The Eyes Have It: Individual Differences and Eye Gaze Behaviour in Biomedical Search

SIS Research Seminar

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Outline

• Introduction
• Natural Search User Interfaces
• Research Questions
• Experimental design
• Summary of Findings
• Implications for Search Interface Design
Ying-Hsang Liu

Dr Liu’s research research interest lies in the area of user-centred design and evaluation of information retrieval systems.

Current research projects

• Natural Search User Interfaces for Complex Biomedical Search ($5,000)
• Understanding the Role of Social Media in Disaster Management (SGD 89,560)
• Computational Intelligence for Complex Structured Data ($275,000)
Natural Search User Interfaces

• Collaborative research with Prof Tom Gedeon (ANU), Dr Paul Thomas (Microsoft) and Marijana Bacic (Monash Health)
• 2014—2015, funded by ALIA (Australian Library Information Association), $5,000
• Natural search user interfaces for complex biomedical search: 2014 ALIA Research Grant Award final report
Research Questions

1. What elements of search interfaces do searchers look at when searching for documents to answer complex questions?

2. What is the relationship between individual differences and the interface elements which are looked at?
Controlled User Experiment
Cognitive Style Test
Experimental Design

• 4 search interfaces of an experimental system based on Solr

- **Interface A**  Google style
- **Interface B**  Per query, ProQuest
- **Interface C**  Per query, ProQuest + EBSCO
- **Interface D**  Per document, EBSCO
Imagine that you are 63-year-old male with acute renal failure probably 2nd to aminoglycosides/contrast dye. You would like to find information about acute tubular necrosis due to aminoglycosides, contrast dye, outcome and treatment. You have saved 4 documents. When you are done, you can move to the next task.

Your search for **acute tubular necrosis dye contrasts** returned 1 results.

**Bubble cells: renal tubular cells in the urinary sediment with characteristics of viability.**
Graber M; Lane B; Lamia R; Pastoriza-Munoz E. J Am Soc Nephrol 1(7):999-1004

The urinary sediment was examined by light microscopy in 65 consecutive inpatients with renal insufficiency (not due to pre- or postrenal factors) referred to a nephrology consult service for evaluation. In the 60 patients in whom a single diagnosis was reached, the sediments of 34 (57%) contained an easily recognized cell, which we have called the "bubble cell". These cells were bizarre, large cells...
Imagine that you are 65-year-old female with urinary retention. You would like to find information about urinary retention, differential diagnosis. You have not saved any documents. When you are done, you can move to the next task.

Search interface B

Your search for urinary retention after menopause returned 1 results.

Try: Aging; Calcitonin/TU; Human; Bone Resorption/DE; Biological Markers; Menopause/PH; Osteoporosis/DT/ME/PP; Hydroxyproline/AN; Proline/AN; Female;

Civitelli R; Gonnelli S; Zaccari F; Bigazzi S; Vattimo A; Avioli LV; Gennari C. J Clin Invest 82(4):1288-74  
To investigate the effectiveness of calcitonin treatment of postmenopausal osteoporosis in relation to bone turnover, we examined 53 postmenopausal osteoporotic women before and after one year of therapy with salmon calcitonin (sCT), at the dose of 50 IU every other day. Baseline evaluation revealed that 17 (32%) patients had high turnover (HTOP), and 36 (68%) normal turnover osteoporosis (NTOP) as...
Imagine that you are 65-year-old female with urinary retention. You would like to find information about urinary retention, differential diagnosis. You have saved one document. When you are done, you can move to the next task.

Search interface C

Your search for urinary retention females returned 12 results.

1. Intravesical prostaglandin F2 for promoting bladder emptying after surgery for female stress incontinence.
   Try: Female, Human, Adult, Aged, Middle Age, Male, Electromyography, Adolescence, Urodynamics; Urinary Tract/IR.
   Prostaglandin F2 alpha 10 mg was administered intravesically in a double-blind placebo-controlled study to promote micturition in cases of urinary retention after operative treatment of urinary stress incontinence in women. Fifteen of 18 patients (83%) succeeded in voiding after treatment with prostaglandin F2 alpha, but the placebo was ineffective in all 18 patients (P less than 0.001). Although the effect of...

2. Do not catheterise your nephrectomies.
   Try: Female, Human, Adult, Aged, Middle Age, Male, Electromyography, Adolescence, Urodynamics; Urinary Tract/IR.
   A retrospective study of 100 consecutive nephrectomy patients showed a 20% catheterisation rate. Of the 11 carried out post-operatively only 4 were for urinary retention. The post-operative catheterisation rate for males was 71% and for females 2%. The rate of post-operative retention was 4.4%, which is much lower than that reported from other units. This rate of post-operative catheterisation for retention is so...
Imagine that you are 23-year-old with dysuria. You would like to find information about Urinary Tract Infection, criteria for treatment and admission. You have saved 7 documents. When you are done, you can move to the next task.

treatment and admission for Urinary Tract Infection

Your search for treatment and admission for Urinary Tract Infection returned 4 results.

1. Epidemiology of symptomatic infections of the urinary tract in children.
   Uhari M, Nuutinen M. BMJ 297(6646):450-2
   Try: Adolescence, Age Factors, Child, Child, Preschool, Female, Finland, Hospitalization, Human, Infant, Infant, Newborn, Male, Recurrence, Risk Factors, Sex Factors, Support, Non-U.S. Gov't, Time Factors, Urinary Tract Infections/*EP.
   The epidemiology of symptomatic infections of the urinary tract in children and the factors that may alter the risk of infection are not well known. Numbers of children aged under 15 discharged from hospitals because of symptomatic infections of the urinary tract during 1978-84 were obtained from the database kept by the Finnish National Board of Health. Information on continuous treatment for recurrent urinary...

2. Perinephric abscess. Modern diagnosis and treatment in 47 cases.
   Edelstein H, McCabe JE. Medicine (Baltimore) 67(2):118-31
   Try: Abscess/*/Di/ET/TH, Adult, Aged, Case Report, Female, Human, Kidney Diseases/*/Di/ET/TH, Male, Middle Age.
   The records of 47 patients with a perinephric abscess diagnosed from 1975 to 1986 at 8 San Francisco Bay Area hospitals were reviewed. The mean age was 51 years. Fifty-five percent were females and 45%, males. The left kidney was affected in 47% of cases, the right kidney in 40%, both in 4%, and a transplanted pelvic kidney in 9%. Fever (55%), chills or diaphoresis (47%), flank pain (40%), abdominal pain...
Experimental Setup

• Dataset from OHSUMED (Hersh et al., 1994)
  • MEDLINE from 1987 to 1991
  • 348,566 records
  • “the data is incomplete and out-of-date”

• Sample search topic
  • Imagine that you are 42-year-old black man with hypertension.
  • You would like to find information about beta blockers and blacks with hypertension, utility.
Experimental Procedure

- Background questionnaire
- **Cognitive style** test (holistic-analytic)
- Search session: 1 practice topic, 8 topics (7 mins for each)
- Post-search session questionnaire
- Exit session questionnaire
Imagine that you 65-year-old female with a breast mass. You would like to find information about diagnostic and therapeutic work up of breast mass.
You have saved one document. When you are done, you can move to the next task.

female breast mass therapy

Your search for female breast mass therapy returned 2 results.

1. **Risk factors for osteoporosis and associated fractures.**
   Kelsey JL., Public Health Rep 104 Suppl. 14-20
   Try. Female; Human; Aged; Osteoporosis; Postmenopausal/DT/PC; Estrogen Replacement Therapy*/ET/PC, Middle Age, Fractures/*/ET, Risk Factors; Osteoporosis; Postmenopausal/ET/PC; Osteoporosis/ET/PC;
   Established risk factors for osteoporosis and associated fractures are increasing age, female sex, white race, removal of the ovaries at an early age, prolonged immobility and prolonged use of corticosteroids. Obesity and use of estrogen replacement therapy are protective. Factors that probably or possibly increase risk in postmenopausal white women include a low calcium intake, cigarette smoking, and, at...

2. **Alternative strategies for prevention of postmenopausal osteoporosis.**
   Lindsay R., Public Health Rep 104 Suppl. 10-16
   Try. Female; Human; Aged; Osteoporosis; Postmenopausal/ET/PC; Estrogen Replacement Therapy*/ET, Middle Age, Fractures/*/ET, Risk Factors; Osteoporosis; Postmenopausal/ET/PC; Osteoporosis/ET/PC;
   Osteoporosis is more readily prevented than treated, and early intervention with effective therapy would be expected to reduce significantly the impact of osteoporotic fractures among the aging population. For the postmenopausal female population, estrogen is the cornerstone of therapy, and multiple studies have demonstrated efficacy in reducing cortical and trabecular bone loss in the axial and peripheral skeleton....
GazeSpot on Search Interface

Imagine that you are a 65-year-old female with a breast mass. You would like to find information about diagnostic and therapeutic work up of breast mass. You have saved one document. When you are done, you can move to the next task.

female breast mass therapy

Your search for female breast mass therapy returned 2 results.

1. Risk factors for osteoporosis and associated fractures
   Established risk factors for osteoporosis and associated fractures
   include advanced age, female sex, white race, removal of the ovaries at an
   early age, prolonged immobility, and prolonged use of corticosteroids.

2. Alternatives to menopausal osteoporosis.
   Established risk factors for osteoporosis and associated fractures
   include advanced age, female sex, white race, removal of the ovaries at an
   early age, prolonged immobility, and prolonged use of corticosteroids.

Region 1 (1)
Gaze: 2.0%

Region 2 (1)
Gaze: 1.2%

Region 3 (1)
Gaze: 2.0%

Region 4 (1)
Gaze: 5.2%

Region 5 (1)
Gaze: 8.7%

Region 6 (1)
Gaze: 4.5%

Region 7 (1)
Gaze: 1.1%

Region 8 (1)
Gaze: 0.6%
Search Interfaces and Gaze
BeeSwarm Visualisation of Cognitive Styles
Summary of Findings

• Proposed search interfaces have significant effect on eye gaze behavior in terms of fixations
• MeSH terms received more attention when displayed alongside each document for experienced searchers
• MeSH terms attracted to domain experts and analytic users when displayed under a search box
Implications for Interface Design

• Search interfaces have significant effect on eye gaze behavior for complex search tasks
• Experienced searchers attracted to suggested keywords, displayed alongside each document
• Domain experts and analytic users attracted to suggested keywords, displayed under a search box
Questions or comments?

Thank You!

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