Directly Evaluating the Cognitive Impact of Search User Interfaces: a Two-Pronged Approach with fNIRs

Why?
• Many existing measures correlate **physiological responses to cognitive function**
• We think **measuring directly** should **provide a richer source of information**
• Intended to **prove/disprove** existing and future theories
• Evaluation and Usability testing are key aspects of **HCI and Information Retrieval (IR) studies.**
• Current approaches are subjective

Current research
• INITIAL INTEREST – **CUES**
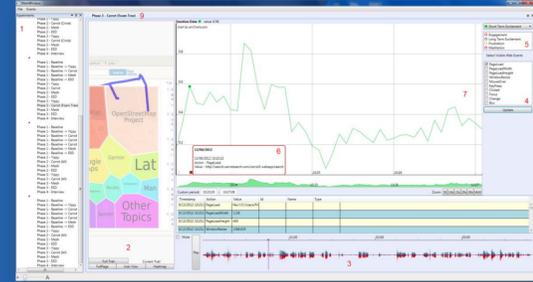
• **EEG TECHNOLOGY**
• **ARTEFACTS ISSUES**

Pike, Matthew, et al. "CUES: Cognitive Usability Evaluation System." *2nd European Workshop on Human-Computer Interaction and Information Retrieval (ML Wilson, T. Russell-Rose, B. Larsen, and J. Kalbach, eds.),(Nijmegen, The Netherlands).* 2012.

Two-Pronged Approach with **fNIRs**
• An optical **imaging** technology
• Measures neural activity and hemodynamic response in the prefrontal cortex (indicative of human cognition)
• Four IR light sources and ten detectors mounted in a flexible band
➤ **PRO**: Low-cost, non-invasive, easy to setup, and relatively robust with respect to movement artefacts (suitable to HCI research). Successfully used in **real, ecological valid tasks**;
➤ **CON**: Hard to process the data, wired version, hemodynamic response approx. 6 sec (overcome: backup signal), not accurate such as fMRI;

Research Path 1 – Evaluating the cognitive aspects of Interactive IR tasks
• Understand **users capabilities and limitations** (such as their **cognition**)
• Things like memory, attention, how people process information, make decisions or solve problems.
• Move beyond using fNIRS to measure workload in simplistic psychology memory tasks
• Break down real search tasks into primary components.
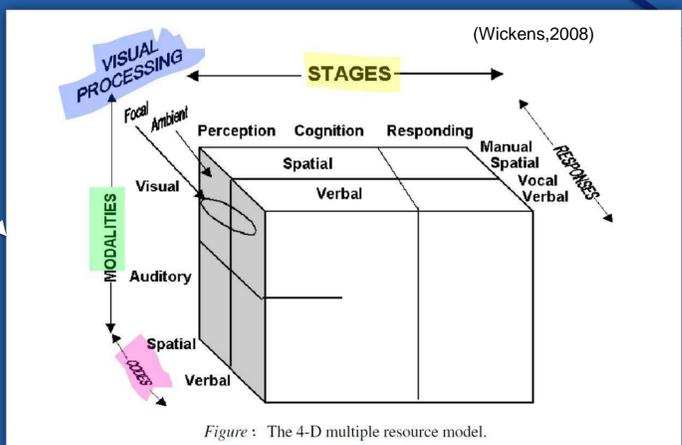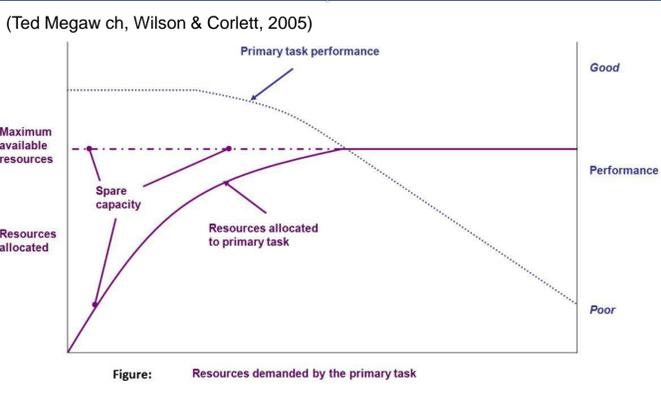
Research Path 2 - **Methods to evaluate the design of SUIs**
• Quantitative data from brain sensing devices into feedback about SUI designs;
• Identifying which aspects of working memory are affected by deferent features of SUIs,
• Determine if a workload difference was caused by SUI design (spatial) or the amount of information the design provides (verbal).

(Ted Megaw ch, Wilson & Corlett, 2005)

(Wickens,2008)

Figure : The 4-D multiple resource model.

Upcoming study: **Evaluating the impact of verbal think aloud protocols (TAP) on human cognition.**
Considerations:
-Assumptions (task demands - TD):
High TD => use concurrent Passive TAP and retrospective TAP
Low TD => use concurrent Invasive TAP

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Proposed methodologies
• Running a series of lab experiments (field experiments are possible due to fNIRS flexibility);
• Collecting quantitative data:
  - Behavioral data (primary task performance, secondary task performance)
  - Brain data (fNIRS data requires preprocessing step)
  - Subjective measures (e.g. NASA TLX)