Efficacy of a Web-Based Intelligent Tutoring System on Genetic Testing For Breast Cancer Risk

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Thank you NCI

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Testing for Genetic Risk of Breast Cancer: "Should I be tested?" is a Complicated Question for Healthy Women

- Difficult to understand breast cancer
- Difficult to understand genetics, how BRCA1/2 function
- Difficult quantitative concepts: base rate, conditional probabilities, 5-year risk, life time risk
- Difficult qualitative concepts: what would you do with a positive, negative, or ambiguous result?
- Expensive, often not covered by insurance
- Issues of privacy with medical records, future insurance policies, employers
- An emotional issue
- Family issues

Intelligent Tutoring System

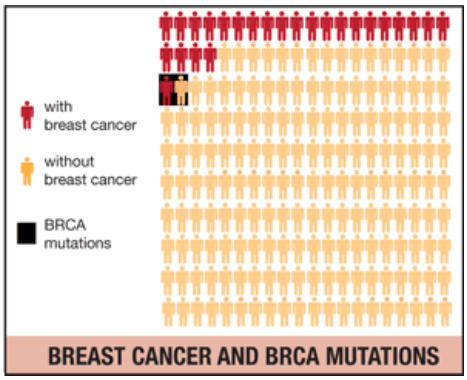
- First use of an ITS in patients' Medical Decision Making (≠ decision tool)
- Among the first web-based ITS to engage in natural language processing
- Talking animated avatar
- Present text, images, video clips
- Engages participants in "tutorial dialogue"
- It "understands" participant answers by comparing them to expectations
- It responds to encourage elaboration until expectations are sufficiently met

Fuzzy Trace Theory

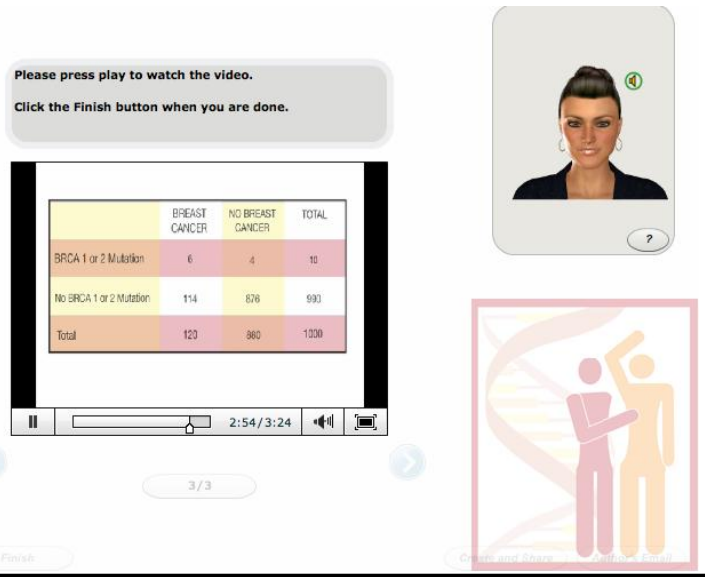
- Strong empirical support: Web of Science 342 citations for the topic “Fuzzy Trace Theory.” Those papers cited 7600 times, mean 22.22.
- People generally rely on the *gist* of information in making medical decisions.
- Suboptimal “strategies” such a denominator neglect help explain why people have difficulties with nested hierarchies.
- Interventions focused on mental representation
- Interventions focused on cognitive processing

Talking Avatar Presenting Written Text

Intervention Focused on *Gist* Mental Representation



Intervention Focused on Cognitive *Processing* Animated 2x2 Table



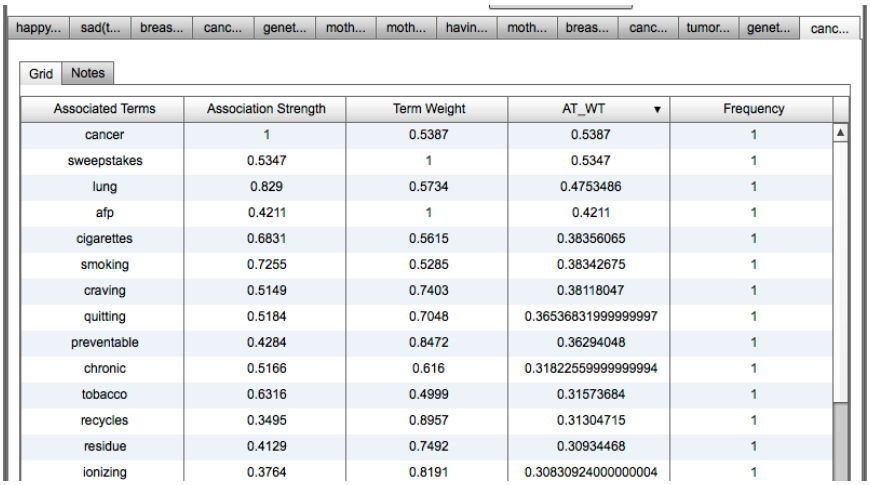
Tutorial Dialogue

Tutorial Dialogue

Expectation Text

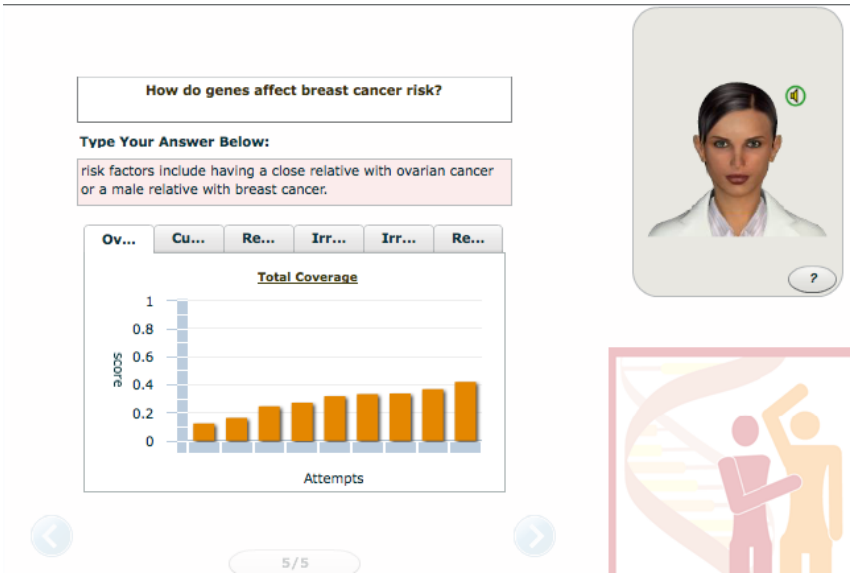
- Derived from longer essays.
- “Tweaked” LSA settings and Expectations texts with trained & untrained student essays, input text, irrelevant texts.

Latent Semantic Analysis (LSA) “Cancer”



Associated Terms	Association Strength	Term Weight	AT_WT	Frequency
cancer	1	0.5387	0.5387	1
sweepstakes	0.5347	1	0.5347	1
lung	0.829	0.5734	0.4753486	1
afp	0.4211	1	0.4211	1
cigarettes	0.6831	0.5615	0.38356065	1
smoking	0.7255	0.5285	0.38342675	1
craving	0.5149	0.7403	0.38118047	1
quitting	0.5184	0.7048	0.36536831999999997	1
preventable	0.4284	0.8472	0.36294048	1
chronic	0.5166	0.616	0.31822559999999994	1
tobacco	0.6316	0.4999	0.31573684	1
recycles	0.3495	0.8957	0.31304715	1
residue	0.4129	0.7492	0.30934468	1
ionizing	0.3764	0.8191	0.30830924000000004	1

Following the study, we judged 85% of the Intelligent Tutoring System's responses were appropriate (IRR = .89)



Randomized Controlled Study Experiment 1

- 203 Undergraduate women participated at Miami and Cornell Universities
- 3 groups equated for time on task in lab
- Static Presentation of comparable sections of NCI Web Site
- Nutrition Tutorial Control
- Intelligent Tutoring System

Breast Cancer and Genetic Risk

Family History as a Risk Factor for Breast Cancer

In cross-sectional studies of adult populations, 5% to 10% of women have a mother or sister with breast cancer, and about twice as many have either a first-degree relative (FDR) or a second-degree relative with breast cancer.[3-6] The risk conferred by a family history of breast cancer has been assessed in both case-control and cohort studies, using volunteer and population-based samples, with generally consistent results.[7] In a pooled analysis of 38 studies, the relative risk (RR) of breast cancer conferred by an FDR with breast cancer was 2.1 (95% confidence interval [CI], 2.0–2.2).[7] Risk increases with the number of affected relatives and age at diagnosis.[4,5,7] (Refer to the Penetrance of Mutations section of this summary for a discussion of familial risk for women from families with *BRCA1/BRCA2* mutations who themselves test negative for the family mutation.)

Family History as a Risk Factor for Ovarian Cancer

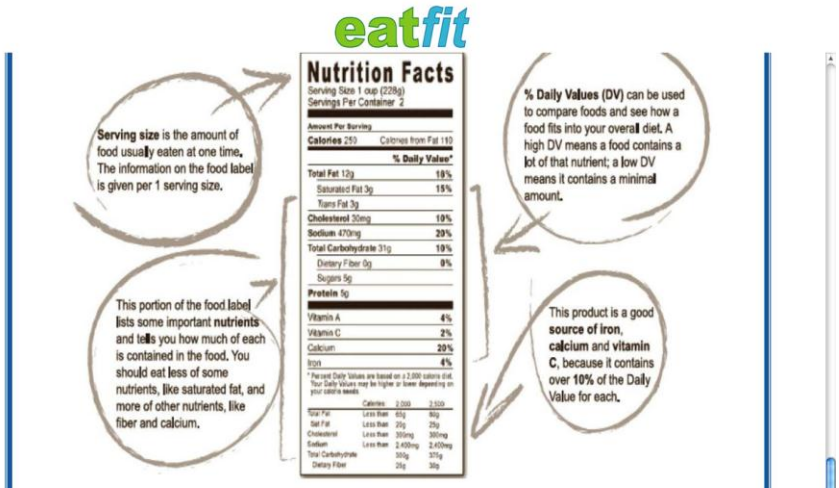
Although reproductive, demographic, and lifestyle factors affect risk of ovarian cancer, the single greatest ovarian cancer risk factor is a family history of the disease. A large meta-analysis of 15 published studies estimated an odds ratio (OR) of 3.1 for the risk of ovarian cancer associated with at least one FDR with ovarian cancer.[8]

Autosomal Dominant Inheritance of Breast/Ovarian Cancer Predisposition

Autosomal dominant inheritance of breast/ovarian cancer is characterized by transmission of cancer predisposition from generation to generation, through either the mother's or the father's side of the family, with the following characteristics:

- Inheritance risk of 50%. When a parent carries an autosomal dominant genetic predisposition, each child has a 50:50 chance of inheriting the predisposition. Although the risk of inheriting the predisposition is 50%, not everyone with the predisposition will develop cancer because of incomplete penetrance and/or gender-restricted or gender-related expression.

Nutrition Tutorial Control



Randomized Controlled Study Experiment 2

- Added content on what is breast cancer, inherited genetic mutations, what should I think about before genetic testing, how does breast cancer spread, stages of breast cancer, and the Gail model.
- 210 Undergraduate women participated at Miami and Cornell Universities
- Additional Measures of Knowledge for new content, Gist Comprehension Measure.
- Same 3 groups equated for time on task in lab

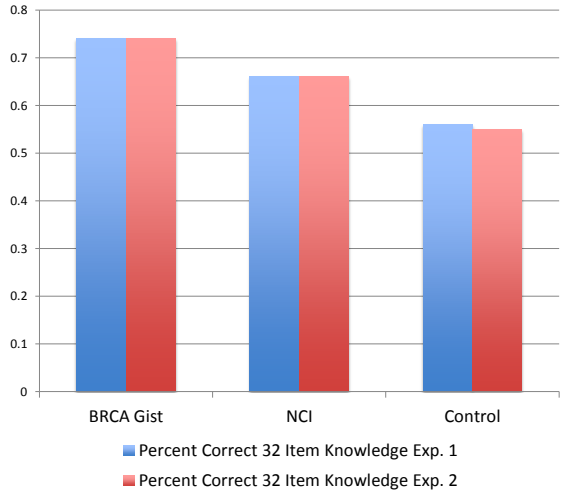
A 32 Item Multiple Choice Test of Content Knowledge. Sample Items:

Breast Cancer usually forms in which part of the breast?
A- ducts and lobules
B- fat tissue
C- muscle tissues
D- the areola

The BRCA1 and BRCA2 genes normally function as (chose one):

A - tumor suppressors
B- developing breast tissue
C- tumor producers
D- regulating the reproductive system

Percent Correct 32 Item Knowledge Test



20 Item Multiple Choice Test of Content Knowledge for New Content (Exp. 2). Sample Item.

Breast cancer that metastasizes to the bones

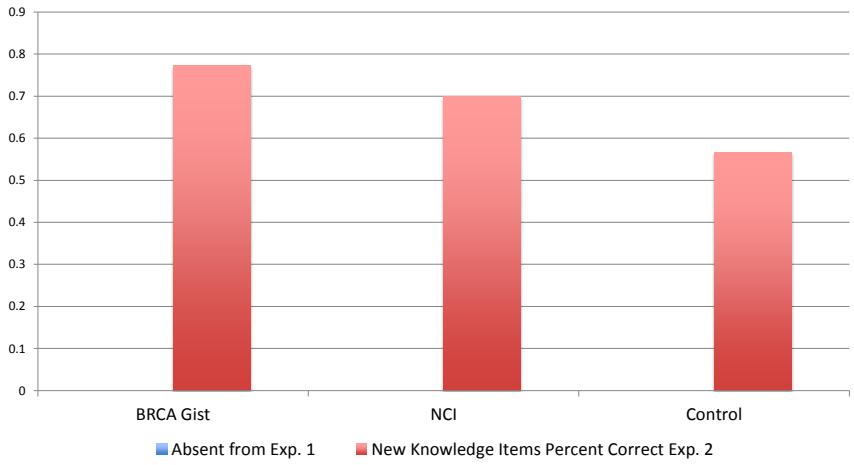
A. Becomes bone cancer.

B. Is still made of breast cancer cells.

C. Is ductal carcinoma in situ.

D. By definition, breast cancer can not metastasizes to the bones.

20 Item Multiple Choice Test of Content Knowledge for New Content by Condition.

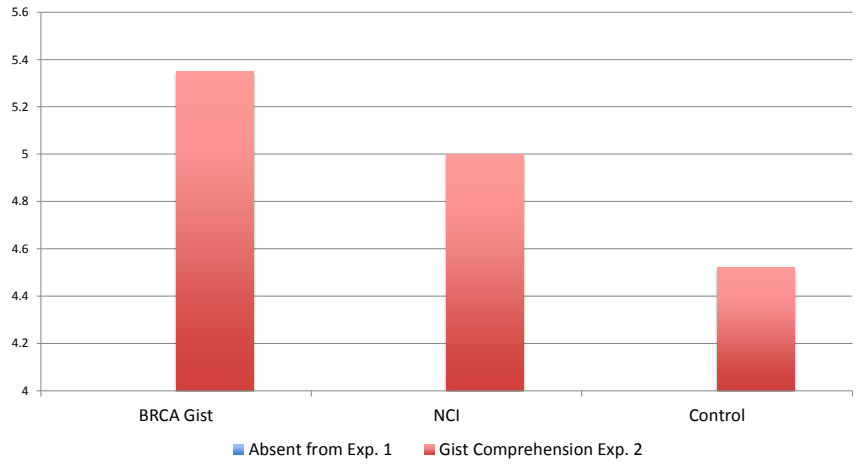


30 Item Gist Comprehension Measure (Exp. 2 only). Sample Item:

BRCA (breast cancer) genetic mutations account for only a small percentage of all breast cancers.

1	2	3	4	5	6	7
Strongly Disagree						Strongly Agree

Gist Comprehension (Exp. 2)



Knowledge Application Tasks

Rate and sort 12 scenarios describing women of high, medium, and low genetic risk for breast cancer. Also should this person be tested?

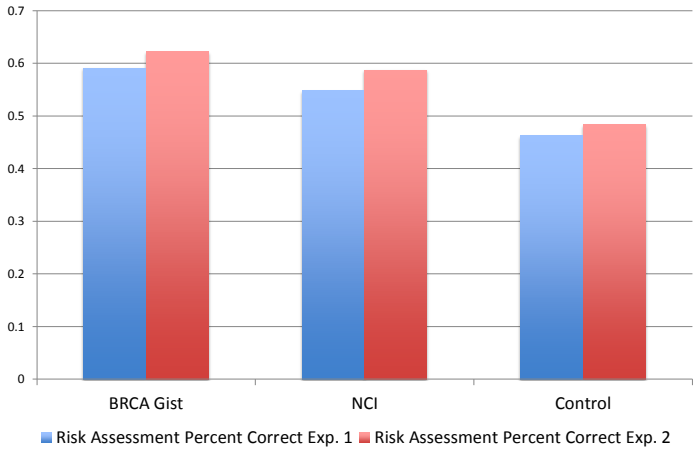
Characteristics of Each Scenario

- Vetted by medical experts.
- Each description has a name, age, ethnicity, hometown, family health facts, and personal health facts.
- Equated for age.
- Range of Words: 56 - 60.
- Range of Flesch Reading Ease Scores: 56.9 – 62.9.
- Range of Flesch-Kincaid Grade Level Scores: 7.3 – 7.9.

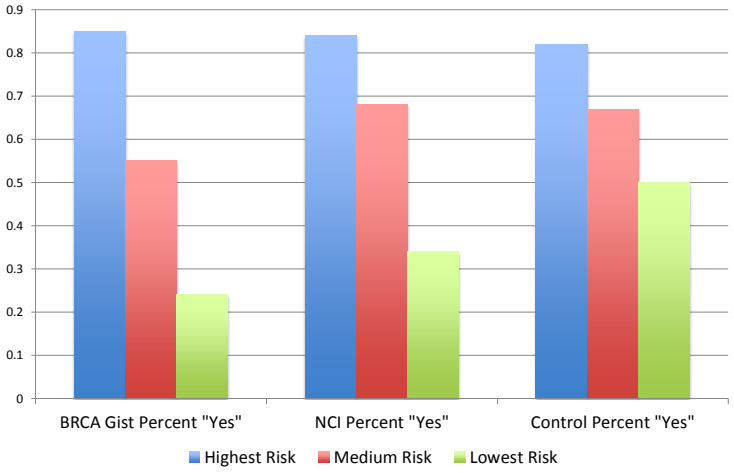
Highest Risk PAT Score 8-10 (Medium PAT 3-5, Low PAT 0)

Rachel is a 47 year-old Chicago woman. Her parents came to this country from Eastern Europe and her family background is Ashkenazi Jewish. She has two cousins on her mother's side who have breast cancer. Her cousin Joanne was diagnosed with Breast cancer at age 56, and Elaine at age 61. Rachel has generally been healthy.

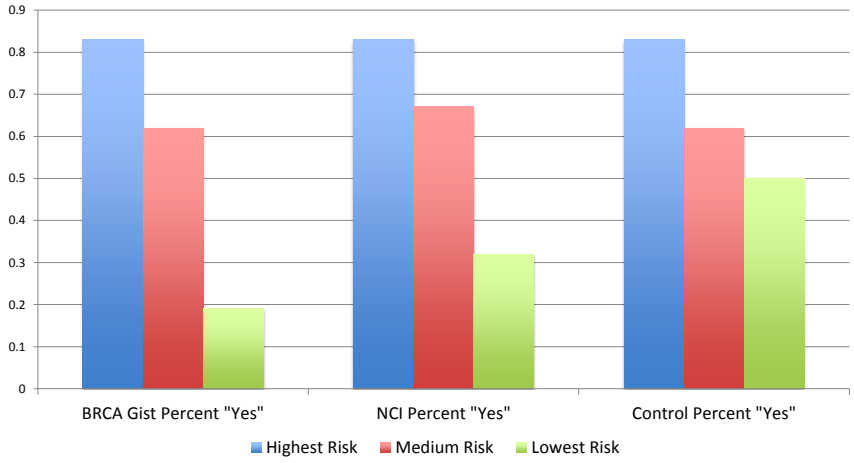
Risk Assessment Mean Percent Correct



Exp. 1 Should this person be tested (percent yes)?



Exp. 2 Should this person be tested (percent yes)?



Conclusions

- The tutor increases content knowledge, gist comprehension, and the ability to assess risk and apply knowledge.
- These factors plus other consequences of tutoring predict differences in endorsing whether low risk people should be tested.
- Future work will focus on randomized, controlled community and web-based experiments with everyday women recruited nationally.

Thank You!

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LSA "Mother sister aunt increased genetic risk breast cancer."

Mother sister aunt increased genetic risk breast cancer

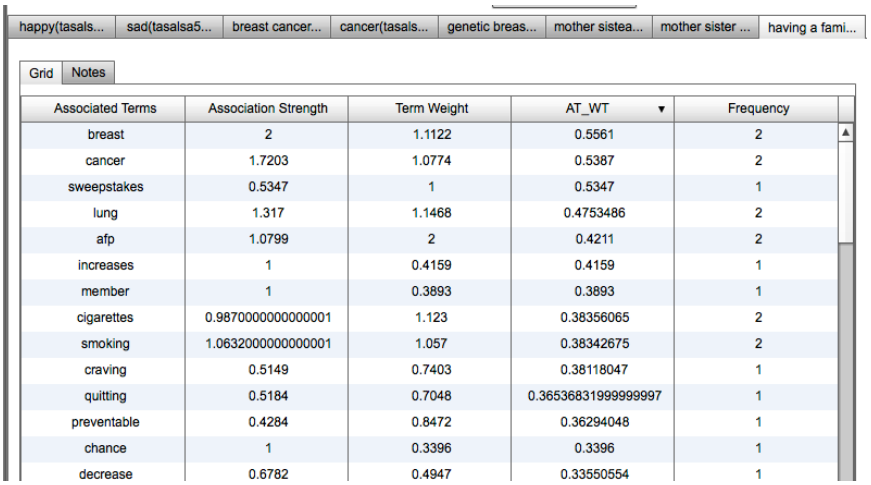
Submit

happy(tasal... | sad(tasalsa... | breast canc... | cancer(tasa... | genetic bre... | mother sist... | mother sist... | having a fa... | mother sist...

Grid | Notes

Associated Terms	Association Strength	Term Weight	AT_WT	Frequency
genome	0.7199	0.9396	0.6764180399999999	1
breast	1	0.5561	0.5561	1
mutation	0.7796	0.7021	0.5473571599999999	1
engineered	0.6468	0.8408	0.54382944	1
genetic	1	0.5412	0.5412	1
sweepstakes	0.5347	1	0.5347	1
genetics	0.8005	0.6647	0.53209235	1
dna	0.8254	0.6139	0.50671306	1
gene	0.8553	0.589	0.5037716999999999	1
genetically	0.7375	0.6782	0.5001725	1
genes	0.8596	0.569	0.48911239999999995	1
risk	1.4191	0.9272	0.4636	2
hybrids	0.5333	0.8209	0.43778596999999997	1
afp	0.8140000000000001	2	0.3929	2
sister	1	0.3808	0.3808	1
catalyzing	0.3918	0.9342	0.36601956	1
risks	0.637	0.5704	0.3633448	1

LSA “Having a family member with breast cancer increases your chances of getting breast cancer.”

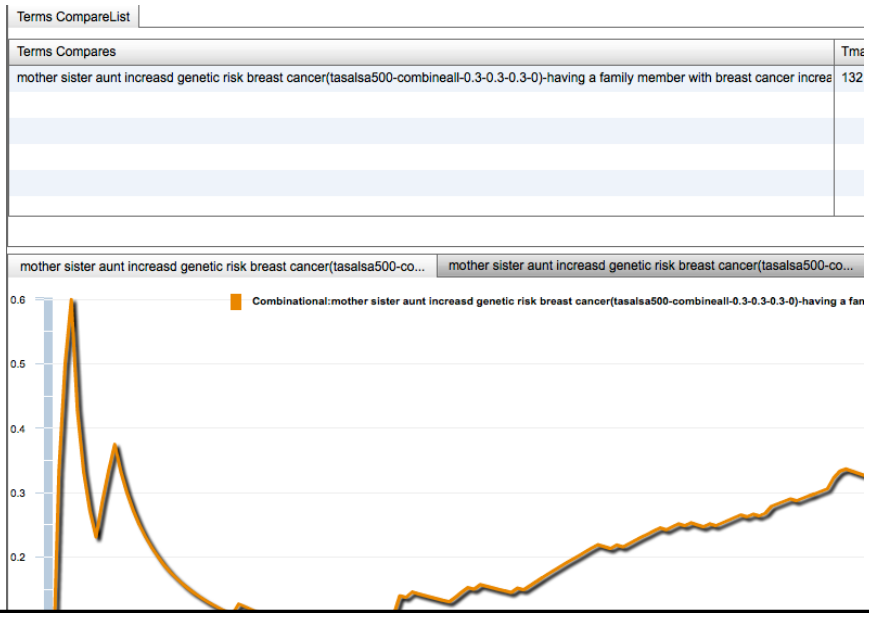


happy(tasals... | sad(tasalsa5... | breast cancer... | cancer(tasals... | genetic breas... | mother sistea... | mother sister ... | having a fami...

Grid | Notes

Associated Terms	Association Strength	Term Weight	AT_WT	Frequency
breast	2	1.1122	0.5561	2
cancer	1.7203	1.0774	0.5387	2
sweepstakes	0.5347	1	0.5347	1
lung	1.317	1.1468	0.4753486	2
afp	1.0799	2	0.4211	2
increases	1	0.4159	0.4159	1
member	1	0.3893	0.3893	1
cigarettes	0.9870000000000001	1.123	0.38356065	2
smoking	1.0632000000000001	1.057	0.38342675	2
craving	0.5149	0.7403	0.38118047	1
quitting	0.5184	0.7048	0.36536831999999997	1
preventable	0.4284	0.8472	0.36294048	1
chance	1	0.3396	0.3396	1
decrease	0.6782	0.4947	0.33550554	1

Latent Semantic Analysis: Comparison



Terms CompareList

Terms Compares	Tma
mother sister aunt increasd genetic risk breast cancer(tasalsa500-combineall-0.3-0.3-0.3-0)-having a family member with breast cancer increa	132

mother sister aunt increasd genetic risk breast cancer(tasalsa500-co... | mother sister aunt increasd genetic risk breast cancer(tasalsa500-co...

Combinational:mother sister aunt increasd genetic risk breast cancer(tasalsa500-combineall-0.3-0.3-0.3-0)-having a fan

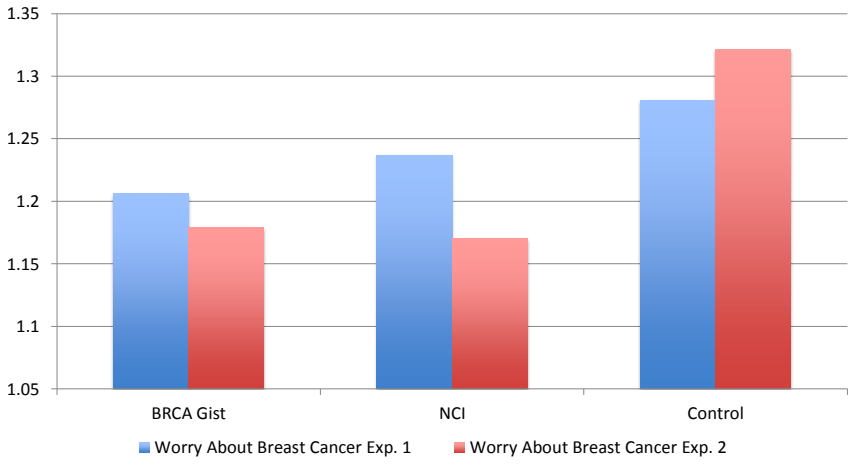
0.6
0.5
0.4
0.3
0.2

5 Item Worry About Breast Cancer (Anderson et al., 2003)

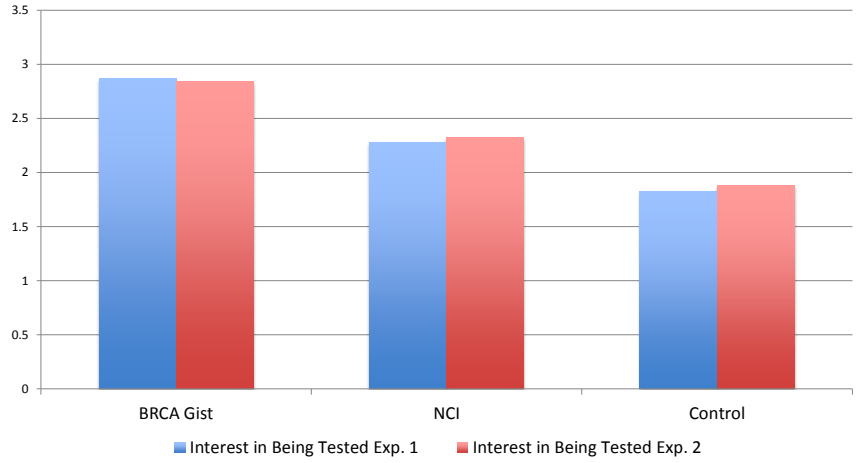
During the past month, how often have you worried about your own chances of developing breast cancer?

1=Not at all or rarely	2=Sometimes	3=Often	4=Almost all the time

5 Item Worry About Breast Cancer (Anderson et al., 2003)



Your Interest in Being Genetically Tested (1=Extremely to 5=Not at All).



Regression to Predict Should this Person be Tested for Low Risk Scenarios (Intercept = 0.966; R^2 = 0.33).

Item	Beta Weight	F	p
52 Item Knowledge Test Percent Correct	-0.343	4.85	0.03
Scenarios Percent Categorized Correctly	-0.710	23.95	<0.0001
Condition (BRCA Gist/NCI/Control)	-0.075/0.004/0.007	3.59	<0.03

Regression to Predict Your Interest in Genetic Testing (Intercept = 3.263; R^2=0.17).

Item	Beta Weight	F	p
FPPI (Base Rate Respect)	0.997	4.87	0.029
Worry About Breast Cancer	-0.149	4.40	0.038
Condition (BRCA Gist/NCI/Control)	0.438/-0.005/-0.433	5.16	0.007

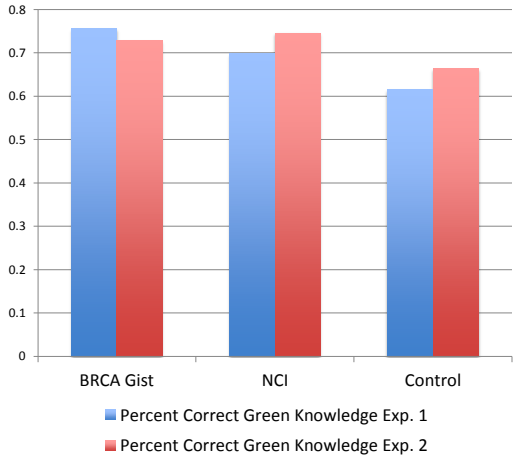
Green, Peterson, Baker, Harper, Friedman, Rubinstein, & Mauger, (2004) *JAMA* 20 Item Knowledge Test

Sample Items

Most women with breast cancer have a BRCA1 or BRCA2 gene mutation (true or false)?

The purpose of a genetic test for breast cancer susceptibility is to detect breast cancer when it is too small to be detected through other methods, such as breast examination or mammography (true or false)?

Green, et al. (2004) *JAMA* 20 Item Knowledge Test



Dialogue Script

Script Information | Information Delivery

Delete | Add Scene | Add Reflection | < | >

Slide 1 | Slide 2 | Slide 3 | Set Up Big Reflection | Reflection1

Relection Content | Configure Feedback

Show: ☑ Co ☑ CS ☑ RN ☑ IN ☑ RO ☑ IO

Turn	type	Relation	[0,1]	feedback from Avatar
3	CO	greater than	0.3	Good job. Can you say more about genetic risk factors.
3	CO	near	0.3	Good job. Can you say more about genetic risk factors.
4	CO	near	0.2	What can you say about families and risk factors?
4	CO	near	0.1	You seem to be off track. Can you say more about genes and brea
4	CO	greater than	0.3	Well done. Can you say more about the importance of the age at w
4	CO	near	0.3	Well done. Can you say more about the importance of the age at w
5	CO	greater than	0.4	Nice job. Are people in some countries and ethnic groups at higher
5	CO	less than	0.4	Okay. Can you say more about cells and tumors?
6	CO	less than	0.2	You seem to be having trouble. What can you say about families a
7	CO	greater than	0.4	Good job. Please click on the finish button to continue.
7	CO	less than	0.4	You are almost done. Please add a little to your answer.
8	CO	less than	0.4	Try one more sentence about families, risk factors, and genetic mu

Add Rule for: RN | IN | RO | IO | CO | CS | Delete Rule

A Multiple Choice Test of Declarative Knowledge

- Items created for NCI web site content.
- Vetted by medical experts.
- Items pre-tested with 82 untrained participants.
- Based on Psychometric properties 32 Items were selected from a larger pool of 49.
- Untrained pretest 32 item mean 57% Correct.

Fuzzy Processing Preference Index (Wolfe & Fisher, in press).
Scores range between 0 and 1.
High indicates “base rate respect.”

At Cloverdale High School 10% of the seniors go on to college. Bob is a senior at Cloverdale High. He gets mostly As and Bs in school and is well liked by his teachers. What is the probability that Bob will go to college?

Fuzzy Processing Preference Index (Wolfe & Fisher, in press).
Scores range between 0 and 1.
High indicates “base rate respect.”