

# Citizen-led Work using Social Computing and Procedural Guidance

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**JACOBS SCHOOL OF ENGINEERING**  
Computer Science and Engineering

Thesis Defense

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



**Dana Lewis**  
Created DIY Pancreas

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



Created DIY Pancreas



Pebble watch with glucose monitoring

[openaps.org](http://openaps.org) [github.com/openaps](https://github.com/openaps)

A screenshot of a GitHub repository page for "openaps / openaps". The page shows basic statistics: 360 commits, 7 branches, 34 releases, and 12 contributors. The MIT license is visible. Below the stats, a list of recent commits is shown, all made by "scottleibrand" and "egirard". The commits are dated from 10 days ago to 16 days ago. The commits include updates to CONTRIBUTING.md, bin, openaps, tests, .gitignore, .travis.yml, and Makefile, along with fixes for install problems and updates to README and MANIFEST.in.

Code on Github

## 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)

Design with algorithm details at OpenAPS blog

# *Lead users create different—and in some cases better designs—than experts*

- 1 Lived experience
- 2 A tight feedback loop
- 3 Strong personal motivation

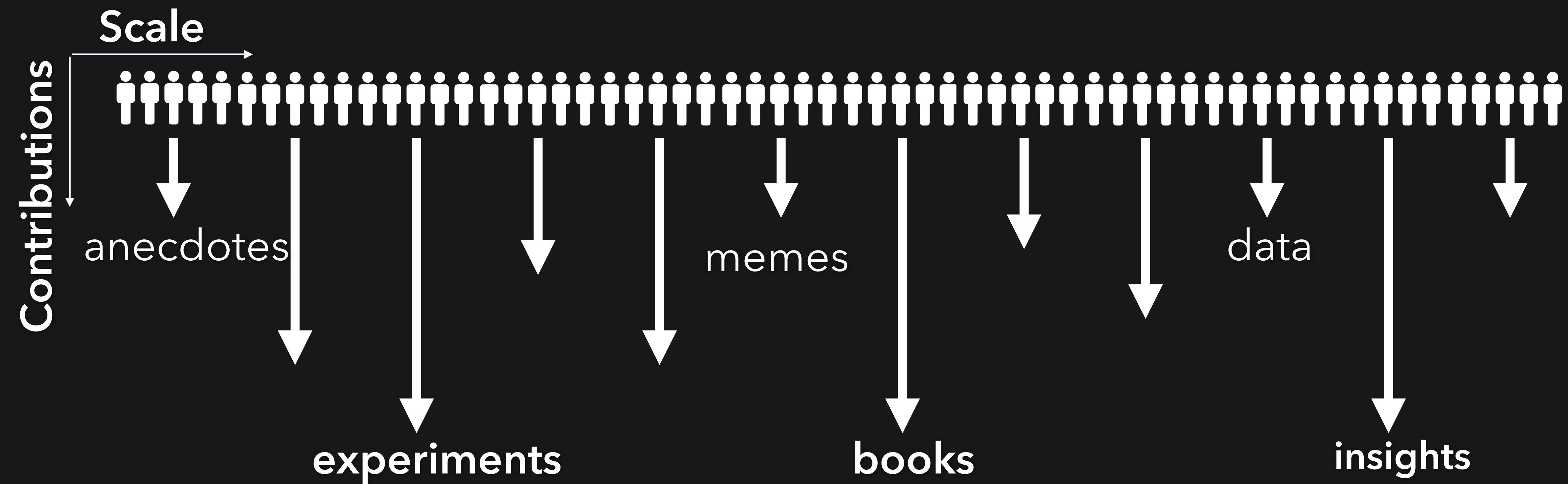
# More commonly, people use online health fora to share insights and look for answers

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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, Probiotics, Colestipol...Glutten Free Diet and Special Carb Diet.** Let me know if any of these help you.

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# Goal: Scale and deepen contributions



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

The New York Times

PLAY THE CROSSWORD

MATTER

## Birds Are Vanishing From North America

The number of birds in the United States and Canada has declined by 3 billion, or 29 percent, over the past half-century, scientists find.

TECH

## Foldit Gamers Solve Riddle of HIV Enzyme within 3 Weeks

The online game poses protein-folding puzzles, and participants provided insights recently that solved the structure of an enzyme involved in reproduction of HIV

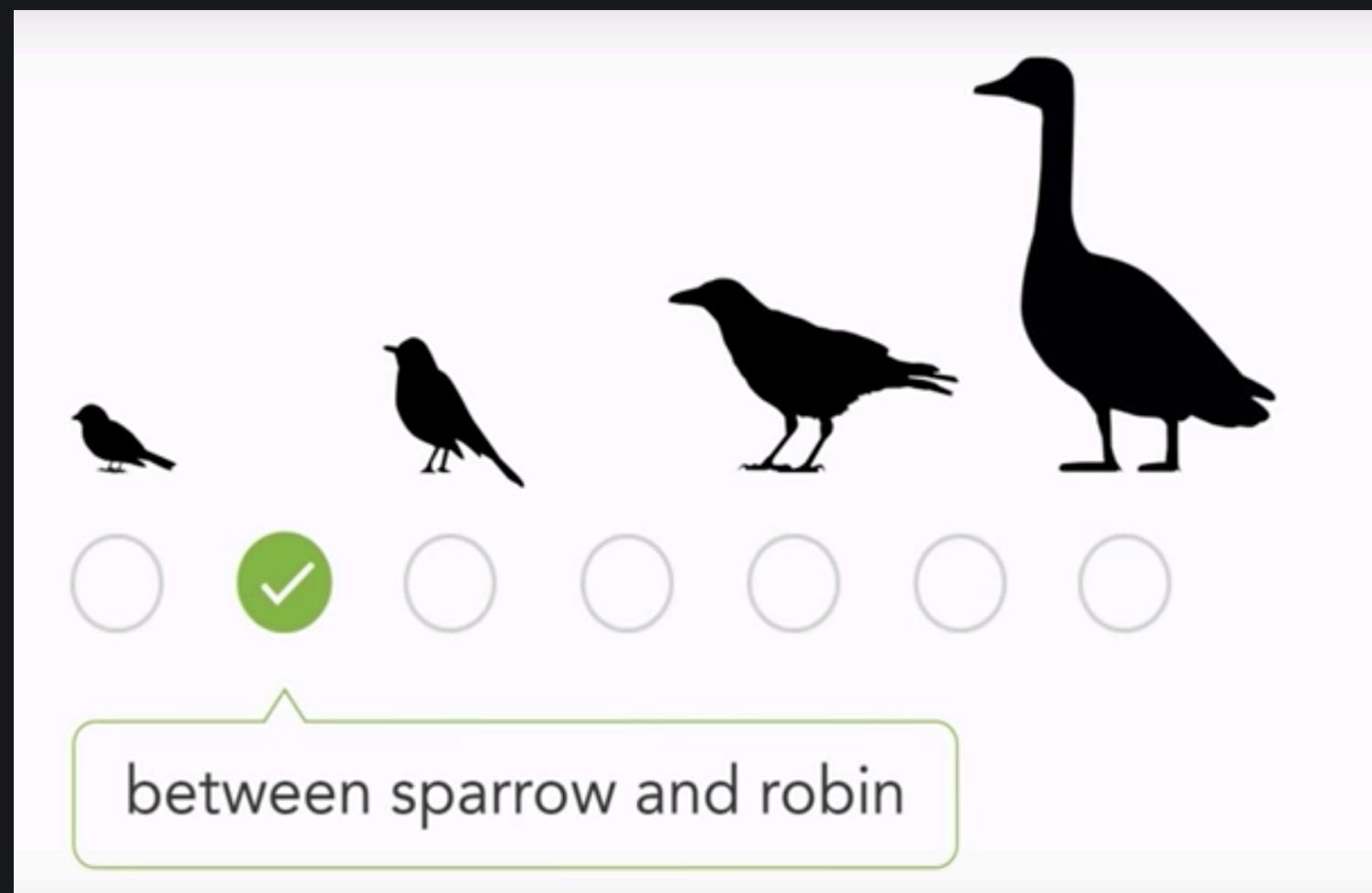
By Michael J. Coren, Fast Company on September 20, 2011

## Tracking bird migration eBird

eBird: A citizen-based bird observation network in the biological sciences. Brian L. Sullivan, Christopher L. Wood et al. Biological Conservation, 2009. 7  
Predicting protein structures with a multiplayer online game. Seth Cooper, Firas Khatib, Adrien Treuille. Nature 2010.

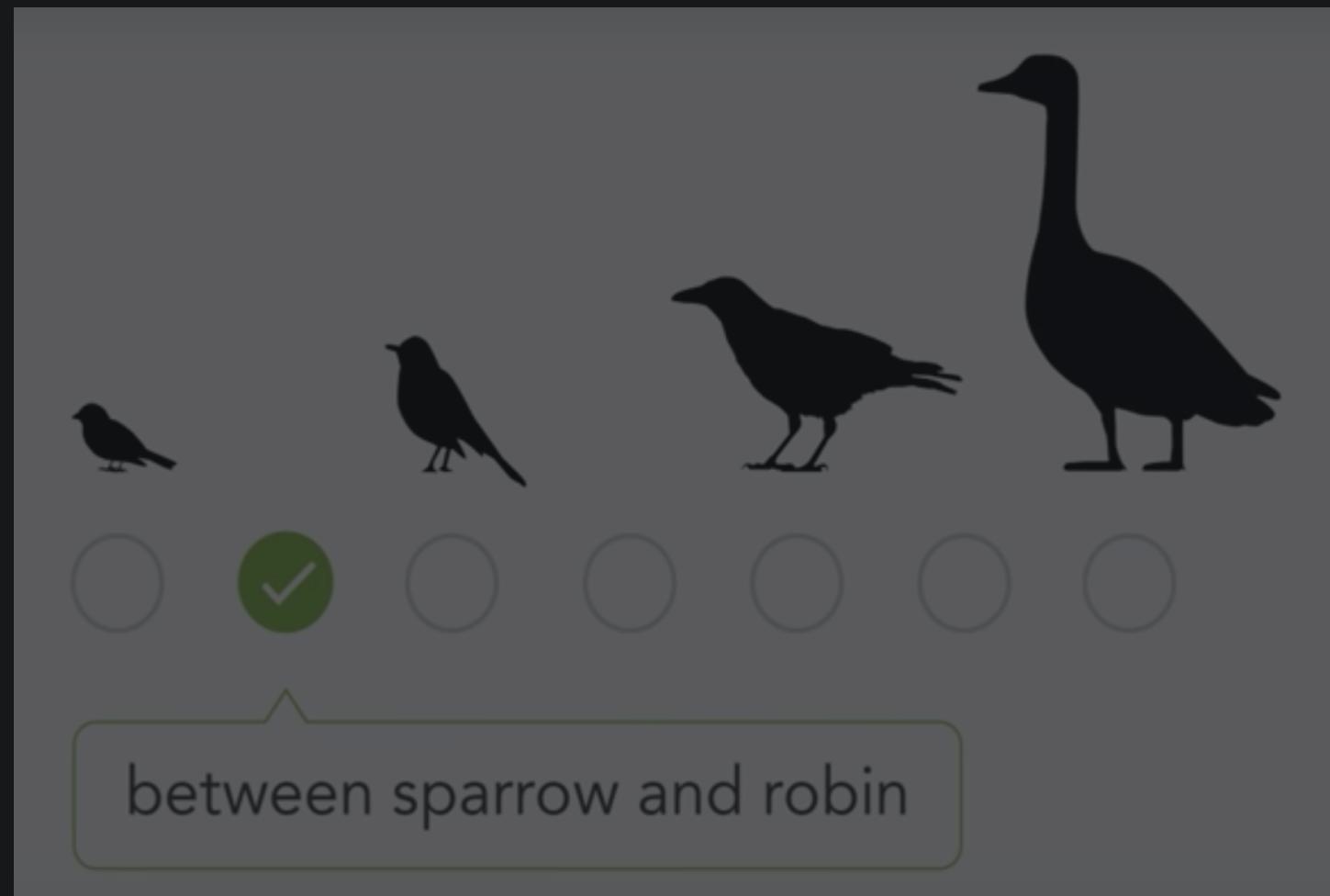
## Folding proteins Foldit

# A state of the art example for tracking

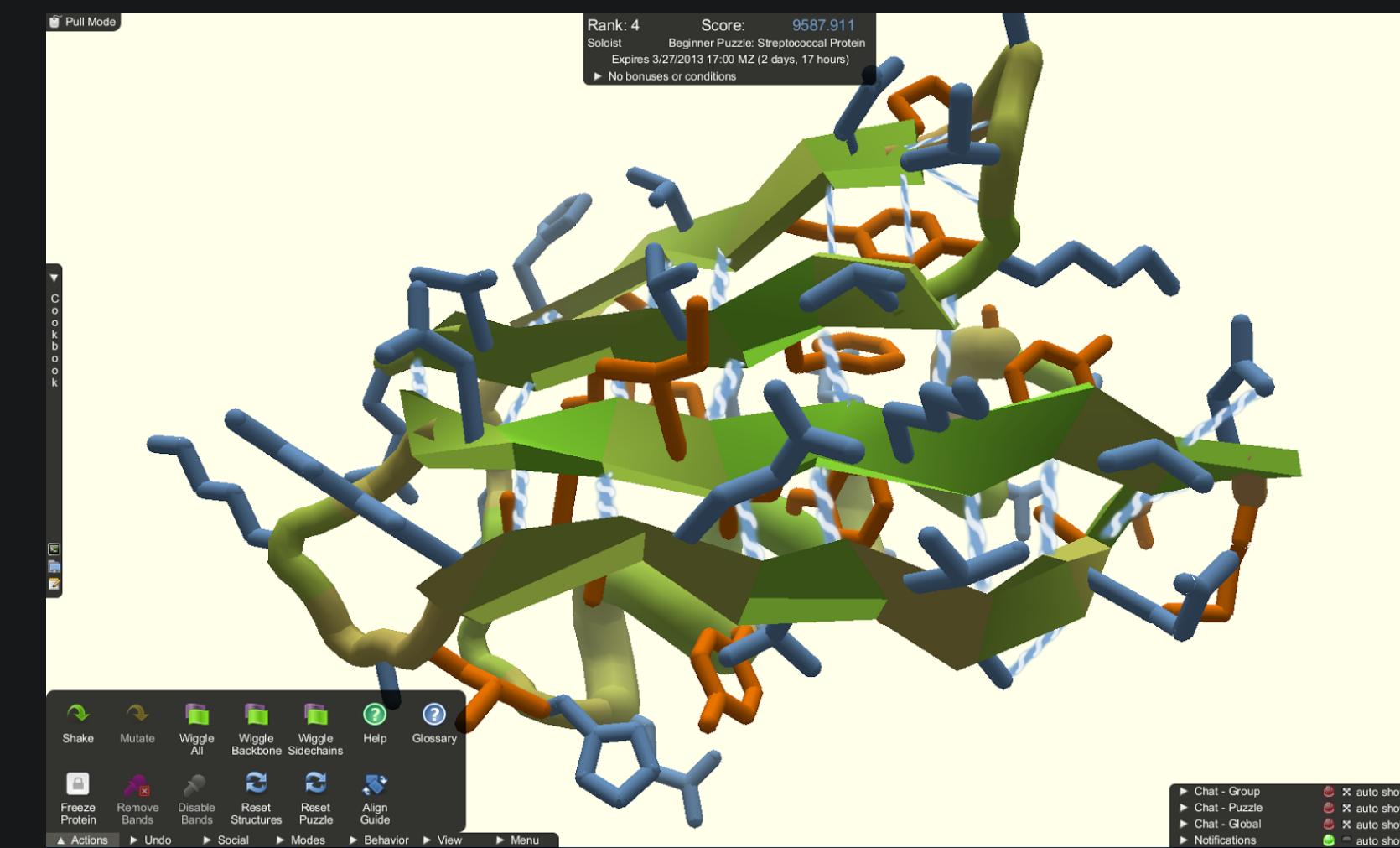


## Identify using prompts

# Example of citizens as *algorithms*

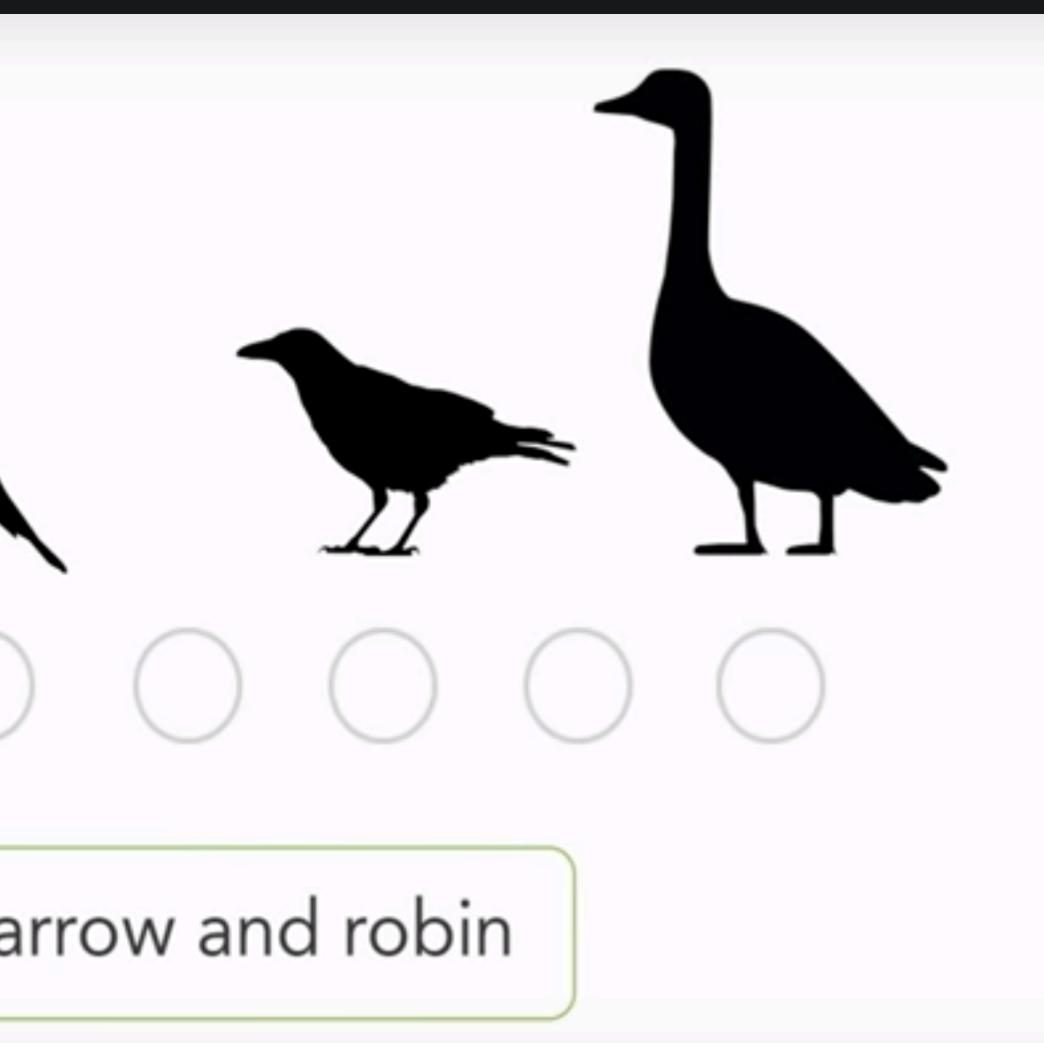


Identify using prompts



Directly manipulate protein structures

# People need better knowledge support for complex work such as....

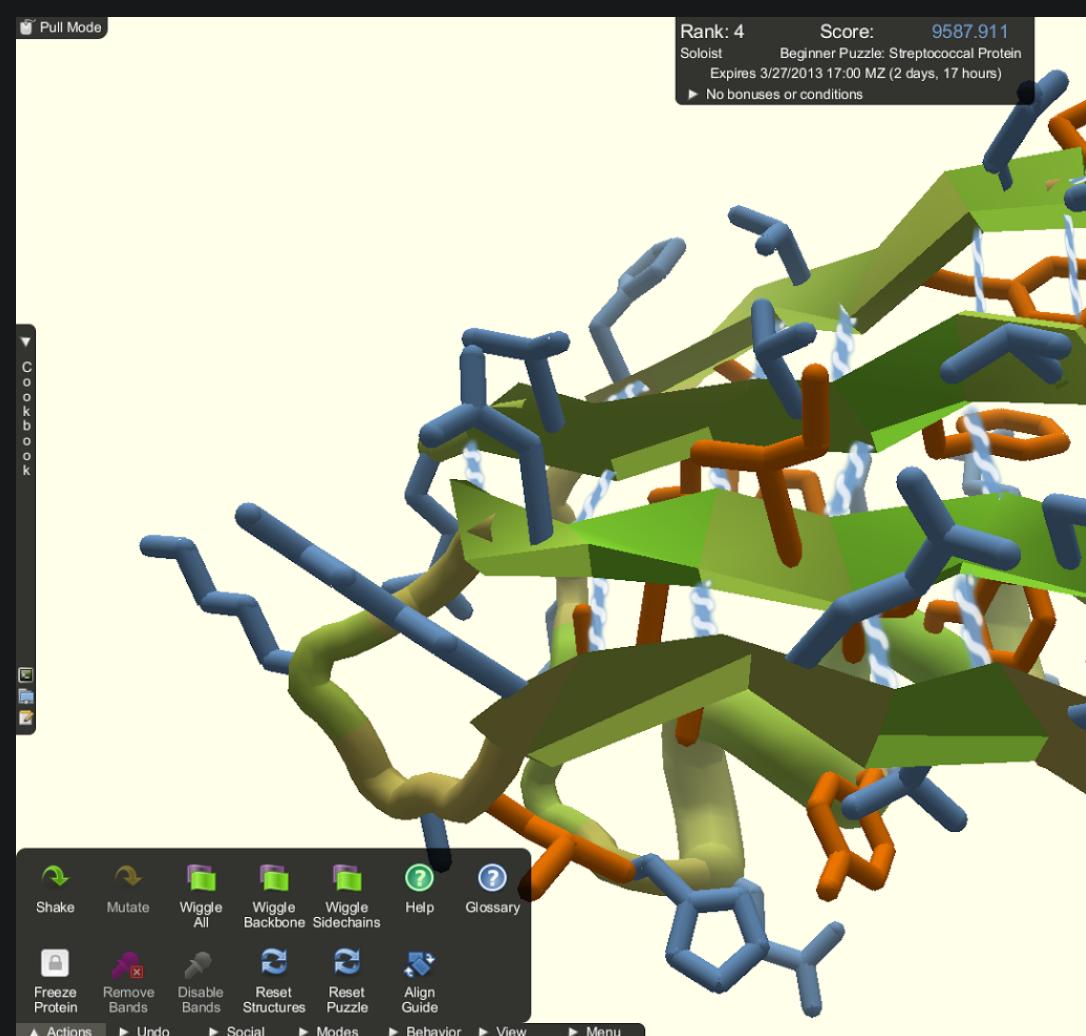


...

Generating hypotheses  
Experimentation  
Data Analysis

Communication: Writing+Talks

...



**Conceptual:  
WHAT**

Concepts,  
principles,  
theories, models

**Procedural:  
HOW**

Methods,  
procedures,  
operation



Thesis statement

**Procedural guidance in social  
computing catalyzes personally  
meaningful & useful scientific work**

# Three systems and corresponding studies have evaluated this thesis

From intuition..

..to questions (**Gut Instinct**: Learn & Ask; CHI 2017)

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

..to experiments (**Galileo**: Design-Review-Run; Soon)

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600 users

37 novel ideas

29 countries

66 experiments

400 hypotheses

5 communities

# 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

## **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.

SCAM OR NOT

## Are Pets the New Probiotic?

By RICHARD SCHIFFMAN JUNE 6, 2017

## Are There Benefits to Drinking Kombucha?

Multiple New York Times articles

# Understanding the human microbiome requires insights into people's lifestyles

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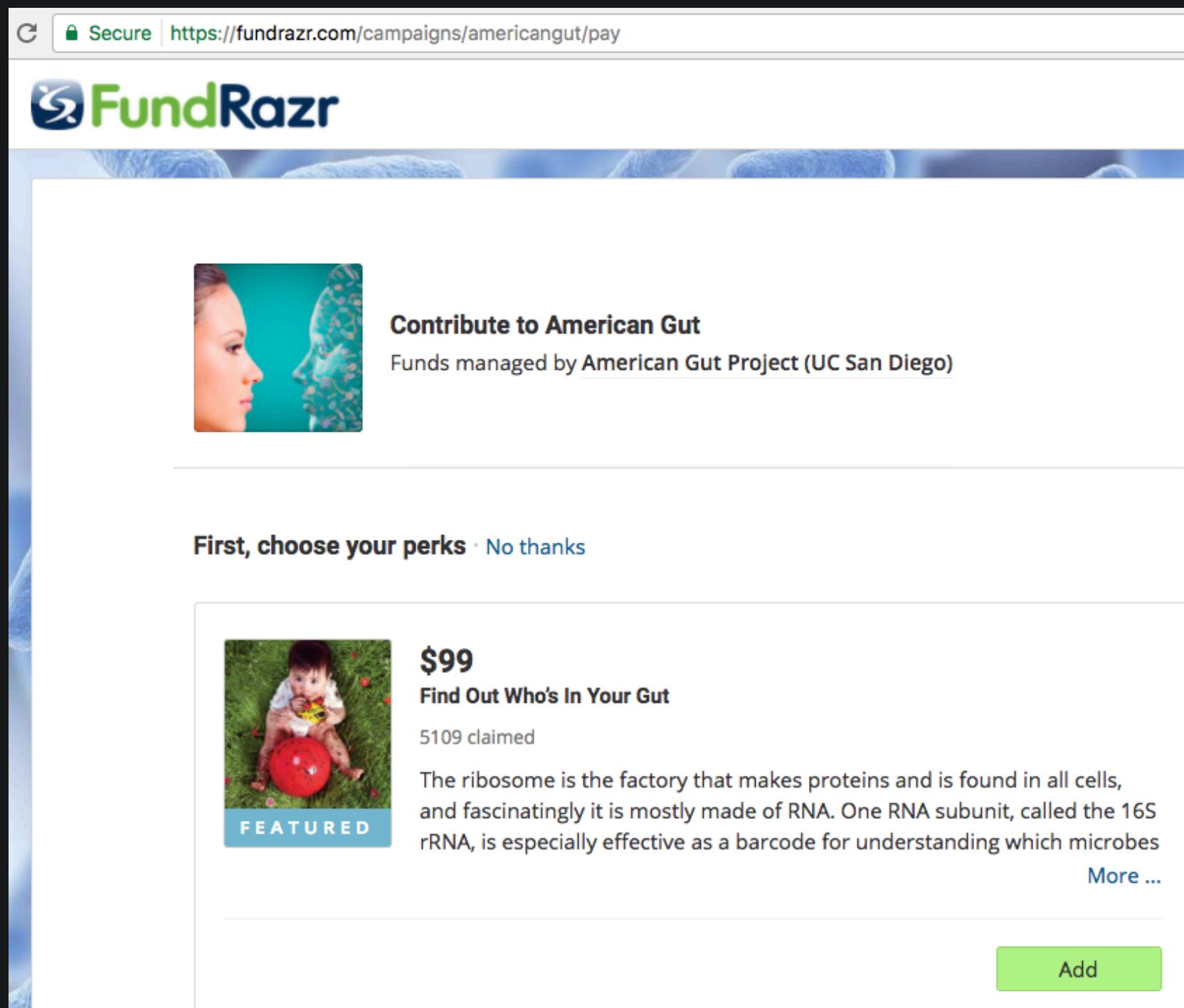
Nascent **Experts know little**

**Motivating People care**

**Contextual Huge individual differences**

Multiple New York Times articles

# 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 title is "Contribute to American Gut" and it's managed by "American Gut Project (UC San Diego)". Below this, there's a "First, choose your perks" section with a "No thanks" link. A featured perk is shown: "\$99 Find Out Who's In Your Gut" (5109 claimed). It describes the ribosome as a factory for proteins and mentions the 16S rRNA barcode. There's a "More ..." link and a green "Add" button.

**1: Create an online account and support the project**



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

[americangut.org](http://americangut.org)

# Participants generate hypotheses by looking at the data

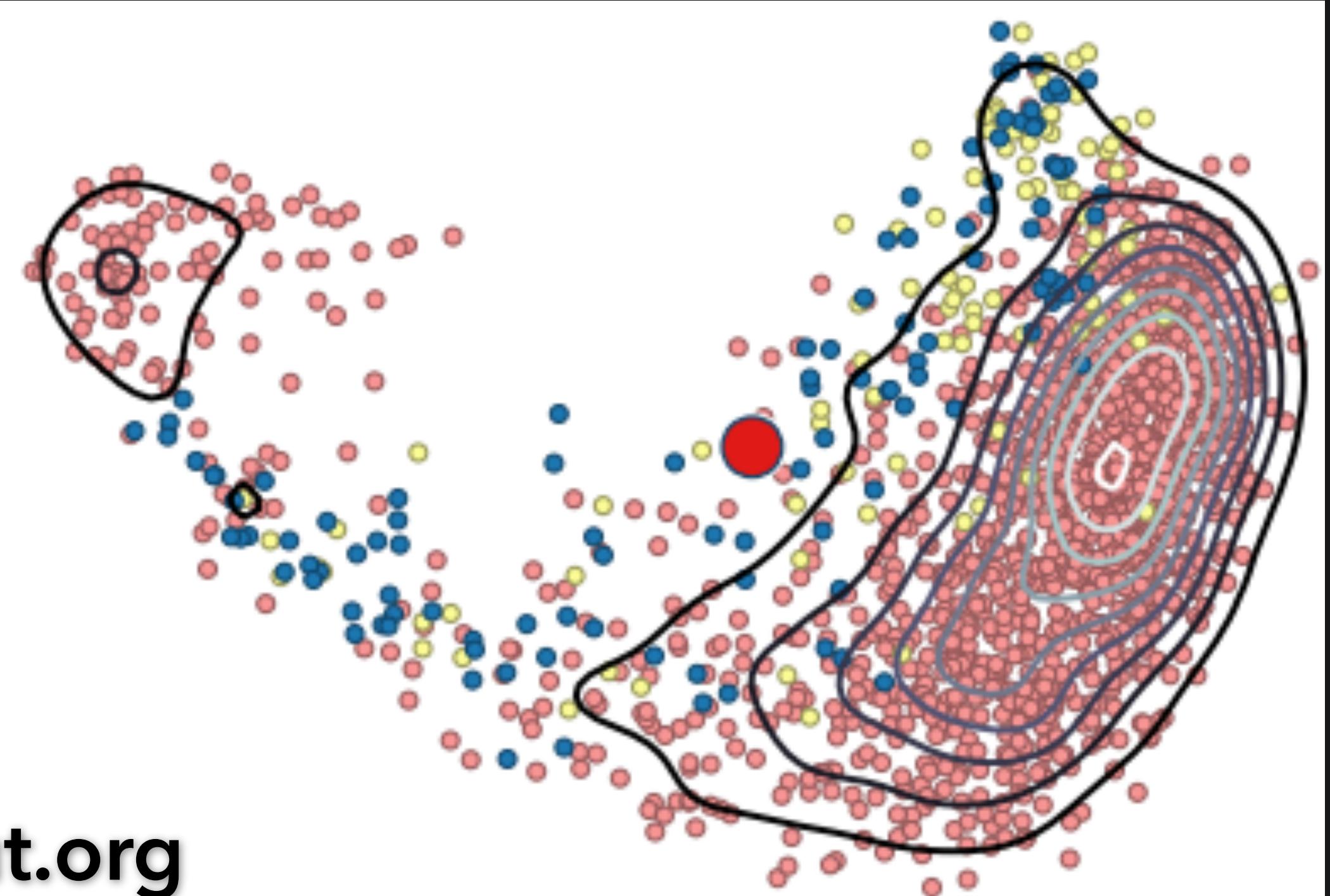


Is my data point unique because

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



[americangut.org](http://americangut.org)

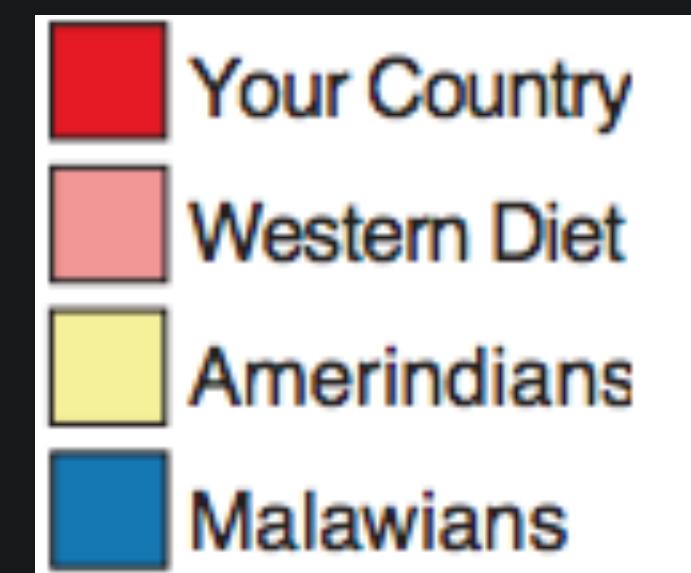


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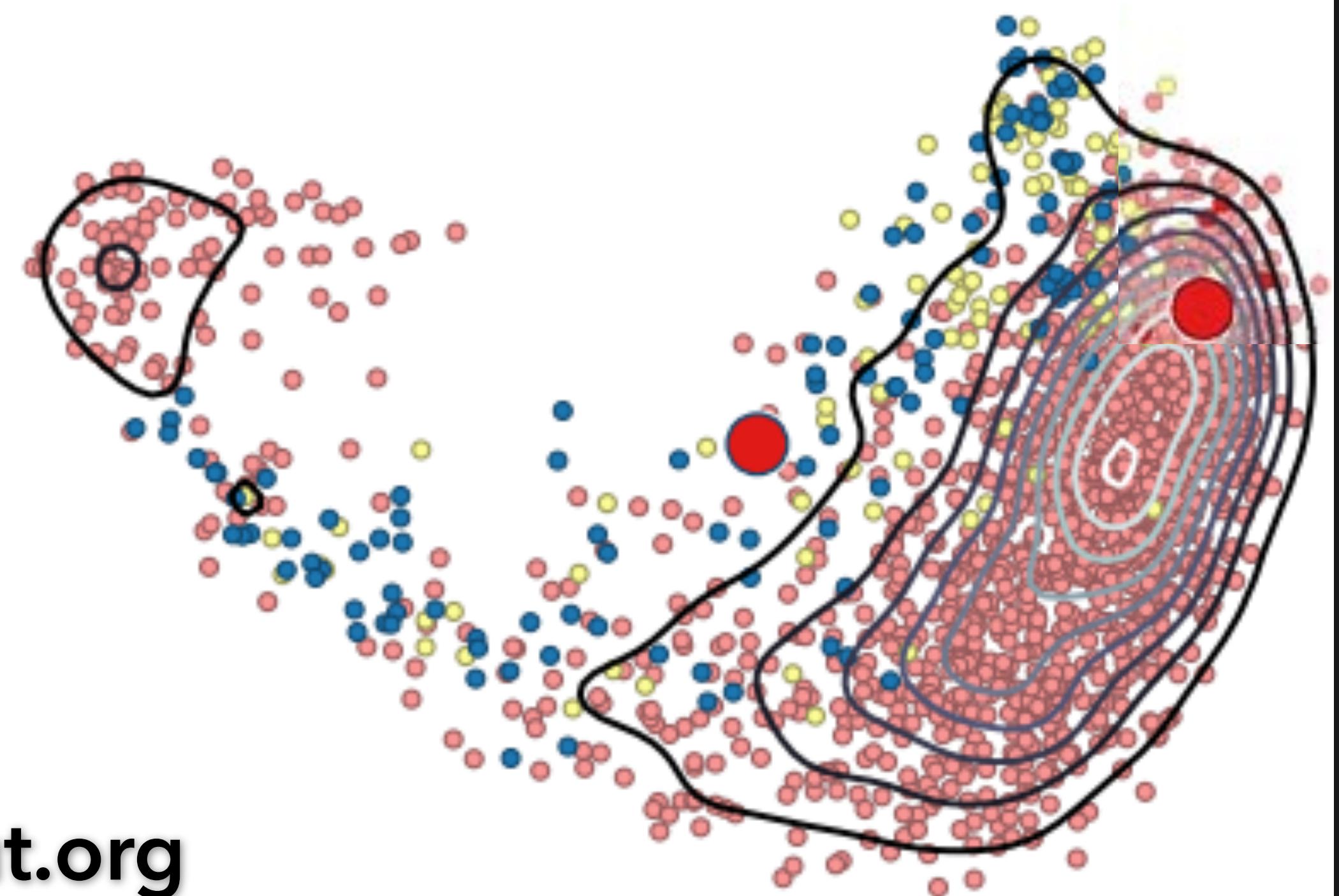


Is my data point unique because

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[americangut.org](http://americangut.org)



# v0.1: Learn about probiotics + the microbiome

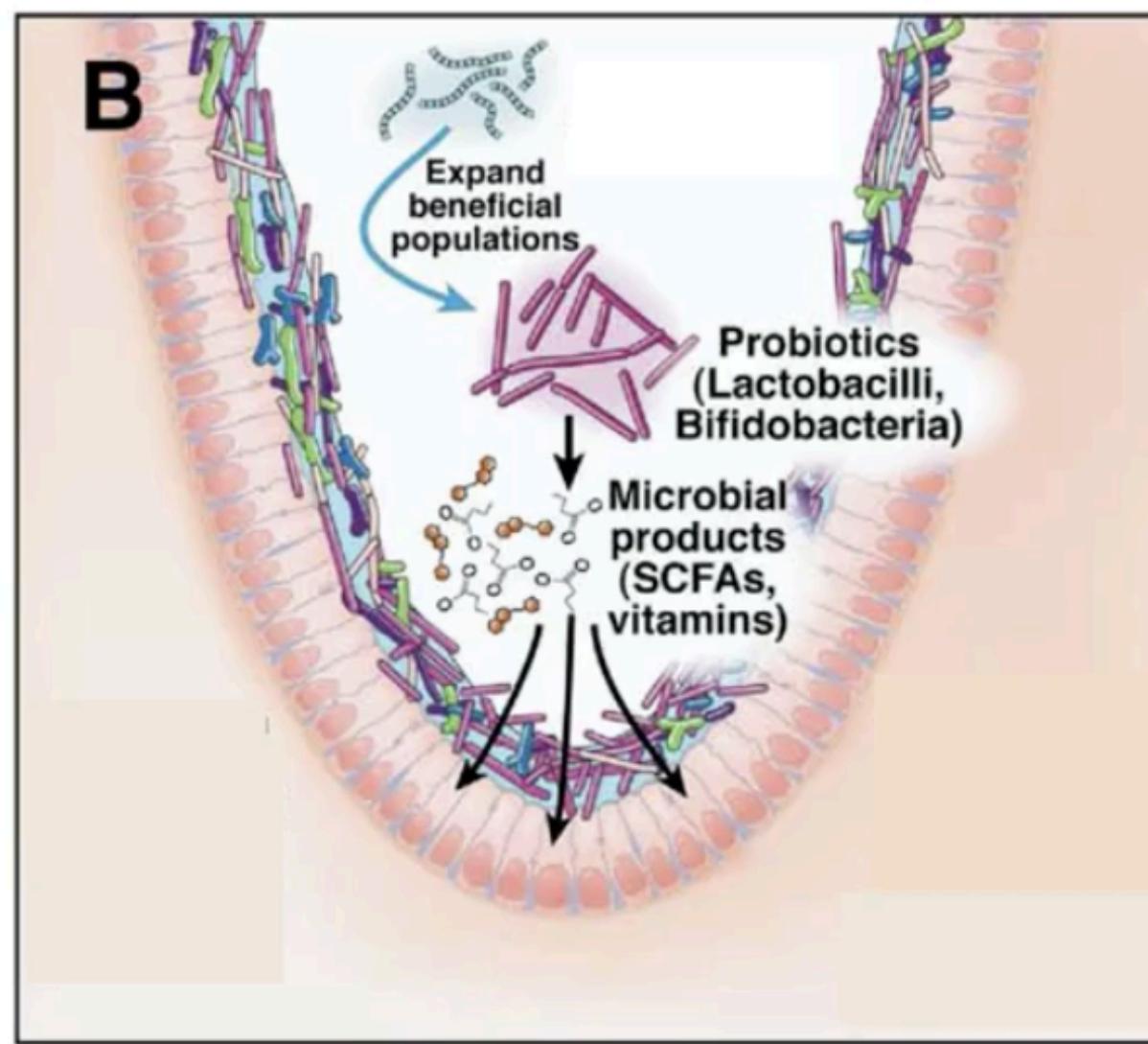
gutinstinct-ucsd.org/t/probiotics

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 synthesizes current  
research about probiotics**

Gut Check: Exploring Your Microbiome. Coursera. 2016

# Expectation: People will come up with crisp intuitions

Like:

“I think consuming probiotics reduces my sugar cravings”

# Reality: People don't structure their intuitions in *useful* ways

- 1 Rambling anecdotes
- 2 Technical details about probiotics
- 3 Questions from general curiosity

# Reality: People don't structure their intuitions in *useful* ways

1 Rambling anecdotes

2 Technical details about probiotics

3 Questions from general curiosity

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,

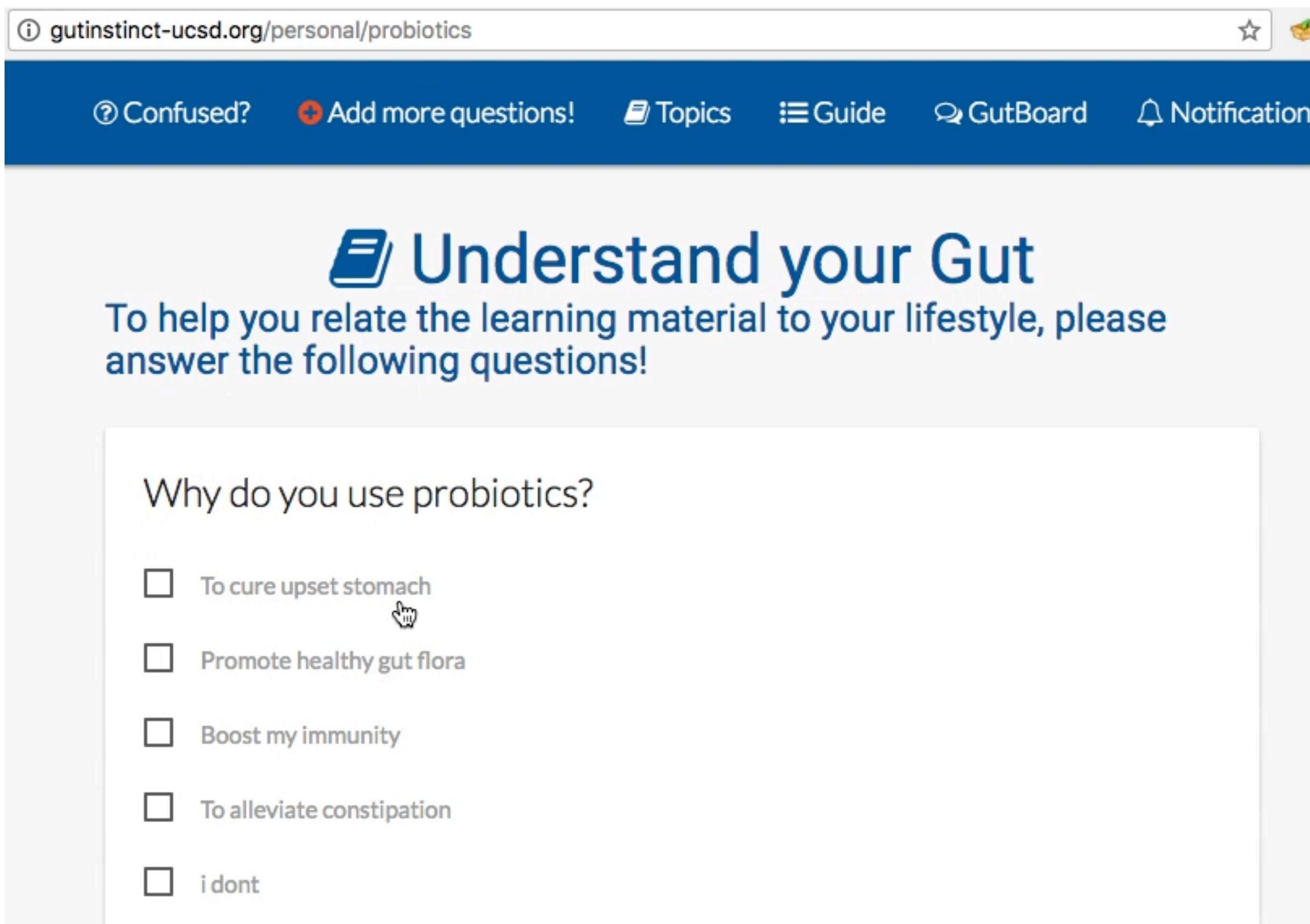
(1 comment)



# Insight: Scaffold hypothesis-generation using procedural training

- 1 Teach people about the success criteria of sharing questions, and
- 2 Support this in the interface

# Learn about a lifestyle topic + the microbiome



The screenshot shows a web page with a blue header bar. The URL in the address bar is [gutinstinct-ucsd.org/personal/probiotics](http://gutinstinct-ucsd.org/personal/probiotics). The header includes links for "Confused?", "Add more questions!", "Topics", "Guide", "GutBoard", and "Notifications". Below the header, there's a section titled "Understand your Gut" with the sub-instruction: "To help you relate the learning material to your lifestyle, please answer the following questions!". A question "Why do you use probiotics?" is followed by a list of options with checkboxes:

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

**Reflect on lifestyle by answering basic questions about probiotics use**

# Learn about probiotics + the microbiome

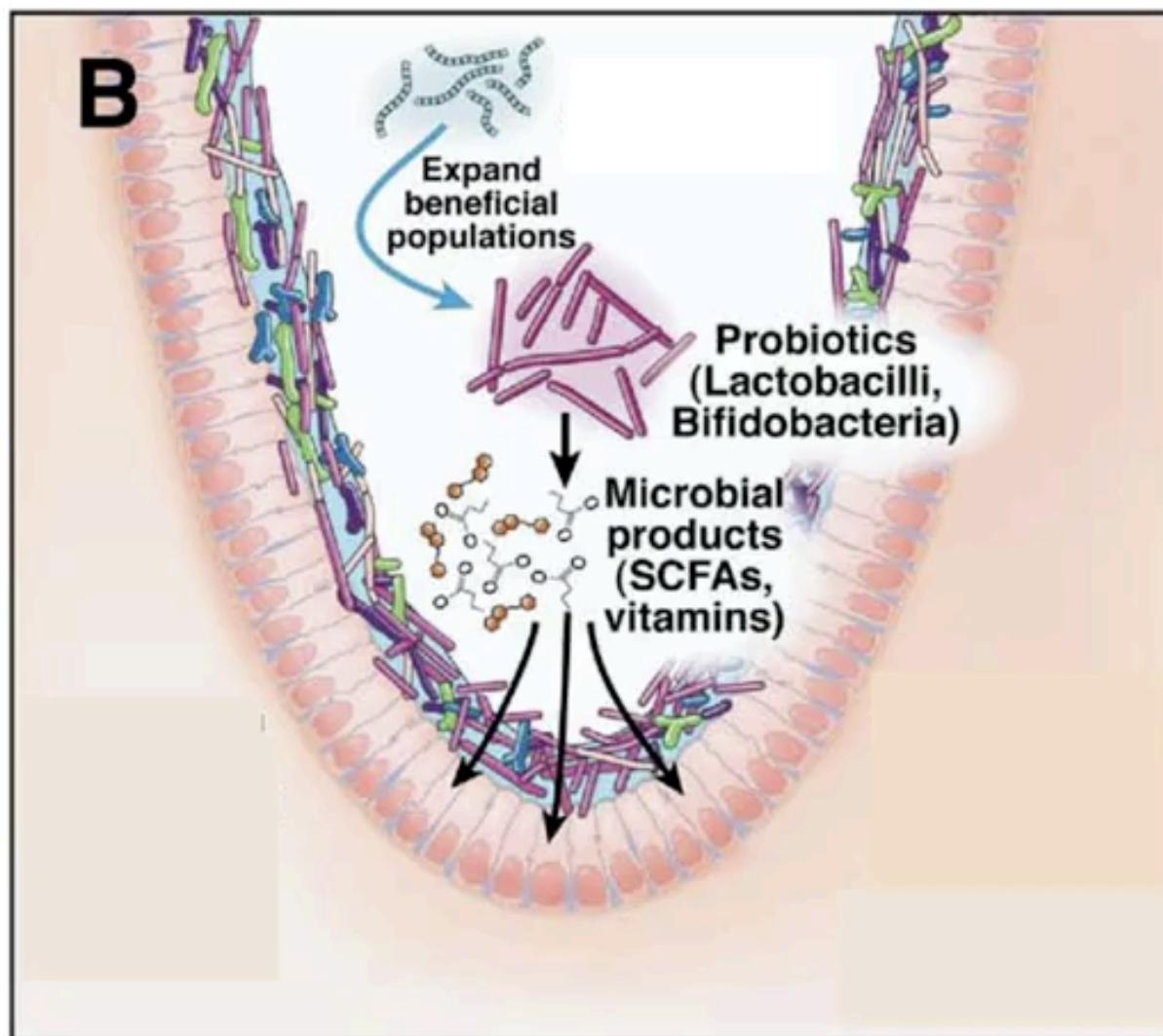
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Confused? Add more questions! Topics Guide GutBoard Notifications

Back to Topics

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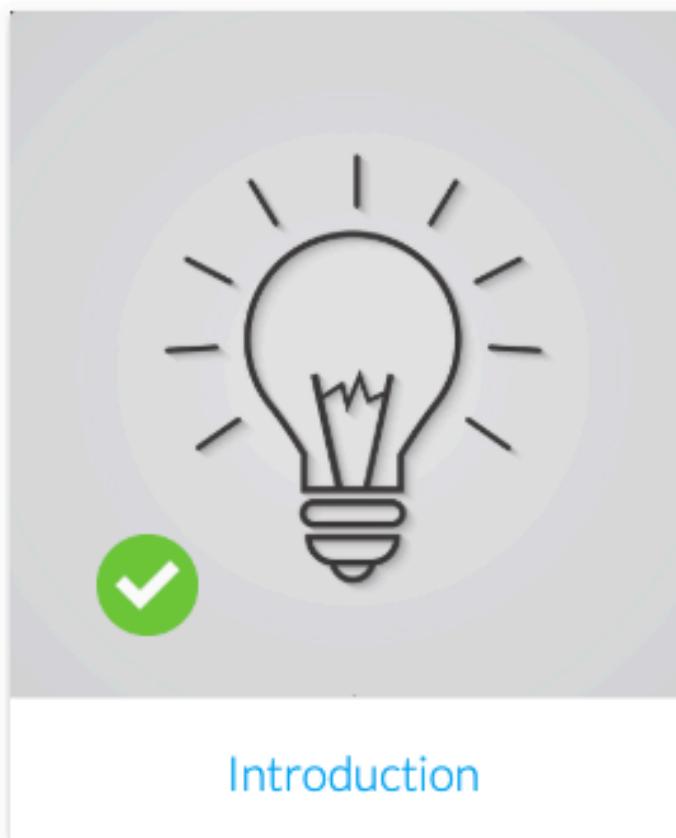
Video  
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Preidis and Versalovic 2009, Gastroenterology

**Watch a 4-minute lecture  
that synthesizes current  
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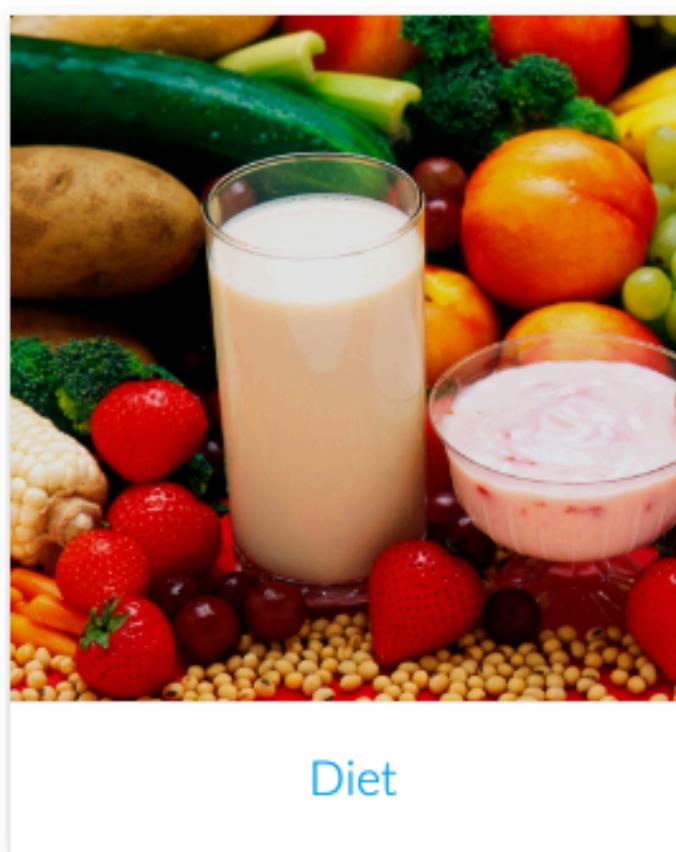
## ➊ Basics



Introduction



Antibiotics



Diet



Genetics

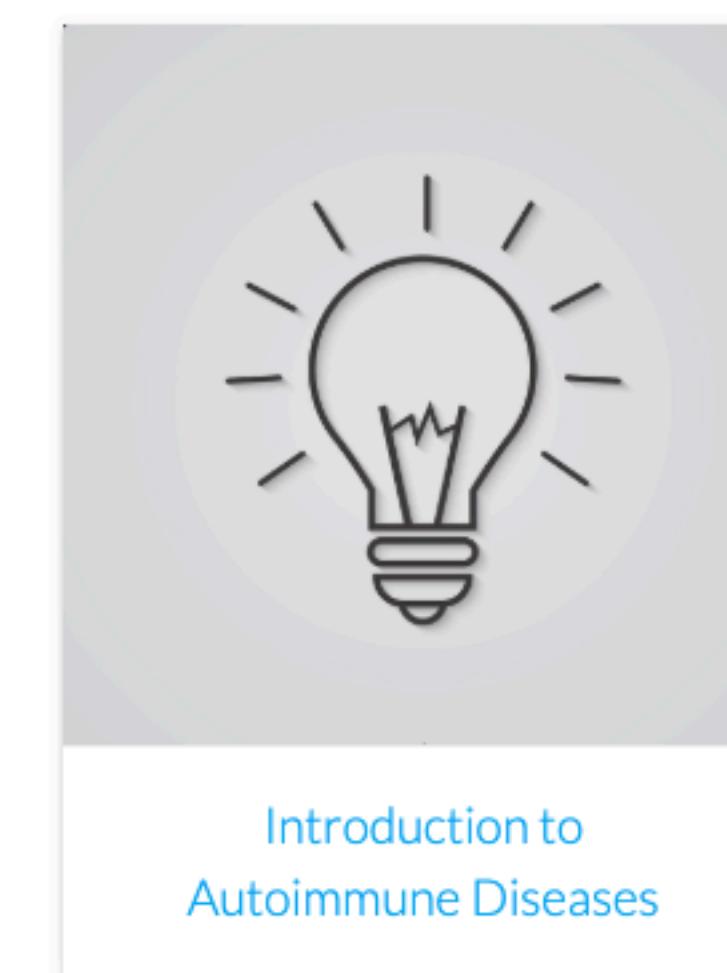


Physiology

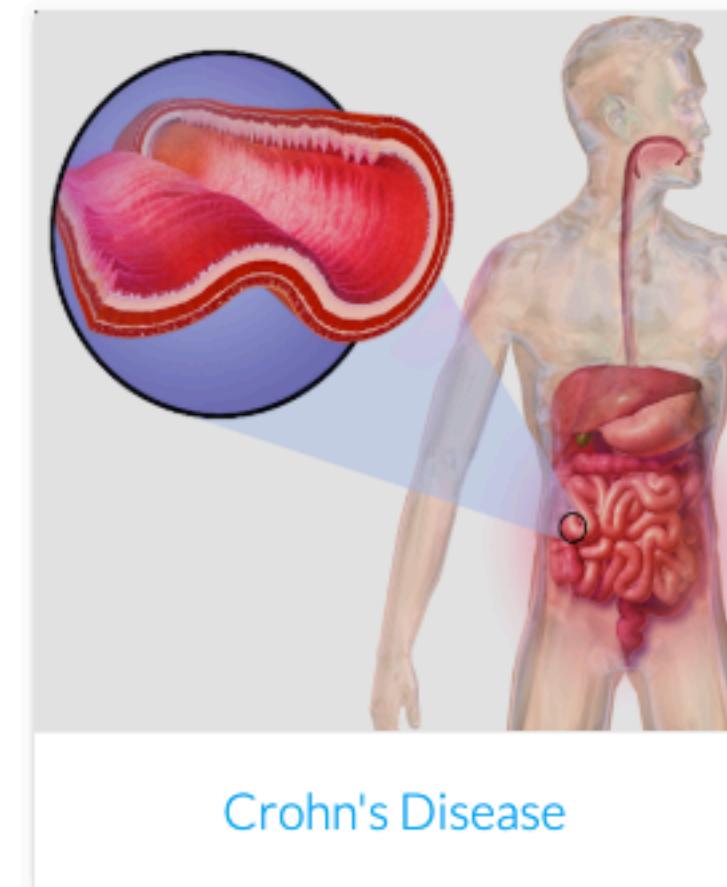


Probiotics

## ➋ Autoimmune Diseases

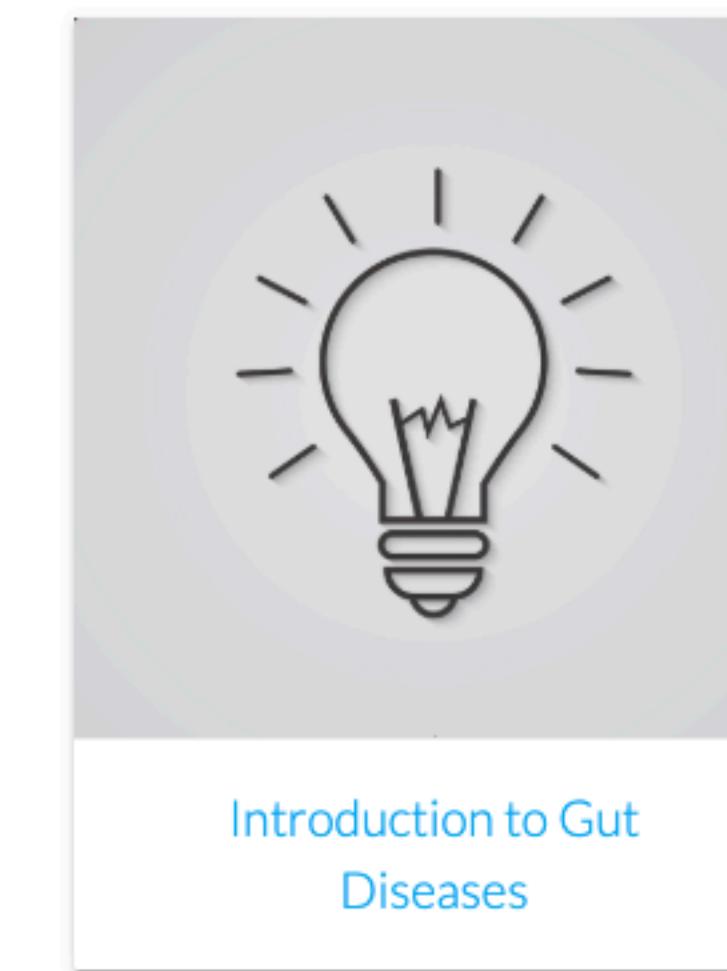


Introduction to  
Autoimmune Diseases

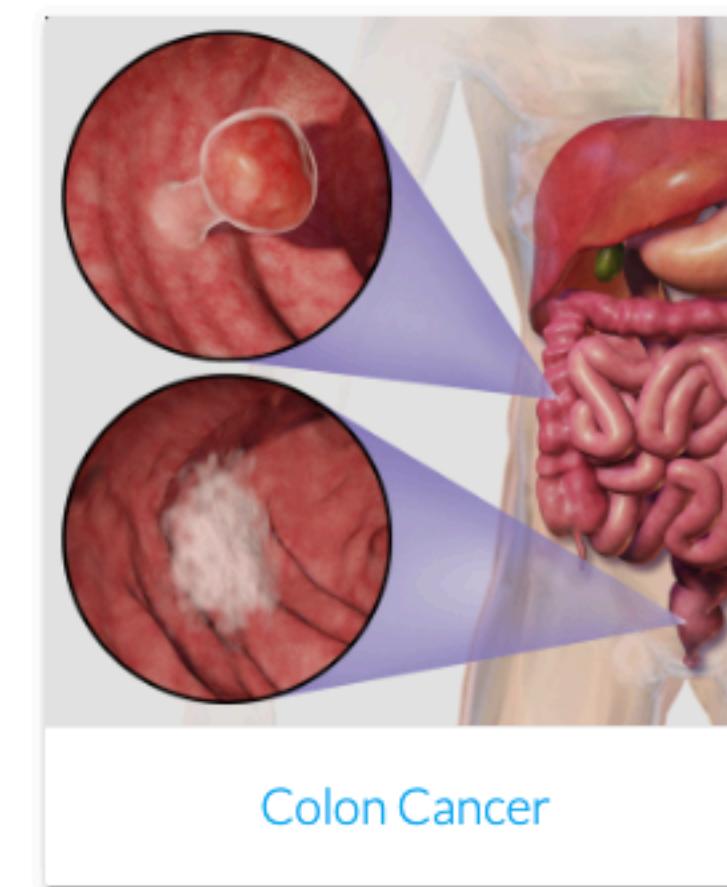


Crohn's Disease

## ➌ Gut Diseases



Introduction to Gut  
Diseases



Colon Cancer

gutinstinct-ucsd.org/guide\_question

Confused? Add more questions! Topics Guide GutBoard Notifications

Learn how to ask expert-like questions

## Step 1: Learn about great questions

A great gut instinct is clear, definite and provocative!

How can you convert your vague insights into useful questions for your peers and researchers?

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!

### Let's begin!

Suppose you're a frequent runner who is curious to understand how running might affect your health. You can imagine asking a friend a question like this one:

**I wonder how running affects my health?**

However, it's difficult for anyone to directly answer such an open-ended question. For instance, what is meant by health here. Also, wouldn't the effects depend on how frequently or how long a person runs? Fortunately, we have identified following five features of useful questions!

**1. Answerable**

**2. Definite**

**3. A link between a cause and an effect**

**4. Operational**

# Train to frame useful questions

## Guidance using examples

① gutinstinct-ucsd.org/gutboard\_slider\_addq

☆ 🍉 ⬆

② Confused? + Add more questions! Topics Guide GutBoard Notifications

Share your Gut Instinct!

?

Show me examples

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

# Ask questions

**Just-in-time  
guidance using  
checklist**

# Contribution: Learn-Train-Ask workflow

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 a pill bottle), and "Introduction" (image of a lightbulb).

**Learn**

31

## 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**

Method

N=344

# Between-subjects experiment for Learn and Train w/ 2x2 factorial study

H1 Access to learning improves question's content

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

		Train=Yes			
		Train	Both		
Learn=No	Train=Yes	<p>What type of alcoholic drinks (with sugar) affect your bowel movements?</p> <ul style="list-style-type: none"><li><input type="checkbox"/> wine</li><li><input type="checkbox"/> beer</li><li><input type="checkbox"/> liquor</li><li><input type="checkbox"/> sugary mixed drinks</li></ul>	<p>What type of alcoholic drinks (with sugar) affect your bowel movements?</p> <ul style="list-style-type: none"><li><input type="checkbox"/> wine</li><li><input type="checkbox"/> beer</li><li><input type="checkbox"/> liquor</li><li><input type="checkbox"/> sugary mixed drinks</li></ul>	<p>Answerable? Others should be able to answer your question</p> <p>Definite? A good question includes a clear timeframe</p>  <p>Probiotics</p> <p>YouTube</p>	<p>Answerable? Others should be able to answer your question</p> <p>Definite? A good question includes a clear timeframe</p>  <p>Probiotics</p> <p>YouTube</p>
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## Between-subjects experiment for Learn and Train w/ 2x2 factorial study

*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

N=344

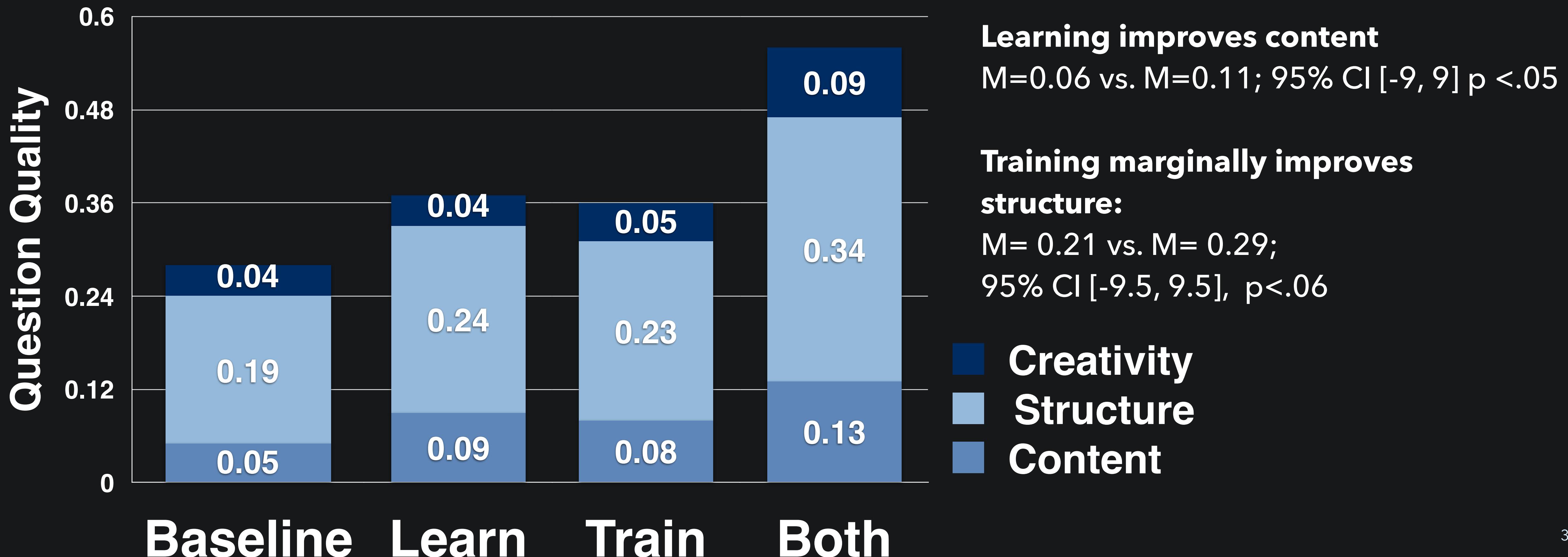
## Learn-Train yields better questions



# Results

N=344

## Learn-Train yields better questions



# Why did Learning and Training help?

- Content learning engaged people
  - greater time on task → more questions
  - exposure to 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

*Common themes*



## Personal Insights provide Novel Hypotheses

Does drinking 100ml of kefir and milk (50:50) before bedtime induce or improve sleep?

Is yogurt better for your gut at room temperature?

## Most Questions contained Known Facts

Do antibiotics lead to GI issues?

Do you use the bathroom more often when you have exercised?



Dive deeper with these follow-up questions!

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

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- 5+
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[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](http://gutinstinct.ucsd.edu/topics) Please keep sharing your gut instincts, these are helpful!

## Add follow-on questions<sup>38</sup>

## Discuss questions and responses

## Share scientific feedback

People contributed in different ways

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

**Lead**

Add & answer  
questions, add  
follow-ups

**Help**

Add & answer  
questions

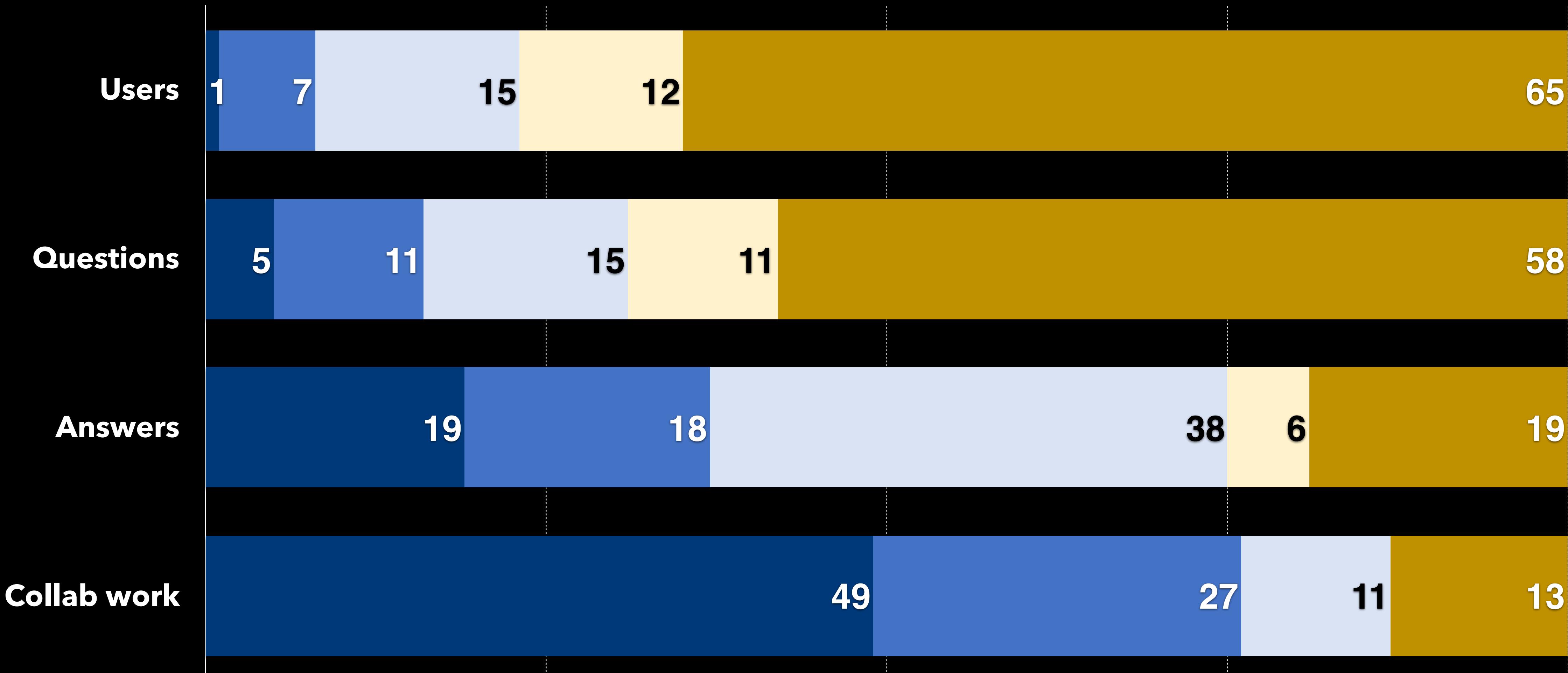
**Participate**

Add questions

**Lurk**

Add a question;  
never return

**Dropout**



# Stack Overflow's Wizard uses procedural guidance for remedial question asking

## 5. Check the criteria

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

**Answerable?**  
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**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

## Tell us more about your question

Your description gives people the information they need to help you answer your question.

Want more help? Check out these examples of great question descriptions: [Example 1](#), [Example 2](#)

The screenshot shows the "Guided Mode" section of the Stack Overflow question wizard. At the top, there are tabs for "Guided Mode" (selected), "Use traditional mode", and "advanced help »". Below the tabs are several buttons: "Links", "Images", "Styling/Headers", "Lists", "Blockquotes", "Code", "HTML", and "advanced help ». The main content area is divided into sections with numbered steps:

- 1. Summarize the problem**: A section for users to describe their problem. It includes a "For example:" section with a green checkmark next to the text "Say 'I'm setting up a new server, and want to support UTF-8 fully in my web application. Where do I need to set the encoding/charsets?'". It also includes a red X next to the text "Don't say 'I want to support UTF-8 fully in my web application.'".
- 2. Provide background including what you've already tried**: A section for users to provide context or steps taken.
- 3. Show some code**: A section for users to include code snippets.

## Procedural guidance with a checklist in Docent

# Social platforms support rapid spread of ideas



Kombucha: a popular drink



# How might people design and run experiments to test such ideas?



Kombucha: a gut probiotic?



Adriana: Kombucha producer (Rio)

# Experimentation requires many decisions

*Idea: “Kombucha helps the gut”*

*Follow these steps*

*Provide your data*

# Experimentation requires many decisions

*Idea: “Kombucha helps the gut”*

How to measure  
“helps the gut”?

*Follow these steps*

Do people  
understand the  
instructions?

*Provide your data*

How might  
participants  
provide their data?

# Experimentation requires many decisions

*Idea: “Kombucha helps the gut”*

**Know what makes for an experiment**

*Follow these steps*

**Iterate to improve the design**

*Provide your data*

**Run it correctly**

# Experimentation requires many decisions

**Conceptual & Procedural guidance**

Know what makes for an experiment

**Structured collaboration**

Iterate to improve the design

**Consistent implementation**

Run it correctly

# A second example of procedural guidance: Experimental design workflow

## 1 Start with an intuition

Drinking kombucha makes me less bloated

These examples might help :

Drinking coffee	<i>increases</i>	<i>alertness</i>	↗
Eating raisins every day	<i>decreases</i>	<i>number of bowel movements</i>	
Not brushing teeth	<i>results in</i>	<i>bad breath</i>	

**Cause      Relation      Effect**

Drinking kombucha    improves    stool consistency|



EXAMPLES

# A second example of procedural guidance: Experimental design workflow

## 1 Start with an intuition

Drinking kombucha makes me less bloated

These examples might help :

Drinking coffee	increases	alertness	↗
Eating raisins every day	decreases	number of bowel movements	
Not brushing teeth	results in	bad breath	

Cause      Relation      Effect

Drinking kombucha      improves      stool consistency



EXAMPLES

## 2 Measure the cause

Drinking kombucha improves stool consistency

To conduct an experiment, you need to

1. change the cause (called manipulation) and then
2. record the effect.

How will you manipulate **Drinking kombucha** in your experiment?

(To keep your experiment simple, choose **one** option)

Absence or Presence

E.g. Milk in your diet could be present or absent

E.g. Exercise in your day could be present or absent



TEMPLATE

# A second example of procedural guidance: Experimental design workflow

## 1 Start with an intuition

Drinking kombucha makes me less bloated

These examples might help:

Drinking coffee	increases	alertness	↗
Eating raisins every day	decreases	number of bowel movements	
Not brushing teeth	results in	bad breath	

**Cause      Relation      Effect**

Drinking kombucha      improves      stool consistency



EXAMPLES



## 3 Set up data collection messages

Send all participants a reminder to provide **Bristol Scale Value** of **stool consistency** at

**edit** the content for the reminder text message to track **stool consistency** at **8:00 pm**



Hello from Galileo! This is your 8:00 pm reminder to measure "stool consistency" today.

How would you classify stool consistency on the Bristol Stool Chart? Please refer to the chart ([https://en.wikipedia.org/wiki/Bristol\\_stool\\_scale](https://en.wikipedia.org/wiki/Bristol_stool_scale)) and reply with a value between 1 to 7.

## 2 Measure the cause

**Drinking kombucha** improves stool consistency

To conduct an experiment, you need to

1. change the cause (called manipulation) and then
2. record the effect.

How will you manipulate **Drinking kombucha** in your experiment?

(To keep your experiment simple, choose **one** option)

**Absence or Presence**

E.g. Milk in your diet could be present or absent

E.g. Exercise in your day could be present or absent



TEMPLATE

# A second example of procedural guidance: Experimental design workflow

## 1 Start with an intuition

Drinking kombucha makes me less bloated

These examples might help:

<i>Drinking coffee</i>	<i>increases</i>	<i>alertness</i>	
<i>Eating raisins every day</i>	<i>decreases</i>	<i>number of bowel movements</i>	
<i>Not brushing teeth</i>	<i>results in</i>	<i>bad breath</i>	

## Cause Relation Effect

Drinking kombucha improves stool consistency

## ② Measure the cause

▶ |Drinking kombucha | improves stool consistency

To conduct an experiment, you need to

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## EXAMPLES



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## 4 Set up exp/control conditions

**Your Hypothesis:** Drinking kombucha improves stool consistency

### Your Experimental Group:

Drinks Kombucha

### Your Control Group

Does not drink Kombucha



## TEMPLATE



COMMUNITIES

Kombucha and Kefir Experiments

Design An Experiment

Dashboard

## Experiment Details

**Hypothesis:** Drinking Kombucha improve stool consistency

**Cause**

Drinking Kombucha

**Relation**

improve

**Effect**

stool consistency

**Mechanism:**

kombucha has beneficial probiotics to help keeping a normal stool consistency

**Related Work:**

There are papers about Kombucha benefits but they do not look specifically at stool consistency. Dufresne and Farnworth (Tea, Kombucha, and health: a review) gives an overview of kombucha benefits (mostly from drinker's testimony) and indicates the need to investigate it with a more scientific approach. This is an old paper, though (from 2000). We have more recent papers, but I could not find one specifically related to stool consistency. There are some related to diabetes, for example.

**How is Drinking Kombucha manipulated?**

- Participants measure Absence/Presence of Drinking Kombucha
- Reminder sent every day at 6 pm with the following message:

"Hello from Austin! This is your 6:00 pm reminder to measure "Drinking Kombucha" 🍷 today. Was Drinking Kombucha absent or present in your day today? Reply Yes for present, No for absent."

**How is stool consistency measured?**

- Participants measure Bristol Scale value of stool consistency

**The Bristol Stool Chart**

Looks like	Consistency	Indicates
Type 1		Separate hard lumps Very constipated
Type 2		Lumpy and sausage like Slightly constipated

# Experiment Design Summary

should be 0. Don't worry if you receive a data\_invalid message; your response is tracked and saved!"

of any flavor  
usual diet and  
l, on a scale of

#### Control Condition

Does not drink kombucha

#### Preparation steps

#### Control steps

1. Do NOT consume kombucha or other fermented foods of any flavor or brand (anytime during the entire day/night)
2. Write down if you consume alcohol or very different food or drink from your usual diet
3. Continue performing your daily activities as usual
4. Measure effect: write down your stool consistency, for each of your daily stool, on a scale of 1 to 7. If no stool that day record 0.
5. Send your measurements to Galileo

#### Inclusion Criteria

(Every participant must meet EACH of the following criteria)

1. feel comfortable drinking kombucha
2. feel comfortable glancing at your stool for science

#### People's review of the hypothesis

Is the cause specific?

Yes  1 | No  0

Is the effect specific?

Yes  1 | No  0

Is the relation between cause and effect clear?

Yes  1 | No  0

Is the hypothesis concrete i.e. it either holds or it does not hold?

Yes  1 | No  0

Is this mechanism the most plausible explanation?

Yes  0 | No  0

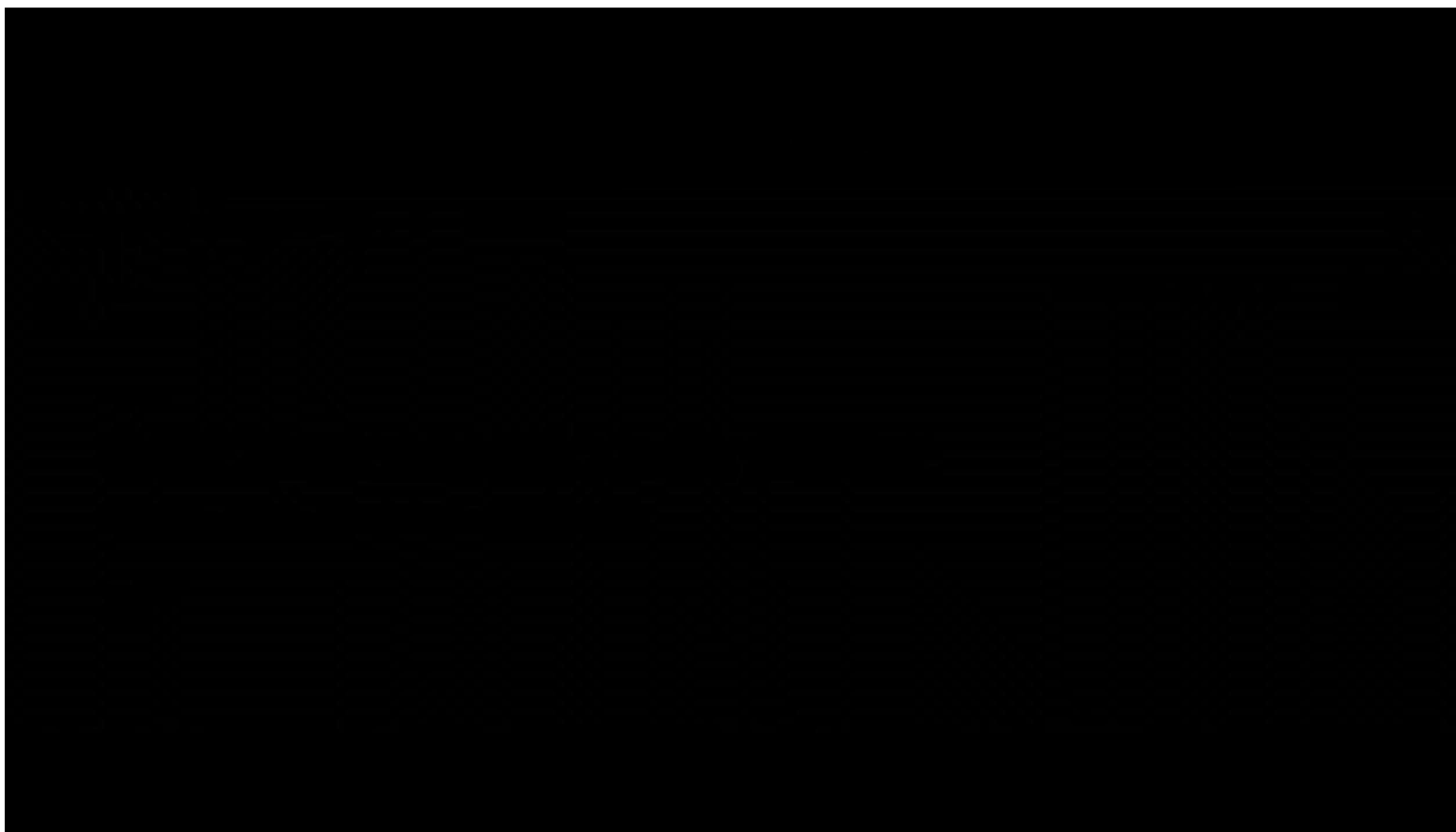
Is the related works description comprehensive?

Yes  0 | No  0

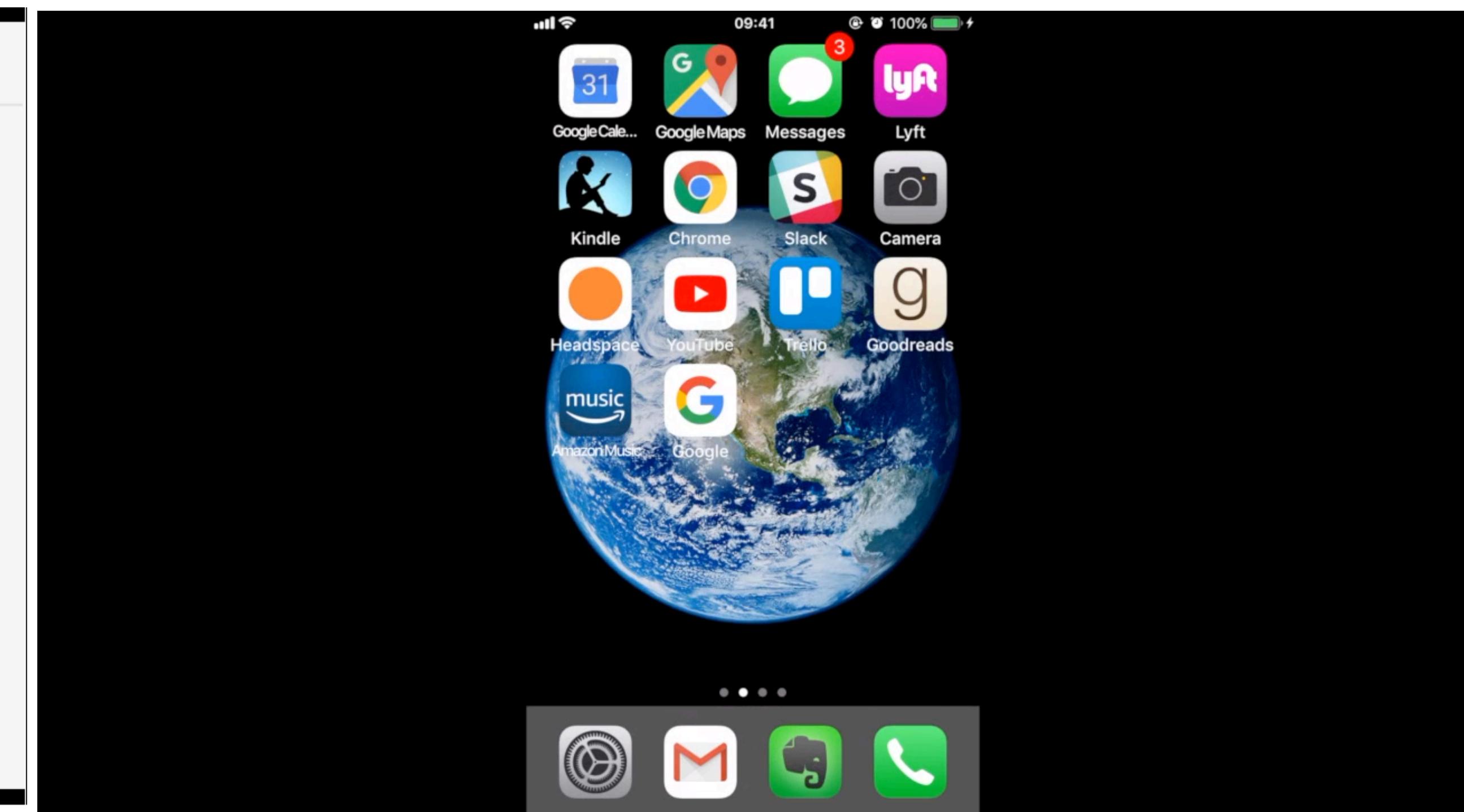
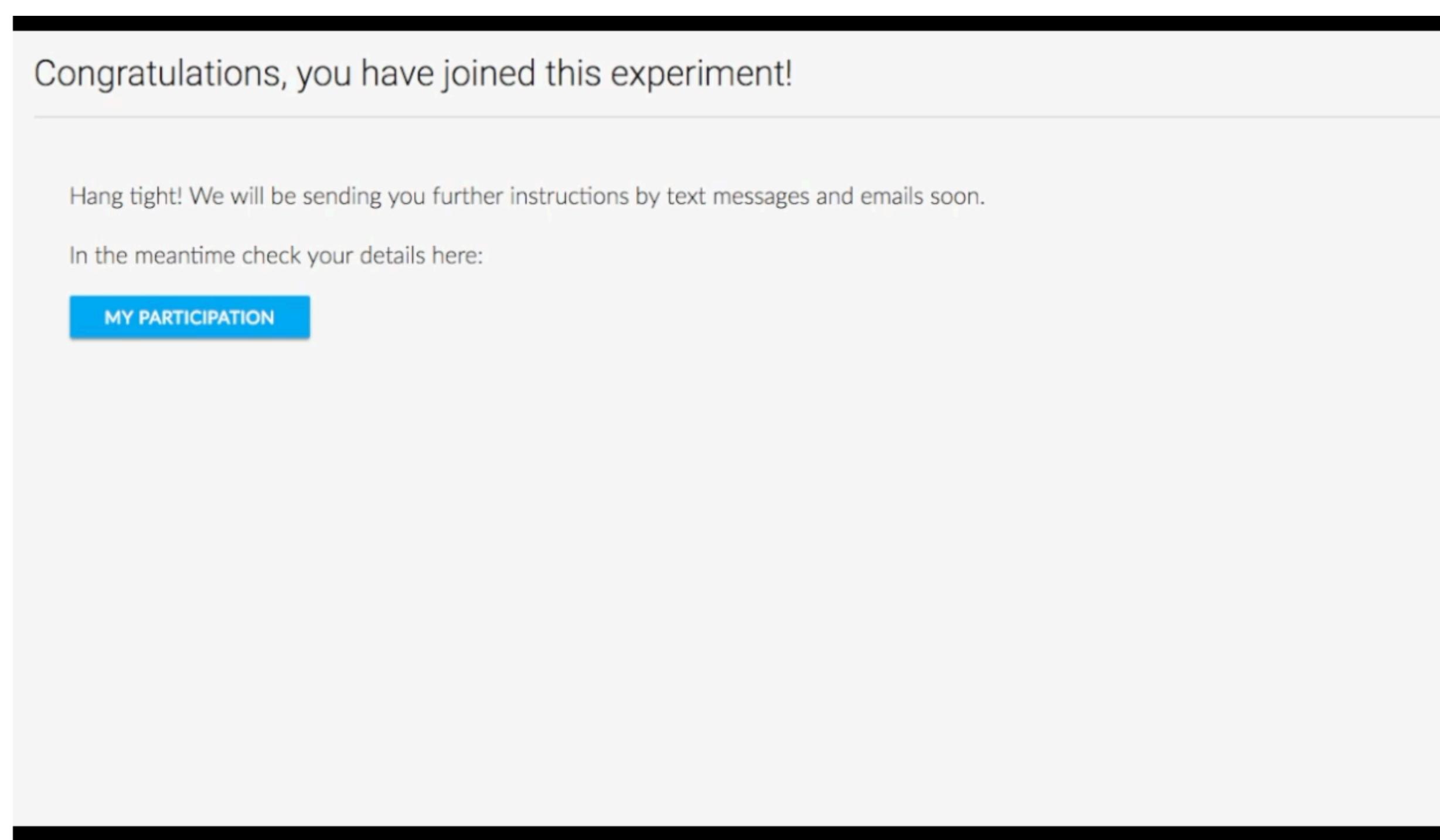
NEXT SECTION

# Improve using scaffolded community reviews

**Participants join online and provide data via text reminders**



# Participants join online and provide data via text reminders





Kombucha and Kefir Experiments

Design An Experiment

Dashboard

Help us improve!



vipandey\_ucsd



## Does Drinking Kombucha affect stool consistency?

Great work! Your experiment has completed.

1

**Review the data provided by participants**

[REVIEW THE DATASHEET](#)

2

**Good job! You have already sent a thank you note to all participants**

3

**You have already requested data analysis. Please be patient to wait the result**

4

**You can discuss the experiment with your participants**

[DISCUSS NOW](#)[My Ready-to-run Experiments](#)

# Galileo's architecture

**Design with  
procedural guidance**

**Review with  
scaffolded  
collaboration**

**Run with consistent  
implementation**

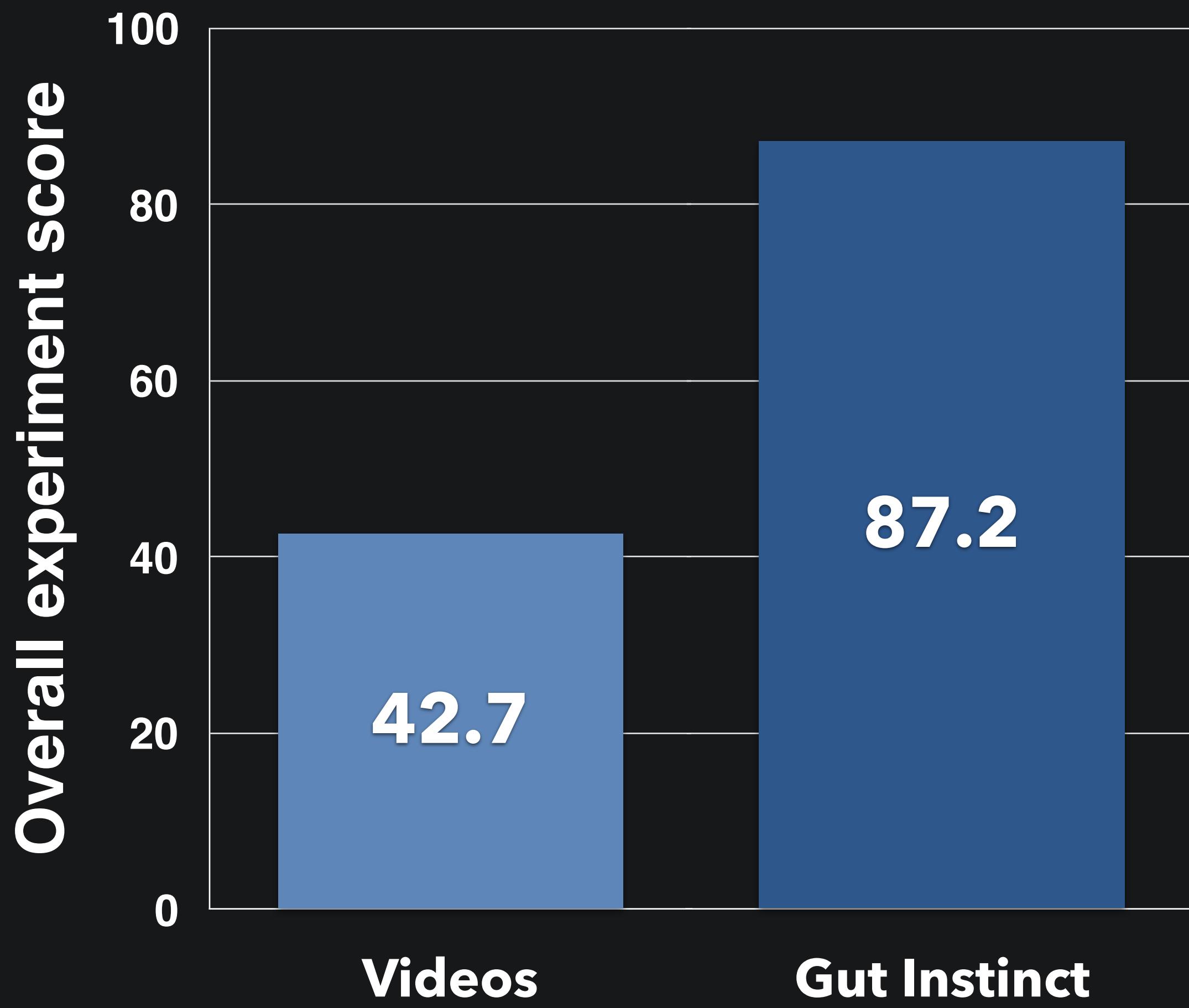
## Research Questions

Q1 Does reifying the activity in software  
with procedural guidance work?

## Research Questions

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with procedural guidance work?

People design better  
with procedural  
guidance ( $N=72$ )



## Research Questions

Q2 Do people collaboratively create useful experiments?

## Research Questions

# Q2 Do people collaboratively create useful experiments?

People design structurally-sound experiments with reviewers' help ( $N=66$ )



**coursera** Explore  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 ...

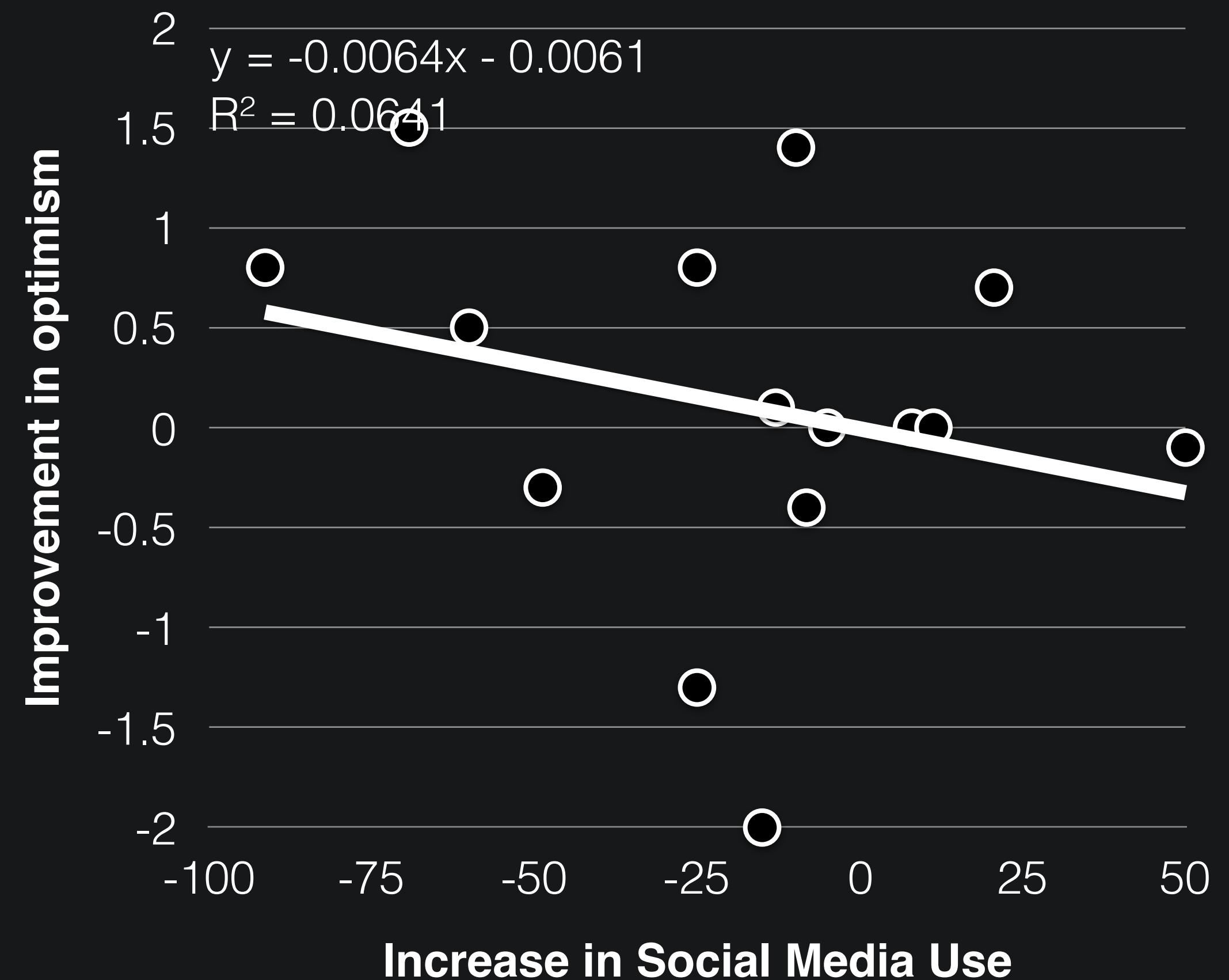
## Research Questions

Q3 Do people successfully run experiments?

## Research Questions

# Do people successfully run experiments?

Three communities ran experiments about gut health, effect of social media, and circadian rhythms ( $N=68$ )



Results

N=66 experiments

# People design structurally sound experiments

Structure (13pts)

Hypothesis: *Is the hypothesis concrete?*

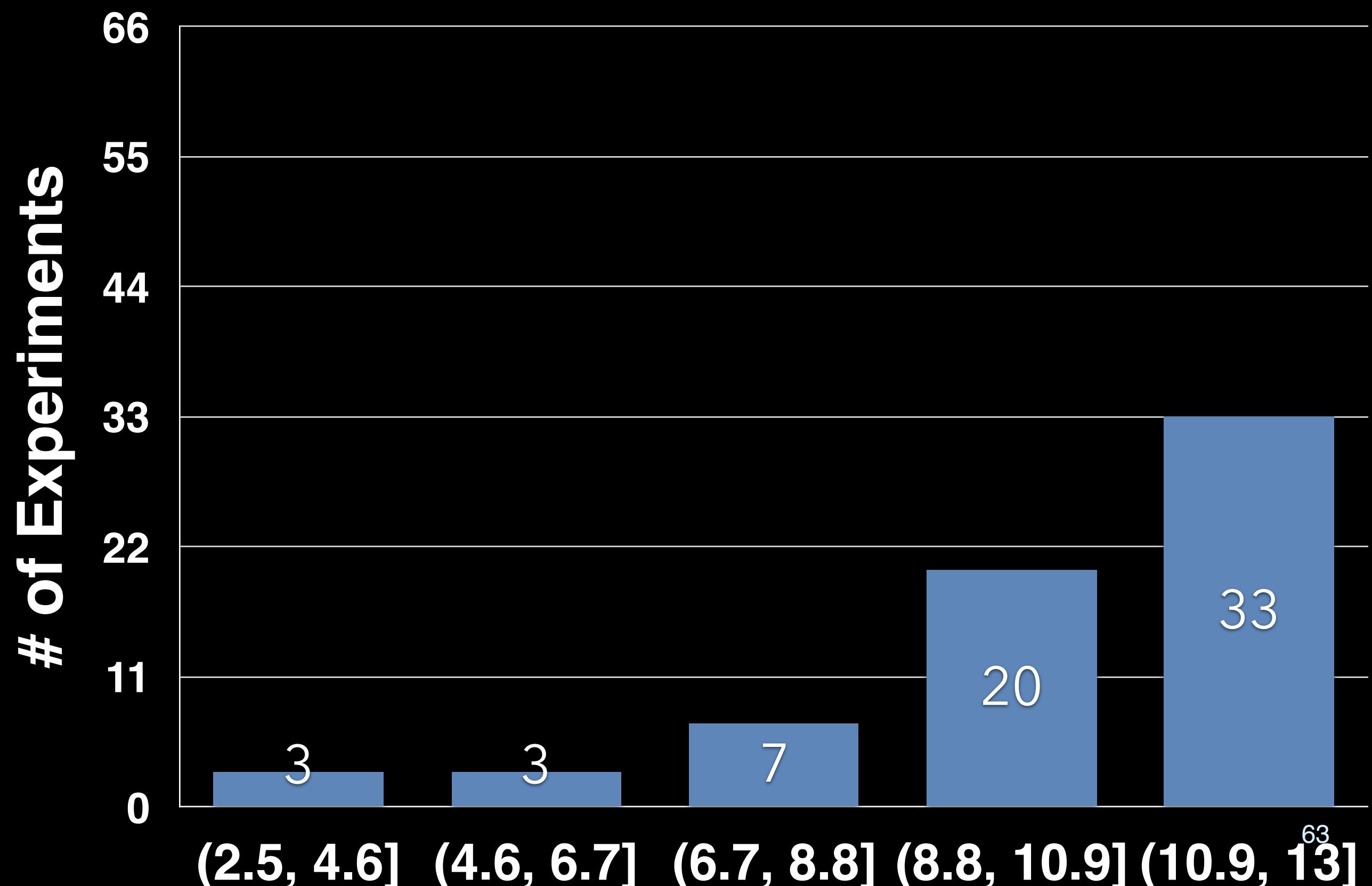
Measurement: *Are the cause and effect properly manipulated/measured?*

Conditions: *Are the conditions designed correctly?*

Steps: *Are experimental steps clear?*

Criteria: *Are the participation criteria appropriate?*

Run: *Can the overall experiment be run as is?*



Results

N=66 experiments

# People draw from personal insights

Avoiding foods high in lectins cures long-term post-infectious diarrhea

Drinking kombucha regularly reduces joint inflammation/arthritis symptoms

Having dry mouth (or Sjogren's Syndrome) promotes the growth of less beneficial gut microbes

Eating yogurt makes a person have a more regular bowel movement

# People draw from personal insights

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Having dry mouth (or Sjogren's Syndrome) promotes the growth of less beneficial gut microbes

Eating yogurt makes a person have a more regular bowel movement

Content (3pts)

**Novelty:** *Is there a chance the world will learn something? 17%*

**Popularity:** *Is the world already curious about this hypothesis? 51%*

**Topics:** *Diet (dietary styles, alcohol, fermented foods), Medicines, Alternative treatments*

**Lived experience:** *Did the hypothesis come from personal experience? 38%*

# Reviewers provide feedback on structure, content, and participant experience

"A simplistic Likert scale seems like a bad idea. There has to be something better than this. At least a couple questions? Like, optimism, excitement, depression, anxiety?"

**Improving structural correctness**

# Reviewers provide feedback on structure, content, and participant experience

"A simplistic Likert scale seems like a bad idea. There has to be something better than this. At least a couple questions? Like, optimism, excitement, depression, anxiety?"

"A1C is measured monthly and won't change after 1g. You mean the BG value?"

**Improving structural correctness**

**Providing domain-specific knowledge**

# Reviewers provide feedback on structure, content, and participant experience

"A simplistic Likert scale seems like a bad idea. There has to be something better than this. At least a couple questions? Like, optimism, excitement, depression, anxiety?"

"A1C is measured monthly and won't change after 1g. You mean the BG value?"

",...the timing of this [reporting steps taken] vs. social media use measure is off and that makes me worry about intervening use throwing things off (e.g. "phew! I've reported my facebook for the day, now I can go use it"?"

**Improving structural correctness**

**Providing domain-specific knowledge**

**Considering participant's experience**

# Kombucha community: Does drinking kombucha improve stool consistency?



Kombucha: a gut probiotic?



Adriana: Kombucha producer (Rio)

# Kombucha community: Does drinking kombucha improve stool consistency?



**Design +  
Pilot**



# Kombucha community: Does drinking kombucha improve stool consistency?



Design +  
Pilot



Gathering  
participants

A photograph of a red glass kombucha bottle with a white label featuring a crest with the text "FERMENTERS CLUB EST. 2011". Below the label, there is a small illustration of a DNA double helix. The bottle is resting on a surface next to a red apple.

**Be part of kombucha science!** 🧬

In collaboration with American Gut project and UCSD Design Lab,  
we're testing the effects of different diets on the human body.

# Kombucha community: Does drinking kombucha improve stool consistency?



Design +  
Pilot

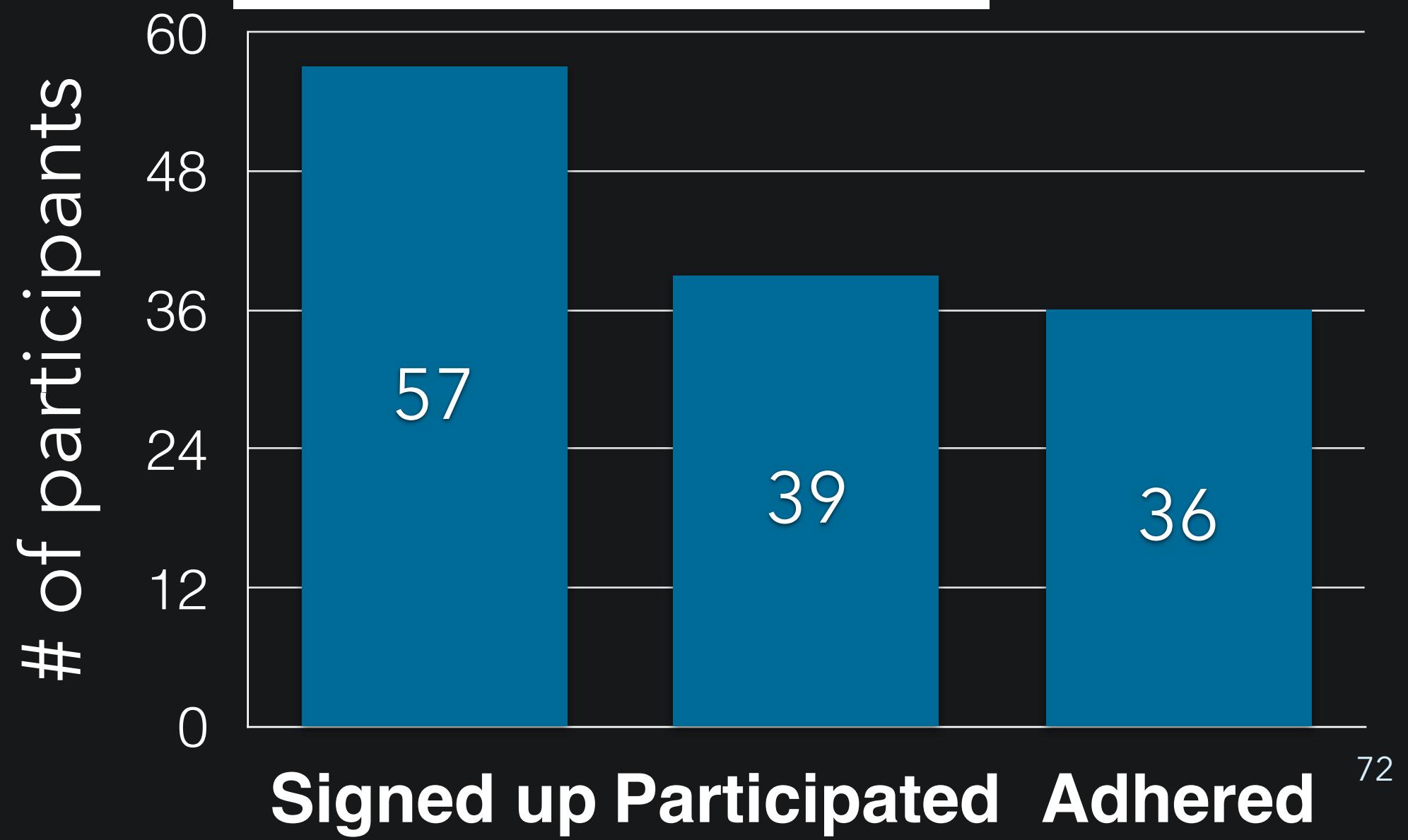


Gathering  
participants



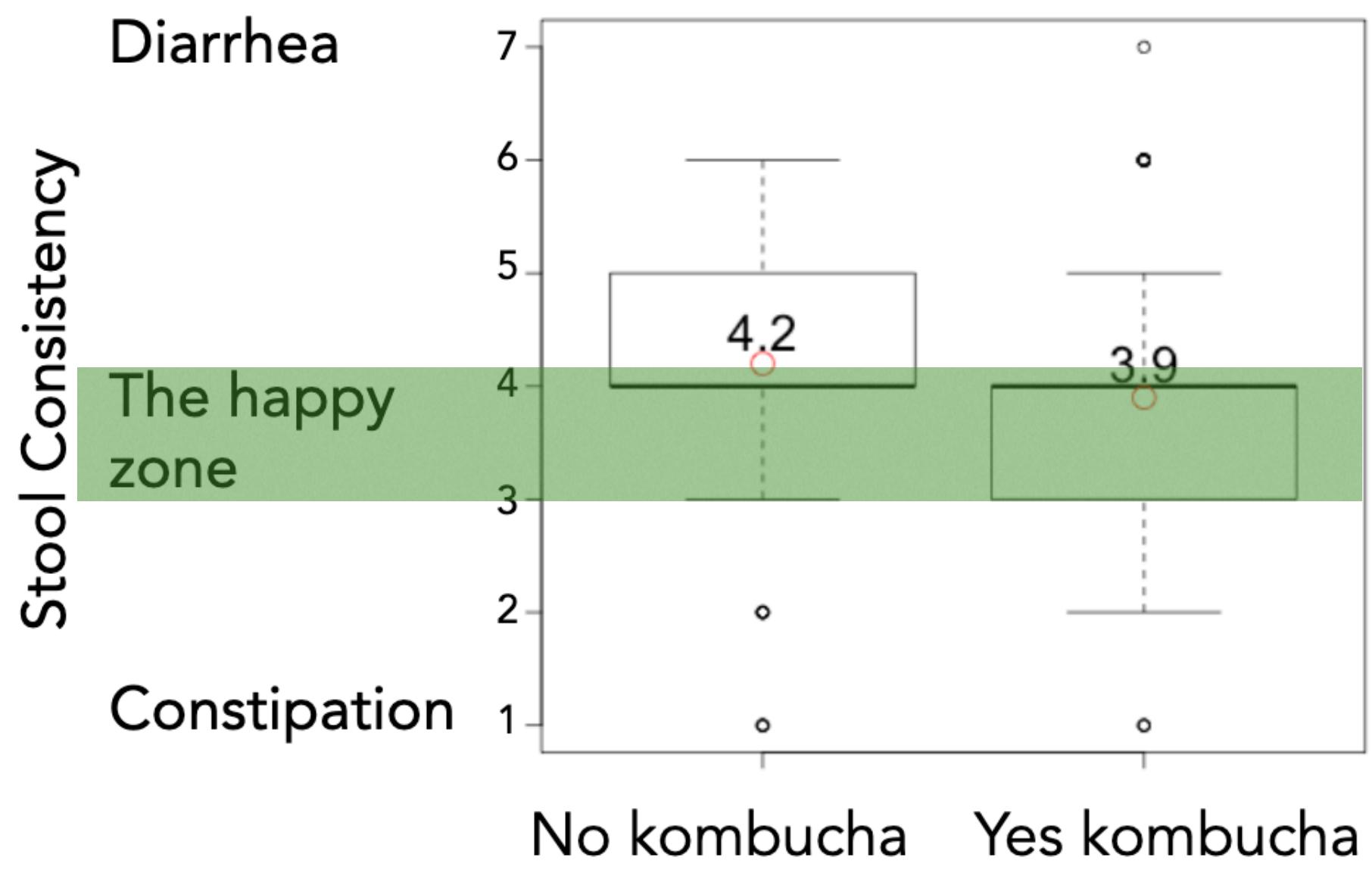
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N=36

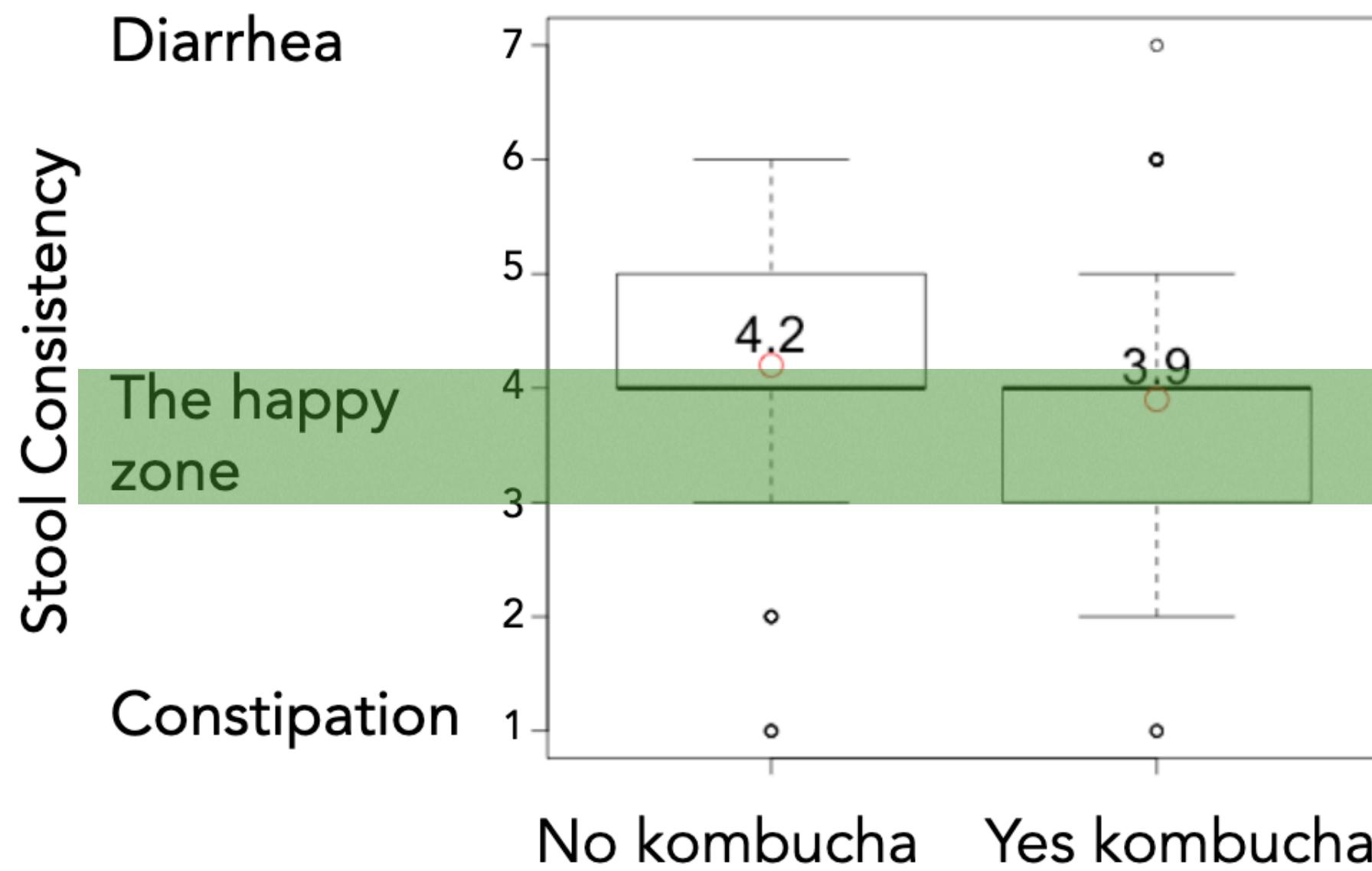
# Kombucha community: Does drinking kombucha improve stool consistency?



**between-subjects  
experiment;  $p<0.03$**

N=36

# Kombucha community: Does drinking kombucha improve stool consistency?



**between-subjects  
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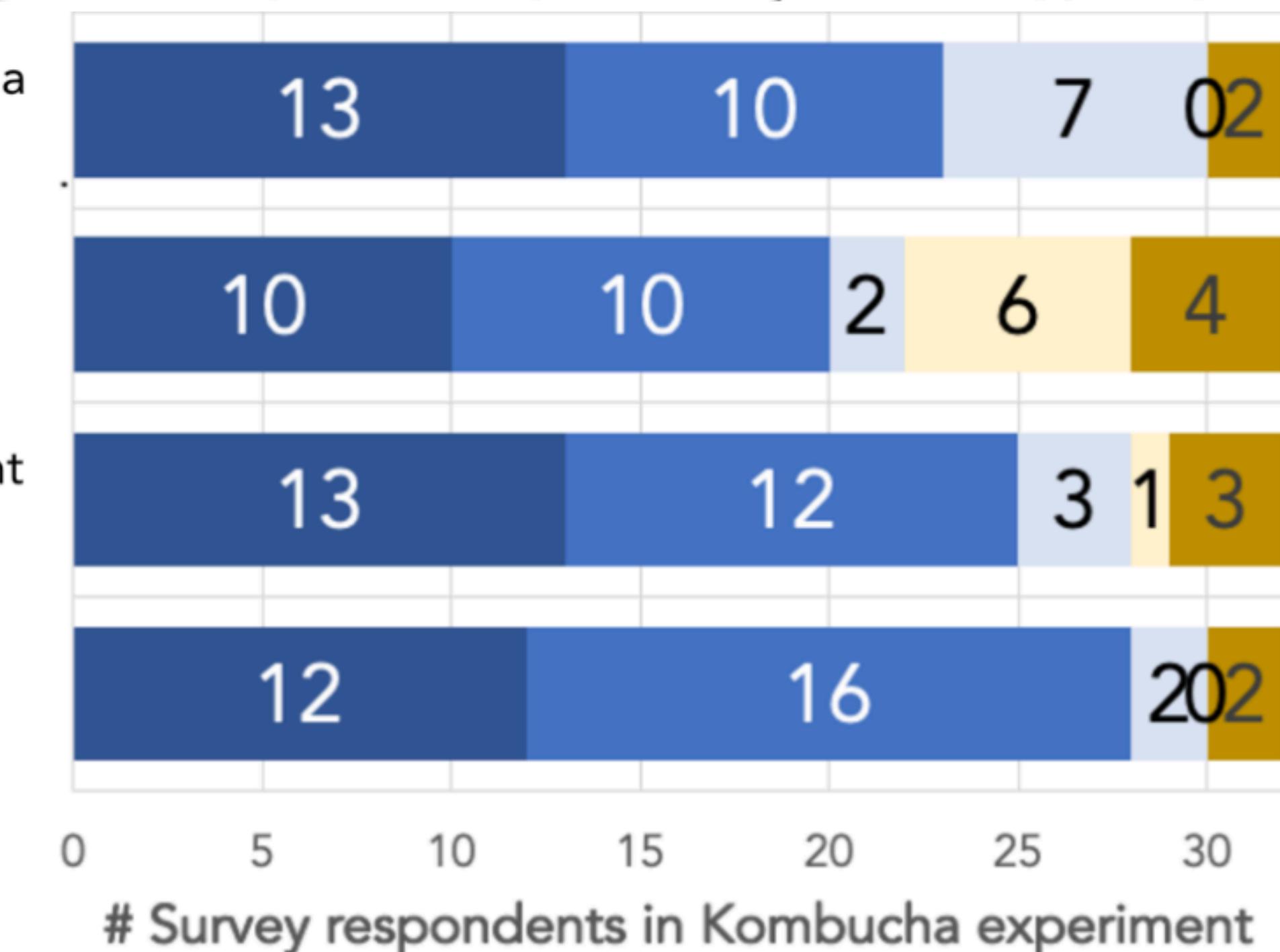
Strongly Agree   Agree   Neither agree nor disagree   Disagree   Strongly Disagree

I'd like to participate in a similar experiment

Participating in this experiment did NOT alter my daily activities

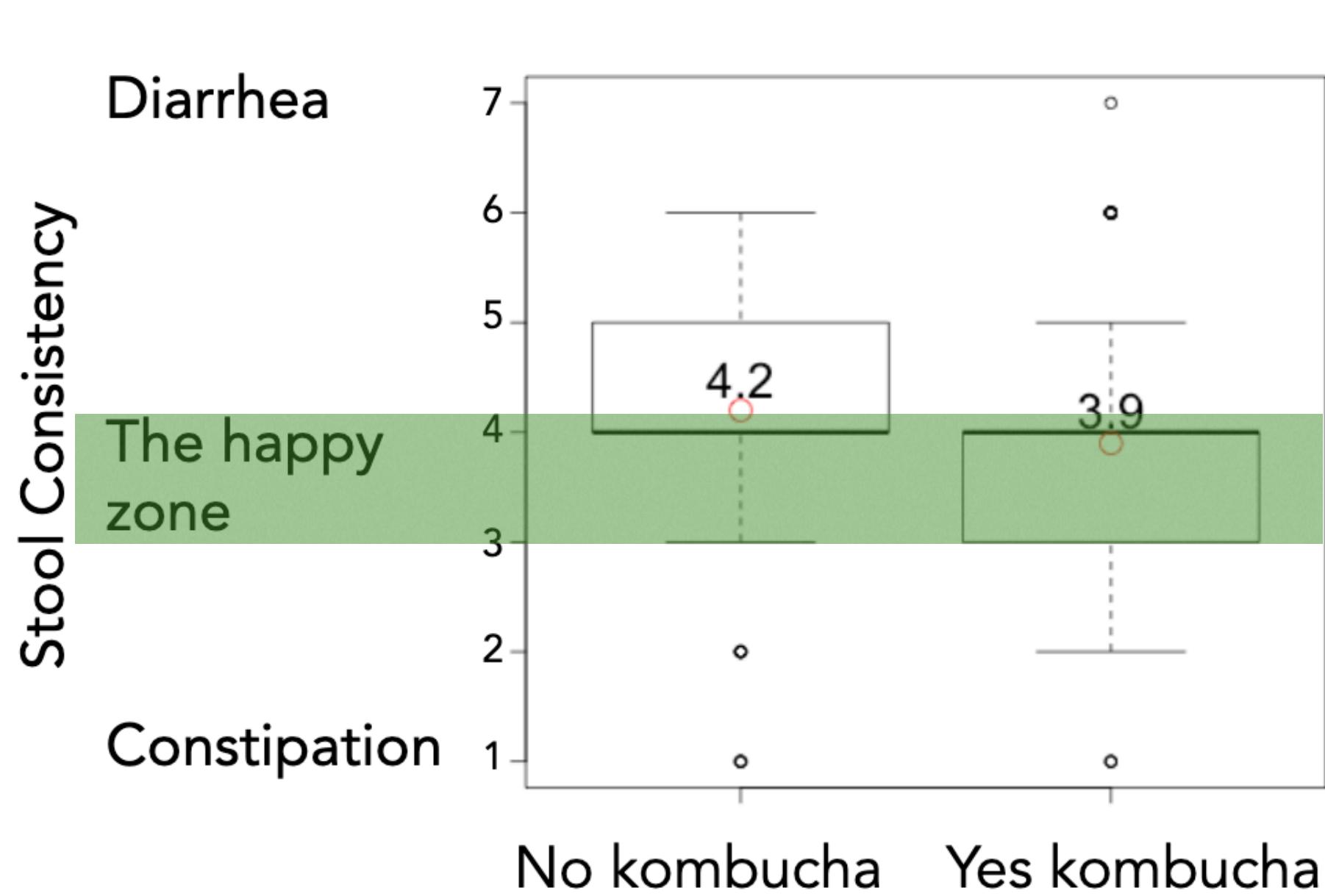
The reminders were sent at appropriate times

The instructions were easy to follow



N=36

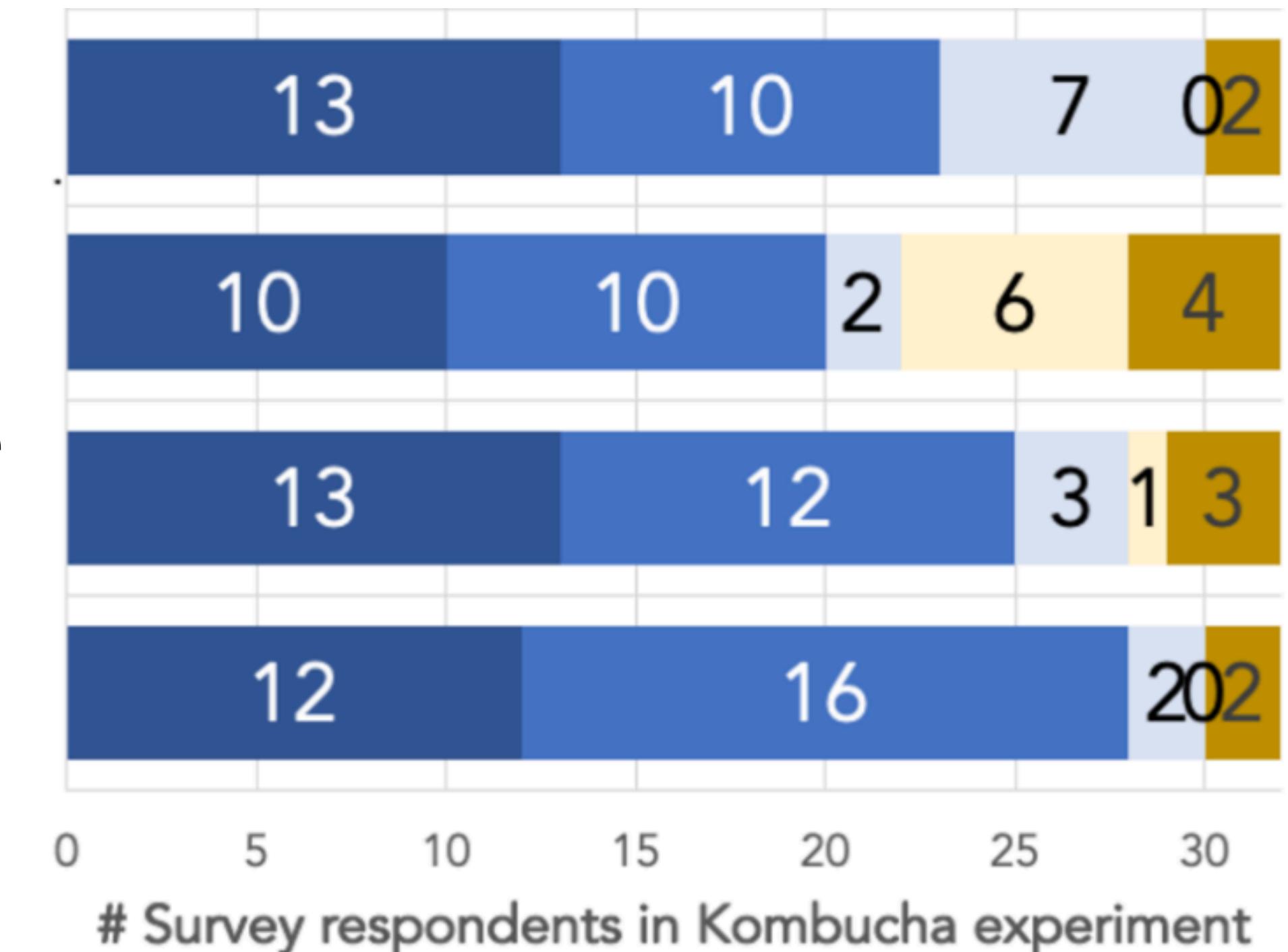
# Kombucha community: Does drinking kombucha improve stool consistency?



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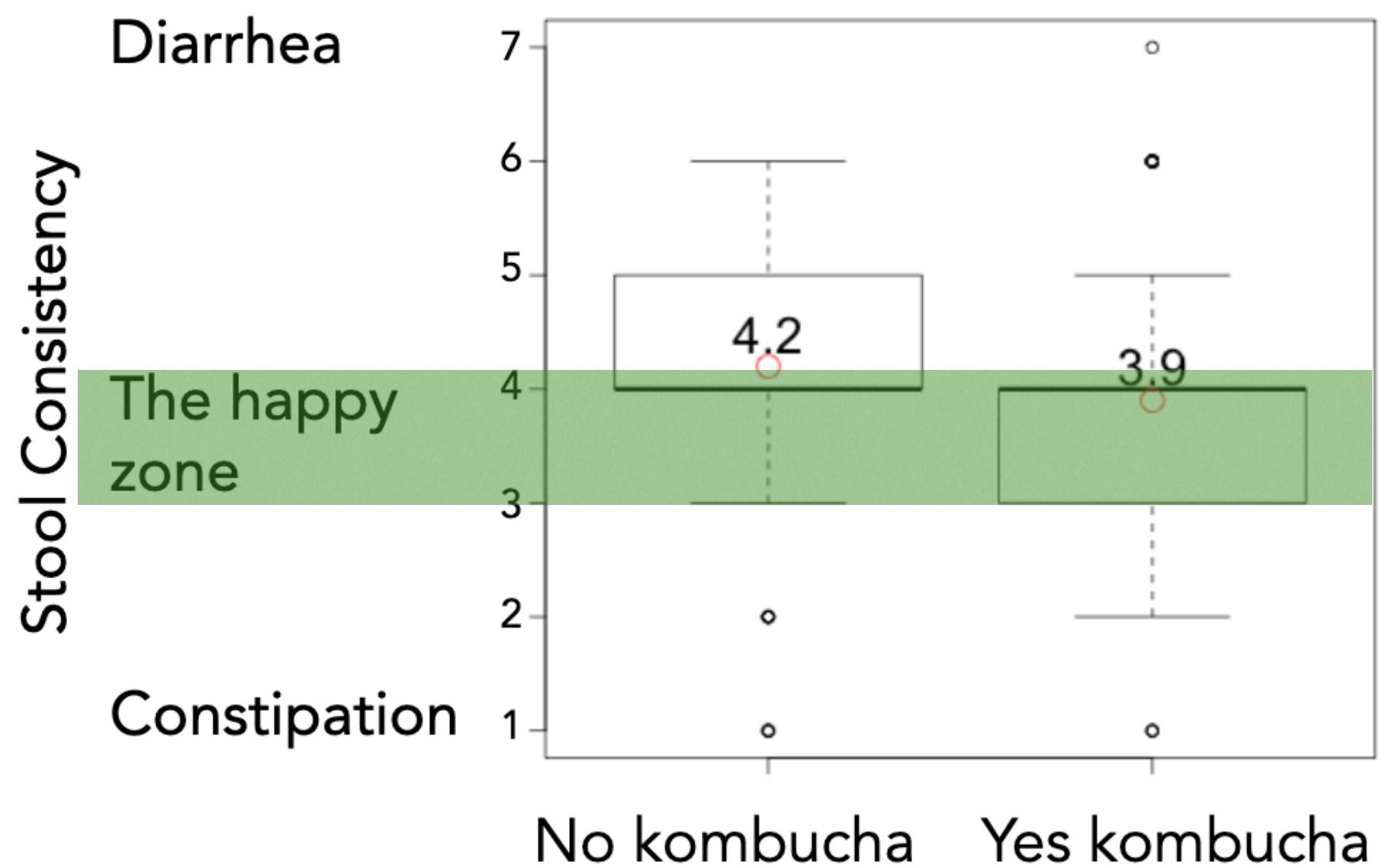
Strongly Agree Agree Neither agree nor disagree Disagree Strongly Disagree

People are  
keen to  
participate



N=36

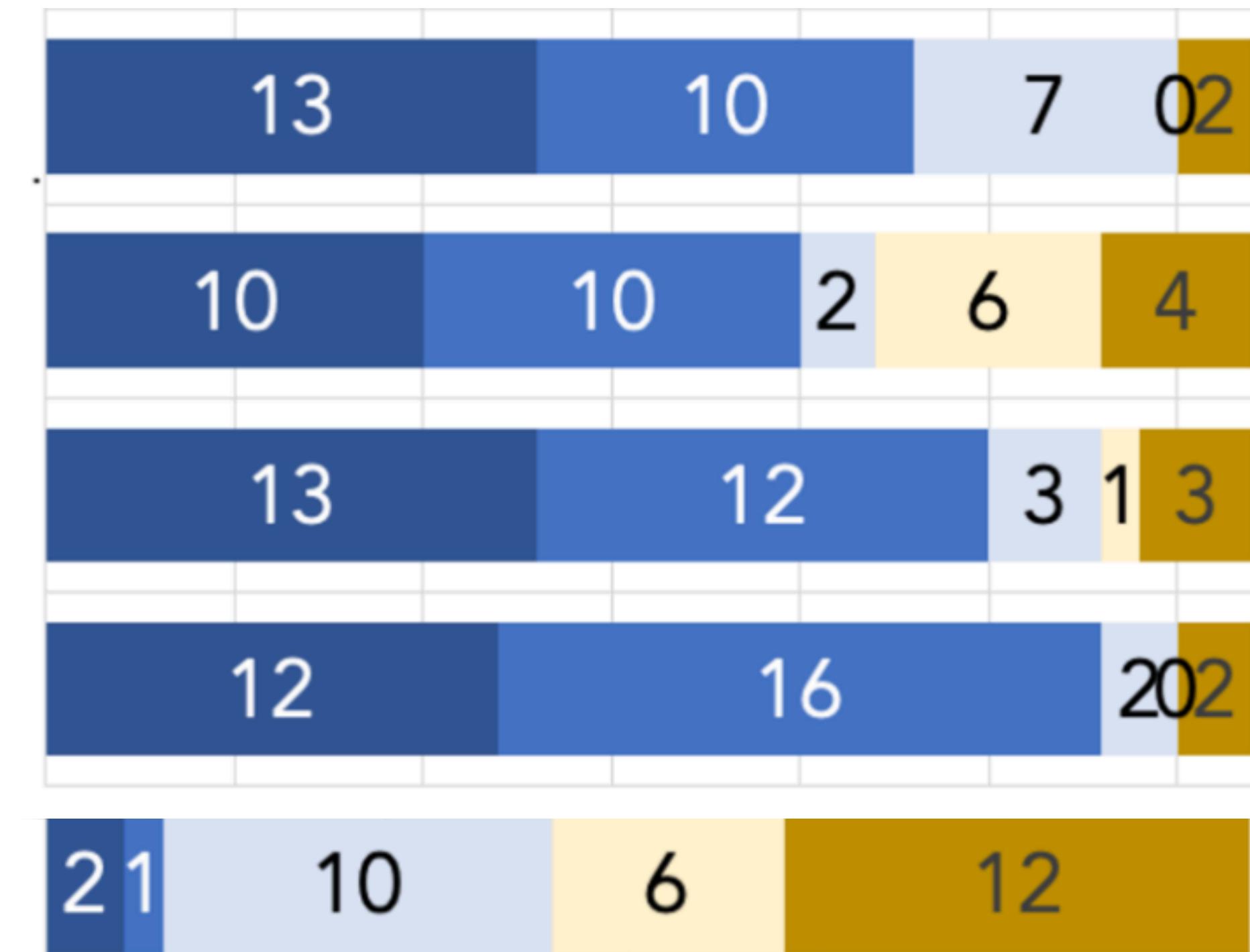
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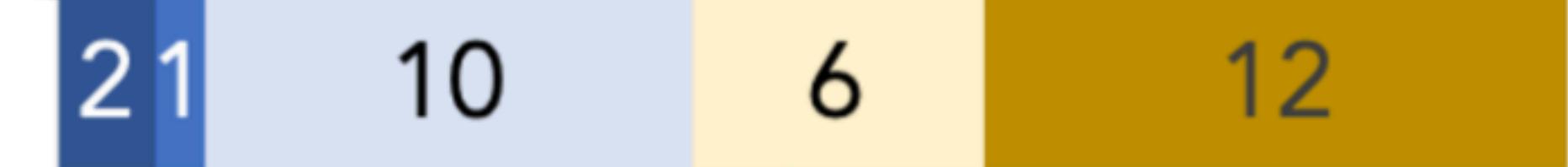
**between-subjects  
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■ Strongly Agree ■ Agree ■ Neither agree nor disagree ■ Disagree ■ Strongly Disagree

People are  
keen to  
participate



I'd like to design and  
run my own experiment



# Challenge: Limited update for running the experiment

- 1 Few people ran experiments
- 2 Experiments were underpowered
- 3 Varying levels of adherence

# Some avenues to explore for future work

EDUCATION

## Democratizing education? Examining access and usage patterns in massive open online courses

John D. Hansen<sup>1\*</sup> and Justin Reich<sup>2</sup>

Massive open online courses (MOOCs) are often characterized as remedies to educational disparities related to social class. Using data from 68 MOOCs offered by Harvard and MIT between 2012 and 2014, we found that course participants from the United States tended to live in more-affluent and better-educated neighborhoods than the average U.S. resident. Among those who did register for courses, students with greater socioeconomic resources were more likely to earn a certificate. Furthermore, these differences in MOOC access and completion were larger for adolescents and young adults, the traditional ages where people find on-ramps into science, technology, engineering, and mathematics (STEM) coursework and careers. Our findings raise concerns that MOOCs and similar approaches to online learning can exacerbate rather than reduce disparities in educational outcomes related to socioeconomic status.

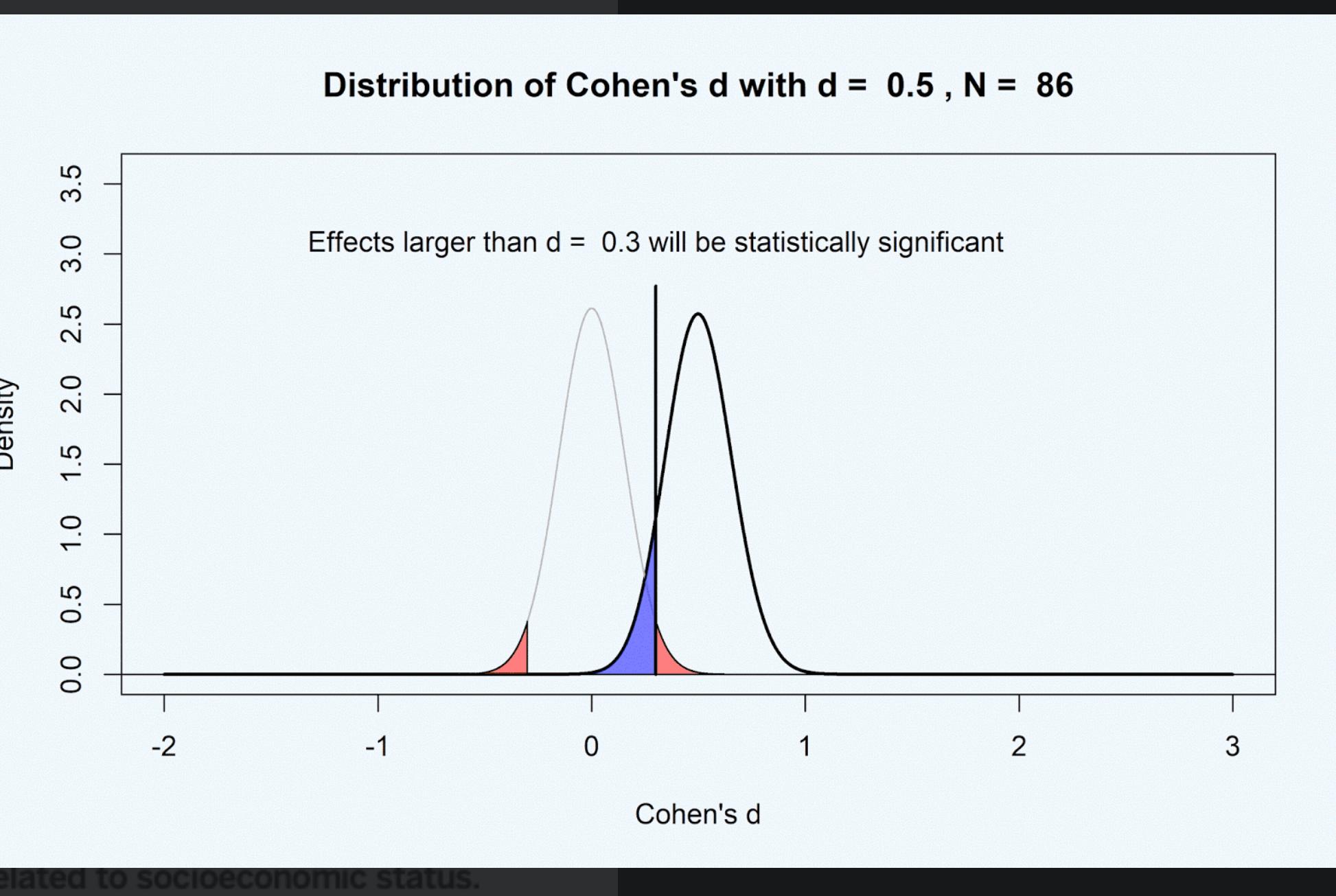
# Some avenues to explore for future work

EDUCATION

## Democratizing education? Examining access and usage patterns in massive open online courses

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Massive open online courses (MOOCs) are often characterized by large socioeconomic disparities related to social class. Using data from 68 million students in MOOCs taken between 2012 and 2014, we found that course participants in more-affluent and better-educated neighborhoods tend to have higher completion rates than those who did not register for courses, students with greater income were more likely to earn a certificate. Furthermore, these differences were larger for adolescents and young adults, the traditional users of MOOCs. In addition, students in science, technology, engineering, and mathematics (STEM) fields were more likely to earn certificates. These findings raise concerns that MOOCs and similar approaches may exacerbate rather than reduce disparities in educational outcomes related to socioeconomic status.



# Some avenues to explore for future work

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A woman with blonde hair tied back, wearing a black headband, looking towards the camera with a slight smile. A white play button icon is overlaid on her right eye.

**FUNDING**

### Headache Halo - the escape pod for your head

We can do better than an ice pack and a dish cloth. Headaches require advanced cold therapy.

**Team koldtec**  
1 Campaign | Toronto, Canada

**\$3,268 USD** 58 backers  
41% of \$7,900 Fixed Goal 31 days left

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# Does experimenting update beliefs?



# Does experimenting update beliefs?



**This Article Won't Change Your Mind**

The facts on why facts alone can't fight false beliefs

---

**Experiment Reconstruction Reduces Fixation on Surface Details of Explanations**

**Samuel Lau**  
Design Lab, UC San Diego  
La Jolla, CA 92093  
lau@ucsd.edu

**Scott Klemmer**  
Design Lab, UC San Diego  
La Jolla, CA 92093  
srk@ucsd.edu

**Tricia Ngoon**  
Design Lab, UC San Diego  
La Jolla, CA 92093  
tngoon@ucsd.edu

**Vineet Pandey**  
Design Lab, UC San Diego  
La Jolla, CA 92093  
vipandey@ucsd.edu

**Abstract**  
Misunderstandings of science affect many lives. Novices commonly misunderstand explanations by overly relying on surface details instead of evaluating underlying logic. Prior work has found adding a patina of neuroscience leads readers towards positively assessing explanations. How might we help people better understand science explanations? A between-subjects experiment tested whether asking readers to reconstruct experiments leads them to focus more on underlying logic. Participants relied less on irrelevant surface details when reconstructing experiments. However, this did not impact their subsequent assessment of explanations. Our results suggest that reconstruction is a useful strategy for understanding explanations but is not readily transferred towards evaluating explanations.

**Author Keywords**

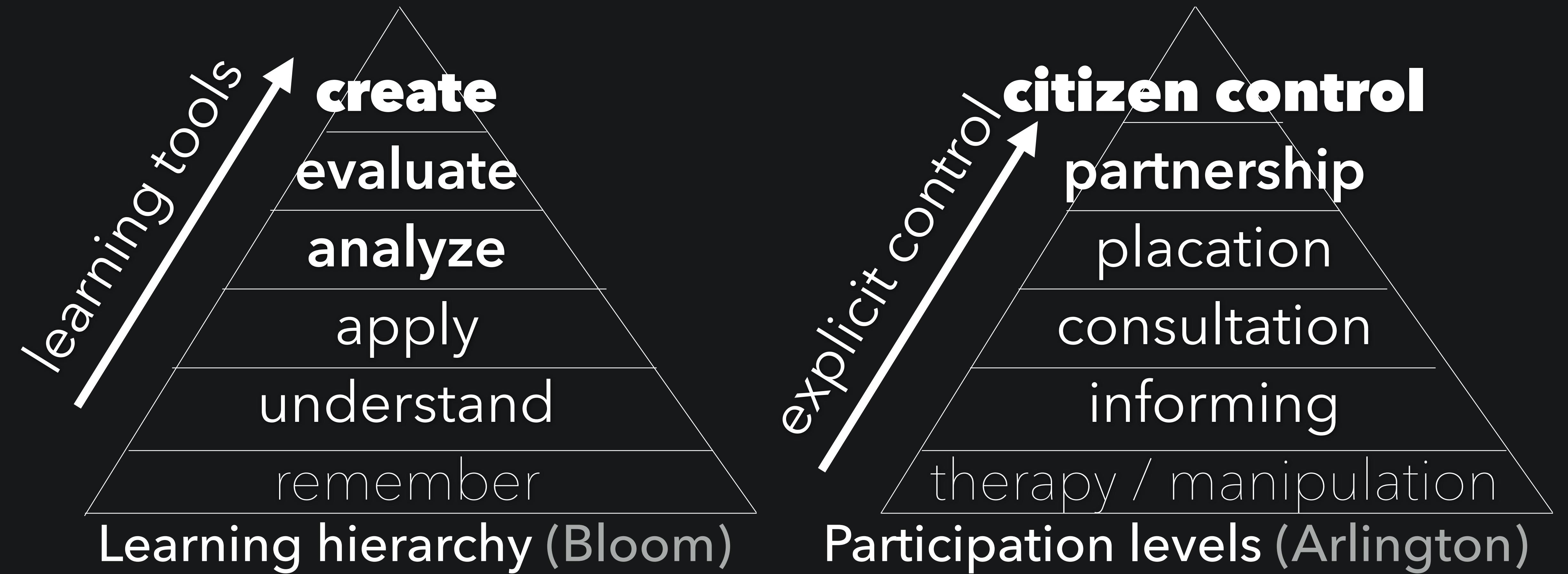
Caren Walker (UCSD) +  
Micah Goldwater  
(University of Sydney) plan to  
run studies using Gut Instinct

Thesis statement

**Procedural guidance in social  
computing catalyzes personally  
meaningful & useful scientific work**

# Learning in Social Computing:

## Doing big things, together!



# 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

# Dissertation Outcomes

# 1 Full Papers

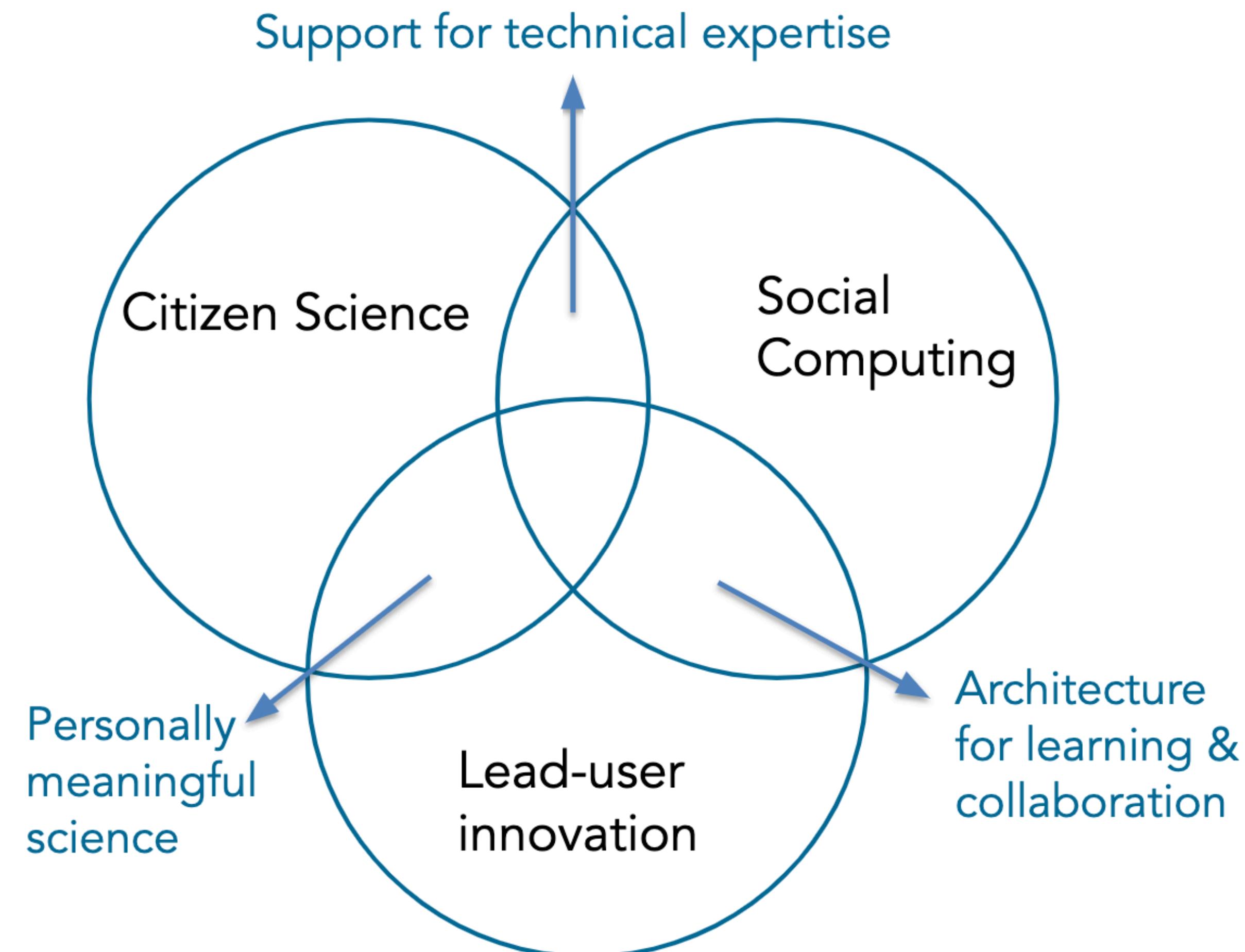
1. **In Submission.** Galileo: Procedural Support for Citizen Experimentation  
[Vineet Pandey](#), Tushar Koul, Chen Yang, Daniel McDonald, Mad Price Ball, Bastian Greshake Tzovaras, Rob Knight, **Scott Klemmer**
2. **2018 ACM Learning at Scale.** Docent: Transforming personal intuitions to scientific hypotheses through content learning and process training  
[Vineet Pandey](#), Justine Debelius, Embriette R Hyde, Tomasz Kosciolek, Rob Knight, **Scott Klemmer**
3. **2018 American Society for Microbiology mSystems.** American gut: an open platform for citizen science microbiome research  
Daniel McDonald, Rob Knight, [Vineet Pandey](#), Scott Klemmer, American Gut Consortium
4. **2017 ACM CHI.** Gut Instinct: Creating Scientific Theories with Online Learners.  
[Vineet Pandey](#), Amnon Amir, Justine Debelius, Embriette R Hyde, Tomasz Kosciolek, Rob Knight, **Scott Klemmer**
5. **2017 ACM SIGMOD.** Concerto: A High Concurrency Key-Value Store with Integrity.  
Arvind Arasu, Ken Eguro, Raghav K., Donald Kossmann, Pingfan Meng, [Vineet Pandey](#), Ravi R.
6. **2016 ACM CHI.** Framing Feedback: Choosing Review Environment Features that Support High Quality Peer Assessment.  
**Catherine M Hicks**, [Vineet Pandey](#), C Ailie Fraser, **Scott Klemmer**
7. **2015 arXiv.org (NOT PEER REVIEWED).** An HCI View of Configuration Problems.  
**Tianyin Xu**, [Vineet Pandey](#), **Scott Klemmer**

# Dissertation Outcomes

## 2 Extended Abstracts (Workshops, Posters, Demos)

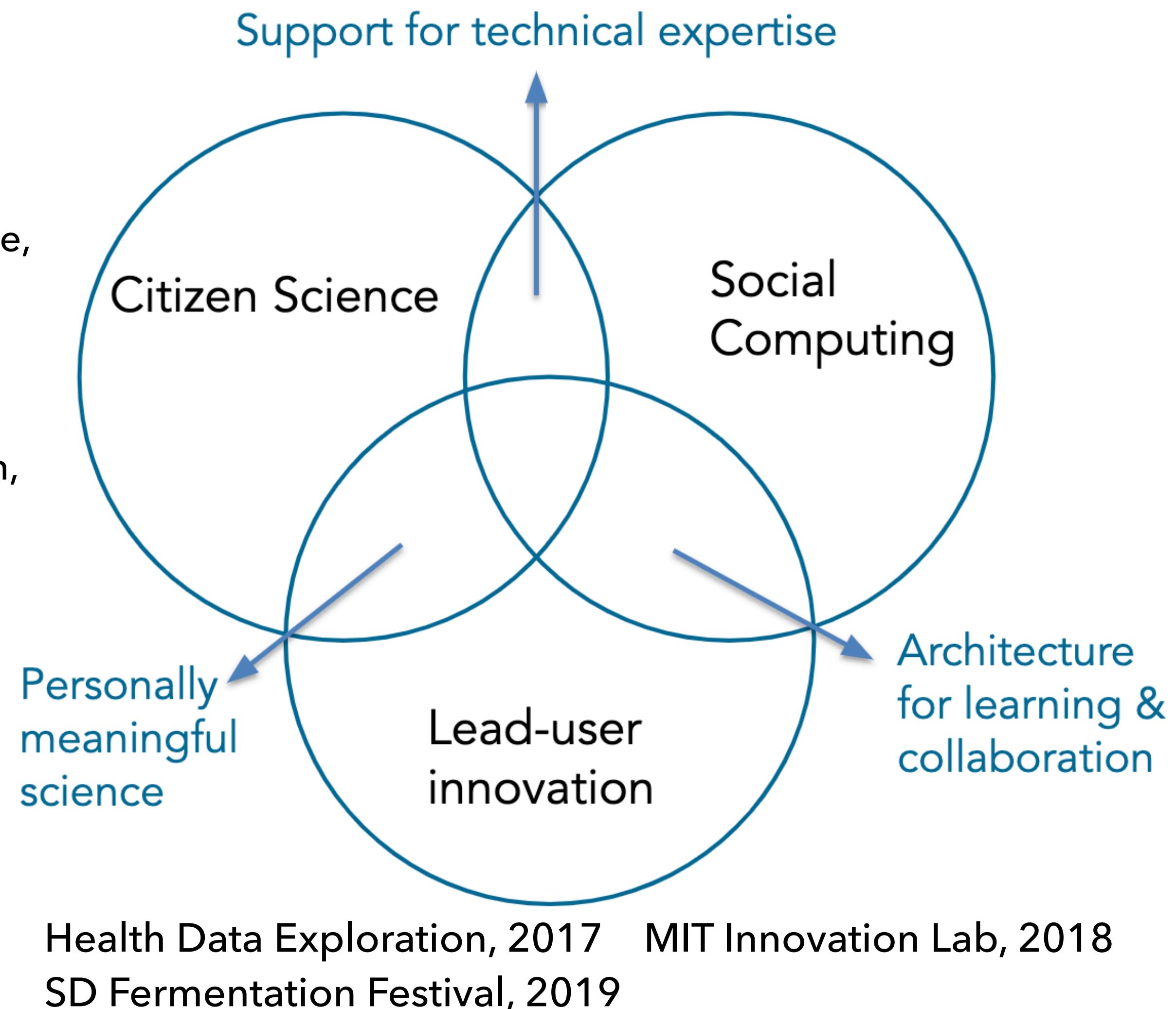
1. **2019 ACM Creativity and Cognition.** Experiment Reconstruction Reduces Fixation on Surface Details of Explanations  
[Samuel Lau](#), Tricia J Ngoon, [Vineet Pandey](#), [Scott Klemmer](#)
2. **2019 American Society of Microbiology.** Citizen Microbiology: Moving Beyond Crowdsourcing to Active, Participatory Science by the Public. [Vineet Pandey](#), Scott Klemmer, Daniel McDonald, Rob Knight.
3. **2019 ACM CHI.** Improving Health Outcomes by Integrating Personal Knowledge, Community, and Data.  
[Vineet Pandey](#)
4. **2018 American Society of Microbiology.** Transitioning the American Gut Project to the Microsetta Initiative. Daniel McDonald, Alexander Aksenov, Alexey Melnik, Pieter Dorrestein, Larry Smarr, Rashmi Sinha, [Vineet Pandey](#), Scott Klemmer, Rob Knight.
5. **2018 ACM CSCW.** Creating Scientific Theories with Online Communities using Gut Instinct.  
[Vineet Pandey](#)
6. **2016 AAAI HCOMP.** 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
7. **2016 ACM CSCW.** Game-theoretic models identify useful principles for peer collaboration in online learning platforms.  
[Vineet Pandey](#), Krishnendu Chatterjee
8. **2016 ACM CHI.** Education Across Borders: Technology Supported Mentoring and Teambuilding.  
[Vineet Pandey](#)
9. **2015 ACM Learning@Scale.** Connecting Stories and Pedagogy Increases Participant Engagement in Discussions.  
[Vineet Pandey](#), Yasmine Kotturi, Chinmay Kulkarni, Michael S Bernstein, [Scott Klemmer](#)

# Dissertation Outcomes Talks and Outreach



# Dissertation Outcomes Talks and Outreach

Digestive Disease Week,  
Chicago, 2017  
Precision Medicine Initiative,  
La Jolla, 2018  
American Society of  
Microbiology, SF, 2019  
Citizen Science Association,  
Raleigh, 2019



Other honors:

1. **Taught at USC:**  
**Computing for Social Good class**
2. **2019 Jacobs School of Engineering Henry Booker Award for Exemplary Ethical Engineering**
3. **Interviewed with KPBS/NPR**

Outreach in SD:  
Maker Faire, Nerd Nite,

# Dissertation Outcomes

# Collaborators: Students mentored



Sam



Tushar



Rachel



Crystal



Brian



Chen



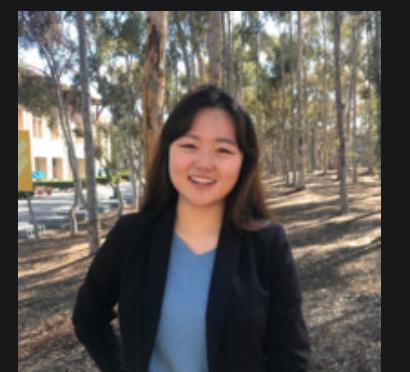
Dingmei



Liby



Aliyah



Hedy



Orr



Kaung



Cody



Senyan

# Collaborators: Students mentored + Microbiome experts



Sam



Tushar



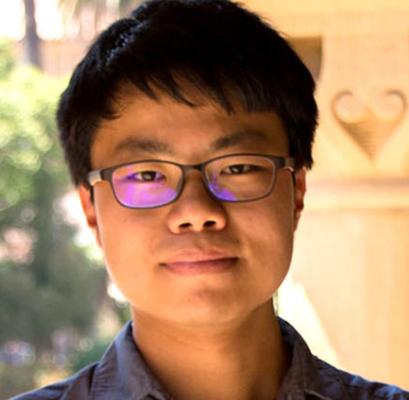
Rachel



Crystal



Brian



Chen



Dingmei



Liby



Aliyah



Hedy



Orr

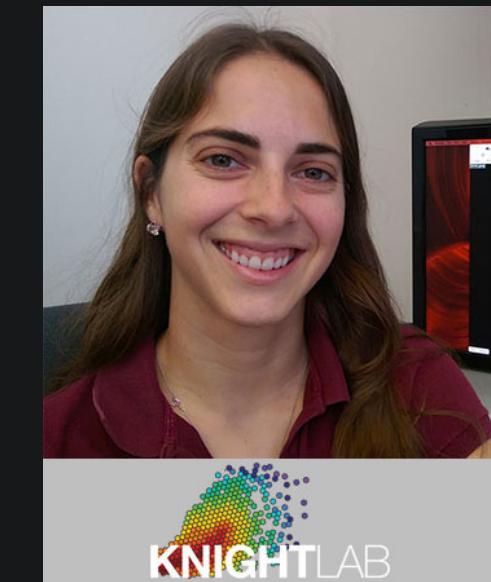


Kaung

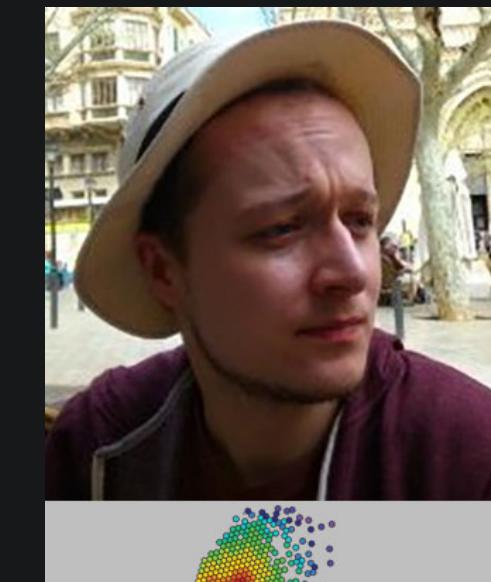


Cody

Senyan



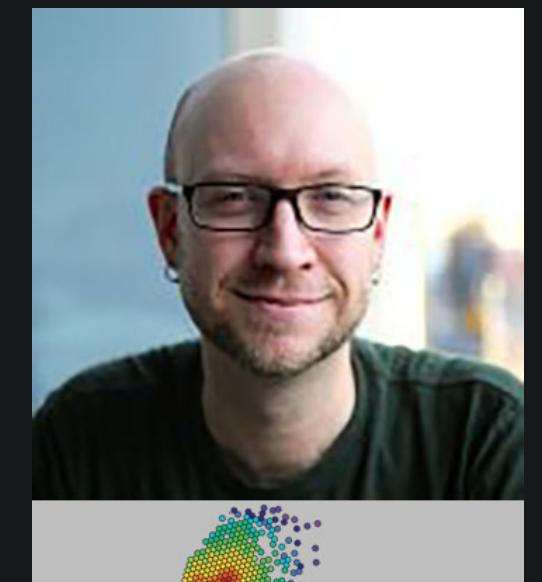
Embriette



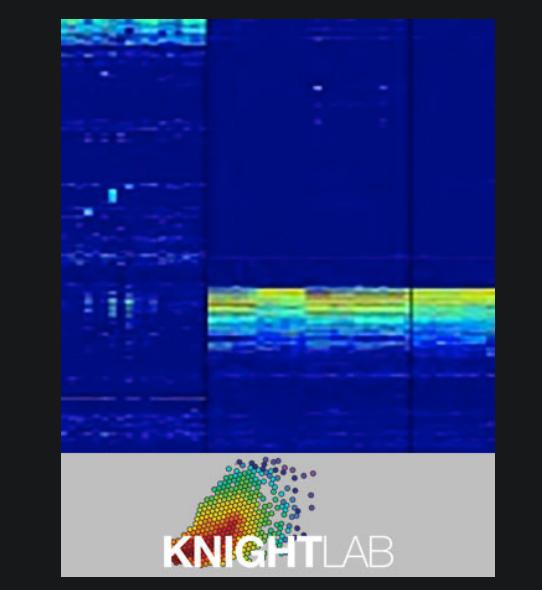
Tomasz



Justine



Daniel



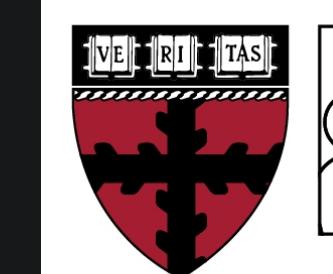
Amnon

# Next step: Postdoctoral work for patient-led experimentation

w/Professor Krzysztof  
Gajos at Harvard  
University



MASSACHUSETTS  
GENERAL HOSPITAL



**CRCS** Center for Research on  
Computation and Society

at Harvard John A. Paulson School of Engineering and Applied Sciences

# Thank You

**Whenever you are in doubt, or when the self becomes too much with you, apply the following test. Recall the face of the poorest and the weakest person whom you may have seen, and ask yourself, if the step you contemplate is going to be of any use to them.**

- Mahatma Gandhi