Cognitive Load Theory:
Why using your EHR is so painful and how to fix it.

Michael Zimmerman, MD
Temescal Creek Medicine
Patient

Surgical History
Social History
Family History
Care Team

Risk Factors
Medications
Data

Problem List

Diabetes
CHF
Asthma
Got Cognitive Load?

Do you feel...
Tired
Overwhelmed
Burned Out
disengaged
Rushed
Short Temper
Lack of enthusiasm

Ask you doctor...
• Cognitive Load is the aggregate mental effort required in problem solving and learning.
Working Memory

Problem or Task

Novel Information is Collected and Processed
1. Auditory
2. Visual

Problem Solving -> Learning

24 divided by 3
Problem Solving -> Learning

1. Novel Information is Collected and Processed
   1. Auditory
   2. Visual

2. Interpretation and consideration of information in context of existing knowledge schemas. (Long Term Memory)

Here’s what I already know...

Concepts of division and multiplication; 24/6 = 4

The Problem or Task
Problem Solving -> Learning

1. Novel Information is Collected and Processed
   1. Auditory
   2. Visual

2. Interpretation and consideration of information in context of existing knowledge schemas. (Long Term Memory)

3. Build and retention of new knowledge based on the problem solving experience.
Cognitive Load is the aggregate mental effort required in problem solving and learning.

- **Intrinsic Cognitive Load**: The inherent complexity of the task. (expertise dependent)
- **Interactivity**: of elements. (will always be big in health problem solving)

<table>
<thead>
<tr>
<th>Complexity</th>
<th>0-</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactivity</td>
<td>0-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrinsic Cognitive Load</td>
<td>Minimal</td>
<td>Moderate</td>
<td>Heavy</td>
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</tbody>
</table>

2+2
18 + 37
879834+79275

Medical Problem Solving?
Extraneous Cognitive Load

manner in which information is presented to solver/learner

it is imposed by mental activities that can have a negative effect on learning if not designed appropriately. Extraneous load can interfere with the construction or automation of schemas.

a round plane figure whose boundary consists of points equidistant from a fixed point.
“Germaine”
Cognitive Load-Learning

Load imposed by constructing new schemas and automating them...Learning! This is **germane cognitive load**.
Intrinsic (Task)  Extrinsic (presentation)  Learning

Aggregate Cognitive Load

Working Memory

Working Memory $\geq$ Cognitive Load

- Task Completed
- Learned some new things
Working Memory $\geq$ Cognitive Load

- Task Completed
- Learned some new things

Working Memory $< \text{Cognitive Load}$

Choices...
- Accept errors/ incomplete solution
- Shrink the Task
- Forgo new knowledge learning

Decrease Extrinsic Cognitive Load!
Intellectual Performance

Working Memory Capacity

Beyond Capacity

Cognitive Load

Increase errors
Suboptimal task completion
Maladaptive Response to Cognitive Overload
Mental shortcuts (Heuristics and Biases)

<table>
<thead>
<tr>
<th>Aggregate bias</th>
<th>Hindsight bias</th>
<th>Search satisfying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchoring</td>
<td>Multiple alternatives bias</td>
<td>Sutton’s slip</td>
</tr>
<tr>
<td>Ascertainment bias</td>
<td>Omission bias</td>
<td>Sunk costs</td>
</tr>
<tr>
<td>Availability</td>
<td>Order effects</td>
<td>Triage cueing</td>
</tr>
<tr>
<td>Base-rate</td>
<td>Outcome bias</td>
<td>Unpacking principle</td>
</tr>
<tr>
<td>Commission bias</td>
<td>Overconfidence bias</td>
<td>Vertical line failure</td>
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<tr>
<td>Confirmation bias</td>
<td>Playing the odds</td>
<td>Visceral bias</td>
</tr>
<tr>
<td>Feedback sanction</td>
<td>Posterior probability error</td>
<td>Yin-Yang out</td>
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<tr>
<td>Framing effect</td>
<td>Premature closure</td>
<td></td>
</tr>
<tr>
<td>Fundamental attribution error</td>
<td>Psych-out error</td>
<td></td>
</tr>
<tr>
<td>Gambler’s fallacy</td>
<td>Representativeness restraint</td>
<td></td>
</tr>
<tr>
<td>Gender bias</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other mental shortcuts:
- Aggregation bias
- Anecdotage bias
- Ascription bias
- Ascertainment bias
- Availability
- Base-rate
- Commission bias
- Confirmation bias
- Feedback sanction
- Framing effect
- Fundamental attribution error
- Gambler’s fallacy
- Gender bias
- Hindsight bias
- Multiple alternatives bias
- Omission bias
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- Yin-Yang out
Reducing Extrinsic Load

Decrease Extrinsic Cognitive Load!

Working Memory < Cognitive Load
### Primary Care Encounter HD

**Walter S. Caldwell**

**Age:** 66  
**DOB:** 09/16/1948  
**Consolidated Health Care**  
**Last Visit:** 08/10/2015

#### Subjective

**Visit Type:** CC

**Patient Agenda:**

- **HPI #1:** 2000 Characters Left
- **HPI #2 & #3:**

#### Objective

- **Probs/Meds:**
  - **LAD:** 04/26/2006  
  - **MVD1:** CHRONIC AIRWAY OBSTRUCTION (COPD) (ICD-490) (ICD:10:J44.1)
  - **LAD:** 04/26/2006  
  - **ARTHRITIS:** (ICD:716.90) (ICD:10:M19.90)
  - **LAD:** 04/24/2006  
  - **ANGINA FUNCTIONAL CLASS II:** (ICD:413.9)
  - **LAD:** PROSTAC HYPERFUNCTION (ICD:460)

#### Assessment/Plan

- **Medications:**
  - **08/10/2015**
    - **MEVACOR LAB 40MG (LOVASTATIN):** 1 po qd
    - **NITROSTAT: 80MG (NITROGLYCERIN):** 1 st pm c/p, max of 3 in 15 min

#### Allergies:

- **PERCOCET (Critical):** (Reaction: Gastrointestinal problems, e.g., nausea, vomiting, diarrhea, nausea)
Reduce Incidental Processing

Basic layout – Simple

• Structure
  • Predictable, Consistent, Minimize scanning

• Colors/Symbols
  • Meaningful, Consistent

• Presentation
  • Consistent with the providers Mental Model/schema
Reduce Incidental Processing

Basic layout – Simple

• Content
  • Increase Signal to Noise Ratio, Eliminate non essential information

• Flow
  • Consistent with clinical thinking, Return me where I left off, Predict and make available 3 next most common actions

• Make documentation a byproduct of the clinical work
Oh yeah, also 800x600 Resolution is so 1999

[Graph showing screen resolution usage over time]

- **Small Screen (800x600 or less)**
- **Medium (1024x768 or 1152x864)**
- **Big (1280-1600 wide)**
- **Huge (1920+)**
CAUTION:
TREES
OBSCURING
VIEW OF
FOREST
NEXT 5 MILES
Problems:

05/09/2015

- TRANSPLANT STATUS-PANCREAS-HCC (ICD-V42.63) (ICD-10:274.83)
- LAD: 05/09/2015
- TOBACCO USE QUIT (ICD-V15.32) (ICD10:287.89)
- LAD: 05/09/2015
- MI OLD: HEALED-HCC (ICD-412) (ICD-10:252.2)
- LAD: 05/09/2015
- CHRONIC SYSTOMIC HEART FAILURE (ICD-428.22) (ICD10:150.22)
- LG: 05/09/2015
- CHF unspec.* (ICD-428.0) (ICD10:150.9)
- LG: 12/18/2014
- COPD-HCC (ICD-490) (ICD10:491.4)
- LG: 12/18/2014
- CKD STAGE 4GFR<50 - MICROALBUMIN-HCC (ICD-585.1) (ICD10:N10.1)
- LG: 07/04/2014
- SEIZURE NOS-HCC (ICD-780.39) (ICD10:R56.9)
- LG: 11/09/2014
- PREVENTIVE HEALTH CARE-ODD (ICD03,ICD10:200.00)

Medications:

05/09/2015

1. BENADRYL 25 MG TAB (DIPHENHYDRAMINE HCL) 1 or 2 capsules at bedtime as needed for sleep or itch (OTC).
2. ACCUPRIL 10 MG TAB (QUINAPRIL HCL) 1 tablet by mouth every morning.
3. ZOLPIDEM TARTRATE 10 MG TABS (ZOLPIDEM TARTRATE) 1 tablet.
4. ADVANEX DISKUS 250-50 MCG/DOSAGE MISC (FLURACSONE-SALMETEROL) Take as directed per Asthma Management Plan.

Allergies:

05/09/2015

- PAMELOR (NORTRIPTYLINE HCL) (Critical)
• example
Reducing Extrinsic Cognitive Load

- Presentation of information in format and structure consistent with how providers see the world (schema).

Remember our card game?
- Example Problems
  - Last Assessment
  - Comments
  - Review Previous
• example
Reducing Extrinsic Cognitive Load

• Structured documentation/data collection- Good templates, bad templates
  • My office phone number
  • (1)5 (2)1 (3)0 (4)2 (5)3 (6)0 (7)2 (8)3 (9)7 (10)2
  • (510) 230-2372

• If you want discrete data captured, you must make it easy
• example
Reducing Extrinsic Cognitive Load

• Make it easy to offload working memory when appropriate
  • Update in family hx, surgical hx.
  • Refill medication
  • Future reminder
  • Flag task to MA

• Right tool for the job- quick visit

• Facilitate next steps
• examples
Reducing Intrinsic Load?

**Working Memory < Cognitive Load**

- Choices...
- “Chunking” - breaking up task
- Examples?
Germaine Load- Learning

Working Memory ≤ Cognitive Load

Best place for learning? Perhaps not the middle of an office visit
• Cognitive Load is the aggregate mental effort required in problem solving and learning.

Working memory is finite and is the rate limiting step

Help the doctor help the patient
✓ Shrink Intrinsic Load by breaking down tasks
✓ Shrink Extrinsic Load by addressing presentation of information
✓ Limit Learning (Germaine) Load by avoiding “education” during visits
References

• Croskerry P. The importance of cognitive errors in diagnosis and strategies to minimize them. Acad Med 2003; 78: 775-780.
