The Positive and Negative Influence of Search Results on People's Decisions about the Efficacy of Medical Treatments

9/20/2017

The 3rd ACM International Conference on the Theory of Information Retrieval (ICTIR). October 1-4 2017 | Amsterdam.

Frances A. Pogacar, Amira Ghenai, Mark D. Smucker and Charles L. A. Clarke
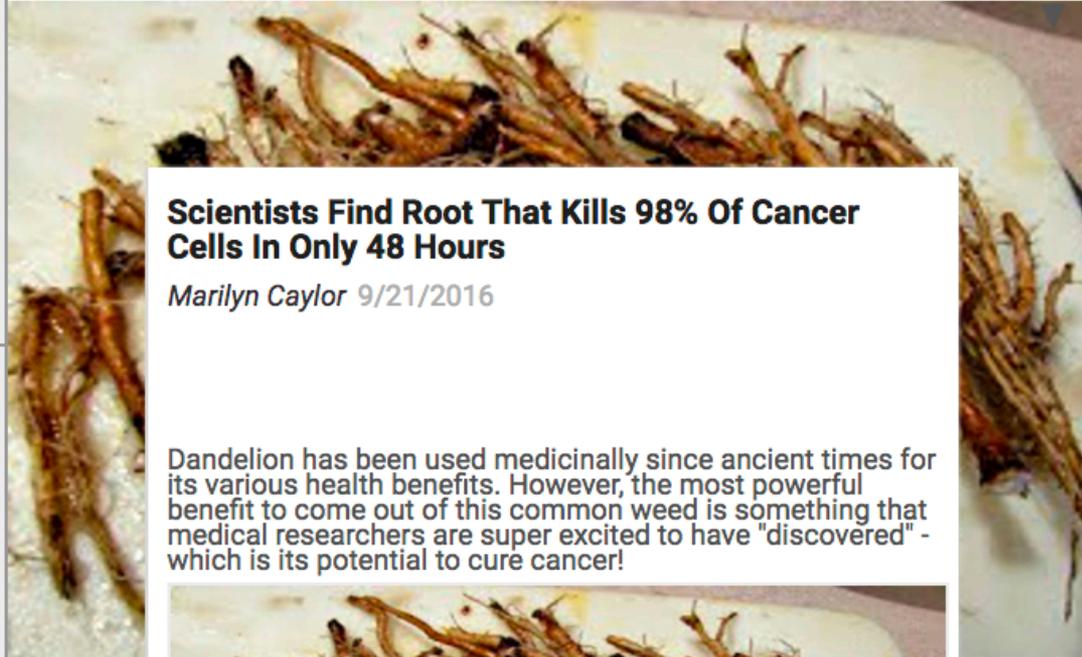
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Scientists Find Root That Kills 98% Of Cancer Cells In Only 48 Hours

Marilyn Caylor 9/21/2016

Dandelion has been used medicinally since ancient times for its various health benefits. However, the most powerful benefit to come out of this common weed is something that medical researchers are super excited to have "discovered" - which is its potential to cure cancer!

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Macular
Degeneration

INDY/PULSE

THREE WOMEN 'LEFT BLINDED AFTER BOTCHED STEM CELL TRIAL'

Patients taking part in clinical trials involving stem cells should consider any preclinical data first, experts warn / *Getty*

The patients are said to have each paid $5,000 (£4,100) to participate in the trial

KATIE FORSTER
@katieforster
Wednesday 15 March 2017 21:56 GMT

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Three women have reportedly been left blind after they took part in a botched clinical trial of an unproven stem cell treatment.

The patients are said to have each paid $5,000 (£4,100) to participate in the procedure, which was advertised online and has been described by experts as "off-the-charts dangerous".

Within a week of undergoing the therapy at a US clinic the patients, ranging in age from 72 to 88, are said to have suffered complications including vision loss, detached retinas and bleeding, according to a report in *The New England Journal of Medicine*.

/ **READ MORE**

Women left in pain by 'botched' surgery fear losing compensation

Multiple miscarriages 'caused by lack of stem cells in womb'

They are now totally blind and unlikely to recover, said Thomas Albini, associate professor of clinical ophthalmology at the University of Miami, where the women were treated after the complications arose.

Experts investigating the case said the study

F. Pogacar, A. Ghenai,
M. Smucker, C. Clarke

Problem Definition

- Search engine finds relevant documents containing correct and incorrect information

- Searchers find correct information among relevant documents and ignore incorrect information in non-relevant documents

- What if searchers are influenced with incorrect information in search results?

- How does online health misinformation (incorrect information) in web search effect people's health?

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Main Findings

- 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.

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OUTLINE

- Background

- Study Design

    - Medical treatments

    - Experimental conditions

    - Performance measures

- Experiment Details

- Results

- Conclusion & Future Work

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BACKGROUND

- [Epstein et al, PNAS 2015] studied the impact of search results in the political domain

  - Preference of undecided votes can be significantly influenced

  - The effect of rank on preferences

  - Influence is associated with certain demographic characteristics

- [Kammerer et al, *Comput. Hum. Behav.* 2013] designed user study to understand how people evaluate web search results

  - Crafted search results (journals, forums …)

  - People spend less time evaluating search results when information seems accurate and reliable

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BACKGROUND

- [White et al, TOIS 2015] conducted large-scale log-based analysis study. They found out that:

  - Web search engines have an uncontrolled bias towards medical treatments "*help*"

  - People are biased towards "*help*" belief

  - People's beliefs are difficult the change if people hold strong beliefs

  - If the searchers are uncertain before search, they are twice as likely to move towards a positive answer

The Positive and Negative Influence of Search Results on
People's Decisions about the Efficacy of Medical Treatments

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Study Design

- Participants were told to pretend to be searching 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

- They either received a search engine result page, or the control condition, with no SERP.

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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 5 helpful and 5 unhelpful treatments, 10 total

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Medical Treatments

Medical Treatment	Efficacy	Crowed Knowledge
Does caffeine help asthma?	Helpful	0.08 ± 0.08
Does traction help low back pain?	Unhelpful	0.17 ± 0.11
Do insoles help back pain?	Unhelpful	0.33 ± 0.14
Do probiotics help treat eczema?	Unhelpful	0.33 ± 0.14
Do benzodiazepines help alcohol withdrawal?	Helpful	0.33 ± 0.14
Does cinnamon help diabetes?	Unhelpful	0.50 ± 0.15
Do antioxidants help female subfertility?	Unhelpful	0.58 ± 0.15
Do sealants prevent dental decay in the permanent teeth?	Helpful	0.67 ± 0.14
Does melatonin help treat and prevent jet lag?	Helpful	0.67 ± 0.14
Does surgery help obesity?	Helpful	0.67 ± 0.14

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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

  - Remaining correct results were placed randomly in the lower ranks.

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SERP Experimental Conditions

- Total of 5 experimental conditions:

  1. Correct, rank 1

  2. Correct, rank 3

  3. Incorrect, rank 1

  4. Incorrect, rank 3

  5. Control (no search results)

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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

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Pre-Task Questionnaire:

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.

Pre-Task Questionnaire:

How much do you know about cinnamon?
- ○ Nothing
- ○ Heard of the treatment
- ○ Know generally about the treatment
- ○ Quite familiar with the treatment
- ○ Know extensive details about the treatment

How much do you know about diabetes?
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Please click the submit button to submit your answer. [Submit]

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Definitions of the treatment and health issue

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Definitions of the treatment and health issue

Prior Knowledge questions

SERP Page:

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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 â€" 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 â€" a reflection of average blood sugar level for the past two to three months â€" 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-20058472

Cinnamon Improves Glucose and Lipids of People With Type 2 Diabetes
OBJECTIVEâ€"The objective of this study was to determine whether cinnamon improves blood glucose, triglyceride, total cholesterol, HDL cholesterol, and LDL cholesterol levels in people with type 2 diabetes. RESEARCH DESIGN AND METHODSâ€"A total of 60 people with type 2 diabetes, 30 men and 30 women aged 52.2 Â± 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

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

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OBJECTIVE—The objective of this study was to determine whether cinnamon improves blood glucose, triglyceride, 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.
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Article: Cinnamon Helps Diabetics
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http://www.naturalhealthweb.com/articles/Moffat3.html

Clickable link, to take to document page

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 **helps** if the treatment is effective and has a direct positive influence on the specified illness.
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Submit Answer

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 â€" 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 â€" a reflection of average blood sugar level for the past two to three months â€" 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-20058

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Instructions & classifications

Submit Answer

Document title, snippet, url

Control Page (No SERP):

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.

For this question, we will not provide you any search results.
Please continue to the next page to answer.

If you have decided on the effectiveness of the treatment, please click the answer button to submit your answer n the next page.

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Instructions & classifications

Submit Answer

No search results provided

Submit Page:

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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.

○ Helps
○ Inconclusive
○ Does Not Help

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Select your response and press submit [Submit]

Instructions & classifications

The participant submits

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M. Smucker, C. Clarke

Performance measures

- **Accuracy**

  - Fraction of correct responses

  - A correct response agrees with the *truth*

- **Harm**

  - Fraction of harmful decisions

  - A harmful decision is opposite of the *truth*

  - *Inconclusive* is not considered a harmful decision

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Experimental Details

- Total of 60 participants:

  - **Gender**: 27 Male, 33 female

  - **Major**: 36 Engineering and Mathematics, 20 Arts and Science and 4 from other majors

  - **Age**: between 18 and 36, average of 23

    - 22% less than 20

    - 50% between 20 and 25

    - 28% greater than 25

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Experimental Details

- Controlled within-subjects laboratory study

- Each participant answered a total of 10 medical questions

- 5 experimental conditions, experienced twice

  - Once for 5 *helpful* medical treatments

  - Once for 5 *unhelpful* medical treatments

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Experimental Details

- 10 ×10 Graeco-Latin Square to fully balance the 5 experimental conditions with the 2 medical treatments

- 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

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Results - Accuracy

Bias	Topmost Correct Rank	Correct decisions	Average Accuracy
Incorrect	3	0.23 ± 0.04	0.23± 0.04
Incorrect	1	0.23 ± 0.04	
Control	No search results	0.43 ± 0.05	0.43 ± 0.05
Correct	3	0.59 ± 0.05	0.65 ± 0.05
Correct	1	0.70 ± 0.04	

Independent Variable	Dependent Variable	Pr(>Chisq)
Search Result Bias	Correct Decision	<< 0.001
Topmost Correct Rank	Correct Decision	0.16

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Correct	3	0.59 ± 0.05	0.65 ± 0.05
Correct	1	0.70 ± 0.04	

Increase accuracy up to 70%

Independent Variable	Dependent Variable	Pr(>
Search Result Bias	Correct Decision	<< 0.001
Topmost Correct Rank	Correct Decision	0.16

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Results - Accuracy

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Correct	1	0.70 ± 0.04	

Sig. reduce accuracy to 23%

Independent Variable	Dependent Variable	Pr(>Chisq)
Search Result Bias	Correct Decision	<< 0.001
Topmost Correct Rank	Correct Decision	0.16

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Search Bias stat. sig on correct decision

Independent Variable	Dependent Variable	Pr(>Chisq)
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Correct	1	0.70 ± 0.04	

Topmost correct had less effect

Independent Variable	Dependent Variable	Pr(>Chisq)
Search Result Bias	Correct Decision	<< 0.001
Topmost Correct Rank	Correct Decision	0.16

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Results - Harm

Bias	Topmost Correct Rank	Harmful decisions	Average Harm
Incorrect	3	0.41 ± 0.05	0.38 ± 0.05
Incorrect	1	0.35 ± 0.04	
Control	No search results	0.20 ± 0.04	0.20 ± 0.04
Correct	3	0.13 ± 0.03	0.10 ± 0.03
Correct	1	0.06 ± 0.02	

Independent Variable	Dependent Variable	Pr(>Chisq)
Search Result Bias	Harmful Decision	<< 0.001
Topmost Correct Rank	Harmful Decision	0.06

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Results - Harm

Bias	Topmost Correct Rank	Harmful decisions	Average Harm
Incorrect	3	0.41 ± 0.05	0.38 ± 0.05
Incorrect	1	0.35 ± 0.04	
Control	No search results	0.20 ± 0.04	0.20 ± 0.04
Correct	3	0.13 ± 0.03	0.10 ± 0.03
Correct	1	0.06 ± 0.02	

Reduce harm from 20% to 6%

Independent Variable	Dependent Variable	Pr...
Search Result Bias	Harmful Decision	<< 0.001
Topmost Correct Rank	Harmful Decision	0.06

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Results - Harm

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Control	No search results	0.20 ± 0.04	0.20 ± 0.04
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Correct	1	0.06 ± 0.02	

Double harm up to 38% avg.

Independent Variable	Dependent Variable	Pr...
Search Result Bias	Harmful Decision	<< 0.001
Topmost Correct Rank	Harmful Decision	0.06

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Correct	1	0.06 ± 0.02	

Search Bias stat. sig on harmful decision

Independent Variable	Dependent Variable	Pr(>Chisq)
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Correct	1	0.06 ± 0.02	

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Search Result Bias	Harmful Decision	<< 0.001
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Results – Dependent Variables

- Search results influence people's ability to determine the efficacy of medical treatments.

  - Correct bias leads to better performance

  - Exposure to incorrect information leads to potential harm

- Over all medical treatments, accuracy increased to 0.65 when biased towards correct compared to 0.23 when biased towards incorrect information

- Incorrect information bias leads to worse performance than no exposure to search results

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Confusion Matrices

- Control Condition

- With SERP

Decision	Total Responses	
Unhelpful	33%	26%
Helpful	33%	**37%**
Inconclusive	33%	**37%**

Decision	Total Responses	
Unhelpful	x%	27%
Helpful	x%	**41%**
Inconclusive	y%	32%

1. Under the control we should expect an even percent of responses in each category.
2. Under the biased conditions, we should expect an even amount between helpful and unhelpful.

➢ There is an overall bias to saying that a treatment is helpful.

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Confusion Matrices

Control Condition

Truth	User answers			Total
	Unhelpful	Helpful	Inconclusive	
Unhelpful	**23**	16	**21**	60

Experimental Condition

Truth	User answers			Total
	Unhelpful	Helpful	Inconclusive	
Unhelpful	79	64	97	240

Truly unhelpful are either unhelpful or inconclusive

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Confusion Matrices

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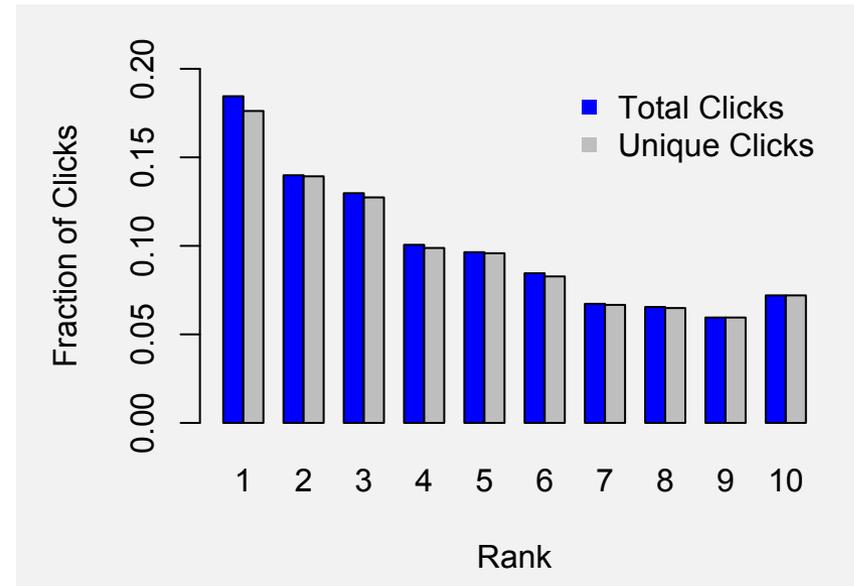
Results - Knowledge

- Participants rated their knowledge of the health treatment and health issue on a 5 point scale.

- More self-reported knowledge resulted in a higher fraction of correct decisions under search results biased towards incorrect information (p=0.04).

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Results - Clicks

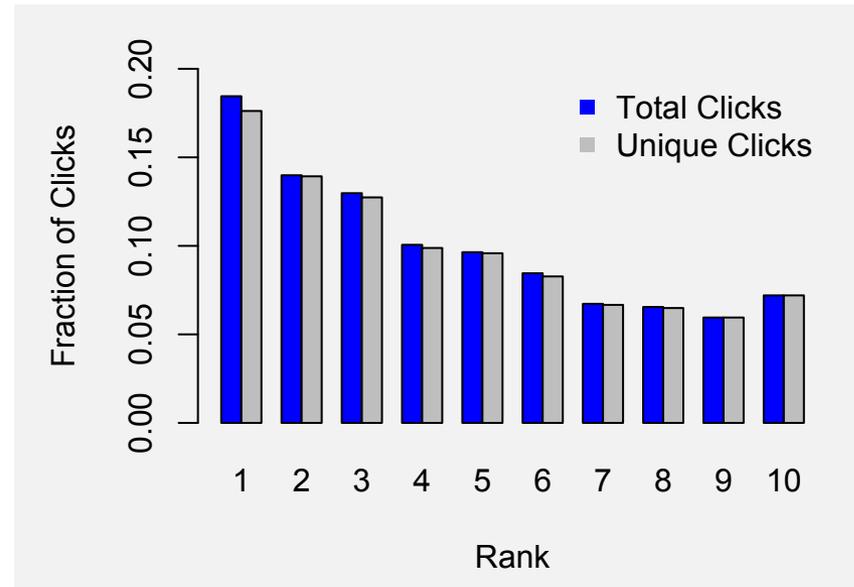F. Pogacar, A. Ghenai,
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- We recorded the overall and unique clicks in each participant's session.

- Participants that interacted more with the search results were more likely to make a correct decision.

Dependent Variable	Mean Number of Clicks
Correct Decisions	3. 73 ± 0.20
Incorrect Decisions	3.32 ± 0.2
Harmed Decisions	3.02 ± 0.30
Unharmed Decisions	3.65 ± 0.3

The Positive and Negative Influence of Search Results on
People's Decisions about the Efficacy of Medical Treatments

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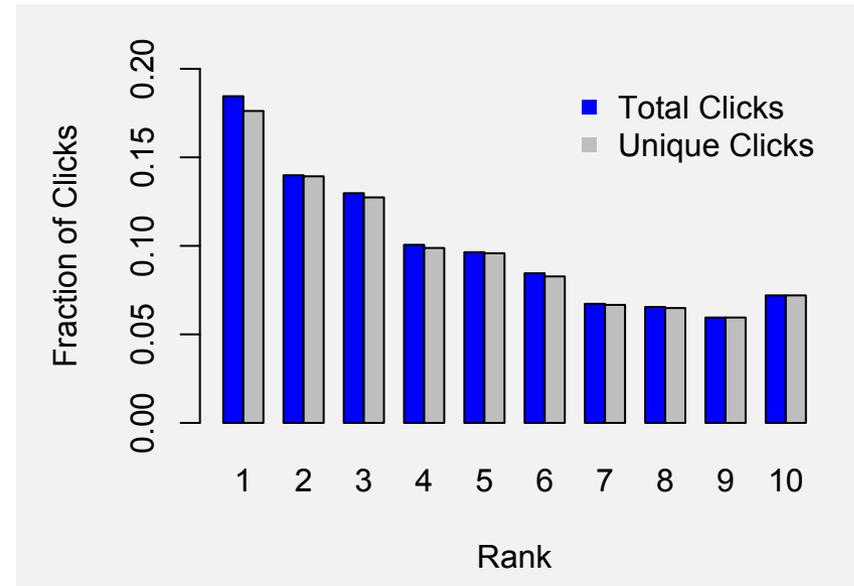

Stat. sig higher than number of clicks for incorrect decisions

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Conclusion

- Searchers experience both correct and incorrect information when searching for health treatments

- This incorrect information is not merely non-relevant, but can have a negative effect on the searcher

- A document that leads a searcher to a harmful belief is damaging, and can undo the value of correct and relevant documents

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Future Work

- What is going on during the decision making process:

- Understand possible factors that influence people in search

  - Stimulated Recall user experiment (play screen recording with questions to participants)

    - Trustworthiness of resources

    - Rank? Exposure bias?

    - Do people use search engines in the wrong way?

- Extend current effectiveness measures to include a notion of negative gain

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