

# 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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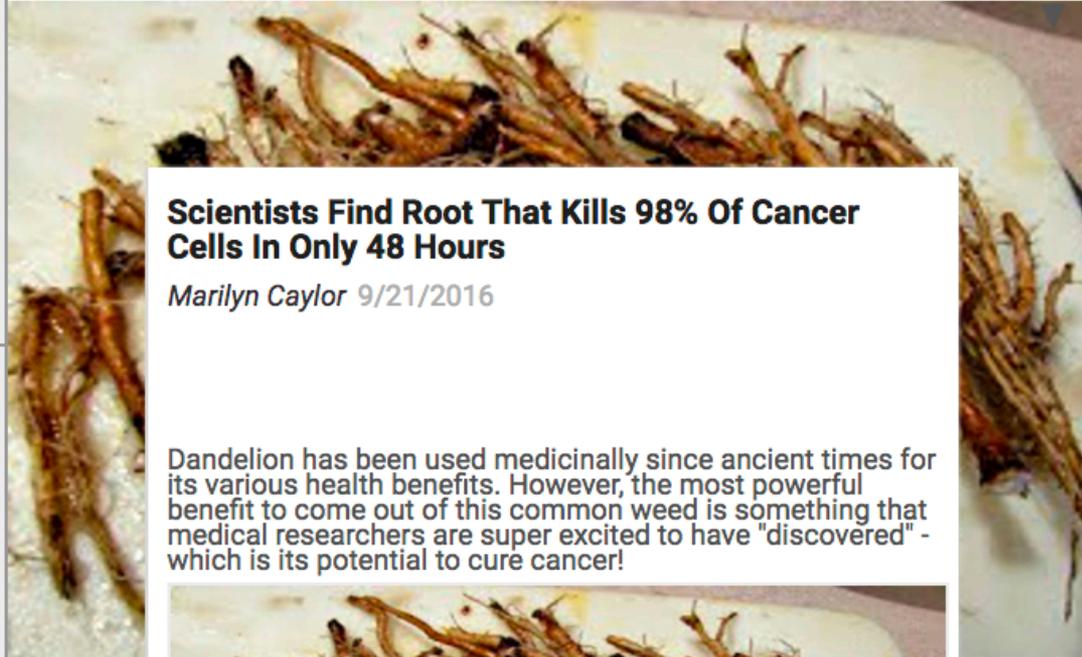
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## Scientists Find Root That Kills 98% Of Cancer Cells In Only 48 Hours

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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1,040,000 Results Date - Language - Region -

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<https://www.snopes.com/dandelion-kills-cancer/>

Dandelion has not been shown to treat or prevent cancer. Dandelion is used in traditional medicine to treat many ailments. Laboratory studies have shown that dandelion can kill certain bacteria and other microbes. It was also found to have anticancer properties in colon cancer, pancreatic cancer, leukemia, and melanoma cells, but studies have not been conducted in humans. Dandelion has estrogenic activity. It may increase the growth of hormone-sensitive cancer cells. Dandelion ...  
Fact checked by snopes.com: ...

Related searches

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- dandelion root cancer research
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- does dandelion root cure cancer
- dandelion root tea kills cancer cells
- dandelion root tea

**The Cancer Fighting Medicine That's Growing in Your Yard**

[thetruthaboutcancer.com](http://thetruthaboutcancer.com) · Cancer Treatments

Science is revealing that the dandelion (which many consider a weed) is actually a potent cancer fighting medicine. Dandelions have long held a top spot in Traditional Chinese Medicine (TCM) as a remedy for digestive upset, inflammation, and kidney disease, boiling nicely into a healing tea. More recently, dandelion root has been a focus of study for its ability to improve liver and gallbladder ...

**Images of dandelion weed cancer**

[bing.com/images](http://bing.com/images)



See more images of dandelion weed cancer

**Dandelion Root - Cure For Cancer?**

[healthyhappybeautiful.com/.../dandelion-root-cure-for-cancer-](http://healthyhappybeautiful.com/.../dandelion-root-cure-for-cancer-)

Interesting that dandelion root is being "rediscovered" in cancer treatment. Essiac tea, used in Canada to cure cancer by a nurse, was a tea made from a combo of dandelion root, red sorrel, yellow burdock and milk thistle....all plants that grew in pasturelands.

**Can dandelions kill cancer? - National | Globalnews.ca**

<https://globalnews.ca/news/212574/can-dandelions-kill-cancer->

Extract from the root of the common weed has great potential as a non-toxic alternative to chemotherapy, according to a study that will be released Friday.

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[www.cbc.ca/news/...test-dandelion-s-cancer-killing-potential-1.2959815](http://www.cbc.ca/news/...test-dandelion-s-cancer-killing-potential-1.2959815)

Thirty patients are being recruited to take part in a study looking at the anti-cancer abilities of dandelion root extract, taken from the common yellow yard weed.

**Dandelion "Weeds" Kill Cancer Cells, Leave Healthy Cells ...**

[returntonow.net/2017/09/27/dandelion-weeds-kill-cancer-cells-leave...](http://returntonow.net/2017/09/27/dandelion-weeds-kill-cancer-cells-leave...)

Dandelion has been considered a valuable ... Kill Cancer Cells, Leave Healthy Cells Intact. ... light to test out dandelion root on thirty Canadian cancer ...

**Dandelion | Memorial Sloan Kettering Cancer Center**

<https://www.mskcc.org/cancer-care/integrative-medicine/herbs/dandelion->

Dandelion root extract has anticancer effects against melanoma , leukemia , pancreatic cancer , and colorectal cancer cell lines. However, human studies are limited. Dandelion has estrogenic activity. It may increase the proliferation of hormone-sensitive breast cancer ...



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Dandelion root far more effective in fighting cancer cells than chemotherapy. Tuesday, May 03, 2016 by: J. D. Heyes Tags: dandelion root, cancer cell suicide ...

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Alternative Cancer Treatments: This article is on Dandelion Root Treatment For Cancer.

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# 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?

# 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.

# OUTLINE

- Background
- Study Design
  - Medical treatments
  - Experimental conditions
  - Performance measures
- Experiment Details
- Results
- Conclusion & Future Work

# 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 to change if people hold strong beliefs
  - If the searchers are uncertain before search, they are twice as likely to move towards a positive answer

# Study Design

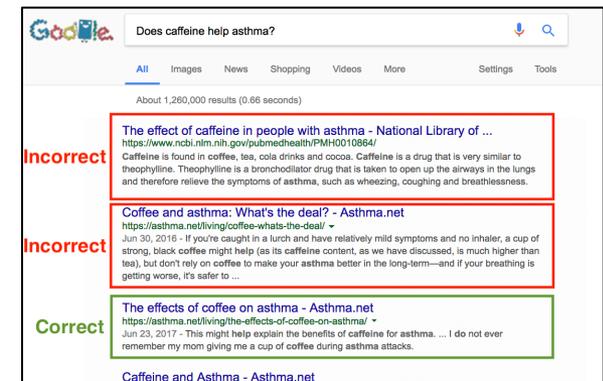
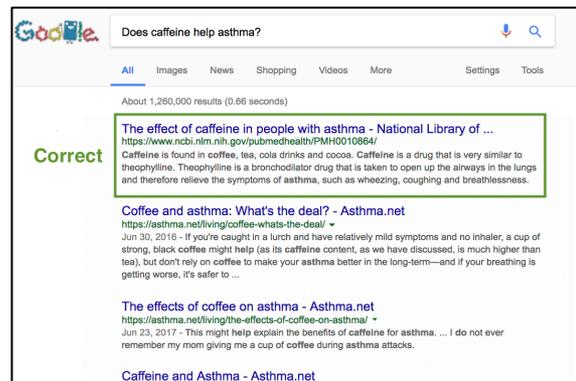
- Participants were told to pretend to be searching for the answer to a question about the effectiveness of a treatment for a health issue.
- Participants had to classify the medical treatments as
  - *Helpful*: Treatment has direct positive effect
  - *Unhelpful*: Treatment is ineffective or has a direct negative effect
  - *Inconclusive*: Unsure about the effectiveness
- They either received a search engine result page, or the control condition, with no SERP.

# 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

# 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:

Question number 2 out of 10:

## 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-20058472>

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

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

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

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# SERP Page:

Question number 2 out of 10:

## 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

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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-20150411>

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Clickable link, to take to document page

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Instructions & classifications

# Control Page (No SERP):

Question number 2 out of 10:

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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.

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 on the next page.

Submit Answer

No search results provided

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Instructions & classifications

# 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

# 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

# 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

# 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

# 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
<b>Correct</b>	<b>1</b>	<b>0.70 ± 0.04</b>	

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

Increase accuracy up to 70%

# 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	

Sig. reduce accuracy to 23%

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

# 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

# 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
<b>Correct</b>	<b>1</b>	<b>0.06 ± 0.02</b>	

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

# 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	

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

# 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

# Results – Helpful bias

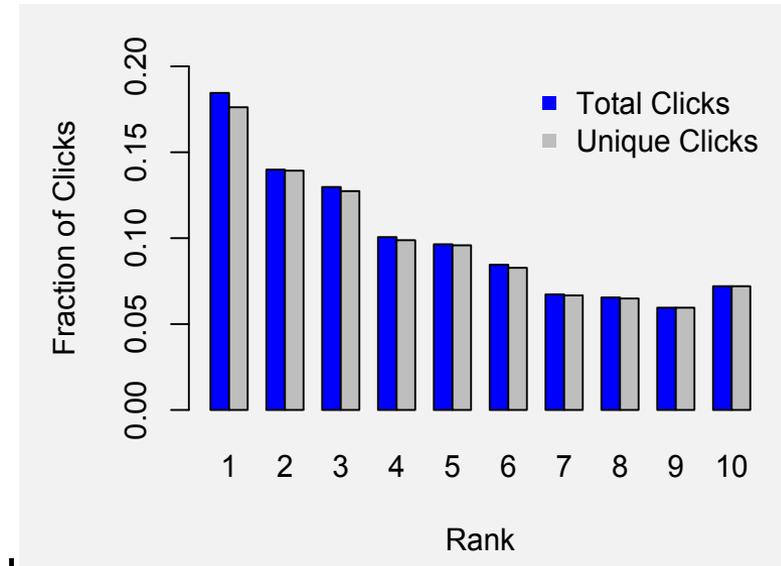
- Overall bias to saying that a treatment is *helpful*
- Under the control condition, when the treatment is truly *unhelpful*, participants answer correctly about as often as they answer *inconclusive*.
- Under the SERP conditions, when the treatment is truly *unhelpful*, participants are more likely to answer *inconclusive* than to correctly answer that the treatment is *unhelpful*.

# 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 ( $p=0.04$ ).

# Results - Clicks

- 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:
  - Mean number of clicks is higher with correct decisions than with incorrect decisions
  - Mean number of clicks is lower in harmful decisions compared to unarmful decisions



# 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

# 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

