

# Majority is not the Answer: A Think-Aloud Study to Understand Factors Affecting Online Health Search

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UNIVERSITY OF  
**WATERLOO**

- Imagine a friend or a loved one you know suffer(s) from eczema
- You see an add on Twitter claiming probiotics are helpful in treating eczema
- You decide to search online for “probiotics” and “eczema”





**Probiotics for Eczema: Does It Work? - healthline.com**  
<https://www.healthline.com/health/skin-disorders/probiotics-for-eczema> -

2017-03-28 · Probiotic bacteria can: boost your immune system. improve digestive function. help prevent urinary tract infections. reduce the incidence of eczema in children if taken prenatally.  
Author: Traci Angel

**How to choose a good probiotic to help heal your eczema ...**  
<https://www.eczemaconquerors.com/how-to-choose-a-good-probiotic-to...> -

2014-03-31 · Probiotics, Eczema and You. So if you were wondering **do probiotics help eczema**? The answer is definitely yes! Good luck in finding a **probiotic** supplement that works best for your **eczema**! I hope all these tips have helped you. 😊  
Have a favourite **eczema probiotic**? Share your experiences or recommend one in the comments below!  
Author: Abby

**Probiotics for eczema: Why use them, and do they work?**  
<https://www.medicalnewstoday.com/articles/318946.php> -

< **Why Use Probiotic...** Do They ... Other Treat... >

There are many different types of eczema, but the most common type is atopic dermatitis. Learning what causes this helps us understand why some people use probiotics to treat it.

[See more on medicalnewstoday.com](#)  
Author: Lana Burgess

**Do probiotics help with eczema? | Probiotic Professionals ...**  
<https://www.optibacprobiotics.co.uk/professionals/faq/do-probiotics-help-with-eczema> -

**Do probiotics help with eczema?** It is now commonly understood that the gut is the principle interface between microbes and the immune system. When the balance of 'good' and 'bad' microbes is lost in favour of increased levels of pathogenic strains then damage to the lining of the gastro-intestinal tract can occur.  
Founded: 2004-04-01

**Do Probiotics Help Eczema – Yes, but... | Eczema Warriors**  
<https://eczemawarriors.com/do-probiotics-help-eczema> -

2018-09-11 · **Do probiotics help eczema** – now the answer is YES. As you take action through the steps above and your leaky gut starts to heal, you should be able to tell by generally feeling better and having higher energy levels. Your **eczema** may not improve drastically yet, as there is still a lot of healing that needs to take place.  
Author: Joo

**7 Ways Probiotics Can Impact Eczema | Vitagene**  
<https://vitagene.com/blog/probiotics-for-eczema> -

**Probiotics** have been used as a supplement to **help** protect against immune dysfunction and reduce inflammation. In some clinical trials it has shown that **probiotic** bacteria spray reduces the severity of atopic dermatitis, or **eczema**, a clinical trial found.

**Can Probiotics Help Eczema? Studies Indicate Yes! - It's ...**  
<https://itchylittleworld.com/can-probiotics-help-eczema> -

2018-12-03 · Let's look at a few studies using **probiotics** and **eczema** to really understand if **probiotics** can **help eczema**! Can **probiotics help eczema**? Check out the proof in clinical trials: One of the longest studies about **probiotics** and **eczema** (1) has been following a group of high risk children from womb to 6 years of age.  
Author: Laura Dolgy

**Probiotics No Help in Childhood Eczema - WebMD**  
<https://www.webmd.com/.../eczema/news/20081010/probiotics-no-help-childhood-eczema> -

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Author: Julie Edgar

**Can Probiotics Help With Eczema? - verywellhealth.com**  
<https://www.verywellhealth.com/probiotics-for-eczema-89944> -

**Probiotics** are a type of beneficial bacteria being explored to ease



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- 90% of the search results are incorrect (either inconclusive or helps)
- The authoritative result (WebMD) is at rank 8
- Top ranked URLs are inconclusive or incorrect
  
- What would people do?
- What will be the final decision?

# Problem Definition

- All returned search results are relevant (about probiotics)
- Precision at 9 is 100%
- If someone believes what search results say, it will be a waste of money and effort
  - Search results are useless!
- What if we are dealing with serious illness (diabetes or cancer)?
  - Search results might be harmful!

# Problem Definition

- Search engine finds relevant documents containing correct and incorrect information
- Searchers are influenced with incorrect information in search results and make potential harmful decision
- How does health-related incorrect information present in web search affect people's decision making process?

# Main Findings

- Similar to [Pogacar et al, ICTIR 2018], results biased towards incorrect information reduced people's accuracy to 32% while results biased towards correct information increased accuracy to 67%.
- Majority, authoritativeness and quality are among the important aspects people pay attention to when using online search.
- People have subconscious biases when using online search for health purposes such as rank and helpful bias.

# OUTLINE

- Prior study
- Study Design
  - Medical treatments
  - Experimental conditions
  - Performance measures
- Results
- Conclusion & Future Work

# In our prior work: (ICTIR 2018)

- Asked people to use our search engine to determine the efficacy of different medical treatments for a number of health issues
- We biased the search results towards correct or incorrect information
- We further manipulated the top ranked results (correct at rank 1 or 3)
- We measured participants' accuracy when deciding about the efficacy of the medical treatments

# In our prior work: (ICTIR 2018)

- Results biased towards incorrect information reduced people's accuracy from 43% to 23%
- Results biased towards correct information increased accuracy from 43% to 65%
- Participants' accuracy was only 59% if the top two results were incorrect compared to 70% accuracy when the rank 1 item was correct
- More self-reported knowledge reduced the effect of incorrect information on accuracy
- More interaction with the search results results in more correct decision

# Follow-up study

- Think-aloud protocol to understand what people are thinking when using search results with a mixture of correct and incorrect information
- What factors affected the decision making process?
- How can we improve the search results to better support people's health-related decisions?

# Study Design

- Participants were told to think-aloud while they search for the answer to a question about the effectiveness of a treatment for a health issue.
- Participants had to classify the medical treatments as
  - *Helpful*: Treatment has direct positive effect
  - *Unhelpful*: Treatment is ineffective or has a direct negative effect
  - *Inconclusive*: Unsure about the effectiveness
- Participants practice the think-aloud doing a tutorial task.

# Study Design

- Participants think-aloud while answering 4 different questions about the treatment effectiveness.
- The searcher keeps notes of participants' reactions.
- Eye-tracking in the think-aloud to capture eye movements
- Retrospective think-aloud where searcher asks questions about the think-aloud.
  - Video recording (with eye-movement) reviewed by participants *post hoc* with further information elicited
- Post-task questionnaire: participants answer open general questions about online health search.

# Medical Treatments

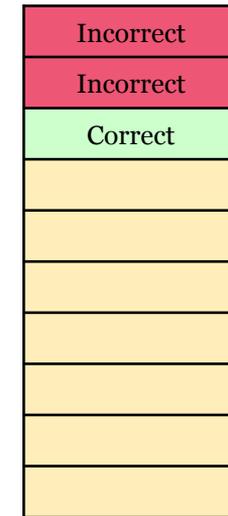
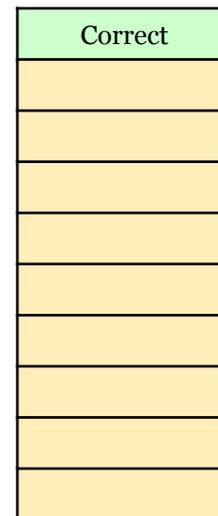
- The medical treatments and associated medical conditions were all formulated as “Does X help Y?”
  - Examples: Unhelpful: “Do insoles help back pain?”
- Each medical question was classified as *helpful* or *unhelpful*, as determined by the corresponding Cochrane Review
  - Internationally recognized as the highest standard in evidence-based health care resources
- Each participant had 2 helpful and 2 unhelpful treatments, 4 total

# Medical Treatments

Medical Treatment	Efficacy
Does caffeine help asthma?	Helpful
Does traction help low back pain?	Unhelpful
Do probiotics help treat eczema?	Unhelpful
Do benzodiazepines help alcohol withdrawal?	Helpful
Does cinnamon help diabetes?	Unhelpful
Do antioxidants help female subfertility?	Unhelpful
Does melatonin help treat and prevent jet lag?	Helpful
Does surgery help obesity?	Helpful

# SERP Experimental Conditions

- Search Result Bias
  - 8:2 ratio of results
  - 8 correct, 2 incorrect
  - 2 correct, 8 incorrect
- Topmost Correct Rank
- Always had a correct result at rank 1 or rank 3



# SERP Experimental Conditions

- Search engine result pages collected from different search engines (Google, Yahoo, Bing)
- Total of 158 documents
- For each medical treatment, we have a pool of 8-10 incorrect documents and 8-10 correct documents
  - Correct documents agrees with truth
  - Incorrect documents contradicts the truth

# SERP Page:

## Task Question: Does cinnamon help diabetes?

**Treatment:** Cinnamon is a sweet spice made from the bark of an Asian tree and used in cooking and baking.

**Health issue:** Diabetes is a serious disease in which the body cannot properly control the amount of sugar in your blood because it does not have enough insulin.

Showing results 1 to 10

### [Is it true that cinnamon can lower blood sugar in people who have diabetes?](#)

Whether cinnamon can lower blood sugar is a topic of debate but recent research suggests that cinnamon may be helpful as a supplement to regular diabetes treatment in people with type 2 diabetes. A 2012 review of several recent studies concluded that the use of cinnamon had a potentially beneficial effect on glycemic control. One study published in 2009 found that a 500 mg capsule of cinnamon taken twice a day for 90 days improved hemoglobin A1C levels a reflection of average blood sugar level for the past two to three months in people with poorly controlled type 2 diabetes (hemoglobin A1C levels greater than 7 percent).

<http://www.mayoclinic.org/diseases-conditions/diabetes/expert-answers/diabetes/faq-200584>

### [Cinnamon Improves Glucose and Lipids of People With Type 2 Diabetes](#)

**OBJECTIVE** The objective of this study was to determine whether cinnamon improves blood glucose, triglycerides, total cholesterol, HDL cholesterol, and LDL cholesterol levels in people with type 2 diabetes. **RESEARCH DESIGN AND METHODS** A total of 60 people with type 2 diabetes, 30 men and 30 women aged 52.2 ± 6.32 years, were divided randomly into six groups. Groups 1, 2, and 3 consumed 1, 3, or 6 g of cinnamon daily, respectively, and groups 4, 5, and 6 were given placebo capsules corresponding to the number of capsules consumed for the three levels of cinnamon.

<http://care.diabetesjournals.org/content/26/12/3215>

### [Is honey and cinnamon a hoax?](#)

Honey is almost entirely composed of different sugars, with water and trace minerals. Excess sugar (and we really get enough carbohydrates of different sorts in our diet anyway) gets stored as fat. So this diet cannot work unless you reduce your food intake to compensate for the excess sugar you are consuming. Certain types of cinnamon may well have useful properties that might influence insulin levels, but probably not at the recommended concentrations.

[http://www.answers.com/Q/Is\\_honey\\_and\\_cinnamon\\_a\\_hoax](http://www.answers.com/Q/Is_honey_and_cinnamon_a_hoax)

### [Article: Cinnamon Helps Diabetics](#)

Cinnamon a spice found in many kitchens around the world especially at Christmas time. Although it is used by Jewish people at Rosh Hashona (the Jewish New Year that falls in September each year). It has been found that this flavoursome spice has its uses for people who are Type 2 Diabetics and helps to control their Blood Sugar. What Is Diabetes? Diabetes is a disorder, where the body is unable to control the Blood Sugar. Insulin a hormone secreted by the Pancreas is essential in helping to control the Blood Sugar. Some unfortunate people are resistant to Insulin so they have to very strictly adhere to a reduced fat intake in their diet.

<http://www.naturalhealthweb.com/articles/Moffat3.html>

Submit Answer

Document title, snippet, url

**Instructions:** Use the search engine results to help you determine the effectiveness of the specified treatment for the corresponding health issue. Once you believe you have determined the effectiveness of the treatment, go to the bottom of the page and click the "Submit Answer" button to submit your answer on the next page.

Category	Explanation
Helps	A medical treatment <b>helps</b> if the treatment is effective and has a direct positive influence on the specified illness.
Inconclusive	The effectiveness of a medical treatment is <b>inconclusive</b> if medical professionals are still unsure if the treatment will have a positive, negative, or no influence on the illness.
Does not help	A medical treatment <b>does not help</b> if the treatment is ineffective and either has no effect or has a direct negative influence on the specified illness.

Instructions & classifications

# Performance measures

- **Accuracy**
  - Fraction of correct responses
  - A correct response agrees with the *truth*
  - White and Hassan's judgment of Cochrane review is used as the *truth*
- **Harm**
  - Fraction of harmful decisions
  - A harmful decision is opposite of the *truth*
  - *Inconclusive* is not considered a harmful decision

# Coding scheme

- Think-aloud data are transcribed
- We use Nvivo 12 qualitative data analysis tool
- We use mixed methods coding research approach:
  - Top-down (some codes inspired by prior work such as rank)
  - Bottom-up (some codes are added during the coding process)

# Coding scheme

- A total of 20 different codes
- The coding was performed by one author twice
  - Different time periods to measure intra-rater reliability
  - Overall Weighted Kappa = 0.7
  - Only report first time period coding

# Experimental Details

- Total of 16 participants:
  - All native English speakers
  - **Gender:** 7 Male, 9 female
  - **Major:** 7 Engineering and Mathematics, 9 Arts and Science
  - **Age:** between 18 and 28, average of 21
    - 37.5% less than 20
    - 56.25% between 20 and 25
    - 6.25% greater than 25

# Experimental Details

- The experimental conditions with the medical treatments were randomly assigned to participants
- Generalized linear (logistic) mixed effect models implemented in R and the lme4 package to determine statistical significance
- Participants and medical treatments modeled as random effects in the models

# Results – Search results bias

Results Bias	Correct decisions	Harmful decisions
Correct	0.67 ± 0.08	0.06 ± 0.03
Incorrect	0.32 ± 0.06	0.28 ± 0.06

Independent Variable	Dependent Variable	Pr(>Chisq)
Search Result Bias	Correct Decision	<< 0.001
Topmost Correct Rank	Correct Decision	0.8

# Results – Search results bias

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Search Bias stat. sig on correct & harmful decision

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# Results – Coding

No	Name	Participants	References
C1	Majority	14	36
C2	Authoritativeness	13	153
C2	Stats & studies	12	20
C6	Advertisements	7	16
C7	Date	7	15
C8	References	7	12
C9	Negative information	6	15
C10	Information representation	5	18
C12	Prior_belief	5	8
C14	Readability	4	8
C13	Relevance	4	7
C15	Past_experience	3	3
C16	Text_length	3	3
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The majority of the search results stating that the treatment helps or that the treatment does not help or looking for a consensus of different search results.

If participants are exposed to results geared towards a specific direction, they end up being influenced by what the majority of the search results state.

# Majority/Prevalence

*“I’m going to say helps because a lot of people, like it was just, the vast number were in agreement.”*

*“So I’m seeing a lot of doctors recommending the melatonin pill. Yeah, I think this helps.”*

*“I think that’s the common thread that we’re seeing. So I’m going to submit and say it does help.”*



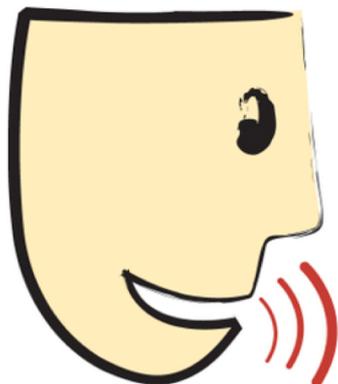
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The trustworthiness and reliability in the content of the search results page.

Participants pay attention to authoritativeness. (We did not control for authoritativeness)

# Authoritativeness



*“Health.com, I’ve seen it before, not really... I don’t really rely on it for information the first time I see it.”*

*“WebMD. It’s a more trustworthy source, I think.”*

*“Okay. I don’t really know what this website is. Medications for management of alcohol withdrawal.”*

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The quality of the search results page such as the presence of ads, research studies or reference/citations.

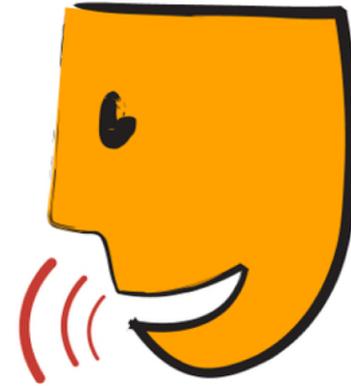
Participants look for clues for quality

# Quality

“ Oh, this one does not look very legitimate. Because there's so many ads and stuff.”

“ By this point I would click to see the source, but at least it provides sources, so this could be good.”

*“So this looks like a research study, so I think it's pretty reliable.”*



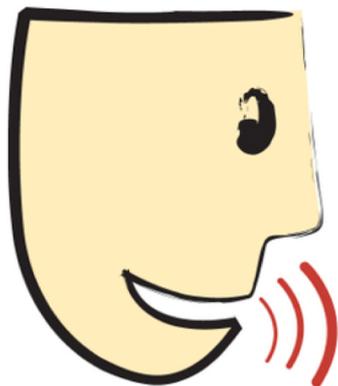
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The order of search results in the SERP page that might effect the trustworthiness and reliability of the pages.

Participants do not mention rank (unconscious bias)

# Position/Rank bias?



*“I’ll just go to the first link, even though it’s wikiHow, it is the first link. I don’t really know much about search engines, but I feel like the first link.... They’re trying to give you the most helpful link. So I’ll just open it, but still.”*

# Retrospective Think aloud

- Get insights of new strategies participants used during the study that might not be captured during the concurrent think-aloud part, such as:
  - Reading pages that state the medical treatment does not help in order to understand the **opposite** arguments (three participants).
  - In case of no consistency between search results, the participant looks at the dates the information was published in order to check whether the non-agreement happens because of time difference (two participants).

# Post Task Questionnaire

No	Question	Yes	No	Maybe
1.	Do you believe that exposure (i.e. most results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	13	2	1
2.	Do you believe that rank (i.e. highly ranked results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	9	6	1
3.	Do you believe that quality is important in determining the effectiveness of the medical treatment? And please elaborate on what quality means to you?	15	0	1
4.	Do you believe that the web page layout is important in determining the effectiveness of the medical treatment? And why?	12	2	2
5.	Do you believe that social factors (i.e. experience of other people you know such as friends, family etc.) is important in determining the effectiveness of the medical treatment? And why?	9	5	2
6.	Did you notice any manipulation of the search results? If yes, then can you guess what was it?	9	7	0
7.	How do you describe your experience with the think-aloud process?	-		

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5.	Do you believe that social factors (i.e. experience of other people you know such as friends, family etc.) is important in determining the effectiveness of the medical treatment? And why?	9	5	2
6.	Did you notice any manipulation of the search results? If yes, then can you guess what was it?	9	7	0
7.	How do you describe your experience with the think-aloud process?		-	

Participants are consciously aware of the influence of majority.



# Post Task Questionnaire

No	Question	Yes	No	Maybe
1.	Do you believe that exposure (i.e. most results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	13	2	1
2.	Do you believe that rank (i.e. highly ranked results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	9	6	1
3.	Do you believe that quality is important in determining the effectiveness of the medical treatment? And please elaborate on what quality means to you?	15	0	1
4.	Do you believe that the web page layout is important in determining the effectiveness of the medical treatment? And why?	10	0	0
5.	Do you believe that social factors (i.e. experience of other people know such as friends, family etc.) is important in determining the effectiveness of the medical treatment? And why?	10	0	0
6.	Did you notice any manipulation of the search results? If yes, then can you guess what was it?	9	7	0
7.	How do you describe your experience with the think-aloud process?		-	

Quality is:  
authoritativeness,  
readability, page layout

# Post Task Questionnaire

No	Question	Yes	No	Maybe
1.	Do you believe that exposure (i.e. most results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	13	2	1
2.	Do you believe that rank (i.e. highly ranked results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	9	6	1
3.	Do you believe that quality is important in determining the effectiveness of the medical treatment? And please elaborate on what quality means to you?			
4.	Do you believe that the web page layout is important in determining the effectiveness of the medical treatment? And why?	12	2	2
5.	Do you believe that social factors (i.e. experience of other people you know such as friends, family etc.) is important in determining the effectiveness of the medical treatment? And why?	9	5	2
6.	Did you notice any manipulation of the search results? If yes, then can you guess what was it?	9	7	0
7.	How do you describe your experience with the think-aloud process?			-

Social factor is a type of subconscious bias

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The deceptive aspects were successful: Only one correct guess!

# Post Task Questionnaire

No	Question	Yes	No	Maybe
1.	Do you believe that exposure (i.e. most results say the treatment helps/does not help) is important in determining the effectiveness of the medical treatment? And why?	13	2	1
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7.	How do you describe your experience with the think-aloud process?			-

- Most participants found the think-aloud insightful  
- Only two found it challenging!

# Conclusion

- Search results have a mixture of correct and incorrect information
- People might be negatively influenced and potentially harmed by the incorrect information
- To help people make correct decisions, we need to gain insights about strategies people use during the decision making process.
- Understanding this cognitive biases is a complex phenomenon.
- The think-aloud results revealed some intuitions people use doing online health search.
  - Delivering credible and authoritative results
  - People consider quality when doing online search

# Future Work

- Authoritativeness effect on health-related online search
- Rank effect on bigger study
- Larger and more varied population
- Extend current effectiveness measures to include a notion of negative gain

