Cognitive Load & Web Search Tasks

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Abstract

Assessing cognitive load on web search is useful for characterizing search system features, search tasks and task stages with respect to their demands on the user’s mental effort. It is also helpful in examining how individual differences among searchers (e.g., cognitive abilities) affect the search process and its outcomes. In this controlled web search study, cognitive load was assessed by introducing secondary task. The results showed lack of relationship between objective task difficulty and cognitive load. There was, however, a significant relationship between search task stages and cognitive load. On some task stages, cognitive load varied between user interface conditions.

Objectives

• Understand techniques for assessing cognitive load.
• Understand how cognitive abilities mediate the levels of mental effort.
• Understand mental demands of search tasks and search interfaces.
• In particular, establish feasibility of separating cognitive load components based on Cognitive Load Theory: intrinsic, extrinsic load (Chandler & Sweller, 1991) and on Xie & Salvendy’s framework (2000).

Measures

Average load per unit of analysis $\bar{L} = \frac{1}{n} \sum_{i=1}^{n} L_i$ (e.g. one task stage)
Peak load during a unit of analysis $L_{\text{peak}}$
Cognitive load was assessed as reaction time to the secondary task: $RT = L$
Reaction time components:
$RT_{\text{mem}}$: less mental effort
$RT_{\text{num}}$: more mental effort

Main Findings

Higher average cognitive load on Q & B
Higher peak cognitive load on C

RTload: Significant relationships

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Task Stages

Q: query formulation
L: examination of search results list
C: examination of individual result (content)
B: bookmarking and tagging relevant result

Studies Design

Web search in a controlled lab setting
• 48 participants; one search session each
• Session: 6 tasks of varied difficulty (3 levels)
  - Task description
  - Difficulty: High, Medium, Low
  - Task Acronym:
    - IG_H
    - FF-H
    - IG_P
    - FF-S
  - Objective
    - Parallel information gathering task (topical search)
    - Simple information gathering task (topical search)
    - Hierarchical fact finding task (known item search)
    - Parallel fact finding task (known item search)
    - Simple fact finding task (known item search)
  - Task Stages
    - Q: query formulation
    - L: examination of search results list
    - C: examination of individual result (content)
    - B: bookmarking and tagging relevant result

Summary & Conclusions

• Mental effort varied across search task stages.
• Different components of cognitive load tended to be related to different aspects of task performance.

Methodological contributions:
• Measures of cognitive load intensity (average load) were shown to be sensitive to dynamic changes in task demands (such as the changes between task stages) and not sensitive to the differences between tasks.
• Our cognitive load assessment technique seems promising for separate measurement of the extrinsic (interface) and the intrinsic load (task).

Implications:
• Identification of task stages when searchers may be more likely to have “spare” mental capacity and be more interruptible.
• Design of relevance feedback and notification delivery.

Future work:
• Refinement of cognitive load component assessment technique.
• Corroboration of cognitive load assessment by physiological measures (such as, pupil dilation, galvanic skin response).
• Consideration of eye-movement patterns.