I have/had an affiliation (financial or otherwise) with a pharmaceutical, medical device or communications organization:
Speaker honorarium: Servier Canada

J’ai (ou j’ai eu) une affiliation (financière ou autre) avec une entreprise pharmaceutique, un fabricant d’appareils médicaux ou un cabinet de communication.
Working memory is limited

Limited space

Limited time
Cognitive Load Theory

- **Intrinsic load** – complexity of the task
- **Extraneous load** – aspects not relevant to task completion
- **Germaine load** – processing to retain new information

van Merrienboer & Sweller. Medical Education. 2010
Sweller, van Merrienboer & Paas. Educational Psychology 2019
Cognitive Load Theory

- Intrinsic load – complexity of the task
- Extraneous load – aspects not relevant to task completion
- +/- Germane load – processing to retain new information
Optimizing instructional design

- Manage Intrinsic load
- Minimize Extraneous load
- Optimize germane load
Optimizing instruction in workplace learning environments
Optimizing instruction in workplace learning environments
Research Aim

Explore the trainee perspective on the aspects of the workplace learning environment that contribute to intrinsic, extraneous and germane cognitive load
Interpretation of transthoracic echocardiograms as a model
Conclusions:
The patient's blood pressure was 110 mmHg/71 mmHg during the study. The heart rate during the study was 110.
Color Flow Doppler was utilized for this exam. Spectral Doppler was utilized for this exam.
1. The left ventricular volume is normal. LV function is normal. LV ejection fraction is estimated to be 60 to 65%.
   There is no left ventricular hypertrophy. No segmental wall motion abnormalities present.
2. The right ventricular volume is normal. Right ventricular function is normal.
3. Left atrial size is normal. Right atrial size is normal.
4. There is no hemodynamically significant valvular disease.
5. Atrial fibrillation precludes the accurate evaluation of diastolic function.
6. The pulmonary artery systolic pressure cannot be determined due to the lack of a complete TR jet.
7. No pericardial effusion noted. The inferior vena cava is greater than 21 mm in diameter and collapses more than
   50% with inspiration consistent with a right atrial pressure of 8 mmHg, which may be normal in an athletic individual.
8. Aortic root dimension is normal.
Methodology
• Qualitative approach- thematic analysis
• Purposeful sample of 10 cardiology and echo fellows
• Semi-structured interviews
• Transcripts coded by 2 independent reviewers
Typical workflow

- Step 1: Select echo
- Step 2: Interpret echo
- Step 3: Generate report
- Step 4: Teaching and feedback
Step 1: Select an echo to interpret

Novices = studies likely to be normal

More senior trainees = complex interpretive skills
Step 1: Select an echo to interpret

“I make things efficient for the lab.

Right now, it's more like try to just get as many echoes read

My reading to learning ratio is not set up optimally for my learning." (PGY 6-b)
Step 1: Select an echo to interpret

Managing intrinsic load:
Match task to learner level

Scaffolding from simple to complex

Extraneous load:
Time to select appropriate echo
Typical workflow

- Step 1: Select echo
- Step 2: Interpret echo
- Step 3: Generate report
- Step 4: Teaching and feedback
Step 2: Interpreting the TTE

- Proximity to help
- Interruptions
- Lack of worked examples
- Complexity
Step 2: Interpreting the TTE

There’s people to ask for help… I could ask someone for help immediately…” (PGY 4-a)
Step 2: Interpreting the TTE

“…then you get distracted with someone else coming in or a phone call….you may overlook that aspect that you had suspicion on. (AEF-b)
Step 2: Interpreting the TTE

Proximity to help

Interruptions
Lack of worked examples
Complexity

I didn’t know what the cut-offs were for LVH, or how you measure LVH... I had no instruction to get me started. (PGY 4-c)
Step 2: Interpreting the TTE

Proximity to help  Interruptions
Lack of worked examples  Complexity

“…if every valve is down, then it can become a very cumbersome study.”
(PGY 4-b)
Step 2: Interpreting the TTE

**Sources of intrinsic load:**
Inappropriate complexity

**Sources of extraneous load:**
Interruptions
Lack of worked examples
Typical workflow

- Step 1: Select echo
- Step 2: Interpret echo
- Step 3: Generate report
- Step 4: Teaching and feedback
Generating a Report

Using the template

Reporting Software

Interruptions

“You’re unfamiliar with the software and then you’re completely unfamiliar with what you’re looking at” (PGY 6-c)
Sources of extraneous load:
Reporting Software
Interruptions

Generating a Report
Typical workflow

- Step 1: Select echo
- Step 2: Interpret echo
- Step 3: Generate report
- Step 4: Teaching and feedback
Teaching and feedback

- Read with attending
- Ask questions
- Obtain feedback independent of attending
Teaching and feedback

- Read with attending
- Ask questions
- Obtain feedback independent of attending

Sources of germane processing
“The attendings are torn between service and teaching … They’re working really hard to read 80 echos a day.” (PGY 5-b)
“There will be cases that you just know are going to take more time and may not necessarily be more learning. I don’t think I’m going to learn much from doing an aortic stenosis case, but I know it’s going to take a long time. Do I want to spend 30 minutes to an hour on a single echo?” (PGY 6-c)
Summary: Sources of cognitive load in the workplace

Intrinsic Load
Mismatch between learner level and task complexity

Number of elements for a novice
Summary: Sources of cognitive load in the workplace

Extraneous Load

Lack of worked examples

Trainee-driven curriculum

Interruptions

Reporting Software
Summary: Sources of cognitive load in the workplace

- Extraneous Load
  - Processing
- Intrinsic Load
  - Reviewing with attendings
  - Asking directed questions
  - Checking final reports

Germaine Processing
Summary: Sources of cognitive load in the workplace

+ / —

Intrinsic Load  Extraneous Load  Germane Processing

TIME PRESSURES
Summary

- Benefit of workplace learning $\rightarrow$ germane processing

- Benefits of workplace learning challenged by mismatch in intrinsic load and sources of extraneous load imposed by workplace

- Future work:
  - How can we improve task selection?
  - How can we minimize the impact of extraneous load and time pressures?
Thank you
Help us improve. Your input matters.

- Download the ICRE App, or
- Go to: www.royalcollege.ca/icre-evaluations to complete the session evaluation.

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- Téléchargez l’application de la CIFR
- Visitez le www.collegeroyal.ca/evaluationscifr afin de remplir une évaluation de la séance.

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Vous pourriez participer au tirage d’une inscription gratuite à la CIFR 2020 à Vancouver.
“It's not built in a way that’s conducive, or in a logical way to read an echo… Wall motion is early on [in the report template] and you can only assess wall motion after integrating almost all the views from the entire echocardiogram.” (PGY 4-b)
Sources of cognitive load in the workplace

<table>
<thead>
<tr>
<th>Intrinsic</th>
<th>Extraneous</th>
<th>Germane</th>
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</thead>
<tbody>
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TIME PRESSURES
“… the attendings get to talk about their thought process... how they organize their thinking of why they think this…” (PGY 4-b)

“…And to go over the reason behind it on different images...to give you a better understanding of where you can improve your skills” (AEF-b)
"It's on the onus of the learner to bring uncertainties of their read to the attending and then ask targeted questions" (PGY 4-b)
Teaching and feedback

- Read with attending
- Ask questions
- Obtain feedback independent of attending

“I had this list... and I try and remember patients that I haven’t gone over yet with an attending. I just look back at the formal read.” (PGY 4-c).