Should learners reason one step at a time?

Sarah Blissett
Deric Morrison
David McCarty
Matt Sibbald
I do not have an affiliation (financial or otherwise) with a pharmaceutical, medical device or communications organization.

Je n’ai aucune affiliation (financière ou autre) avec une entreprise pharmaceutique, un fabricant d’appareils médicaux ou un cabinet de communication.
Cognitive load

• Mental effort used in working memory

• Working memory is limited

van Merrienboer JG, Sweller. Medical Education 2010: 44: 85–93
Clinical decision making is difficult

- Making a diagnosis often requires integration of multiple variables
- Process can overwhelm working memory

Schema use

• Increased diagnostic accuracy

• Lower cognitive load
Optimal schema layout?
Terminally branching schema

- Single variable decisions
- Optimize working memory
- Perceptual error could result in diagnostic error
Hybrid schema

• Single variable decisions + chart

• Limits of working memory

• Allows cross checking to avoid diagnostic error if perceptual error made
The trade off

Hybrid

Terminally branching

Impact of perceptual error on diagnostic accuracy

Cognitive load
Research Question

Does schema layout impact **diagnostic accuracy** or **cognitive load**?
Model

- 86 PGY1-3 Internal Medicine Residents at Western University
- Murmur identification on Harvey, a cardiopulmonary simulator
86 PGY 1-3
Internal Medicine Residents
Randomized
86 PGY 1-3 Internal Medicine Residents Randomized

- Systolic TB schema
- Systolic Hybrid schema
- Diastolic TB schema
- Diastolic Hybrid schema
86 PGY 1-3 Internal Medicine Residents Randomized

- Diagnostic accuracy
- Perceptual error
- Cognitive load

Systolic

- TB schema

Systolic

- Hybrid schema

Diastolic

- TB schema

Diastolic

- Hybrid schema
Diagnostic accuracy
Perceptual error
Cognitive load

Systolic TB schema
Systolic Hybrid schema
Diastolic TB schema
Diastolic Hybrid schema

86 PGY 1-3 Internal Medicine Residents Randomized
86 PGY 1-3 Internal Medicine Residents Randomized

- Diagnostic accuracy
- Perceptual error
- Cognitive load

Systolic
TB schema

Systolic
Hybrid schema

Diastolic
TB schema

Diastolic
Hybrid schema

Diastolic
Hybrid schema

Systolic
TB schema
Effect of schema organization

- Repeated measures MANOVA

- Main effect of schema type ($p=0.004$, $\eta^2_p=0.15$)

- No significant effect of domain encountered first ($p=0.763$) or within subjects ($p=0.145$)

- No significant effect of year of study ($p=0.209$)
## Effect of schema organization

<table>
<thead>
<tr>
<th></th>
<th>TB schema (95% CI)</th>
<th>Hybrid schema (95% CI)</th>
<th>P-value</th>
<th>$\eta_p^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diagnostic Accuracy (%)</strong></td>
<td>65 (58, 74)</td>
<td>55 (47, 63)</td>
<td>0.038</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Perceptual error</strong></td>
<td>0.61 (0.45, 0.77)</td>
<td>0.95 (0.78, 1.1)</td>
<td>0.002</td>
<td>0.115</td>
</tr>
<tr>
<td><strong>Cognitive load (1-7)</strong></td>
<td>3.1 (2.9, 3.4)</td>
<td>3.5 (3.2, 3.8)</td>
<td>0.026</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Terminally branching schema:

- diagnostic accuracy
- errors, cognitive load
Use of schemas may explain results
Perspectives

- Schema design
- Clinical decision aids
- Approach to complexity
Limitations

- Model was inherently uncertain
- Focused on schema use
Conclusion

Use of a terminally branching schema by intermediate learners was associated with higher diagnostic accuracy and lower cognitive load, suggesting intermediate learners should reason “one step at a time”
Acknowledgements

• Dr Matt Sibbald, David McCarty and Deric Morrison

• Western University Department of Medicine
• Centre for Education Research & Innovation
• Royal College Robert Maudsley Fellowship for Studies in Medical Education
Questions
References


