevant real-world problems improves learning.

**Between-subjects experiment (N=44) w/3
conditions -Lab study followed by 3-day use**

Between-subjects expt (N=44) w/3 conditions: *Contribute, Learn, & Combined*

The image displays two vertical screenshots of mobile application interfaces. Both screens feature a top header with a stylized illustration of a brain and gut, followed by a timestamp ('18 days ago'), the source ('ADDED BY: CITIZEN SCIENTISTS [T102]'), and a title/question.

Screenshot 1 (Top):

- Title:** Breast-Feeding New Yorker
- Text:** Why human milk is a
- Image:** NEWYORKER.COM
- Question:** 1. Do you use antibacterial soap?
- Tags:** soap, **antibacterial**, fda, triclosan
- Buttons:** YES (green), NO (red)
- Link:** Discuss (3 comments)

Screenshot 2 (Bottom):

- Title:** Is your gut m
- Text:** New research sugge
- Image:** THEGUARDIAN.COM
- Question:** 1. Do you eat meals while working?
- Tags:** diet, habits
- Buttons:** YES (green), NO (red)
- Link:** Discuss (3 comments)

(1) Contribute

Between-subjects experiment (N=44) w/3 conditions

Contribute, Learn, & Combined

The screenshot shows two separate contributions on a platform:

- Top Contribution:** "18 days ago • ADDED BY: CITIZEN SCIENTISTS [T102]"
Title: "1. Do you use antibacterial soap?"
Description: "Why human milk is a..." (partially visible)
Tags: soap, antibacterial, fda, triclosan
Buttons: YES (green), NO (red), Discuss (3 comments)
- Bottom Contribution:** "18 days ago • ADDED BY: CITIZEN SCIENTISTS [T103]"
Title: "1. Do you eat meals while working?"
Description: "New research sugge..." (partially visible)
Tags: diet, habits
Buttons: YES (green), NO (red), Discuss (3 comments)

(1) Contribute

The screenshot shows a learning section titled "#diet".

Top Panel: A PCA plot titled "c" showing gut microbiome samples from "US", "Malawians", and "Amerindians". Below it is a question:
"Which of these is not true? Germ-free mice have:"
List of options:

- Similar immune activity to normal mice
- Reduced immune activity
- Fewer immune cells
- Increased rates of infection

Middle Panel: Question: "Does short-term diet"
List of options:

- Correct! Rapid changes in short microbiome. Consuming only fat the video for more.
- Yes, but it cannot cause diarrhea
- Yes, it can cause huge swings
- No, it does not have influence
- Researchers just don't know

Bottom Panel: Question: "Leaky gut refers to:"
List of options:

- Diarrhea after consumption of certain synthetic fats, such as olestra
- Short-chain fatty acids getting into the gut epithelium
- Bacteria passing across the gut epithelial membrane
- Food passing across the gut into the bloodstream more than it should

(2) Learn

Between-subjects experiment (N=44) w/3 conditions

Contribute, Learn, & Combined

18 days ago • ADDED BY: CITIZEN SCIENTISTS [T102]

Breast-Feeding New Yorker

Why human milk is a NEWYORKER.COM

1. Do you use antibacterial soap?

soap antibacterial fda triclosan

YES NO Discuss (3 comments)

18 days ago • ADDED BY: CITIZEN SCIENTISTS [T103]

Is your gut microbiome healthy?

New research suggests that live in our guts can affect conditions including THEGUARDIAN.COM

1. Do you eat meals while working?

diet habits

YES NO Discuss (3 comments)

#diet

#diet is one of many topics. You can explore more topics from the main topics page.

c US Malawians Amerindians

PC2 (6.6%) from UniFrac distance

Which of these is not true? Germ-free mice have:

Incorrect. Attempted 4 times.

- Similar immune activity to normal mice
- Reduced immune activity
- Fewer immune cells
- Increased rates of infection

SUBMIT

Does short-term diet

Correct! Rapid changes in short microbiome. Consuming only fast food for more than a week can cause huge swings in gut microbiome.

Click here to discuss about this question

Leaky gut refers to:

Correct. Attempted 3 times.

- Yes, but it cannot cause diarrhea
- Yes, it can cause huge swings in gut microbiome
- No, it does not have influence
- Researchers just don't know

SUBMIT

Click here to discuss about this question

#diet

#diet is one of many topics. You can explore more topics from the main topics page.

c US Malawians Amerindians

PC2 (6.6%) from UniFrac distance

18 days ago • ADDED BY: CITIZEN SCIENTISTS [T102]

1. Do you use antibacterial soap?

soap antibacterial fda triclosan

YES NO Discuss (3 comments)

18 days ago • ADDED BY: CITIZEN SCIENTISTS [T103]

Does short-term diet

Correct! Rapid changes in short microbiome. Consuming only fast food for more than a week can cause huge swings in gut microbiome.

1. Do you eat meals while working?

diet habits

YES NO Discuss (3 comments)

(1) Contribute

(2) Learn

(3) Combined

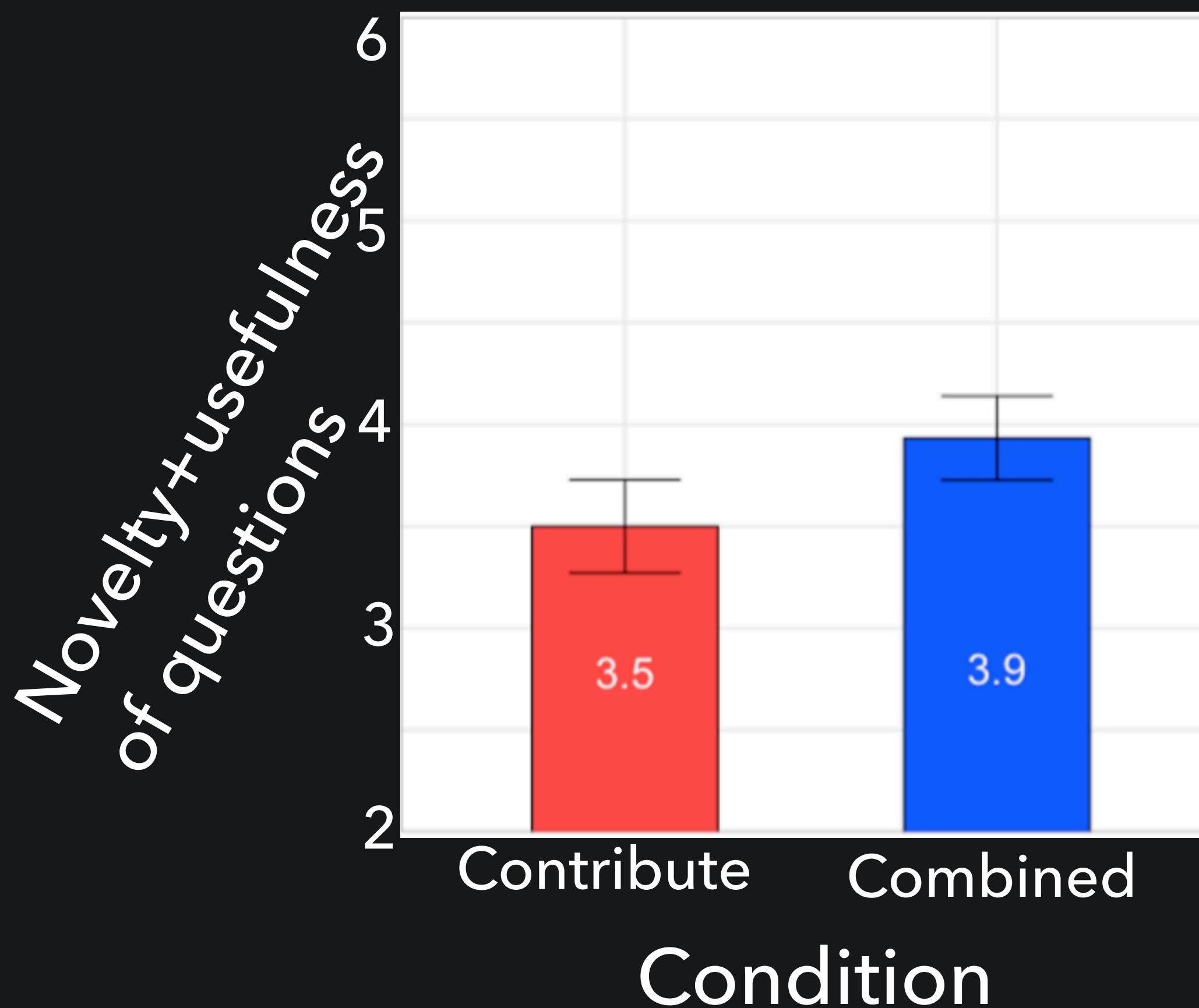
Measures

- Questions: Novelty and usefulness
(measured by blind, independent raters)
- Learning: Score on summative test

Existence Proof: 10 of 29 participants' *questions matched* *researchers' questions* *(we think this is good)*

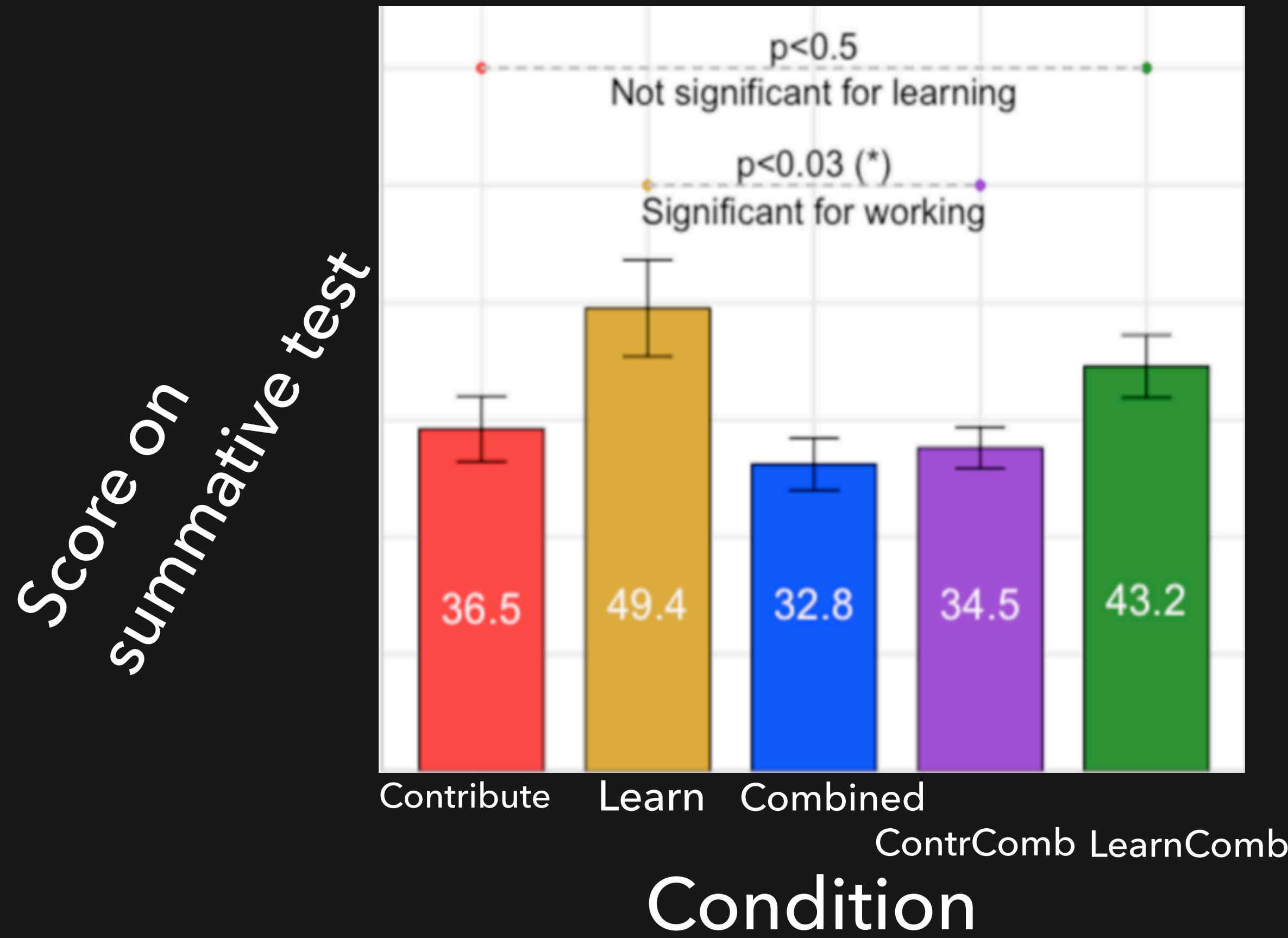
Do you drink soylent regularly?
Do you eat red meat so often?
Do you use the treadmill at the gym?
Do you take any meal replacements such as protein powders?
Do you smoke?
Do you poop regularly?
Were you not breast fed as a child?
Are you regular got drunk?
Do you exercise regularly or have enough physical activities?
Do you sleep at least 7-8 hours a night?
Have you quit smoking in the past?
Do you eat hot (spicy) food often?
Did you ever switch from a meat based diet to a vegan diet or vice versa?
Do you eat meals while working?
Do you eat raw meat?
Do you smoke weed ?
Do you just eat 1-2 meals a day ?
Do you eat probiotic yogurt?
Do you think you have a belly?
Do you eat probiotic yogurt?
Do you have really bad smelling poop?
Do you eat blueberries regularly?
Do you drink coffee?
Do you often feel fatigued?
Are you a morning person ?
Do you follow a sleep cycle?
Do you use antibacterial soap?
Do you wash your hands everytime you use the bathroom?
Do you follow a specific diet?

Results: H1. Did learning improve quality of questions? No.



Participants in Contribute and Combined conditions created questions of similar quality

Results: H2. Did asking questions improve learning scores? No.



Participants in Learn condition performed the best on a summative test.

Learning did not show a significant effect on score but working did.

Combined condition did not perform better because..

- Multiple criteria of success
- Cognitive overload of multiple tasks
- Short "incubation" time for "scientists"
- Personalized learning and need for feedback
- ...

Systems with two objectives often achieve one but not the other



Duolingo
Language learning
+ translation
[Hacker 2014]



Have your cake
Language learning
+ translation
[Culbertson et al. 2017]



Is this galaxy likely to have
high rates of star formation? T F

Crowdclass
Decision-trees
+ galaxy classification
[Lee et al. 2016]

Dual-objective online learning systems: Promise and challenges

- Learning & working
 - Integrate objectives and provide clear criteria of success
 - Task-specific scaffolding (aka how to generate good hypotheses)
- Make learning & work personally relevant
 - Working with intrinsically motivated participants

Challenge: Gut Instinct questions are not framed as hypotheses

1. Do you drink soylent regularly?

diet soylent

Tweet

YES NO Discuss (1 comment)

12% said "Yes" and 88% said "No"

2. If so, have you noticed any specific changes in your lifestyle? For example, do you get hungry more often or do you feel more energetic?

Score: 5/6

(Novelty: 2, Usefulness: 3)

1. Do you think you have a belly?

exercise

Tweet

YES NO Discuss (2 comments)

64% said "Yes" and 36% said "No"

2. What steps do you take to get a flatter stomach?

Score: 2/6

(Novelty: 1, Usefulness: 1)

Challenge: Convert questions to hypotheses

1. Do you drink soylent regularly?

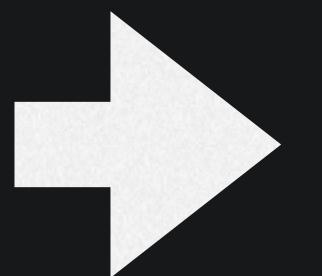
diet soylent

 Tweet

 YES  NO  Discuss (1 comment)

12% said "Yes" and 88% said "No"

2. If so, have you noticed any specific changes in your lifestyle? For example, do you get hungry more often or do you feel more energetic?



Do you get hungry
more often when you
drink soylent daily?

Challenge: Convert questions to hypotheses

1. Do you drink soylent regularly?

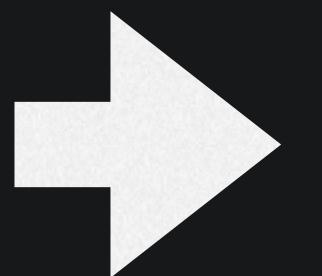
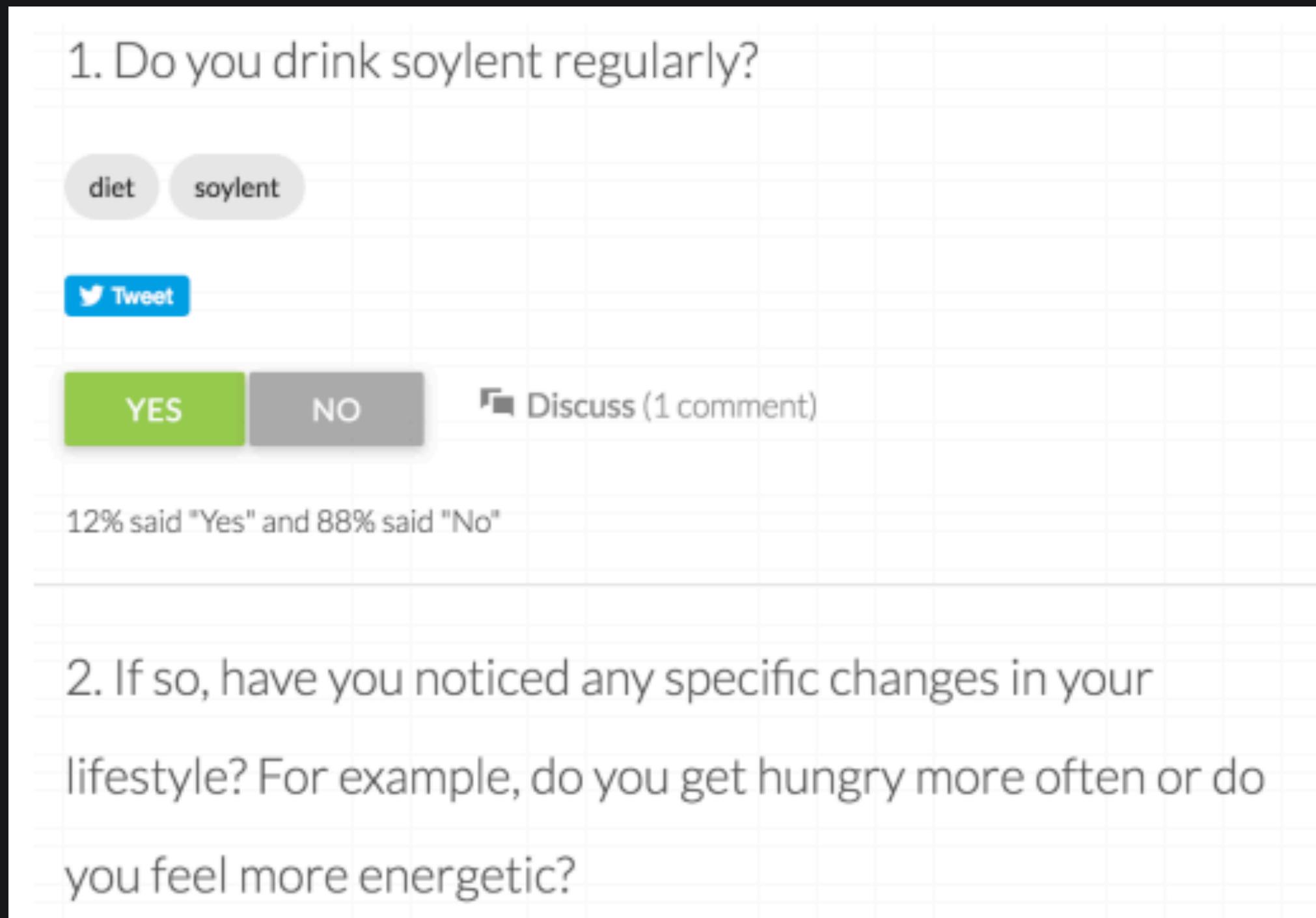
diet soylent

[Tweet](#)

[YES](#) [NO](#) [Discuss \(1 comment\)](#)

12% said "Yes" and 88% said "No"

2. If so, have you noticed any specific changes in your lifestyle? For example, do you get hungry more often or do you feel more energetic?



How often do you drink soylent?

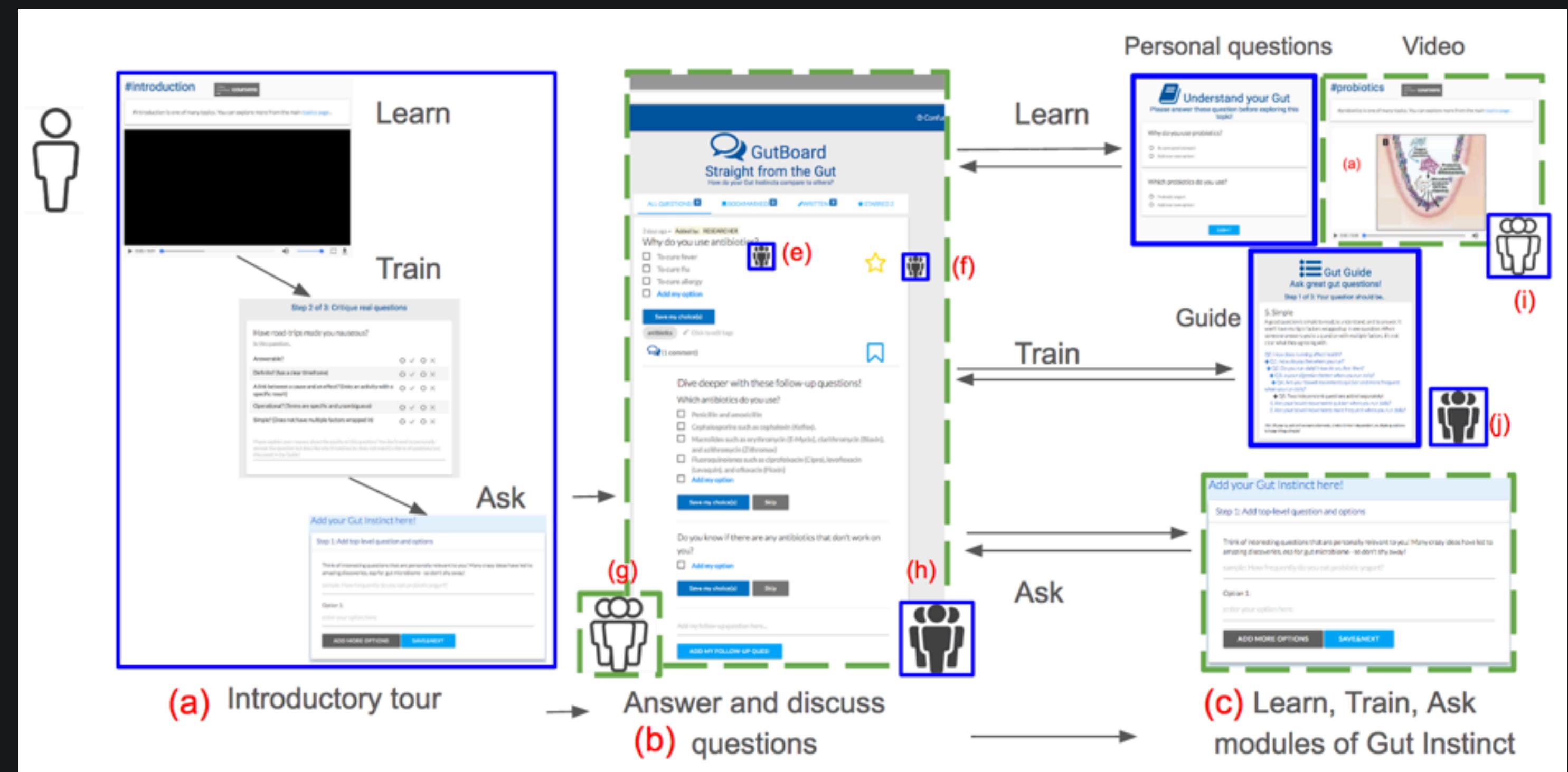
Do you get hungry more frequently?

From intuition..

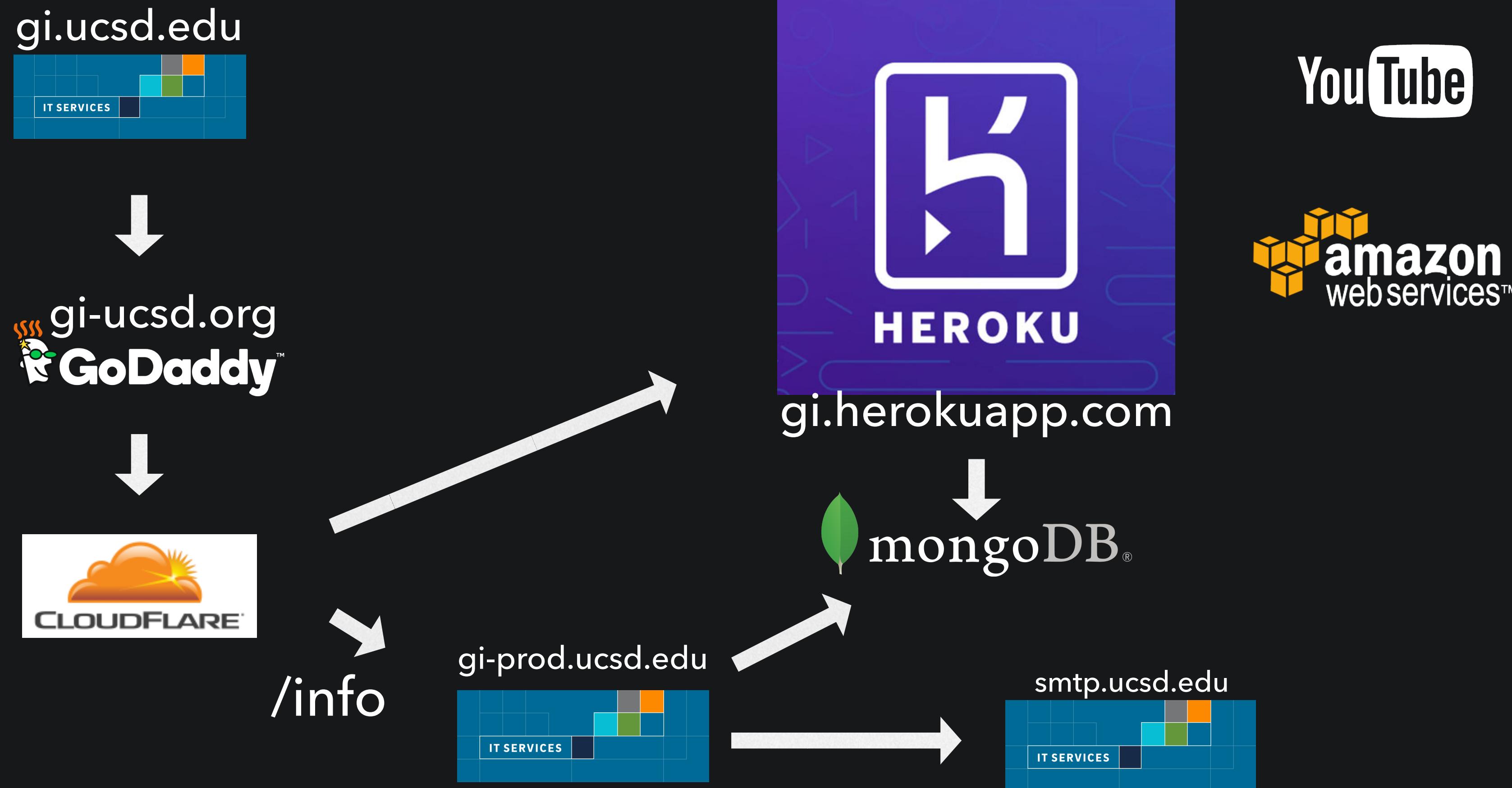
..to questions (*Gut Instinct: Learn-Ask-Answer*)

..to hypotheses (*Docent: Learn-Train-Ask*)

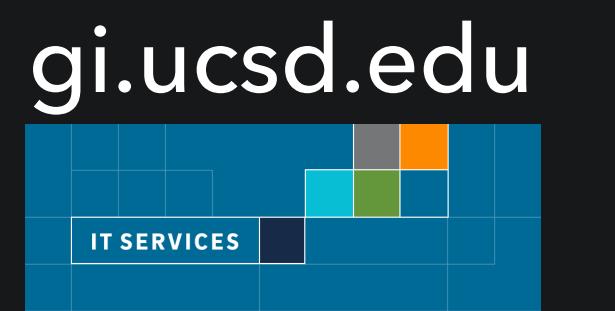
..to experiments (*Galileo: Self-organized crowd expts*)



What happens when a user accesses gutinstinct.ucsd.edu?

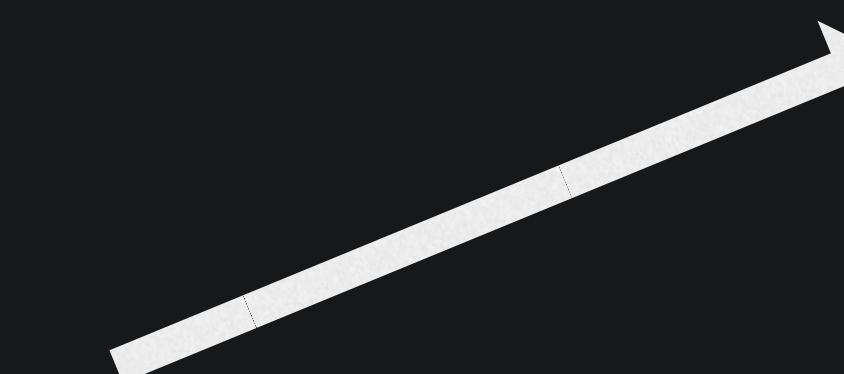


What happens when a user accesses gutinstinct.ucsd.edu?



/info

gi-prod.ucsd.edu



mongoDB®



YouTube



22K lines of code

5K lines of data

METER⁶³

Welcome to Gut Instinct

Beta

Learn. Ask. Answer.

Curious to know more about the gut microbiome, but don't know which sources to trust?

Learn about current science of the gut microbiome with expert-curated learning materials.



START YOUR JOURNEY

Returning user

[Login](#)

New user

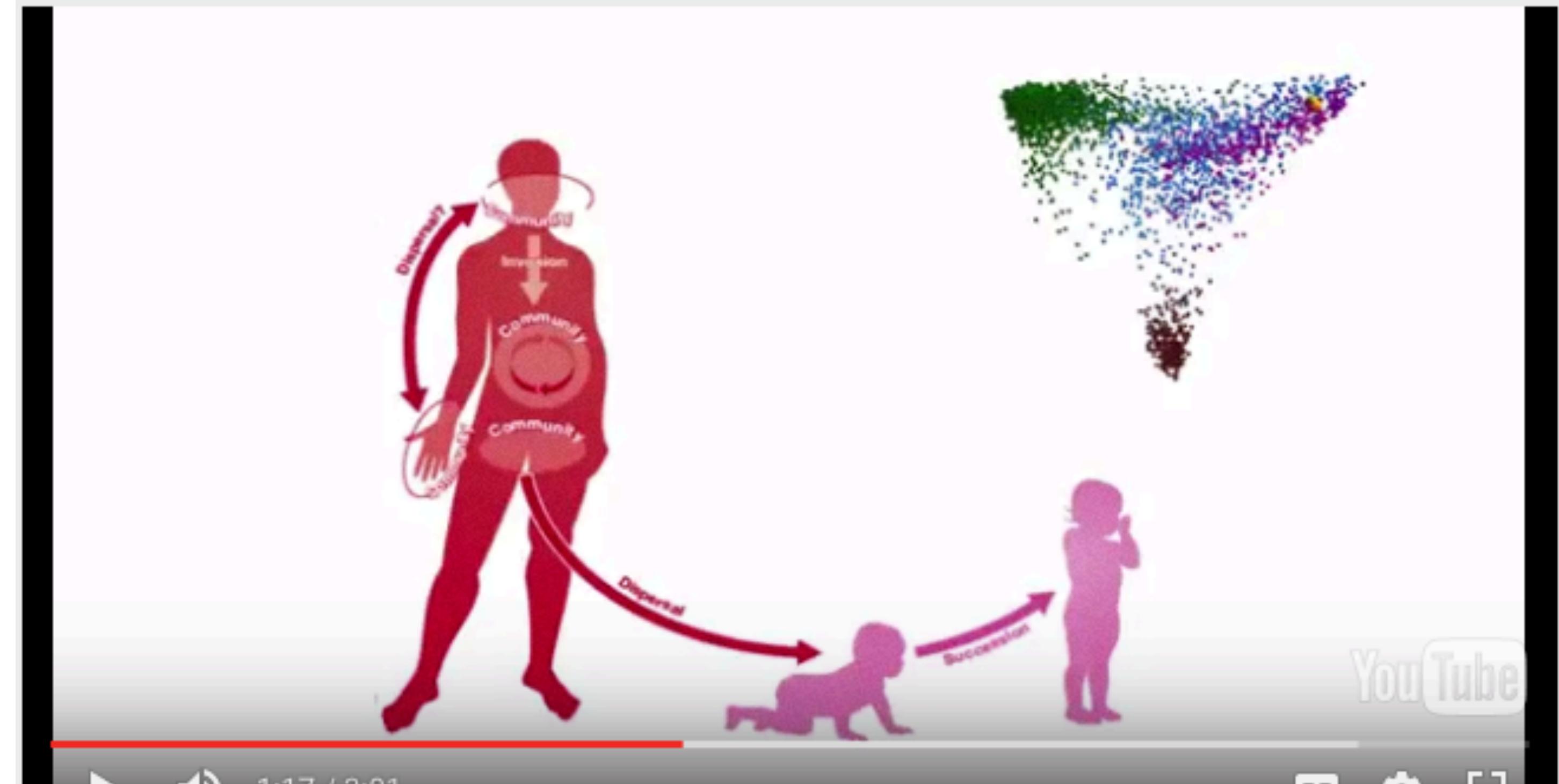
[Sign Up](#)

Visit Project Info Page:

<http://gutinstinct.ucsd.edu/info/>

Learn-Train-Ask

Let's get started! Here's a quick introduction about how gut microbiome affects your health before we dive deeper!



NEXT: LEARN HOW TO ASK INTERESTING AND USEFUL QUESTIONS!

Learn-Train-Ask

Cloud Let's get started!

Suppose you're a runner who's curious to understand how running might affect your health.

Q0: How does running affect health?

1. Answerable

2. Definite

3. A link between a cause and an effect

Your question should attempt to link an activity with a specific result, allowing others to agree/disagree and share their insights.

Q0: How does running affect health?

→ **Q1. How do you feel when you run?**

→ **Q2. Do you run daily? How do you feel then?**

→ **Q3. Is your digestion better when you run daily?**

Hint: Draw from your personal experience! Or even folk theories passed on in your family!

4. Operational

5. Simple

Learn-Train-Ask

Welcome > Step 1: Your question should be... > Step 2: Critique real questions

Have road-trips made you nauseated?

Is this question..

Answerable?

✓ ✗

Definite? (has a clear timeframe)

✓ ✗

A link between a cause and an effect? (links an activity with a specific result)

✓ ✗

Operational? (Terms are specific and unambiguous)

✓ ✗

Simple? (Does not have multiple factors wrapped in)

✓ ✗

Please explain your reasons about the quality of this question! You don't need to personally answer the question but describe why it matches (or does not match) criteria of questions just discussed in the Guide!

Learn-Train-Ask

Add your Gut Instinct here!

Step 1: Add top-level question and options

Step 2: Add follow-up question and options

Step 3: Add more follow up questions

Step 4: Start a discussion

Step 5: Add tags

Step 6: Add a URL/ Attach a file!

Step 7: Review and submit

Check if your questions meet these criteria!

1. Answerable: Others can answer it
2. Definite: Has a clear timeframe
3. Links cause with effect: An activity with a specific result
4. Operational: Terms are specific and unambiguous
5. Simple: Does not have multiple items wrapped in

Problem: Poor choice of options

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

Saved

regularity, diet,

(1 comment)



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

Are vegetarians more regular

- Are vegetarians more regular?
- Add my option

Save my choice(s)

Skip

Problem: Poor choice of options

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Saved

regularity, diet,

 (1 comment)



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

Are vegetarians more regular

- Are vegetarians more regular?
- Add my option

Save my choice(s)

Skip

Solution: Provide templated options

Yes _____ x

No _____ x

First Brand _____ x

Second Brand _____ x

Third Brand _____ x

Fourth Brand _____ x

Fifth Brand _____ x

0 lb _____ x

1 lb _____ x

2 lb _____ x

3 lb _____ x

4 lb _____ x

Never _____ x

1 time _____ x

2 times _____ x

3 times _____ x

4 times _____ x

GutBoard: Answer questions created by participants

The screenshot shows a web browser window with the URL https://hde.gutinstinct-ucsd.org/gutboard_slider. The page features a blue header with the GutBoard logo and the tagline "Straight from the Gut: How do your Gut Instincts compare to others?". Below the header, there are three navigation links: "ALL QUESTIONS! 22", "BOOKMARKED 0", and "WRITTEN 10". The main content area displays a question posted "a month ago" by "CITIZEN SCIENTISTS". The question is: "How many minutes after you wake up do you have a bowel movement?". It includes a red star icon. Below the question are several answer options with their counts and percentages: "Immediately after waking" (1 Answer(s) / 33%), "After 5-10 mins" (1 Answer(s) / 33%), "After 30 mins" (0 Answer(s) / 0%), "After 1 hour" (0 Answer(s) / 0%), and "More than 1 hour later" (1 Answer(s) / 33%). There is also a link to "Add my option". At the bottom of the question card, there are two buttons: "Saved" and a tag "bowelmovement".

① https://hde.gutinstinct-ucsd.org/gutboard_slider

GutBoard
Straight from the Gut
How do your Gut Instincts compare to others?

ALL QUESTIONS! 22 BOOKMARKED 0 WRITTEN 10

a month ago • Added by: CITIZEN SCIENTISTS

How many minutes after you wake up do you have a bowel movement?

Immediately after waking 1 Answer(s) / 33%

After 5-10 mins 1 Answer(s) / 33%

After 30 mins 0 Answer(s) / 0%

After 1 hour 0 Answer(s) / 0%

More than 1 hour later 1 Answer(s) / 33%

[Add my option](#)

Saved

bowelmovement

a month ago • Added by: CITIZEN SCIENTISTS

How many minutes after you wake up do you have a bowel movement?



 Edit this question

- Immediately after waking 1 Answer(s) / 33% 
- After 5-10 mins 1 Answer(s) / 33% 
- After 30 mins 0 Answer(s) / 0% 
- After 1 hour 0 Answer(s) / 0% 
- More than 1 hour later 1 Answer(s) / 33% 
- Add my option

Saved

bowelmovement

 (0 comments)



GutBoard: Add follow-on questions!

Dive deeper with these follow-up questions!

What strategies do you use to nudge a bowel movement in the morning?

 Edit this question  View original question

- Coffee

GutBoard: Answer follow- on questions created by other participants

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

Problem: Questions do not share personal insights

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

Saved

regularity, diet,

1 comment



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

Are vegetarians more regular

- Are vegetarians more regular?
- Add my option

Save my choice(s)

Skip

Problem: Questions do not share personal insights

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

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

Saved

regularity, diet,

1 comment



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

Are vegetarians more regular

- Are vegetarians more regular?
- Add my option

Save my choice(s)

Skip

Solution: Work with communities with specific concerns

Welcome to Gut Instinct!

Please select a platform to use Gut Instinct

#IBD

IBD is the micro-platform for inflammatory bowel disease.

ENTER PLATFORM

#DIABETES

DIABETES is the micro-platform for diabetes.

ENTER PLATFORM

Problem: Questions do not share personal insights

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](#)

Saved

regularity, diet,

 (1 comment)



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

Are vegetarians more regular

- Are vegetarians more regular?
- [Add my option](#)

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

Skip

Solution: Work with communities with specific concerns

Welcome to Gut Instinct!

Please select a platform to use Gut Instinct





NO STOMACH FOR CANCER®
Supporting Research. Empowering Families.

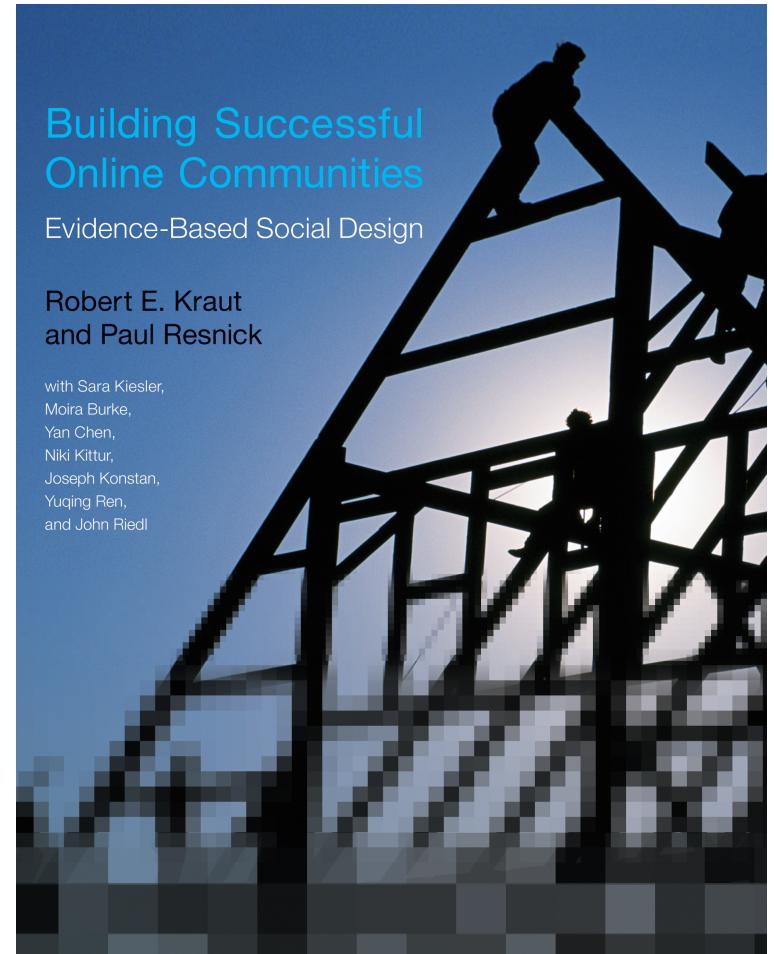
Topics (advanced): Learn about specific conditions

1. Gut-Brain Axis
2. Autoimmune diseases
3. Gut diseases

The screenshot shows a web browser window with the URL <https://staging.gutinstinct-ucsd.org/topics>. The page title is "Follow Your Gut" with a blue notebook icon. Below it says "Choose among following topics to understand your gut!". A sidebar on the left lists "Gut Brain Axis" and "Autism". The main content area is a grid of four boxes:

Autism	Introduction
Gut Brain Axis	Gut Brain Axis
Autism - Gut Brain Axis	Introduction - Gut Brain Axis
Autism Gut Brain	Stress Depression
Gut Brain Axis	Gut Brain Axis
Autism Gut Brain - Gut Brain Axis	Stress Depression - Gut Brain Axis

Building engagement: Notifications + social media



Welcome to Gut Instinct! 3 things you can do right now..

gutinstinct@ucsd.edu to me 7:23 PM (14 hours ago)

american gut GUTINSTINCT

Hello Vineet!

Welcome to Gut Instinct - we're excited to have you onboard! You have joined a lively community of online citizen scientists who will discuss your insights about your health to find answers to puzzles of the gut microbiome! That's not all, trained gut researchers will work with you to learn novel things about your gut and to share their knowledge.

3 things you can do right now:

- Add a question
- Join a discussion
- Prepare for Gut Instinct

We are excited to hear your ideas.

Cheers,



Embriette for American Gut Project and Gut Instinct

Login →

Gut Instinct @GutInstinctUCSD

#gutinstinct highlight of the day: "Ever wonder how much biome you share with your pets?" @KnightLabNews is on it! go.ucsd.edu/2n9kpE5

Man's Best Germs: Does Your Dog Influence Your Health?

By Heather Buschman, PhD | May 07, 2015 Share This Article

Our bodies contain around eight million genes. Yet only about 0.3 percent are human. The rest come from your microbiome — the sum total of genes from the numerous microbes (mostly bacteria, but also viruses, yeasts and fungi) that coat your skin, mouths, gut lining — just about everything.



Far from inert, many studies suggest your own health, and susceptibility to disease, may depend on your microbiome. And any number of lifestyle factors can influence your microbiome, things like diet, antibiotic use and even the people we live with. While a person might only have 10 percent of their microbiomes in common with a random stranger, people who live together share more microbial populations in common.

Research has even shown that you and your dog share similar microbial populations — raising questions about how your dog might affect your health, too.

You and your dog

"With a fair amount of precision, we could pick your dog out of a crowd based solely on microorganisms," said Rob Knight, PhD, professor of pediatrics and computer science and engineering at UC San Diego.

RETWEETS 11 LIKES 9

7:42 PM - 22 Mar 2017

Hey Vineet! New discussion comment has been added to your question on Gut Instinct ★

gutinstinct to me May 25 ***

american gut GUTINSTINCT

Hello Vineet,

New discussion comment has been added to the your question:
"Which kind of alcohol do you drink frequently?"

View discussion →

Goal: Roll out Gut Instinct to
10,000+ american gut participants



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,  (1 comment) 

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](#)

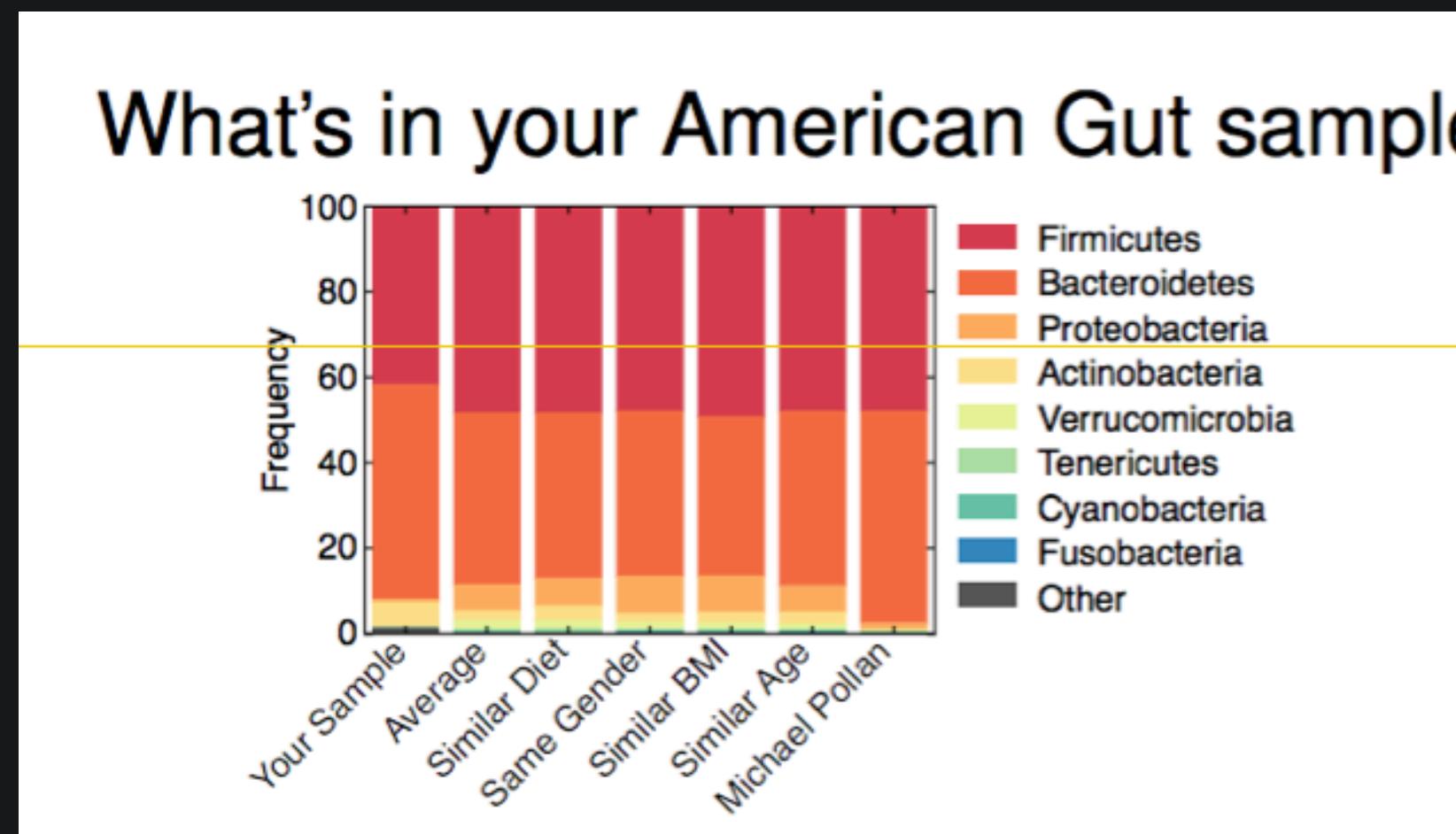
Requires clinical expertise to answer

Requires novices to understand limitations of nascent scientific domains

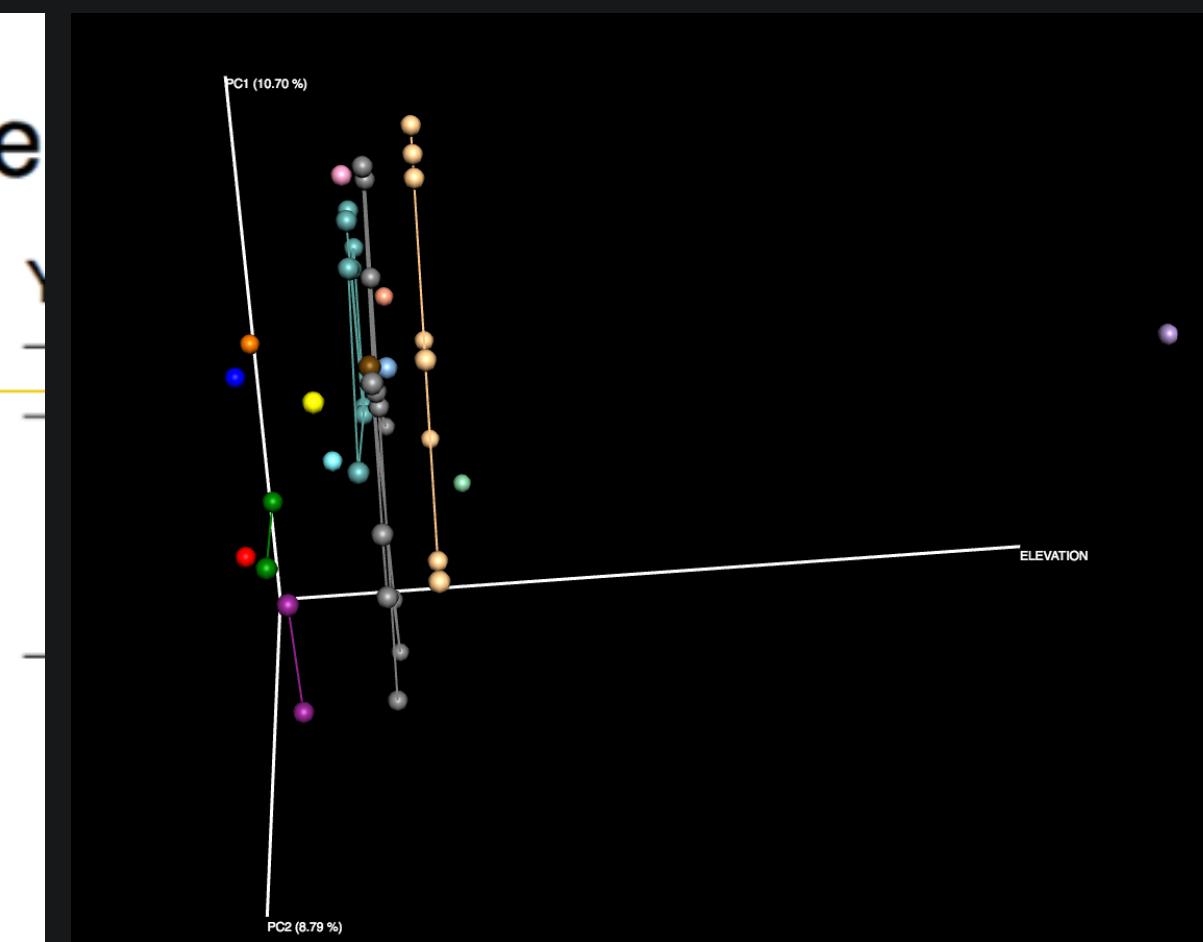
Microbiome science is far from providing prescriptive information

Requires substantial investment of time too!

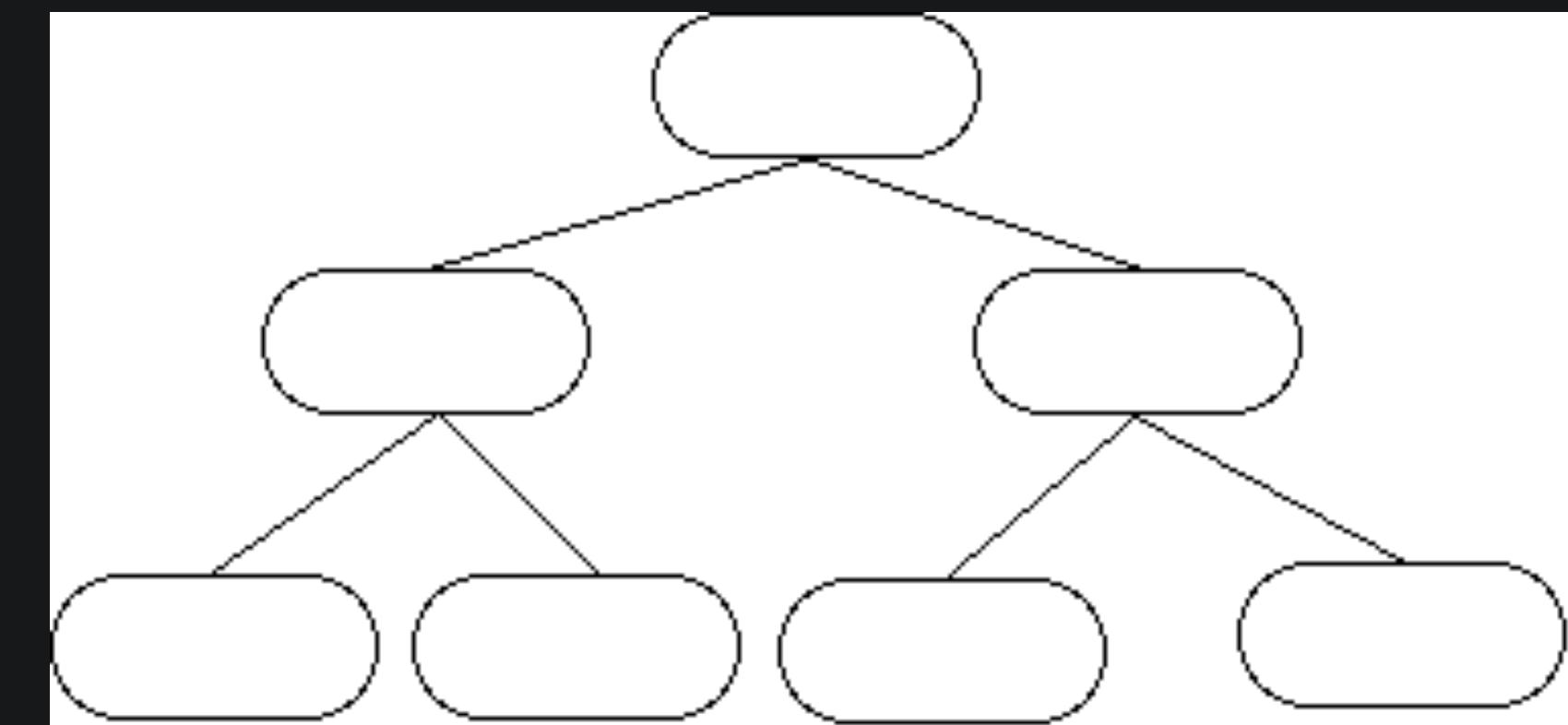
Challenge: Understanding multivariate microbiome data with crowd-responses is hard



Microbiome data is difficult to interpret



PCoA plots confuse novices

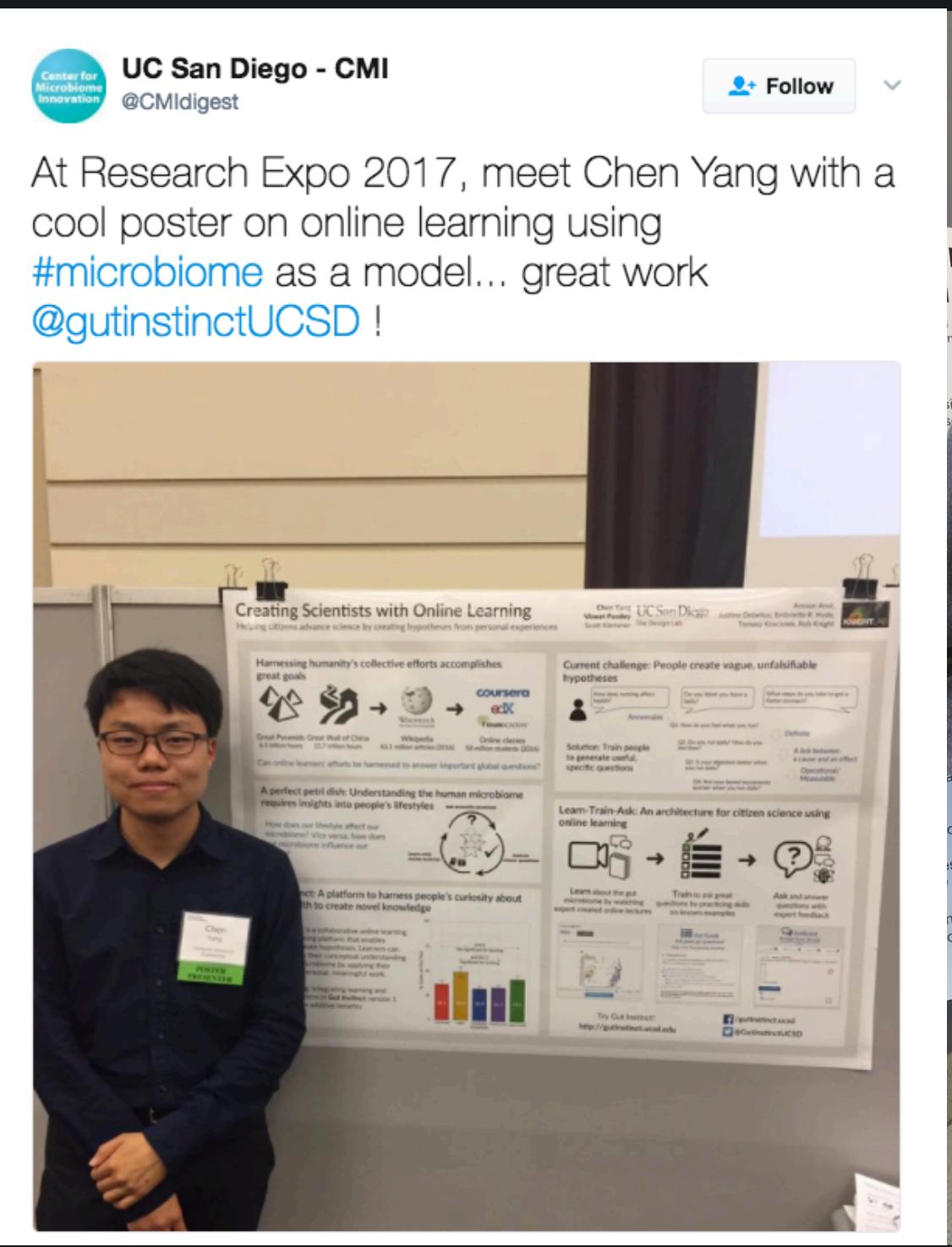
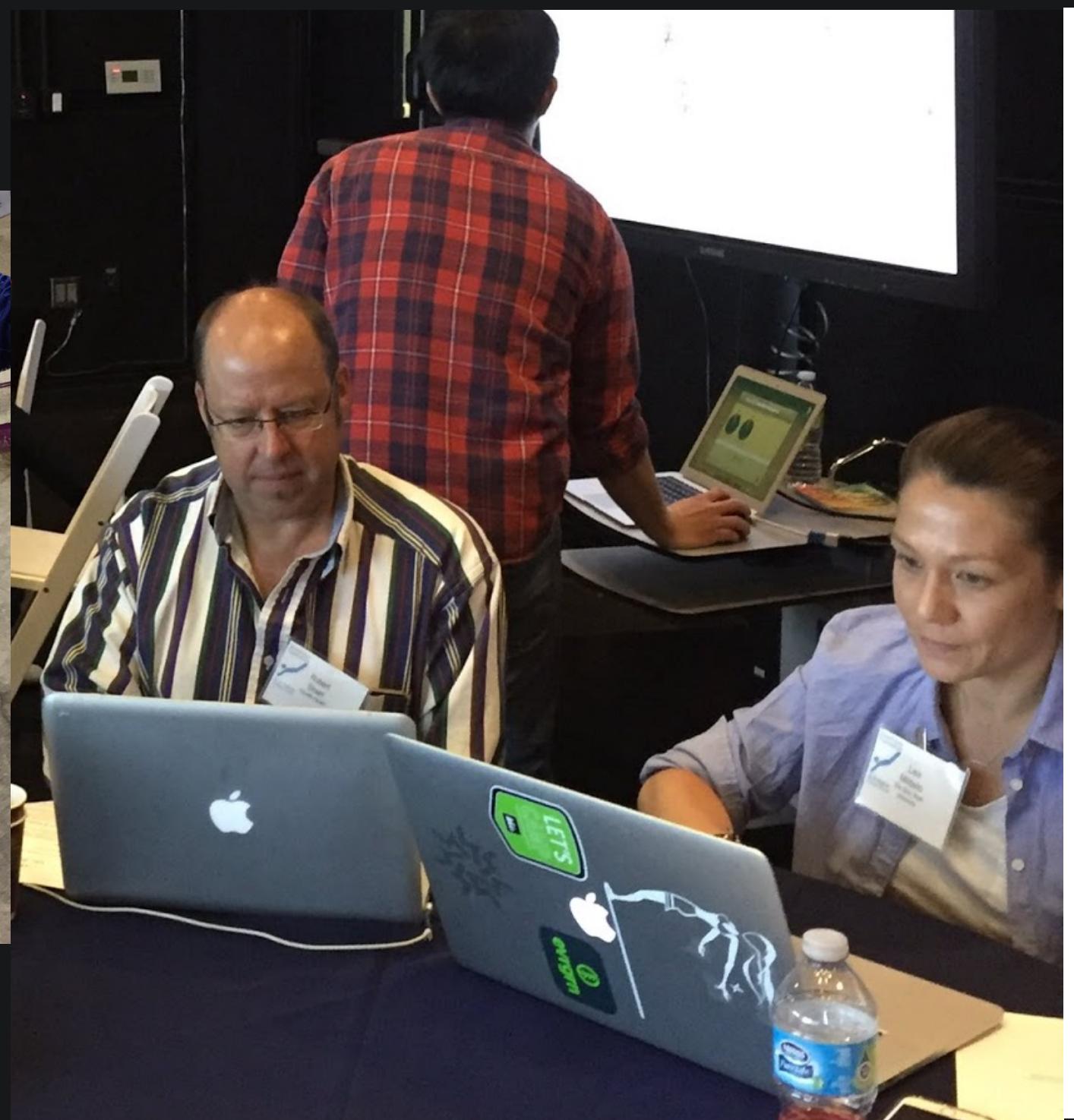
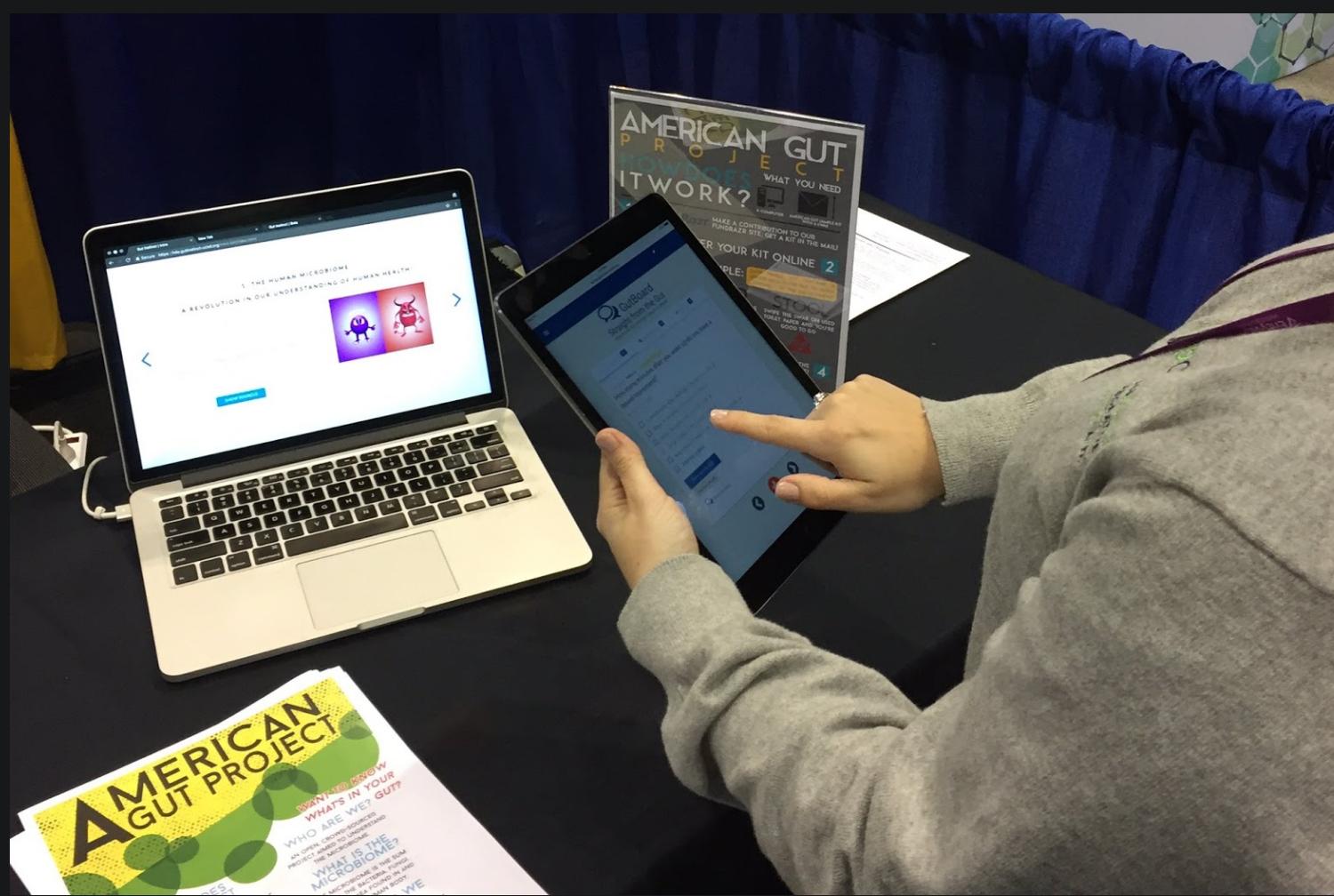


Running analysis without expert support is not possible

Measures of success

1. Modifications to official American Gut survey
2. Expert-run controlled experiments to test hypotheses
3. Participant-run experiments to test hypotheses

Docent has been deployed at HDE workshop and with 50 AG users; Poster presented at multiple venues



From intuition..

..to questions (*Gut Instinct: Learn-Ask-Answer*)

..to hypotheses (*Docent: Learn-Train-Ask*)

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



Justus Sustermans. **Portrait of Galileo Galilei.** 1636.

https://commons.wikimedia.org/wiki/File:Justus_Sustermans_-_Portrait_of_Galileo_Galilei,_1636.jpg

Self-tracking and self-experimentation are useful but..

TummyTrials: A Feasibility Study of Using Self-Experimentation to Detect Individualized Food Triggers

Ravi Karkar¹, Jessica Schroeder¹, Daniel A. Epstein¹, Laura R. Pina^{1,2}, Jeffrey Scofield¹, James Fogarty¹, Julie A. Kientz², Sean A. Munson², Roger Vilardaga³, Jasmine Zia⁴

¹Computer Science & Engineering, ²Human Centered Design & Engineering, ⁴Division of Gastroenterology DUB Group, University of Washington, Seattle, WA, United States

³Center for Addiction Science and Technology, Duke University, Durham, NC, United States
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Self-Experimentation for Behavior Change: Design and Formative Evaluation of Two Approaches

Jisoo Lee

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Erin Walker

School of Computing, Informatics,
and Decision Systems Engineering
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Matthew Buman

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Eric B. Hekler

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Arizona State University
ehekler@asu.edu

Session: Citizen Science

CSCW 2017, February 25–March 1, 2017, Portland, OR, USA

Soylent Diet Self-Experimentation: Design Challenges in Extreme Citizen Science Projects

Markéta Dolejšová

National University of Singapore
11 Computing Drive, Singapore 117416
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Denisa Kera

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Self-tracking for Mental Wellness: Understanding Expert Perspectives and Student Experiences

Christina Kelley¹, Bongshin Lee², Lauren Wilcox¹

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Georgia Institute of Technology
{christina.kelley, wilcox}@gatech.edu

²Microsoft Research
bongshin@microsoft.com

..they do not create generalizable scientific knowledge

1. Not broadly applicable

Random assignment needed

2. Not blinded

Placebo effects can account for 70% of effects

RCTs > N=1 studies

Lithium delays progression of amyotrophic lateral sclerosis

Francesco Fornai^{*†‡}, Patrizia Longone[§], Luisa Cafaro[†], Olga Kastsiuchenka^{*}, Michela Ferrucci^{*}, Maria Laura Manca[†], Gloria Lazzari^{*}, Alida Spalloni[§], Natascia Bellio[†], Paola Lenzi^{*}, Nicola Modugno[†], Gabriele Siciliano[§], Ciro Isidoro[†], Luigi Murri[†], Stefano Ruggieri[†], and Antonio Paparelli^{*}

PNAS

^{*}Department of Human Morphology and Applied Biology, and [†]Department of Neuroscience, Clinic "Istituto Neurologico Mediterraneo, Istituto Di Ricovero e Cura a Carattere Scientifico Neuromed, Bari, Italy; [‡]Neurogenetics Unit, Santa Lucia Foundation, 00179 Rome, Italy; and [§]Department of Medical Sciences, University of Novara, 28100 Novara, Italy

Edited by Thomas C. Südhof, University of Texas Southwestern Medical Center, Dallas, TX, and approved December 21, 2007 (received for review August 24, 2007)

ALS is a devastating neurodegenerative disorder with no effective treatment. In the present study, we found that daily doses of lithium, leading to plasma levels ranging from 0.4 to 0.8 mEq/liter, delay disease progression in human patients affected by ALS. None of the patients treated with lithium died during the 15 months of the follow-up, and disease progression was markedly attenuated when compared with age-, disease duration-, and sex-matched control patients treated with riluzole for the same amount of time. In a parallel study on a genetic ALS animal model, the G93A mouse, we found a marked neuroprotection by lithium, which delayed disease onset and duration and augmented the life span. These effects were concomitant with activation of autophagy and an increase in the number of the mitochondria in motor neurons and suppressed reactive astrogliosis. Again, lithium reduced the slow necrosis characterized by mitochondrial vacuolization and increased the number of neurons counted in lamina VII that were severely affected in saline-treated G93A mice. After lithium administration in G93A mice, the number of these neurons was higher even when compared with saline-treated WT. All these mechanisms may contribute to the effects of lithium, and these results offer a promising perspective for the treatment of human patients affected by ALS.

autophagy | clinical study | G93A mice | morphological analysis

G93A ALS mouse model. Based on the promising data, we obtained in mice we quickly moved into a clinical trial, which is now at the end of its second year.

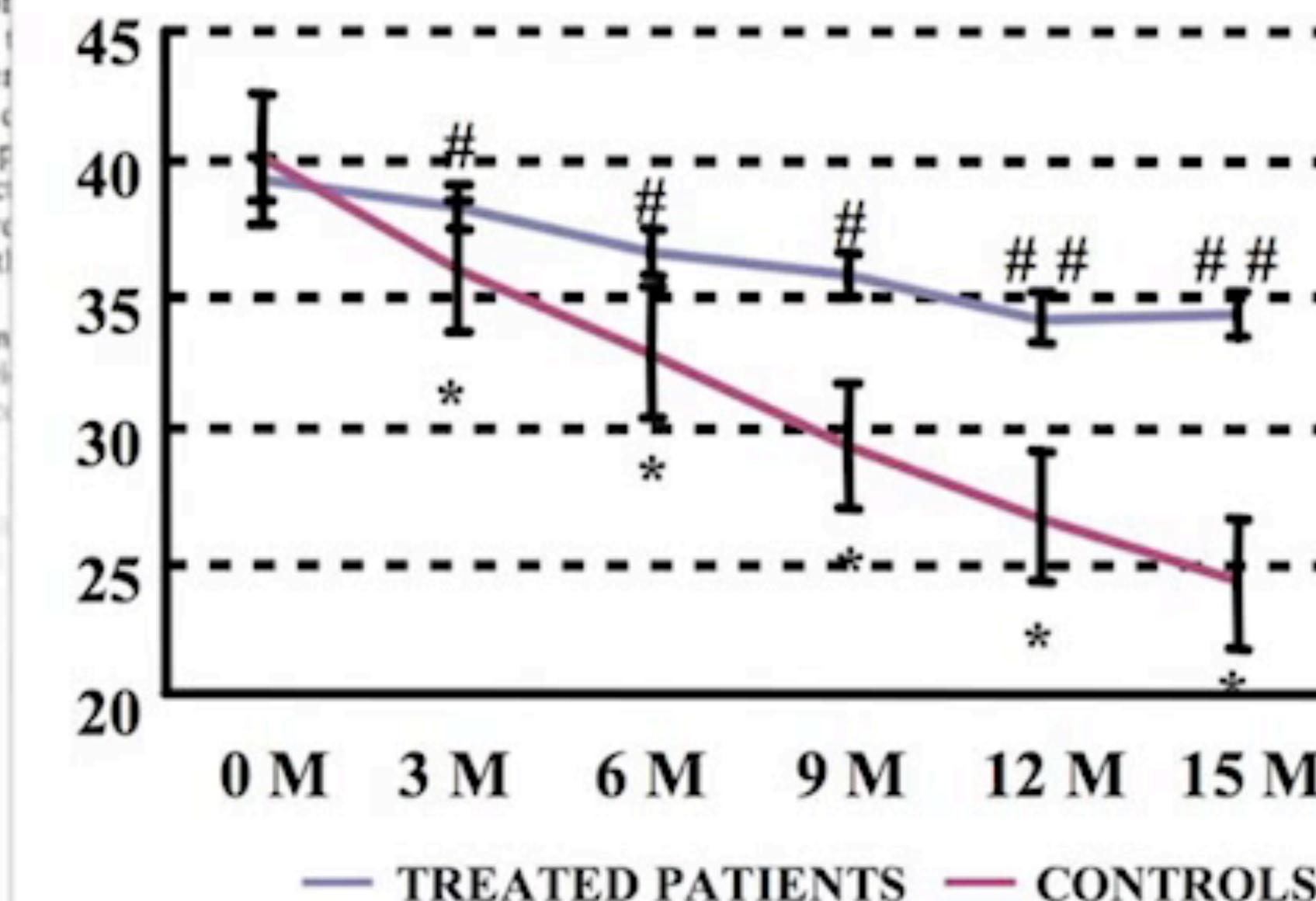
Results

Effects of Lithium on Disease Duration and Survival in G93A Mice.

G93A male mice were treated daily with lithium carbonate (1 mEq/kg, i.p.), significantly prolonged the mean survival time to 148 ± 4.3 ($n = 10$; $P < 0.001$) at 12 months (from a mean of 108 days of age) compared with the untreated mice. The lithium treatment also increased the increase in the number of neurons in the lumbar and limb adductor muscles shown). More specifically, the number of neurons in the lumbar and limb adductor muscles was increased in the lithium-treated mice compared with the untreated mice. Additional tests we performed included the assessment of the hindlimb grip strength and stride length.

Effects of Lithium on Disease Duration and Survival in G93A Mice. Lumbar and Cervical motor neuron counts were assessed at 12 months of age (SI Fig. 1). The disease course occurred later in the lithium-treated mice than in the untreated mice. Within the lumbar and cervical motor neuron counts, the number of neurons was comparable between the two groups, but the percentage of degenerated neurons was lower in the lithium-treated mice.

ALSFRS-R (raw data)

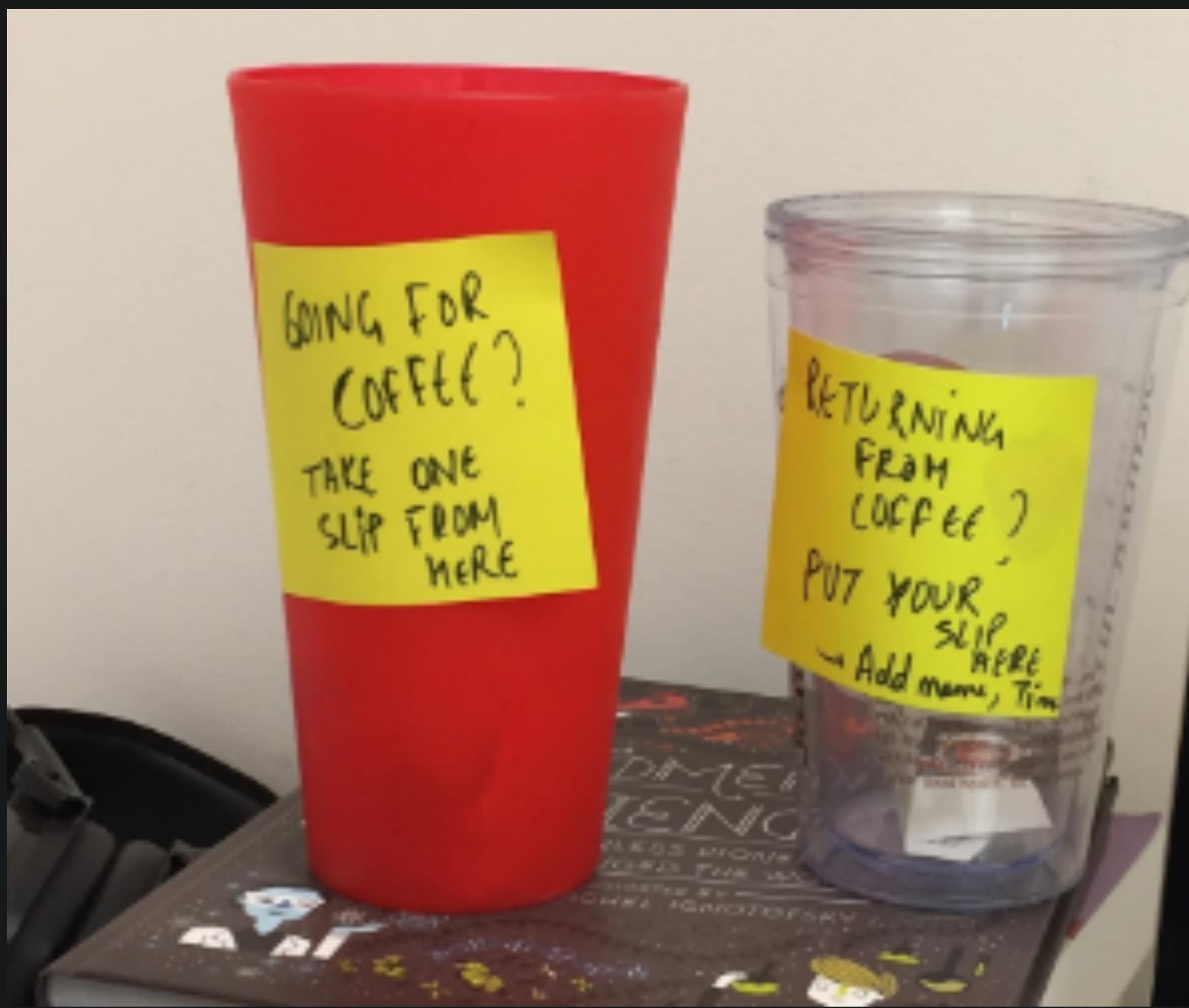


Your data doing
good: The
Lithium study
from
PatientsLikeMe.
<https://vimeo.com/149413987>

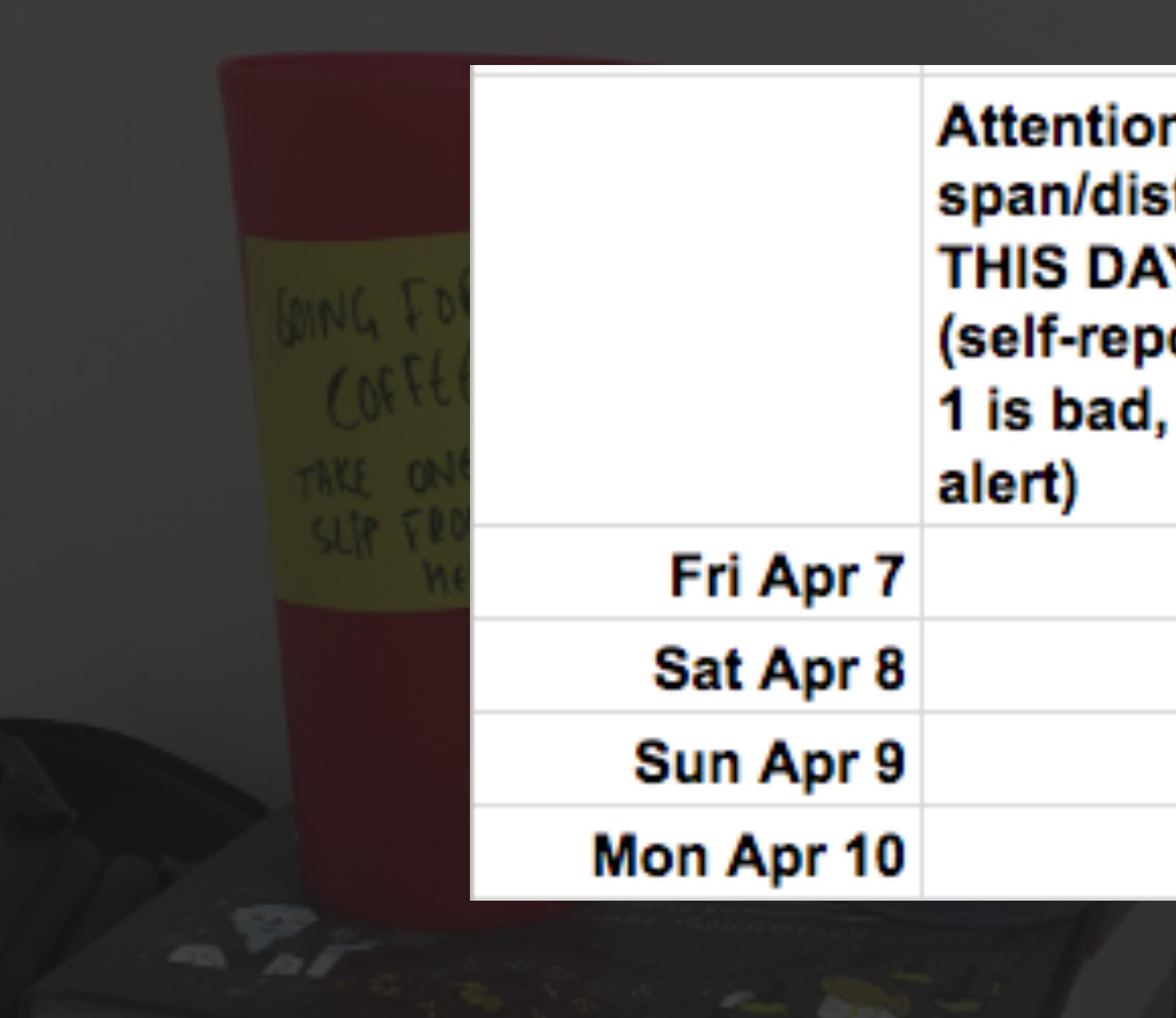
patientslikeme®

How can a crowd self-organize to design and run experiments?

Pilot with 4 lab members: How does drinking coffee affect quality of sleep?

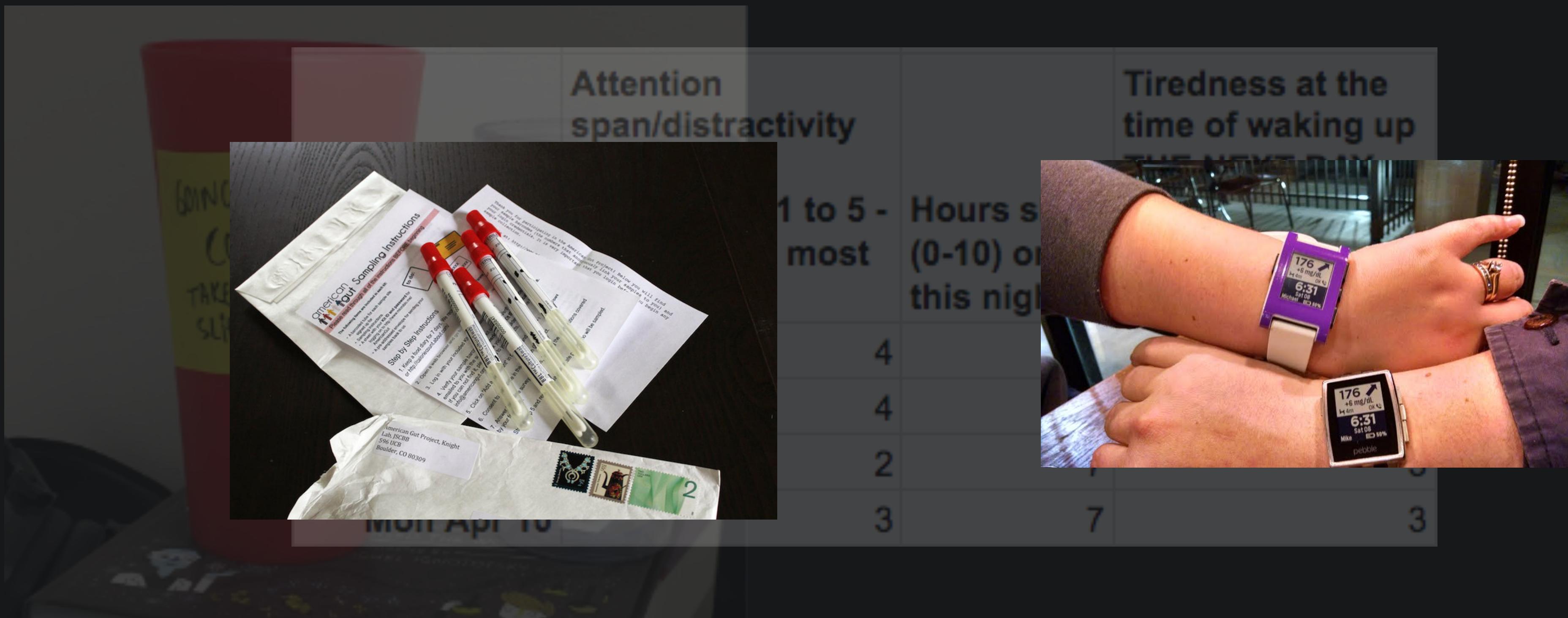


Pilot with 4 lab members: How does drinking coffee affect quality of sleep?



	Attention span/distractivity THIS DAY <small>(self-report: 1 to 5 - 1 is bad, 5 is most alert)</small>	Hours slept (0-10) on this night	Tiredness at the time of waking up THE NEXT DAY <small>(self-report: 1-5 where 1 is very tired)</small>
Fri Apr 7	4	7.5	3
Sat Apr 8	4	7	4
Sun Apr 9	2	7	3
Mon Apr 10	3	7	3

Pilot with 4 lab members: How does drinking coffee affect quality of sleep?

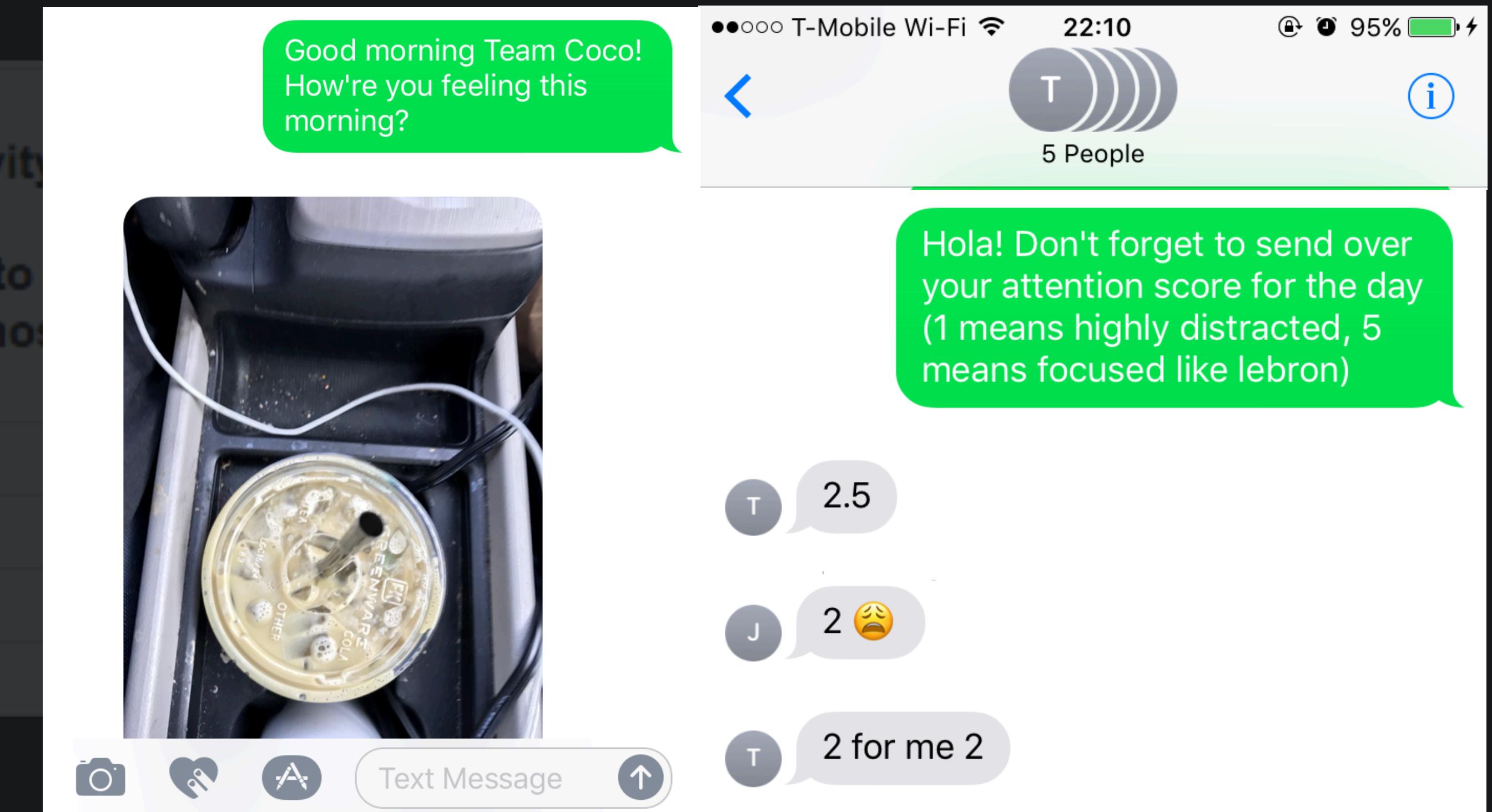
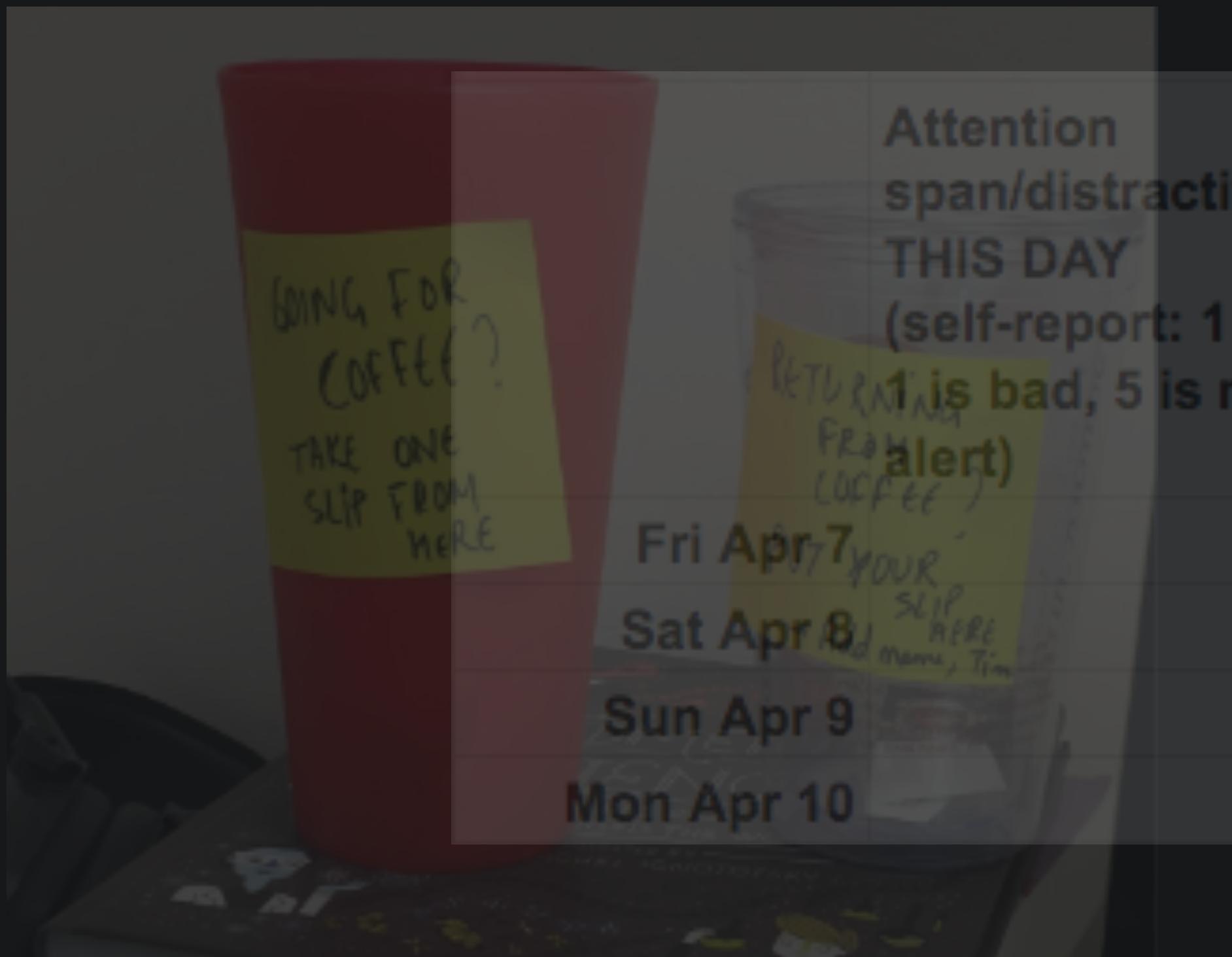


Pilot with 4 lab members: How does drinking coffee affect quality of sleep?

The image shows a clipboard with handwritten notes and a smartphone screen. The clipboard has a red background with a yellow sticky note in the center. The sticky note contains the text: "GOING FOR COFFEE?", "TAKE ONE SLIP FROM HERE", "RETURNING FROM COFFEE", and "alert". Above the sticky note, it says "Attention span/distractivity THIS DAY (self-report: 1 to 5 - 1 is bad, 5 is most alert)" and "Fri Apr 7 YOUR SLIP HERE name, Tim". To the right of the clipboard is a smartphone screen showing a messaging app. The top status bar shows signal strength, T-Mobile Wi-Fi, 22:10, battery level at 95%, and a lock icon. The messaging screen shows a group chat with 5 people. A message from 'T' in a green bubble reads: "Hola! Don't forget to send over your attention score for the day (1 means highly distracted, 5 means focused like lebron)". Below this, messages from 'T', 'J', and 'T' show attention scores: "2.5", "2 😞", and "2 for me 2".

	Attention span/distractivity THIS DAY (self-report: 1 to 5 - 1 is bad, 5 is most alert)	Hours slept (0-10) on this night	Tiredness at time of waking THE NEXT DAY (self-report: 1 where 1 is very tired)
Fri Apr 7	4	7.5	
Sat Apr 8	4	7	
Sun Apr 9	2	7	
Mon Apr 10	3	7	

Pilot with 4 lab members: How does drinking coffee affect quality of sleep?



Heuristics: How can novices design and run experiments as scientists?

1. Learning by doing > Learning-then-doing
2. Automatically create tracking sheets
3. Train people about common biases

C ⓘ localhost:3000/galileo ⋮

> Phase 1-Provide your hypothesis

1.1 : Convert your intuition into a hypothesis

Let's begin with an intuition you have about your health. Think of activities that affect your gut.

Not eating meat reduces IBD symptoms

A **hypothesis** is a statement that links one cause with one effect. To automatically identify the cause, effect and relationship in your intuition, use the format given below to rewrite your intuition as a hypothesis.

Cause	Relation	Effect
Not eating meat	decreases	IBD symptoms

These examples might help :

Eating cabbage	increases	bloating
Drinking 3 cups of coffee everyday	decreases	number of bowel movements

> Phase 1-Provide your hypothesis

1.1 : Convert your intuition into a hypothesis

Let's begin with an intuition you have about your health. Think of activities that affect your gut.

Not eating meat reduces IBD symptoms

A hypothesis is a statement that links one cause with one effect. To automatically identify the cause, effect and relationship in your intuition, use the format given below to rewrite your intuition as a hypothesis.

Cause	Relation	Effect
Not eating meat	decreases	IBD symptoms

These examples might help:

Eating cabbage increases
Drinking 3 cups of coffee everyday decreases

Examples: good and bad

> Phase 1-Provide your hypothesis

Here are a few questions/intuitions/statements that are NOT specific enough to be a hypothesis

- "Running improves health"

Whats wrong : Both the cause ("Running") and the effect ("Health") need to be specific.

Improved hypothesis : "Running for 30 mins daily improves quality of sleep"

Not eating meat reduces IBD symptoms

1.2 : Improve your odds of a successful experiment

Remember, *the main purpose of an experiment is to vary the cause (independent variable) and track the effect (the dependent variable). So we need to ensure that we can measure them in some way!*

Do you think your cause and effect can be measured? Or do you need to convert them to something concrete?

These examples might help:	Eating cabbage	increases	bloating
	Drinking 3 cups of coffee everyday	decreases	number of bowel movements

Checklist

Templates

The screenshot shows a web browser window at localhost:3000/galileo. The title bar says 'Phase 1-Provide your hypothesis'. The main content area has a section titled '1.3 : Measure your cause' with the cause listed as 'Cause : Not eating meat'. Below this, a question asks 'How would you measure the cause? We provide some templates below but you can also add your own options. Select all that apply :'. There are three options: 'Absence or Presence (?)' (checked), 'Amount (?)', and 'Severity (?)'. Each option has a detailed description and an example. A dropdown menu shows 'once a day' as the selected frequency.

localhost:3000/galileo

> Phase 1-Provide your hypothesis

1.3 : Measure your cause

Cause : Not eating meat

How would you measure the cause? We provide some templates below but you can also add your own options. **Select all that apply :**

[Absence or Presence \(?\)](#)
If you want to measure your cause as a Yes/No value. Yes means the cause is present, No means cause is absent. E.g. a headache could be present or absent

How often do you want to take this measurement? once a day ▾

[Amount \(?\)](#)
If you want to measure a numerical amount by which the cause varies. E.g. weight measured in pounds, miles ran etc

[Severity \(?\)](#)
If your cause can't be measured by a number directly. Recommended if your cause can be described by a feeling. E.g. the severity of headache can be measured on a scale of 1-5, 5 being most severe

[BACK](#) [NEXT](#)

Share hypotheses and measures for feedback

The screenshot shows a web browser window with the URL localhost:3000/galileo. The page title is "Phase 1-Provide your hypothesis". A blue header bar indicates "Phase 1 of 4 completed". The main content area contains a message from another user: "Hi there! I'm running an experiment to figure out if Staring at LCD screen for an extended period adversely affects my eyesight. I would love to collaborate with you to see what we can find! You can find the experiment at [this link](#)". Below this, a note says "Hitting share will post a preliminary version of your experiment with the above message on the Galileo forum. You may continue with your experiment design after submitting." At the bottom are "BACK" and "SHARE & CONTINUE" buttons.

localhost:3000/galileo

> Phase 1-Provide your hypothesis

Phase 1 of 4 completed

Now is the time to review your work and get some feedback. Share your experiment with other interested participants using the invite message below. Your goal in providing feedback

1. Does the hypothesis **clearly link one cause with one effect**?
2. Is the **cause** specific? Can it be measured using details in the summary?
3. Is the **effect** specific? Can it be measured using details in the summary?

Hi there! I'm running an experiment to figure out if Staring at LCD screen for an extended period adversely affects my eyesight. I would love to collaborate with you to see what we can find! You can find the experiment at [this link](#)

Hitting share will post a preliminary version of your experiment with the above message on the Galileo forum. You may continue with your experiment design after submitting.

BACK

SHARE & CONTINUE

> Phase 1 > Phase 2-Design an experiment

2.1 : Create a controlled experiment

Galileo will enable you to design a between-subjects randomized controlled experiment.

1. Between-subjects

Each participant is placed in one condition - E.g. if you're testing the effect of "brand A" probiotic yogurt on sleep quality, some people will ALWAYS consume "brand A" probiotic yogurt while others will ALWAYS consume normal yogurt.

2. Randomized

3. Controlled experiment

4. Blind

BACK

NEXT

**Phase 3: Pilot
the experiment**

**Phase 4: Run
and analyze
the experiment**

Galileo learning system has two objectives

1. Teach people how to design and run experiments
2. Create useful scientific knowledge while enabling people to answer personally meaningful questions

Measures of success

First self-organized, community-reviewed experiment

Learning gains about the scientific process and conceptual understanding of the topic

Challenges

1. Maximizing chances of a domain-specific successful experiment?
2. Encourages pseudo-science?
3. Technical support to analyze and interpret the results?

Is this ethical?

1. Experts do not nudge participants into running any experiments
2. IRB allows removing participants for their own safety

Project 161235: Tools for collaborative citizen science - under review with addition of experimentation bit



UNIVERSITY OF CALIFORNIA, SAN DIEGO
HUMAN RESEARCH PROTECTIONS PROGRAM

TO: Dr. Scott Klemmer

RE: Project #161235S Tools for collaborative citizen science

Dear Dr. Klemmer:

The above-referenced project was reviewed and approved by one of this institution's Institutional Review Boards in accordance with the requirements of the Code of Federal Regulations on the Protection of Human Subjects (45 CFR 46 and 21 CFR 50 and 56), including its relevant Subparts. This approval, based on the degree of risk, is for 365 days from the date of IRB review and approval unless otherwise stated in this letter. The regulations require that continuing review be conducted on or before the 1-year anniversary date of the IRB approval, even though the research activity may not begin until some time after the IRB has given approval.

A waiver of documented written consent has been granted for this study under CFR 46.117 (c)(2) the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is required outside the research for the survey portion of the study. Consent will be implied with the initiation and/or completion of the online survey after review of study information. Written consent will be obtained from students for the in-person interview portion of the research study.

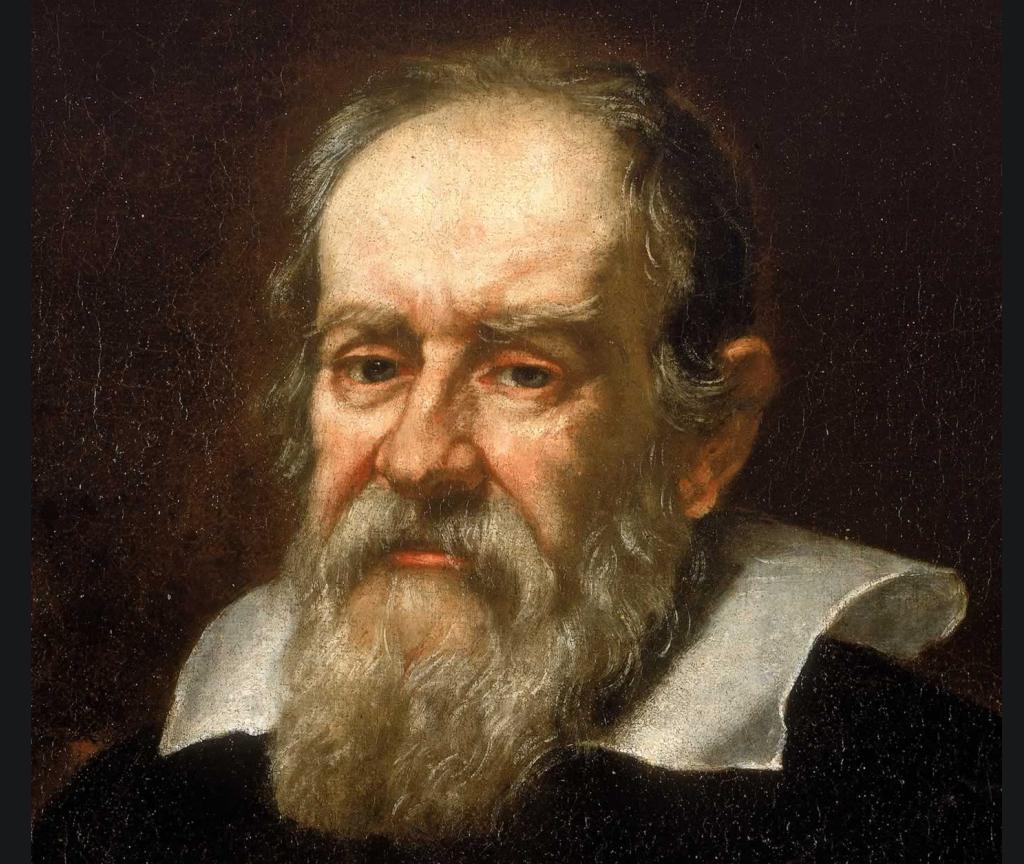
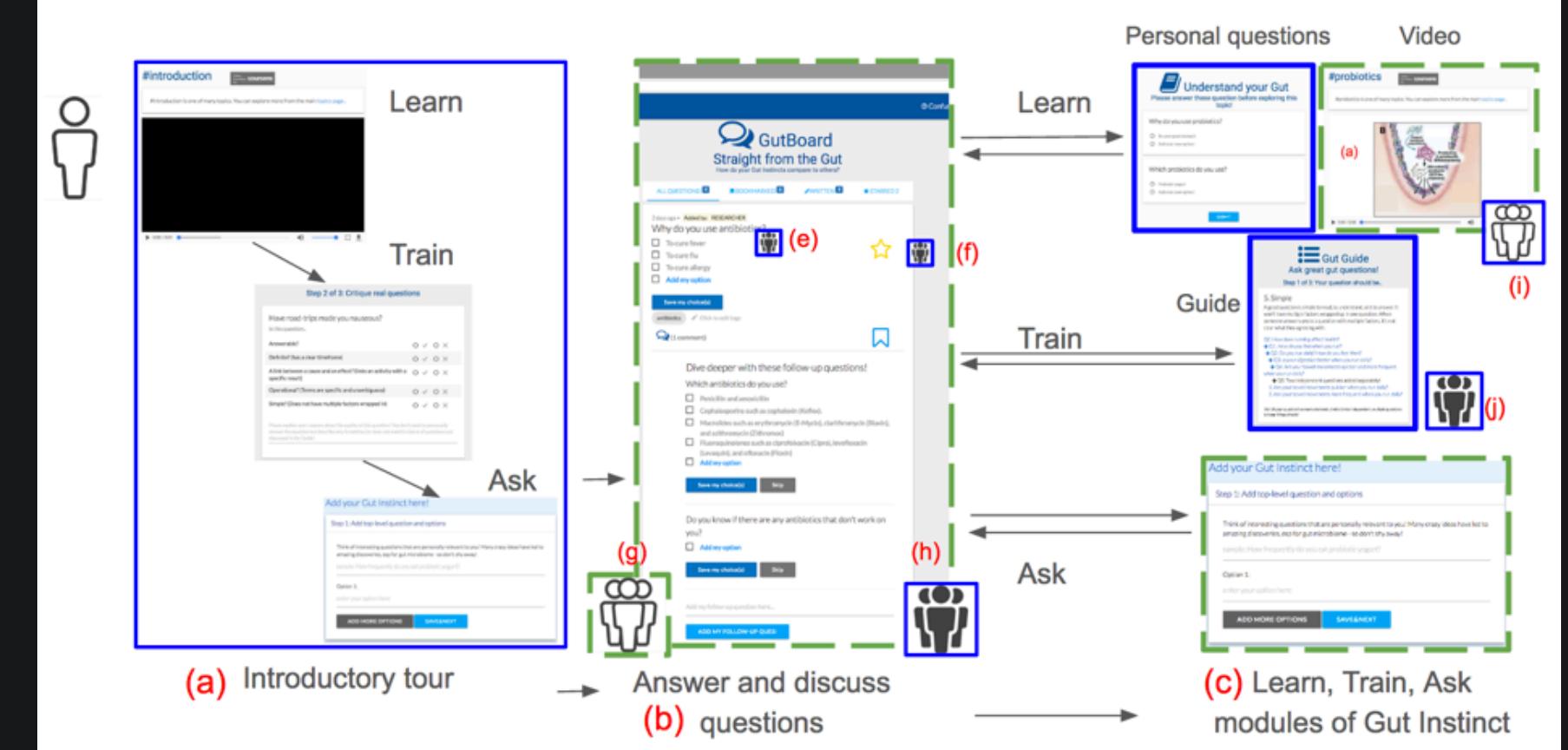
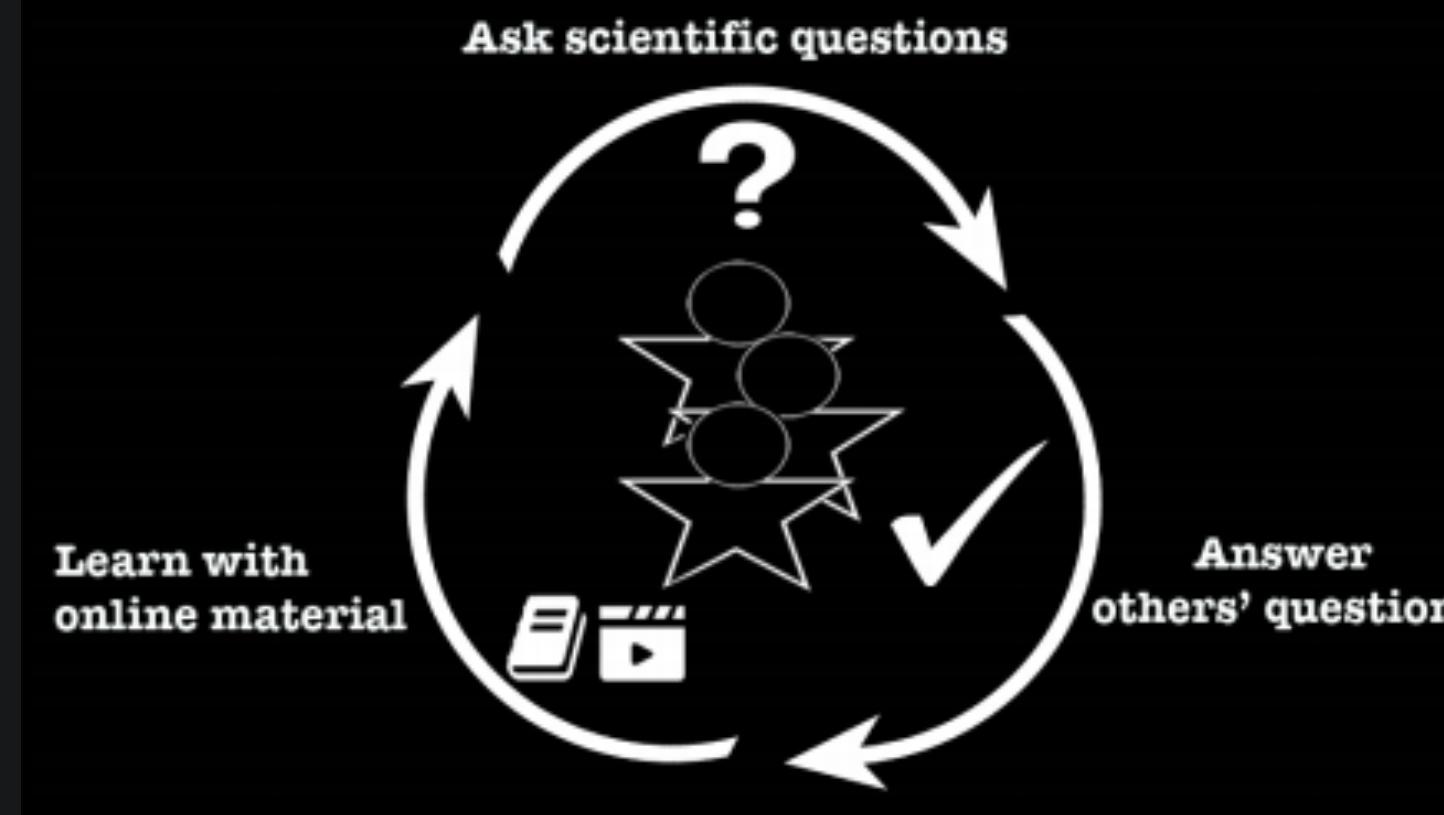
The IRB determined that this project presents no more than minimal risk to human subjects in that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

From intuition..

..to questions (*Gut Instinct: Learn-Ask-Answer*)

..to hypotheses (*Docent: Learn-Train-Ask*)

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



Intellectual Contributions

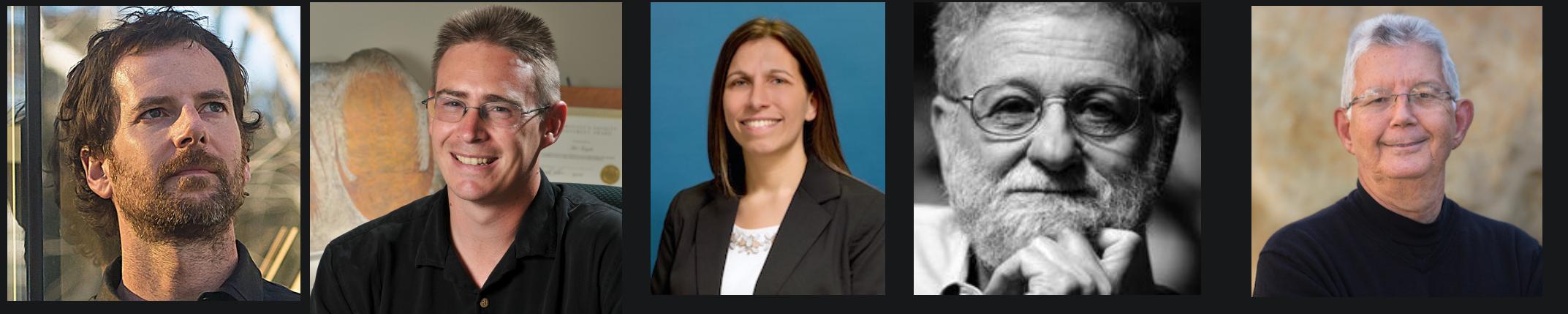
1. An architecture integrating online learning with scientific work
2. A workflow enabling people to rapidly test their intuitions
3. Integrating traditional science with work performed by distributed communities@scale+diversity of the internet

Broader Contributions

1. Improve scientific understanding among people
2. Enable lead-users to informally validate their innovations
3. Open-source software for all systems and studies: all code and analysis scripts

Month	Milestone	Details	External results (talks/submissions)
2017 Summer	Docent public deployment	Docent - Study with specific usersets Galileo - Prelim study	Submit to CHI 2018: Docent and Galileo Talk: Doctoral Consortium@UIST 2018
	Online platform integration	Integrate Docent&Galileo with online classes (Coursera, EdX) / full Docent deployment	Possible collaboration with Universidad de Costa Rica / Indian Univs
2018 Winter	Galileo public deployment	Add statistical analysis module, full-scale deployment (including classrooms)	Submit to UIST 2018: Galileo automated tool paper
	Integrate GI + Galileo	Improve efficiency: Reduce turnaround time for results	–
	Galileo for other domains	Participant driven end-to-end science in multiple domains; debate open questions in crowdsourced science	Submit to CHI 2019: Galileo+* work Talk: HCI Consortium
Fall			–
2019 Winter+Spring		Write Thesis <u>Defend in Spring 2019</u>	Faculty job talks

Thank You



Embriette

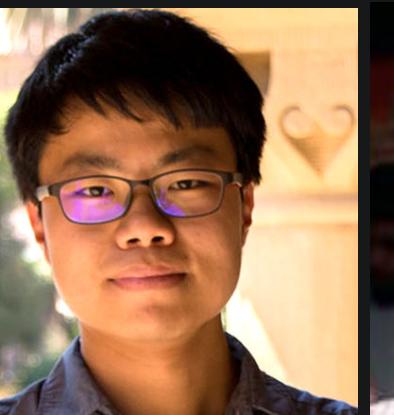
Justine

Tomasz

Amnon



Brian



Chen



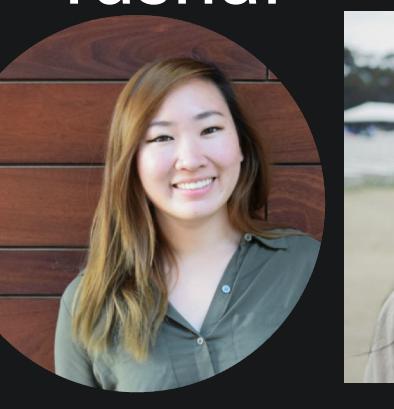
Tushar



Catherine



Ailie



Rachel



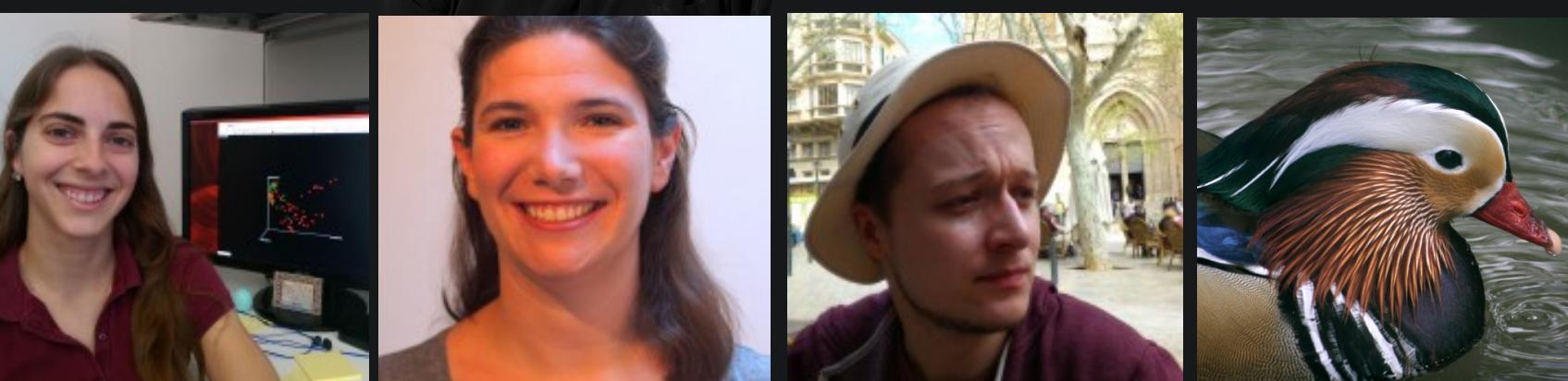
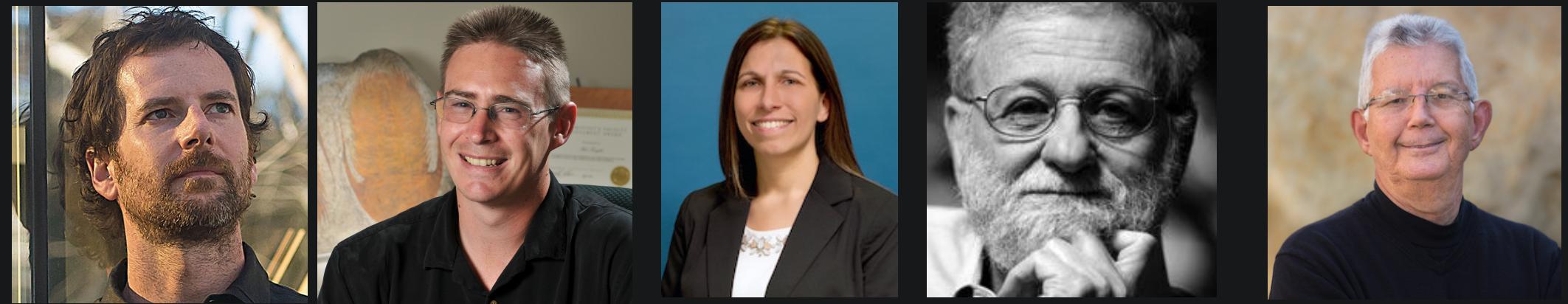
Crystal

Thesis Committee

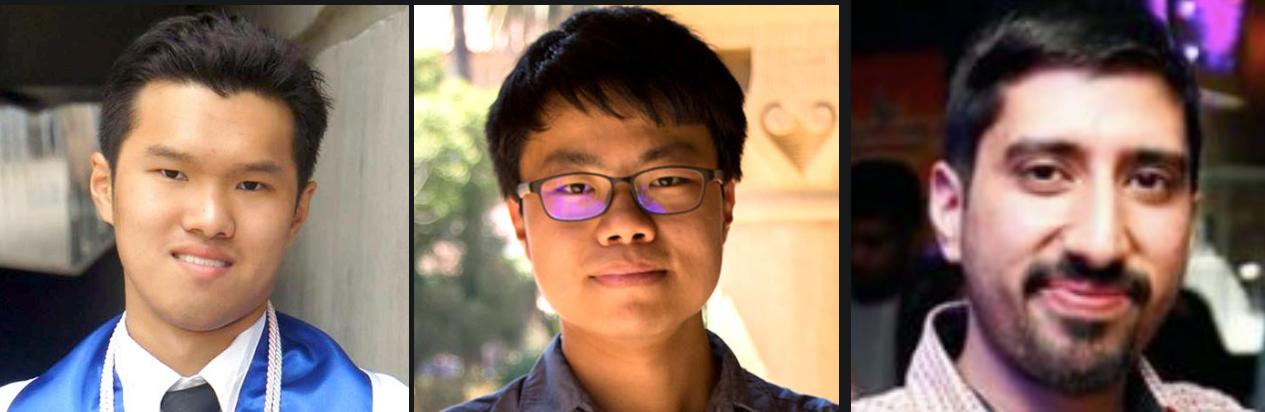


UC San Diego
The Design Lab

Thank You



Embriette Justine Tomasz Amnon



Brian Chen Tushar



Catherine Ailie Rachel Crystal

Vineet Pandey
@vineet1pandey

1. **ACM CHI 2017.** Gut Instinct: Creating Scientific Theories with Online Learners. [Vineet Pandey](#), Amnon Amir, Justine Debelius, Embriette R Hyde, Tomasz Kosciolek, Rob Knight, [Scott Klemmer](#).
2. **ACM CHI 2016.** Framing Feedback: Choosing Review Environment Features that Support High Quality Peer Assessment. Catherine M Hicks, [Vineet Pandey](#), C Ailie Fraser, [Scott Klemmer](#).
3. **ACM SIGMOD 2017.** Concerto: A High Concurrency Key-Value Store with Integrity. Arvind Arasu, Ken Eguro, Raghav K., Donald Kossmann, Pingfan Meng, [Vineet Pandey](#), Ravi R.

Extended Abstracts

1. **AAAI HCOMP 2016.** Integrating citizen science with online learning to ask better questions. [Vineet Pandey](#), [Scott Klemmer](#), Amnon Amir, Justine Debelius, Embriette R Hyde, Tomasz Kosciolek, Rob Knight.
2. **ACM CSCW 2016.** Game-theoretic models identify useful principles for peer collaboration in online learning platforms. [Vineet Pandey](#), Krishnendu Chatterjee.
3. **arXiv.org.** An HCI View of Configuration Problems. Tianyin Xu, [Vineet Pandey](#), [Scott Klemmer](#).
4. **ACM Learning@Scale 2015.** Connecting Stories and Pedagogy Increases Participant Engagement in Discussions. [Vineet Pandey](#), Yasmine Kotturi, Chinmay Kulkarni, Michael S Bernstein, [Scott Klemmer](#).

Backup

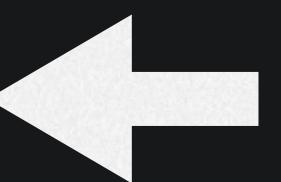
Mining big data is powerful when experts know what to look for

Steps in machine learning

- Problem formulation
 - What is it that we try to predict for new data
- Data collection
 - “training data”, optionally with “labels” provided by a “teacher”.
- Representation
 - how the data are encoded into “features” when presented to learning algorithm.
- Modeling
 - choose the class of models that the learning algorithm will choose from.
- Estimation
 - find the model that best explains the data: simple and fits well.
- Validation
 - evaluate the learned model and compare to solution found using other model classes.
- Deploy the learned model

Mining big data is powerful when experts know what to look for

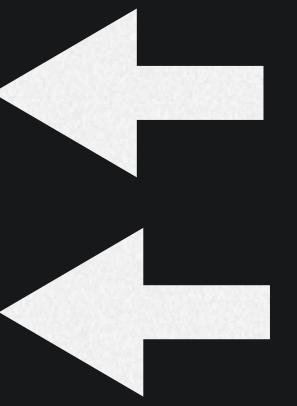
- Data collection
 - “training data”, optionally with “labels” provided by a “teacher”.
- Representation
 - how the data are encoded into “features” when presented to learning algorithm.



People assist experts here

Mining big data is powerful when experts know what to look for

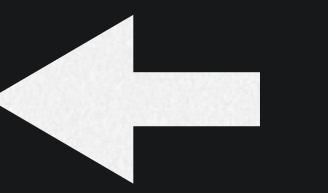
- Data collection
 - “training data”, optionally with “labels” provided by a “teacher”.
- Representation
 - how the data are encoded into “features” when presented to learning algorithm.



People assist experts here
But what if domain-specific experts
don't know all the important
features?

Mining big data is powerful when experts know what to look for

- Data collection
 - “training data”, optionally with “labels” provided by a “teacher”.
- Representation
 - how the data are encoded into “features” when presented to learning algorithm.



← Needs tacit knowledge from people!

Questions used in summative test for gut microbiome

If a mouse M is raised by an adopted mother different than its biological mother, which of the following is true about the gut microbiome of M?

It will depend on the genome of its biological mother but not on the microbiome its adopted mother

It will depend on the microbiome of its adopted mother but not on the genome of its biological mother

It will depend on the microbiome of its biological mother AND the genome of its adopted mother

It could depend on the microbiome of its adopted mother, depending on specific genes it possesses

Identify which of the following will lead to more Prevotella bacteria?

Vitamins

Carbohydrates

Protein

why not forums?

1. open-ended discussions - difficult to draw insights from
 - sure there are NLP - questions and options are easier
2. one option: curate open-ended discussions using crowd - how about we just teach people to do better
3. people learn from all of this
4. less issues to participate..