

Introduction and Background

- Usability is a major barrier to the adoption and meaningful use of Electronic Health Records (EHRs) [1,2].
- Efficient, objective, and reliable methods are needed for EHR usability evaluation.
 - 1) As part of growing suite of usability evaluation tools, this metric assesses the representation of user interface elements.
 - 2) This metric is based on the theory of distributed cognition [3].

Examples of actionable user interface (UI) elements

COGNITIVELY TRANSPARENT

Current Medications			
Drug Name & Strength	Sig	Start Date	
Edit Diabeta 2.5 mg tab	1 tab daily by mouth	07/20/2010	
Edit Lipitor 10 mg tab	1 tab daily by mouth	02/21/2011	

The operation "Edit" is externally represented. No memory is required to interpret what it is for.

Close proximity of the object and operation makes clear their relation.

NOT COGNITIVELY TRANSPARENT

Current Medications			
Drug Name & Strength	Sig	Start Date	
Diabeta 2.5 mg tab	1 tab daily by mouth	07/20/2010	
Lipitor 10 mg tab	1 tab daily by mouth	02/21/2011	

No clear indication of the operation except for its clickability. Requires memory.

The relation between operation and object is external, though the meaning of the operation is internal.

For additional information, please contact SHARPC@uth.tmc.edu

Metric for Cognitive Transparency		Representation of Object-Operation Relation	
		External (clear on the UI)	Internal (memory required)
Representation of Operation	External	Transparent	Not Transparent
	Internal	Not Transparent	Not Transparent

$$\text{Cognitive Transparency} = \frac{\text{External Info}}{\text{External Info} + \text{Internal Info}}$$

Method

1. Pilot User Expectation Experiment

- Participants: 3 subjects with general computer experience
- Stimuli: actionable UI elements in E-Prescribing Use Case in three ambulatory EHRs, presented in screenshots
- Data Collection: Participants were asked to predict the anticipated task-specific consequences of actions (i.e. "what do you think will happen if you click on this?")
- Data Analysis: Responses from participants were compared to the actual consequences of actions designed on the UI elements in live EHRs. If the user's response matches the actual consequence of action, the UI element was classified as *cognitively transparent*; otherwise it was classified as *not cognitively transparent*.

2. Evaluation of the Metric

- Application: One evaluator applied the metric to the same set of actionable UI elements to determine if they were transparent or not.
- Evaluation: The cognitive transparency ratings by using the metric were compared with the cognitive transparency classifications from the user expectation experiment. The specificity and sensitivity of the metric were analyzed.

Results

1. Observation-Prediction Comparison

Table 1. Observation-prediction comparison on individual UI elements

EHR 1 (total 35 UI elements)		Observation from Experiment	
		Transparent (agreed by 3 subjects)	Not Transparent (at least 1 subject)
Prediction from Metric	Transparent	60%	3%
	Not Transparent	6%	31%
EHR 2 (total 17 UI elements)		70%	12%
EHR 3 (total 18 UI elements)		50%	11%
		0%	39%

Table 2. Sensitivity and specificity of the metric compared with the observation from experiment

	Sensitivity	Specificity
EHR 1	91%	92%
EHR 2	92%	50%
EHR 3	100%	78%

2. Predictions across EHRs using the Metric

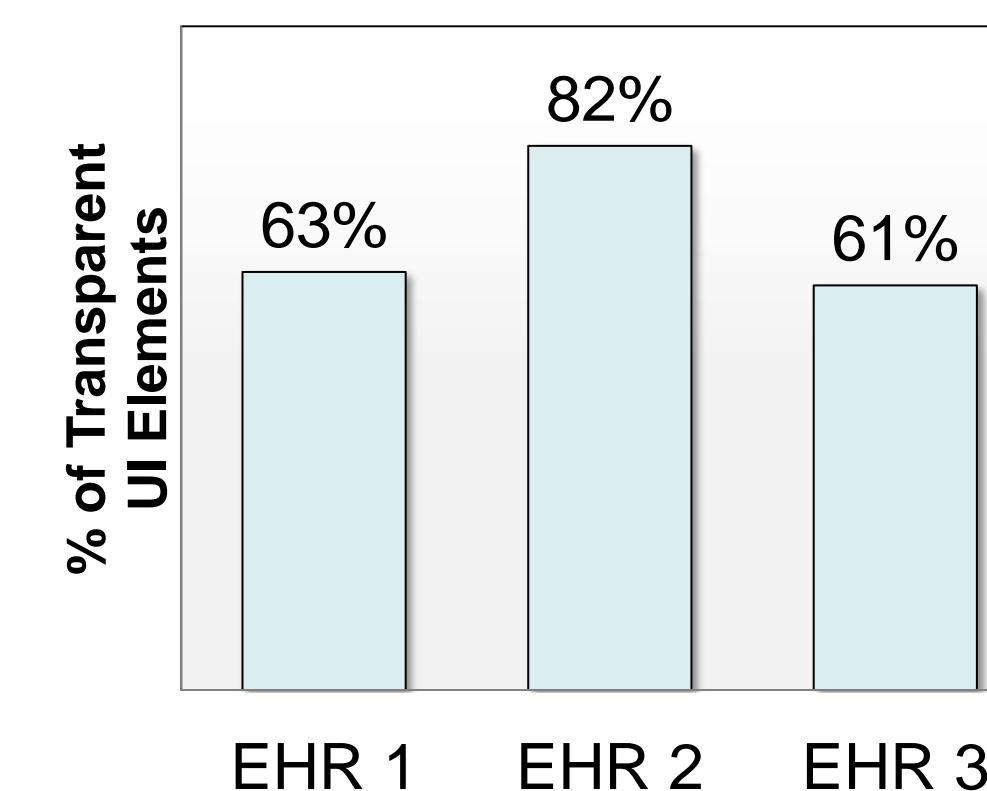


Figure 1. Predicted cognitive transparency of UI elements involved in E-Prescribing across EHRs

Discussion

1. Significance of Cognitive Transparency for EHRs

- Cognitive transparency is a measure of memory load for EHR users. The more transparent the UI elements are, the less memory is required.
- Cognitive transparency is also a measure of learnability for novice users. The more needs to be memorized, the harder the learning is.
- Under time-critical and safety crucial circumstances, cognitively transparent EHRs are essential.

2. Study Limitation and Future Research

- This is a pilot study with a small sample of subjects.
- A comprehensive experiment is planned to systematically validate the cognitive transparency metric.

Summary of Conclusions

- ❑ This pilot study suggests that the cognitive transparency metric has high sensitivity and acceptable specificity compared with the observation data from human users.
- ❑ This metric provides an objective method to evaluate EHR usability.

References

1. Zhang, J. Human-centered computing in health information systems: Part I-- Analysis and Design (Editorial). Journal of Biomedical Informatics, 2005;38; 1-3.
2. Zhang, J., Walji, M. F. TURF: Toward a unified framework of EHR usability. Journal of Biomedical Informatics 2011 (in press).
3. Zhang, J., Patel, V. Distributed cognition, representation, and affordance. Pragmatics & Cognition, 2006;14(2); 333-341.

Acknowledgement

This project was supported by Grant No. 10510592 for Patient-Centered Cognitive Support under the Strategic Health IT Advanced Research Projects (SHARP) from the Office of the National Coordinator for Health Information Technology.